PH8151 - Engineering Physics

Dept. of Physics

Multiple Choice Questions (MCQ)

Regulations 2017 (Common to All)

UNIT I PROPERTIES OF MATTER

TOPIC 1.1 ELASTICITY

1. The property by which a body returns to its original shape after removal of the force is called _____
a) Plasticity
b) Elasticity
c) Ductility
d) Malleability

Answer: b
Explanation: When an external force acts on a body, the body tends to undergo some deformation. If the external force is removed and the body comes back to its original shape and size, the body is known as elastic body and this property is called elasticity.

2. The property of a material by which it can be beaten or rolled into thin plates is called _____
a) Malleability
b) Plasticity
c) Ductility
d) Elasticity

Answer: a
Explanation: A material can be beaten into thin plates by its property of malleability.

3. Which law is also called as the elasticity law?
a) Bernoulli's law
b) Stress law
c) Hooke's law
d) Poisson's law

Answer: c
Explanation: The hooke"s law is valid under the elastic limit of a body. It itself states that stress is proportional to the strain within the elastic limit.

4. The materials which have the same elastic properties in all directions are called _____
a) Isotropic
b) Brittle
c) Homogeneous
d) Hard

Answer: a
Explanation: Same elastic properties in all direction is called the homogenity of a material.

5. A member which does not regain its original shape after removal of the load producing deformation is said _____
a) Plastic
b) Elastic
c) Rigid
d) None of the mentioned

Answer: a
Explanation: A plastic material does not

regain its original shape after removal of load. An elastic material regain its original shape after removal of load.

6. The body will regain it is previous shape and size only when the deformation caused by the external forces, is within a certain limit. What is that limit?
a) Plastic limit
b) Elastic limit
c) Deformation limit
d) None of the mentioned

Answer: b
Explanation: The body only regain its previous shape and size only upto its elastic limit.

7. The materials which have the same elastic properties in all directions are called _____
a) Isotropic
b) Brittle
c) Homogenous
d) Hard

Answer: a
Explanation: Isotropic materials have the same elastic properties in all directions.

8. As the elastic limit reaches, tensile strain _____
a) Increases more rapidly
b) Decreases more rapidly
c) Increases in proportion to the stress
d) Decreases in proportion to the stress

Answer: a
Explanation: On reaching the tensile stress to the elastic limit after the proportionality limit, the stress is no longer proportional to the strain. Then the value of strain rapidly increases.

9. What kind of elastic materials are derived from a strain energy density function?
a) Cauchy elastic materials
b) Hypo elastic materials
c) Hyper elastic materials
d) None of the mentioned

Answer: c
Explanation: The hyper elastic materials are derived from a strain energy density function. A model is hyper elastic if and only if it is possible to express the cauchy stress tensor as a function of the deformation gradient.

10. What the number that measures an object's resistance to being deformed elastically when stress is applied to it?
a) Elastic modulus
b) Plastic modulus
c) Poisson's ratio
d) Stress modulus

Answer: a
Explanation: The elastic modulus is the ratio of stress to strain.

TOPIC 1.2 STRESS-STRAIN DIAGRAM AND ITS USES

1. The slope of the stress-strain curve in the elastic deformation region is _____
a) Elastic modulus
b) Plastic modulus
c) Poisson's ratio
d) None of the mentioned

Answer: a
Explanation: The elastic modulus is the ratio of stress and strain. So on the stress strain curve, it is the slope.

2. What is the stress-strain curve?
a) It is the percentage of stress and stain
b) It is the relationship between stress and strain
c) It is the difference between stress and strain
d) None of the mentioned

Answer: b
Explanation: The relationship between stress

and strain on a graph is the stress strain curve. It represents the change in stress with change in strain.

3. Which point on the stress strain curve occurs after the proportionality limit?
a) Upper yield point
b) Lower yield point
c) Elastic limit
d) Ultimate point

Answer: c
Explanation: The curve will be stress strain proportional upto the proportionality limit. After these, the elastic limit will occur.

4. Which point on the stress strain curve occurs after the lower yield point?
a) Yield plateau
b) Upper yield point
c) Ultimate point
d) None of the mentioned

Answer: a
Explanation: The points on the curve comes in the given order,
A. proportionality limit
B. elastic limit
C. upper yield point
D. lower yield point
E. yield plateau
F. ultimate point
G. breaking point.

5. Which point on the stress strain curve occurs after yield plateau?
a) lower yield point
b) Upper yield point
c) Ultimate point
d) Breaking point

Answer: c
Explanation: After the yield plateau the curve will go up to its maximum limit of stress which is its ultimate point.

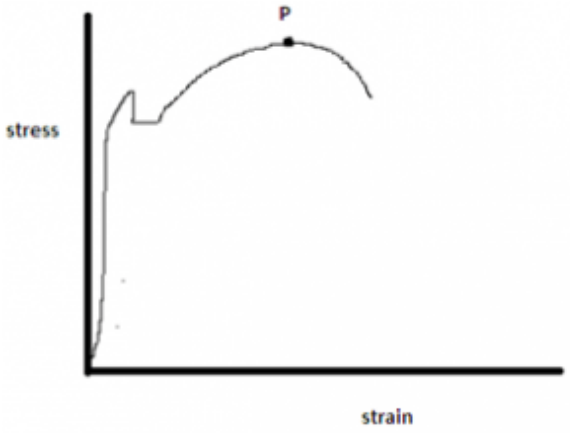
6. Which point on the stress strain curve occurs after the ultimate point?
a) Last point
b) Breaking point
c) Elastic limit
d) Material limit

Answer: b
Explanation: After the ultimate point the value of stress will reduce on increasing of strain and ultimately the material will break.

7. Elastic limit is the point _____
a) up to which stress is proportional to strain
b) At which elongation takes place without application of additional load
c) Up to which if the load is removed, original volume and shapes are regained
d) None of the mentioned

Answer: c
Explanation: The elastic limit is that limit up to which any material behaves like an elastic material.

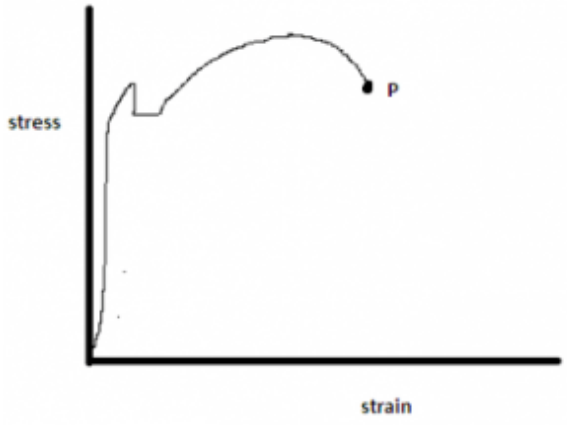
8. What is the point P shown on the stress strain curve?



a) Upper yield point
b) Yield plateau
c) Elastic limit
d) Ultimate point

Answer: d
Explanation: It is the point showing the maximum stress to which the material can be subjected in a simple tensile stress.

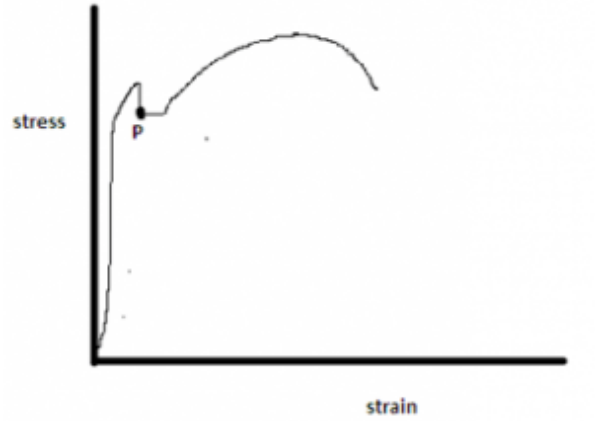
9. What is the point P shown in the stress-strain curve?



a) Lower yield point
b) Elastic limit
c) Proportionality limit
d) Breaking point

Answer: d
Explanation: The breaking point is the point where the material breaks. The breaking point will be the last point on the stress strain curve.

10. What is the point shown in the stress strain curve?



a) Elastic limit
b) Lower yield point
c) Yield plateau
d) Lower strain point

Answer: b
Explanation: It is the lower yield point at which the curve levels off and plastic deformation begins.

11. Where is the necking region?
a) The area between lower yield point and upper yield point
b) The area between the plastic limit and elastic limit
c) The area between the ultimate point and initial point
d) The area between the ultimate point and rupture

Answer: d
Explanation: Necking is a tensile strain deformation which is cased in after the ultimate amount of stress occurs in the material.

TOPIC 1.3 FACTORS AFFECTING ELASTIC MODULUS AND TENSILE STRENGTH

1. What is the elastic modulus of steel?
a) 69-79 GPa
b) 41-45 GPa
c) 190-217 GPa
d) 330-360 GPa

Answer: c
Explanation: Steel has an elastic modulus of 190-217 GPa. It has E higher than aluminum and magnesium alloys. But lower than tungsten and molybdenum alloys.

2. What is the elastic modulus of titanium alloys?
a) 150-170 GPa
b) 180-214 GPa
c) 80-130 GPa
d) 41-45 GPa

Answer: c
Explanation: Titanium alloys have the elastic modulus in the range of 80 to 130 GPa. It is greater than aluminum and magnesium alloys but lesser than steel.

3. What is the order of elastic modulus for Nickel alloys, Lead alloys, Molybdenum alloys, alumina?
a) Pb < Mo < Ni < Al_2O_3
b) Ni < Pb < Mo < Al_2O_3
c) Pb < Ni < Mo < Al_2O_3
d) Pb < Ni < Al_2O_3 < Mo

Answer: c
Explanation: Lowest elastic modulus is of Lead and its alloys of 14-18 GPa. Ni and Mo alloys have elastic modulus of 180-214 and 330-360 GPa respectively. Al_2O_3 has highest E among the four of 415 GPa.

4. What property enhances with a decrease in E?
a) Flexibility
b) Stiffness
c) Hardness
d) UTS

Answer: a
Explanation: The lower the elastic modulus of material, the more flexible it is. Bending of material becomes easier. On the other hand, stiffness decreases.

5. What is the unit of elastic modulus?
a) Mohs
b) GPa
c) Kg
d) N

Answer: b
Explanation: Elastic modulus is expressed in GPa. Mohs is the unit used for hardness. Stress is measured in MPa.

6. When applied stress is of shear type, the modulus of elasticity is known as ___
a) Bulk modulus
b) Modulus of resilience
c) Shear modulus
d) Stiffness

Answer: c
Explanation: When the type of stress applied is shear, E is known as shear modulus. It is also known as modulus of rigidity. Stiffness is measured in terms of E.

7. Which of the following tensile property is dimensionless?
a) Tensile stress
b) Elastic modulus
c) True strain
d) Toughness

Answer: c
Explanation: True strain is dimensionless property. Tensile strength and elastic modulus are measured in MPa and GPa respectively.

8. What is a factor which controls the elastic modulus?
a) Alloying
b) Heat treatment
c) Interatomic forces
d) Cold working

Answer: c
Explanation: On a constant temperature and pressure, E only is function of two factors. First is type of interatomic forces. Second is arrangement of atoms or crystal structure.

9. Stress should not exceed ___ when in service.
a) Yield strength
b) Tensile strength
c) Fracture strength
d) Toughness

Answer: a
Explanation: Above yield strength, material starts to deform plastically. It causes a change in dimensions and properties of a material. So material should be used below it.

10. Stress should not exceed ___ when in mechanical working
a) Yield strength
b) Tensile strength

c) Fracture strength
d) Toughness

Answer: b
Explanation: Mechanical working process consists of plastic deformation. So it is performed above yield strength. But it is limited below tensile strength so as to avoid fracture.

11. Ductility of material is its ability to flow plastically under compressive load.
a) True
b) False

Answer: b
Explanation: Ductility is a tensile property. It is studied under tensile loading. It is the ability to plastic flow without rupture.

12. Work per unit volume of the material is a known modulus of toughness.
a) True
b) False

Answer: a
Explanation: Toughness is measured by the amount of work per unit volume of the material under static loading. Work per unit volume of material is called modulus of toughness.

TOPIC 1.4 TORSIONAL STRESS AND DEFORMATIONS

1. Which of the following cannot be determined using a torsion test?
a) Modulus of elasticity in shear
b) Torsion yield strength
c) Modulus of rupture
d) Young's modulus

Answer: d
Explanation: Modulus of elasticity in shear, torsion yield strength and modulus of rupture can all be determined by performing torsion test on material.

2. What is the use of weight head in a torsion testing equipment?
a) Holding the job only
b) Holding the job and applying twisting moment
c) Holding the job and measuring the twisting moment
d) It is not a part of torsion testing equipment

Answer: c
Explanation: The main job of weight head is to hold the job and measure the twisting moment.while twisting head holds the other end of job and applies twisting moment.

3. Which of the following is used to measure how much the specimen is twisted?
a) Micrometer
b) Clinometer
c) Troptometer
d) Tropometer

Answer: c
Explanation: Troptometer is an instrument which is used for measuring the angular distortion of the material. Mocrometer and vernier callipers are used to measure length. Tropometer measures amount of torsion for a bone.

4. Torsional stress multiplied with original cross sectional are is:
a) Maximum twisting load
b) Minimum twisting load
c) Minimum shear load
d) Yield shear load

Answer: a
Explanation: Torsional stress is given by the ratio of maximum twisting load and original are of cross section of the material. Therefore, torsional stress multiplied with original cross sectional gives us maximum twisting load.

5. Plastic deformation can only occur in case of torsional force.
a) True
b) False

Answer: b
Explanation: The above given statement is false as plastic deformation can occur in case of tensile, compressive and torsional load after a point. After this point, the body cannot recover its original shape.

6. What is the unit of polar moment of inertia?
a) m^2
b) m^5
c) m^3
d) m^4

Answer: d
Explanation: Polar moment of inertia denoted by J, is given by integration of radius square with respect to small area of cross-section. Hence the unit is $(m)(m)(m)^2$ which is equal to m^4.

7. Shear stress on a solid bar and hollow bar is same for given dimension.
a) True
b) False

Answer: b
Explanation: Shear stress for a hollow bar and a solid bar are different dimensions as the hollow bar has two dimensions, outer and inner radius because of which calculation is different than the solid bar which has only one diameter.

8. In which of the following the angle of twist increases fast for a small amount of torque?
a) Cold working condition
b) Hot working condition
c) Warm working condition
d) The increase is the same for cold working, hot working and warm working

Answer: b
Explanation: When the torsion test is conducted in hot working, it is observed that for a slight change in torque on the given specimen the angle of twist increase fast as the material becomes soft at hot working temperature.

TOPIC 1.5 TWISTING COUPLE

1. Torque is _____ moment.
a) Twisting
b) Shear
c) Bending
d) Couple

Answer: a
Explanation: A cylindrical shaft is subjected to twisting moment or torque when a force is acting on the member tangentially at some radius in a plane of its cross section.

2. Twisting moment is a product of _____ and the radius.
a) Direction
b) Velocity
c) Force
d) Acceleration

Answer: c
Explanation: Twisting moment will be equal to the product of force and radius. When a shaft is subjected to a twisting moment, every cross section of the shaft will surely experience shear stress.

3. Torsion is denoted by _____
a) R
b) Q
c) T
d) N

Answer: c
Explanation: If the moment is applied in a plane perpendicular to the longitudinal axis of the beam (or) shaft it will be subjected to torsion. Torsion is represented or denoted by T.

4. The SI units for torsion is _____
a) N m
b) N

c) N/m
d) m

Answer: a
Explanation: As torsion is a product of perpendicular force and radius, the units will be N m.
Torque is also known as torsion or twisting moment or turning moment.

5. _____ torsion is produced when twisting couple coincides with the axis of the shaft.
a) Exact
b) Pure
c) Nominal
d) Mild

Answer: b
Explanation: When a member is subjected to the equal and opposite twisting moment at its ends, then the member is said to be subjected under pure torsion. Pure Torsion is often produced when the axis of the twisting couple coincides with the axis of the shaft.

6. Which of the following is known as Re-entrant mouthpiece?
a) External Mouthpiece
b) Convergent Mouthpiece
c) Internal Mouthpiece
d) Cylindrical Mouthpiece

Answer: c
Explanation: According to the position, mouthpieces are classified as an external mouthpiece and internal mouthpiece. If the tube projects inside the tank, it is called an internal mouthpiece or re-entrant or borda's mouthpiece.

7. Micrometre contraction gauge is used to determine _____
a) Cv
b) Cc
c) Ca
d) Cd

Answer: b
Explanation: The coefficient of contraction may be determined experimentally by measuring the radius of jet as vena contact with the help of micro meter contraction gauge. This method is not accurate because it is very difficult to measure the correct radius of jet.

8. What is the general value for coefficient of contraction?
a) 0.64
b) 0.67
c) 0.66
d) 0.7

Answer: a
Explanation: The ratio of the area of a jet at vena contracta to the area of orifice is known as the coefficient of contraction. The value of Cc varies from 0.61 to 0.69 for different orifices. Generally, for sharp edged orifice the value of Cc may be taken as 0. 64.

9. The Cd value for internal mouthpiece running free is _____
a) 0.6
b) 0.5
c) 0.7
d) 0.8

Answer: b
Explanation: The Cd value for internal mouthpiece running free is 0.5.

Type Of Mouthpiece	Value of Cd
External cylindrical mouthpiece	0.855
Internal mouthpiece running free	0.5
Internal mouthpiece running full	0.707

10. _____ is the velocity with which water reaches the notch or before it flows over it.
a) Velocity of contact
b) Velocity of moment

c) Velocity of approach
d) Velocity of head

Answer: c
Explanation: The velocity of approach is defined as the velocity with which water reaches the notch or weir before it flows over it. This velocity of approach creates an additional head "ha" equal to Va2 / 2g and effect head over the notch is increased to H+ha.

11. Which of the following formula was proposed by Bazin?
a) $m(2g)^{1/2} \times LH^{3/2}$
b) $m(2g)^{1/2} \times H^{3/2}$
c) $n(2g)^{1/2} \times LH^{4/3}$
d) $n(2g)^{1/2} \times LH^{3/2}$

Answer: a
Explanation: Bazin proposed the following formula for the discharge over rectangular weir:
$Q = m(2g)^{1/2} \times L\ H^{3/2}$.
Where m = 0.405 + 0.003/H.

12. For measuring low discharges _____ notch is preferred.
a) Rectangular
b) Stepped
c) Trapezoidal
d) Triangular

Answer: d
Explanation: A triangular notch is preferred to a rectangular notch due to
i. The nappe emerging from a triangular notch has the same shape for all heads. As such the value for the triangular notch is constant for all heads.
ii. The expression for discharge for right angle triangle law not is very simple.

13. Which of the following is also known as V notch?
a) Trapezoidal
b) Stepped
c) Triangular
d) Sharp edged

Answer: c
Explanation: A triangular notch also called a v notch is of triangle shape with apex down. The expression of the discharge over triangular notch or weir is $Q = 8/15\ Cd\ (2g)^{1/2} \times H^{5/2}$.

14. Calculate the discharge over rectangular Weir of 3 metres length under the head of 400mm.Use Francis formula.
a) 1.268 m^3/s
b) 1.396 m^3/s
c) 1.475 m^3/s
d) 1.528 m^3/s

Answer: b
Explanation: Francis formula for discharge
$Q = 1.84\ LH^3/2$.
Given L = 3m & H = 0.4m
$Q = 1.84 \times 3 \times (0.4)^3/2$.
$Q = 1.396\ m^3/s$.

15. _____ converts mechanical energy into hydraulic energy.
a) Dynamo
b) Pump
c) Turbine
d) Generator

Answer: b
Explanation: A pump is a mechanical device which converts the mechanical energy into hydraulic energy. The hydraulic energy is in the form of pressure energy. The pumps are generally used for lifting liquid from a lower level to a higher level.

TOPIC 1.6 TORSION PENDULUM: THEORY AND EXPERIMENT

1. Torsional sectional modulus is also known as _____
a) Polar modulus
b) Sectional modulus
c) Torsion modulus
d) Torsional rigidity

Answer: a
Explanation: The ratio of polar moment of inertia to radius of section is called Polar modulus or Torsional section modulus. Its units are mm^3 or m^3 (in SI).

2. _____ is a measure of the strength of shaft in rotation.
a) Torsional modulus
b) Sectional modulus
c) Polar modulus
d) Torsional rigidity

Answer: c
Explanation: The polar modulus is a measure of the strength of shaft in rotation. As the value of Polar modulus increases torsional strength increases.

3. What are the units of torsional rigidity?
a) Nmm^2
b) N/mm
c) N-mm
d) N

Answer: a
Explanation: The product of modulus of rigidity (C) and polar moment of inertia (J) is called torsional rigidity. Torsional rigidity is a torque that produces a twist of one radian in a shaft of unit length.

4. The angle of twist can be written as _____
a) TL/J
b) CJ/TL
c) TL/CJ
d) T/J

Answer: c
Explanation: The angle of Twist = TL/CJ
Where T = Torque in Nm
L = Length of shaft
CJ = Torsional rigidity.

5. The power transmitted by shaft SI system is given by _____
a) $2\pi NT/60$
b) $3\pi NT/60$
c) $2\pi NT/45$
d) NT/60 W

Answer: a
Explanation: In SI system, Power (P) is measured in watts (W) ; $P = 2\pi NT/60$
Where T = Average Torque in N.m
N = rpm
$= 2\pi NT/ 45$ 1 watt = 1 Joule/sec = 1N.m/s.

6. Area of catchment is measured in _____
a) mm^3
b) Km^2
c) Km
d) mm

Answer: b
Explanation: Catchment area can be defined as the area which contributes the surplus water present over it to the stream or river. It is an area which is responsible for maintaining flow in natural water bodies. It is expressed in square kilometres.

7. _____ catchment area is a sum of free catchment area and intercepted catchment area.
a) Total
b) Additional
c) Combined
d) Overall

Answer: c
Explanation: Combined catchment area is defined as the total catchment area which contributes the water in to stream or a tank. Combined Catchment area = Free catchment area + intercepted catchment area.

8. _____ has steep slopes and gives more run off.
a) Intercepted Catchment Area
b) Good Catchment Area
c) Combined Catchment Area
d) Average Catchment Area

Answer: b
Explanation: Good catchment area consists of hills or rocky lands with steep slopes and little vegetation. It gives more run off.

9. How many number of rain gauge stations should be installed an area between 250 to 500 km^2.
a) 2
b) 4
c) 3
d) 5

Answer: c
Explanation: 3 number of rain gauge stations should be installed an area between 250 to 500 km^2.

Area of Basin(Km^2)	Number of Rain gauge stations
< 125	1
125 – 250	2
250 – 500	3

10. Trend of rainfall can be studied from _____
a) Rainfall graphs
b) Rainfall records
c) Rainfall curves
d) Rainfall cumulatives

Answer: b
Explanation: Rainfall records are useful for calculating run off over a basin. By using rainfall records estimate of design parameters of irrigation structures can be made. The maximum flow due to any storm can be calculated and predicted.

11. Estimation of run off "R" is 0.85P-30.48. The above formula was coined by _____
a) Lacey
b) Darcy
c) Khosla
d) Ingli

Answer: d
Explanation: Run off can be estimated by
R= 0.85P-30.48
Where R = annual runoff in mm
P = annual rainfall in mm.

12. Monsoon duration factor is denoted by _____
a) P
b) S
c) F
d) T

Answer: c
Explanation: Monsoon duration factor is denoted by F.

Class of Monsoon	Monsoon Duration Factor (F)
Very Short	0.5
Standard length	1.0
Very long	1.5

13. Runoff coefficient is denoted by _____
a) P
b) N
c) K
d) H

Answer: c
Explanation: The runoff coefficient can be defined as the ratio of runoff to rainfall. Rainfall and runoff can be interrelated by runoff coefficient.
R = KP
K = R/P [K = is a runoff Coefficient depending on the surface of the catchment area].

14. _____ is a graph showing variations of discharge with time.
a) Rising limb graph

b) Crest graph
c) Hydraulic graph
d) Gauge graph

Answer: c
Explanation: Hydrograph is a graph showing variations of discharge with time at a particular point of the stream. The hydrograph shows the time distribution of total run off at a point of measurement. Maximum flood discharge can also be calculated by using hydrograph.

15. Calculate the torque which a shaft of 300 mm diameter can safely transmit, if the shear stress is 48 N / mm^2.
a) 356 kNm
b) 254 kNm
c) 332 kNm
d) 564 kNm

Answer: b
Explanation: Given, the diameter of shaft D = 300 mm
Maximum shear stress fs = 48 N/mm^2.
Torque = T = $\pi/16$ fs D^3
= 254469004.9 Nmm
= 254 kNm.

TOPIC 1.7 BENDING OF BEAMS. BENDING MOMENT

1. What is the bending moment at end supports of a simply supported beam?
a) Maximum
b) Minimum
c) Zero
d) Uniform

Answer: c
Explanation: At the end supports, the moment (couple) developed is zero, because there is no distance to take the perpendicular acting load. As the distance is zero, the moment is obviously zero.

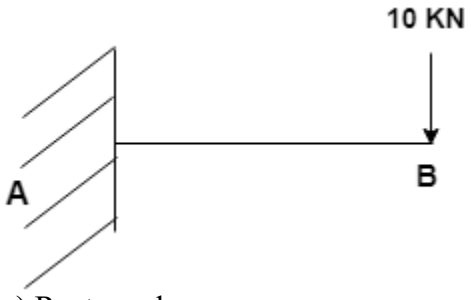
2. What is the maximum shear force, when a cantilever beam is loaded with udl throughout?
a) w×l
b) w
c) w/l
d) w+l

Answer: a
Explanation: In cantilever beams, the maximum shear force occurs at the fixed end. In the free end, there is zero shear force. As we need to convert the udl in to load, we multiply the length of the cantilever beam with udl acting upon. For maximum shear force to obtain we ought to multiply load and distance and it surely occurs at the fixed end (w×l).

3. Sagging, the bending moment occurs at the _____ of the beam.
a) At supports
b) Mid span
c) Point of contraflexure
d) Point of emergence

Answer: b
Explanation: The positive bending moment is considered when it causes convexity downward or concavity at top. This is sagging. In simply supported beams, it occurs at mid span because the bending moment at the supports obviously will be zero hence the positive bending moment occurs in the mid span.

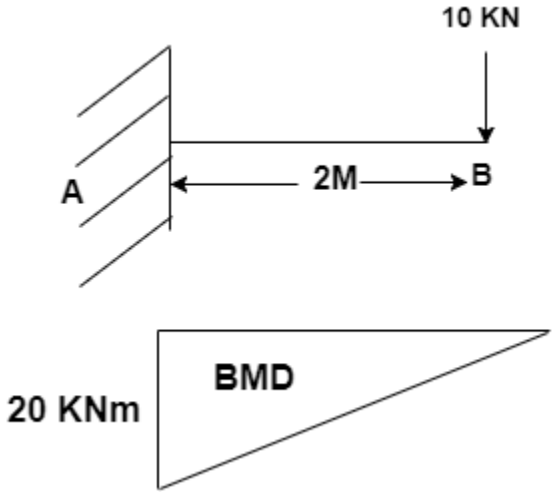
4. What will be the variation in BMD for the diagram? [Assume l = 2m].



a) Rectangular
b) Trapezoidal

c) Triangular
d) Square

Answer: c
Explanation: At support B, the BM is zero. The beam undergoes maximum BM at fixed end.
By joining the base line, free end and maximum BM point. We obtain a right angled triangle.

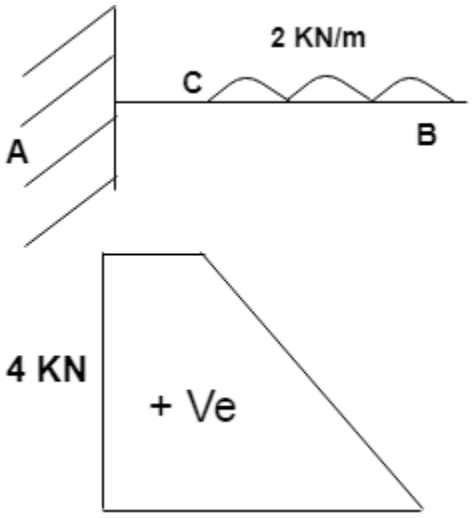


5. What is the maximum bending moment for simply supported beam carrying a point load "W" kN at its centre?
a) W kNm
b) W/m kNm
c) W×l kNm
d) W×l/4 kNm

Answer: d
Explanation: We know that in simply supported beams the maximum BM occurs at the central span.
Moment at A = Moment at B = 0
Moment at C = W/2 × l/2 = Wl/ 4 kNm (Sagging).

6. How do point loads and udl be represented in SFD?
a) Simple lines and curved lines
b) Curved lines and inclined lines
c) Simple lines and inclined lines
d) Cant represent any more

Answer: c
Explanation: According to BIS, the standard symbols used for sketching SFD are
Point load = ———
Udl load = \



7. _____ curve is formed due to bending of over hanging beams.
a) Elastic
b) Plastic
c) Flexural
d) Axial

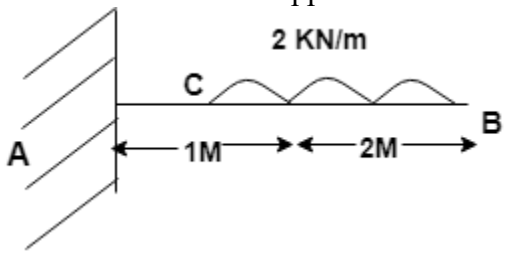
Answer: a
Explanation: The line to which the longitudinal axis of a beam bends or deflects or deviates under given load is known as elastic curve on deflection curve. Elastic curve can also be known as elastic line or elastic axis.

8. The relation between slope and maximum bending moment is _____
a) Directly proportion
b) Inversely proportion
c) Relative proportion
d) Mutual incidence

Answer: b
Explanation: The relationship between slope and maximum bending moment is inversely proportional because, For example in simply supported beams slope is maximum at supports and zero at midspan of a

symmetrically loaded beam where as bending moment is zero at supports and maximum at mid span. Hence we conclude that slope and maximum bending moment are inversely proportional to each other in a case of the simply supported beam.

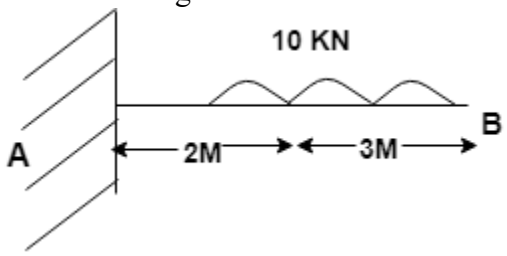
9. What is the SF at support B?



a) 5 kN
b) 3 kN
c) 2 kN
d) 0 kN

Answer: d
Explanation: Total load = 2×2 = 4kN
Shear force at A = 4 kN (same between A and C)
Shear force at C = 4 kN
Shear force at B = 0 kN
Maximum SF at A = 4 kN.

10. Where do the maximum BM occurs for the below diagram.



a) -54 kNm
b) -92 kNm
c) -105 kNm
d) – 65 kNm

Answer: c
Explanation: Moment at B = 0
Moment at C = – (10 × 3) × (3/2)
= – 45 kNm
Moment at A = – (10 × 3) × (1.5 + 2)
Maximum BM at A = – 105 kNm
= 105 Nm (hogging).

TOPIC 1.8 CANTILEVER: THEORY AND EXPERIMENT.

1. The ratio of maximum deflection of a beam to its _____ is called stiffness of the beam.
a) Load
b) Slope
c) Span
d) Reaction at the support

Answer: c
Explanation: The stiffness of a beam is a measure of it's resistance against deflection. The ratio of the maximum deflection of a beam to its span can be termed as stiffness of the beam.

2. Stiffness of the beam is inversely proportional to the _____ of the beam.
a) Slope
b) Support reaction
c) Deflection
d) Load

Answer: c
Explanation: Stiffness of a beam is inversely proportional to the deflection. Smaller the deflection in a beam due to given external load, greater is its stiffness.

3. The maximum ____ should not exceed the permissible limit to the span of the beam.
a) Slope
b) Deflection
c) Load
dl Bending moment

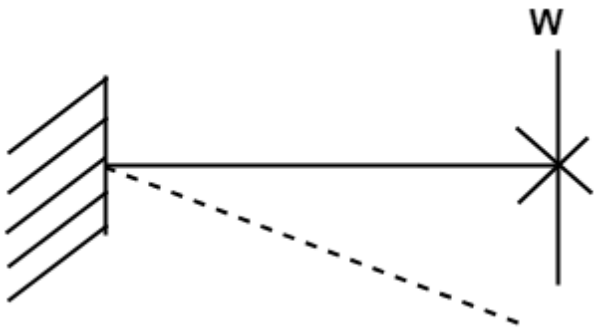
Answer: b
Explanation: The maximum deflection of a loaded beam should not exceed the permissible limit in relation to the span of a beam. While designing the beam the designer

should be keep in mind that both strength and stiffness criteria.

4. In cantilever beam the deflection occurs at _____
a) Free end
b) Point of loading
c) Through out
d) Fixed end

Answer: a
Explanation: Deflection can be defined as the perpendicular displacement of a point on straight access to the curved axis. In cantilever beams, the maximum deflection occurs at free end.

5. The maximum deflection in cantilever beam of span "l"m and loading at free end is "W" kN.



a) $Wl^3/2EI$
b) $Wl^3/3EI$
c) $Wl^3/4EI$
d) $Wl^2/2EI$

Answer: b
Explanation: Maximum deflection occurs at free end distance between centre of gravity of bending moment diagram and free end is x = 2l/3.
As deflection is equal to the slope × "x". The slope = Wl2/2EI radians
Maximum deflection (y) = Ax/EI = $Wl^3/3EI$.

6. In an ideal fluid, the _____ stresses are pretend to be absent.
a) Bending
b) Shearing
c) Tensile
d) Compressive

Answer: b
Explanation: An ideal fluid is a fluid where there is no resistance to the deformation. Ideal Fluids are those Fluids which have no viscosity surface tension. The shear stress is also absent. This fluid is also called as perfect fluid.

7. Air and water are the examples of _____
a) Non Newtonian fluids
b) Vortex fluids
c) Real fluids
d) Ideal fluids

Answer: d
Explanation: The ideal Fluids are imaginary fluids in nature, they are incompressible. These fluids possess low viscosity. Air and water are considered as ideal fluids.

8. _____ fluids are practical fluids
a) Ideal
b) Real
c) Vortex
d) Newtonian

Answer: b
Explanation: These fluids possess properties such as viscosity, surface tension. They are compressible in nature. The certain amount of resistance is always offered by the fluids, they also possess shear stress. They are also known as practical fluids.

9. Specific weight of water at 4°C is _____ N/m^3.
a) 9810
b) 9760
c) 9950
d) 9865

Answer: a
Explanation: The specific weight (weight density) of a fluid is weight per unit volume.

It is represented by symbol w & it is expressed in Newton per metre cube (N/m^3). The specific weight of water at 4 degree centigrade is 9810 N/m3or 9.81 kN/m^3.

10. The inverse of specific weight of a fluid is _____
a) Specific gravity
b) Specific Volume
c) Compressibility
d) Viscosity

Answer: b
Explanation: Specific volume is the volume of the fluid by Unit Weight it is the reciprocal of specific weight is denoted by "v". SI units are m^3/N.
v= 1/specific weight.

11. Calculate the specific gravity of mercury.
a) 12.5
b) 14.7
c) 13.6
d) 11.8

Answer: c
Explanation: The specific gravity of any fluid is the ratio of the specific weight of fluid by specific weight of water. For mercury, the specific weight is 133416 N/m^3. For water, w = 9810 N/m^3.
S = 133416/9810
S= 13.6.

12. Specific gravity of water is _____
a) 0.8
b) 1
c) 1.2
d) 1.5

Answer: b
Explanation: The specific gravity is also called as relative density. It is dimensionless quantity and it has no units. The specific gravity of water is the ratio of specific weight of fluid to specific weight of water, as both the numerator and denominator are same. The value is 1.

13. Compute the maximum deflection at free end of a cantilever beam subjected to udl for entire span of l metres.
a) $wl^4/8EI$
b) $wl^4/4EI$
c) $wl^3/8EI$
d) $wl^2/6EI$

Answer: a
Explanation: The slope at free end = A/EI = $wl^3/6EI$
Maximum deflection at free end is Ax/EI; [x= ¾ l] y= $wl^3/6EI \times ¾\ l = wl^4/8EI$.

14. Calculate the maximum deflection of a cantilever beam with udl on entire span of 3m the intensity of you udl be 25 kN/m. Take EI as 4000 kN/m^2.
a) 0.052m
b) 0.063m
c) 0.076m
d) 0.09m

Answer: b
Explanation: For cantilever beams with udl on entire span, the maximum deflection = $wl^4/8EI$
$y = wl^4/8EI = 25 \times 3^4/ 8 \times 4000 = 0.063m$.

15. Which of the following is not an example of Malleability?
a) Wrought Iron
b) Ornamental silver
c) Torsteel
d) Ornamental gold

Answer: c
Explanation: Torsteel is an example of mechanical property ductility. The ductility is a property of a material by which material can be fractured into thin wires after undergoing a considerable deformation without any rupture.

TOPIC 1.9 UNIFORM AND NON-UNIFORM BENDING: THEORY AND EXPERIMENT

TOPIC 1.10 I-SHAPED GIRDERS

1. A beam section is provided on the basis of (i) section modulus, (ii) deflection, (iii) shear
a) i, ii
b) ii, iii
c) i, iii
d) i, ii and iii

Answer: d
Explanation: A beam section is provided on the basis of (i) section modulus, (ii) deflection, (iii) shear. The beam should be economical with furnishing required modulus of section.

2. Which of the following is not correct?
a) Angles and T section are strong in bending
b) Channels can be used only for light loads
c) I sections are most efficient and economical shapes
d) I section with cover plates are provided when large section modulus is required

Answer: a
Explanation: Angles and T section are weak in bending. Channels can be used only for light loads. I sections (rolled and built-up) are most efficient and economical shapes. I section with cover plates are provided when large section modulus is required. Generally, ISLB or ISMB are provided in such cases.

3. Local buckling can be prevented by
a) limiting width-thickness ratio
b) increasing width-thickness ratio
c) changing material
d) changing load on member

Answer: c
Explanation: Local buckling of compression members of beam causes loss of integrity of beam cross section. It is a function of width-thickness ratio and can be prevented by limiting width-thickness ratio.

4. Which of the following is true?
a) in case of rolled section, less thickness of plate is adopted to prevent local buckling
b) for built-up section and cold formed section, longitudinal stiffeners are not provided to reduce width to smaller sizes
c) local buckling cannot be prevented by limiting width-thickness ratio
d) in case of rolled section, high thickness of plate is adopted to prevent local buckling

Answer: d
Explanation: In case of rolled section, higher thickness of plate is adopted to prevent local buckling. Local buckling cannot be prevented by limiting width-thickness ratio. For built-up section and cold formed section, longitudinal stiffeners are provided to reduce width to smaller sizes.

5. Which of the following is not true?
a) only plastic section can be used in intermediate frames
b) slender sections are preferred in hot rolled structural steelwork
c) compact sections can be used in simply supported beams
d) semi-compact sections can be used for elastic designs

Answer: b
Explanation: Only plastic section can be used in intermediate frames which form collapse mechanism. Compact sections can be used in simply supported beams which fail after reaching Mp at one section. Semi-compact sections can be used for elastic designs where section fails after reaching My at extreme fibres. Slender sections are not preferred in hot rolled structural steelwork, but they are extensively used in cold formed members.

6. As per IS specification, the beam sections should be
a) not symmetrical about any principal axes
b) at least symmetrical about one of the principal axes
c) symmetrical about all principal axes
d) unsymmetrical about all principal axes

Answer: b
Explanation: The beam sections should be at least symmetrical about one of the principal axes as per IS specification. Angle and T-sections are inherently weak in bending while channels can only be used for light loads. Rolled I0section is generally preferred as beam.

7. Which of the following is the design criteria for beams?
(i) Strength in bending (ii) stiffness (iii)economy
a) ii only
b) i and iii
c) ii and iii
d) i, ii and iii

Answer: d
Explanation: Beams should be proportioned for strength in bending keeping in view the lateral and local stability of compression flange. beam should have adequate strength to resist applied bending moments and accompanying shear forces. Beams should be proportioned for stiffness, keeping in mind the deflections and deformations under service condition. Beams should be proportioned for economy. Member should be safe against buckling.

8. Which of the following is not true?
a) for optimum bending resistance, beam material should be near neutral axis
b) for optimum bending resistance, beam material should be far away from neutral axis
c) for optimum bending resistance, web area of beam has to be adequate for resisting shear
d) maximum bending and maximum shear usually occur at different cross section

Answer: a
Explanation: For optimum bending resistance, beam material should be far away from neutral axis and web area of beam has to be adequate for resisting shear. Maximum bending and maximum shear usually occur at different cross section. in continuous beams, they may occur at same cross section near interior supports, but interaction effects are normally neglected.

TOPIC 1.11 STRESS DUE TO BENDING IN BEAMS.

1. A beam is said to be of uniform strength, if _____
a) B.M. is same throughout the beam
b) Shear stress is the same through the beam
c) Deflection is the same throughout the beam
d) Bending stress is the same at every section along its longitudinal axis

Answer: d
Explanation: Beam is said to be uniform strength if at every section along its longitudinal axis, the bending stress is same.

2. Stress in a beam due to simple bending is _____
a) Directly proportional
b) Inversely proportional
c) Curvilinearly related
d) None of the mentioned

Answer: a
Explanation: The stress is directly proportional to the load and here the load is in terms of bending. So the stress is directly proportional to bending.

3. Which stress comes when there is an eccentric load applied?
a) Shear stress
b) Bending stress
c) Tensile stress
d) Thermal stress

Answer: b
Explanation: When there is an eccentric load it means that the load is at some distance from the axis. This causes compression in one side and tension on the other. This causes bending stress.

4. What is the expression of the bending equation?
a) M/I = σ/y = E/R
b) M/R = σ/y = E/I
c) M/y = σ/R = E/I
d) M/I = σ/R = E/y

Answer: a
Explanation: The bending equation is given by M/I = σ/y = E/R
where
M is the bending moment
I is the moment of inertia
y is the distance from neutral axis
E is the modulus of elasticity
R is the radius.

5. On bending of a beam, which is the layer which is neither elongated nor shortened?
a) Axis of load
b) Neutral axis
c) Center of gravity
d) None of the mentioned

Answer: b
Explanation: When a beam is in bending the layer in the direction of bending will be In compression and the other will be in tension. One side of the neutral axis will be shortened and the other will be elongated.

6. The bending stress is _____
a) Directly proportional to the distance of layer from the neutral layer
b) Inversely proportional to the distance of layer from the neutral layer
c) Directly proportional to the neutral layer
d) Does not depend on the distance of layer from the neutral layer

Answer: a
Explanation: From the bending equation M/I = σ/y = E/R
Here stress is directly proportional to the distance of layer from the neutral layer.

7. Consider a 250mmx15mmx10mm steel bar which is free to expand is heated from 15C to 40C. what will be developed?
a) Compressive stress
b) Tensile stress
c) Shear stress
d) No stress

Answer: d
Explanation: If we resist to expand then only stress will develop. Here the bar is free to expand so there will be no stress.

8. The safe stress for a hollow steel column which carries an axial load of 2100 kN is 125 MN/m^2. if the external diameter of the column is 30cm, what will be the internal diameter?
a) 25 cm
b) 26.19cm
c) 30.14 cm
d) 27.9 cm

Answer: b
Explanation: Area of the cross section of column = $\pi/4\ (0.30^2 - d^2)\ m^2$
Area = load / stress.
So, $\pi/4\ (0.30^2 - d^2)\ m^2 = 21 / 125$
d = 26.19cm.

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UNIT II WAVES AND FIBER OPTICS

TOPIC 2.1 OSCILLATORY MOTION

1. The motion of the earth about its axis is periodic and simple harmonic.
a) True
b) False

Answer: b
Explanation: The earth takes 24 hours to complete its rotation about its axis, but the concept of to and fro motion is absent, and hence the rotation of the earth is periodic and not simple harmonic.

2. An object of mass 0.2kg executes simple harmonic motion along the x-axis with a frequency of (25/π)Hz. At the position x = 0.04, the object has kinetic energy of 0.5J and potential energy 0.4J. The amplitude of oscillation is?
a) 6cm
b) 4cm
c) 8cm
d) 2cm

Answer: a
Explanation: Total energy,
$E=2\pi^2 mv^2 A^2$
$0.5+0.4=2\pi^2\times0.2\times(25/\pi)^2 A^2$
$A^2=0.9/(0.4\times25^2)$
$A=3/(2\times25)=3/50$ m=6cm.

3. A spring of force constant 800N/m has an extension of 5cm. The work done in extending it from 5cm to 15cm is?
a) 8J
b) 16J
c) 24J
d) 32J

Answer: a
Explanation: At x_1 = 5 cm,
$U_1=1/2\times k(x_1)^2=1/2\times800\times0.05^2=1J$
At x_2=15cm,
$U_2=1/2\times k(x_2)^2=1/2\times800\times0.15^2=9J$
$W=U_2-U_1=9-1=8J$.

4. A simple pendulum is attached to the roof of a lift. If the time period of oscillation, when the lift is stationary is T, then the frequency of oscillation when the lift falls freely, will be _____
a) Zero
b) T
c) 1/T
d) ∞

Answer: a
Explanation: In a freely falling lift,
g=0
$v=1/2\pi\times\sqrt{(g/l)}=1/2\pi\times\sqrt{(0/l)}=0$.

5. There is a simple pendulum hanging from the ceiling of a lift. When the lift is standstill, the time period of the pendulum is T. If the resultant acceleration becomes g/4, then the new time period of the pendulum is?
a) 0.8T
b) 0.25T
c) 2T
d) 4T

Answer: c
Explanation: $T=2\times\sqrt{(l/g)}$
$T'=2\pi\times\sqrt{((l/g)/4)}$
$T'=2T$.

6. A lightly damped oscillator with a frequency v is set in motion by a harmonic driving force of frequency v'. When v' is lesser than v, then the response of the oscillator is controlled by _____
a) Spring constant
b) Inertia of the mass
c) Oscillator frequency
d) Damping coefficient

Answer: a
Explanation: Frequency of driving force is lesser than frequency v of a damped oscillator. The vibrations are nearly in phase

with the driving force and response of the oscillator is controlled by spring constant.

7. Statement: In simple harmonic motion, the velocity is maximum, when the acceleration is minimum.
Reason: Displacement and velocity in simple harmonic motion is differ in phase by π/2.
a) Both statement and reason are true and the reason is the correct explanation of the statement
b) Both statement and reason are true but the reason is not the correct explanation of the statement
c) Statement is true, but the reason is false
d) Statement and reason are false

Answer: b
Explanation: Both statement and reason are true but the reason is not the correct explanation of the statement, In fact, the phase difference between velocity and acceleration is π/2.

8. What is the time period of a pendulum hanged in a satellite? (T is the time period on earth)
a) Zero
b) T
c) Infinite
d) T/√6

Answer: c
Explanation: In a satellite, g= 0
$T=2\pi\sqrt{(l/g)}=2\pi\sqrt{(l/0)}=\infty$.

9. Which of the following functions represents a simple harmonic oscillation?
a) sinωt-cosωt
b) sinωt+sin2ωt
c) sinωt-sin2ωt
d) $\sin^2 \omega t$

Answer: a
Explanation: y=sinωt-cosωt
dy/dt=ωcosωt+ωsinωt
$(d^2 y)/dt^2 = -\omega^2 \sin\omega t+\omega^2 \cos\omega t$
$=-\omega^2 (\sin\omega t-\cos\omega t)$
$a=-\omega^2 y$ that is $a\propto y$
This satisfies the condition of simple harmonic motion.

10. The displacement of a simple harmonic motion doing oscillation when kinetic energy = potential energy (amplitude = 4cm) is?
a) 2√2cm
b) 2cm
c) 1/√2 cm
d) √2 cm

Answer: a
Explanation: When kinetic energy = potential energy,
y=a/√2=4/√2=2√2 cm.

TOPIC 2.2 FORCED AND DAMPED OSCILLATIONS: DIFFERENTIAL EQUATION AND ITS SOLUTION

TOPIC 2.3 PLANE PROGRESSIVE WAVES

1. The ratio of velocity of sound in hydrogen and oxygen at STP is _____
a) 16:1
b) 8:1
c) 4:1
d) 2:1

Answer: c
Explanation: $v_H/v_O = \sqrt{(M_O/M_H)}$
$=\sqrt{(32/2)}=4:1$.

2. It takes 2 seconds for a sound wave to travel between two fixed points when the day temperature is 10°C. If the temperature rises to 30°C, the sound wave travels between the same fixed parts in _____
a) 1.9s
b) 2s
c) 2.1s
d) 2.2s

Answer: a
Explanation: $v \propto \sqrt{T}$
$t \propto 1/v$
$t \propto 1/\sqrt{T}$
$t_2/t_1 =$
$\sqrt{(T_1/T_2)}=\sqrt{((273+10)/(273+30))}=\sqrt{(283/303)}$
$t_2=\sqrt{(283/303)}\times 2s=1.9s.$

3. The disc of a siren containing 60holes rotates at a constant speed of 360rpm. The emitted sound is in unison with a tuning fork of frequency.
a) 10Hz
b) 360Hz
c) 216Hz
d) 60Hz

Answer: b
Explanation: Frequency of revolution of disc=360rpm=360/60rps=60rps
Frequency of emitted sound=6×No.of holes =6×60=360Hz.

4. The quantity which does not change, when sound enters from one medium to another _____
a) Wavelength
b) Speed
c) Frequency
d) Velocity

Answer: c
Explanation: Frequency remains unchanged when sound travels from one medium to another.

5. The equation of a simple harmonic wave is given by
$y=5\sin(\pi/2)\ (100t-x)$
Where x and y are in metre and time is in second. The period of the wave in second will be _____
a) 0.04
b) 0.01
c) 1
d) 5

Answer: a
Explanation: $y=5\sin(\pi/2)\ (100t-x)$
$y=A\sin(\omega t-kx)$
$\omega=2\pi/T=\pi/2\times 100$
$T=2/50=0.04s.$

6. If wave $y=A\cos(\omega t+kx)$ Is moving along x-axis, the shapes of a pulse at t=0 and t=2s.
a) Are different
b) Are same
c) May not be the same
d) Unpredictable

Answer: b
Explanation: The shapes of y-x graph remains the same at t=0 and t=2s.

7. $y_1=4\sin(\omega t+kx)$, $y_2=-4\cos(\omega t+kx)$, the phase difference is _____
a) $\pi/2$
b) $3\pi/2$
c) π
d) Zero

Answer: b
Explanation: $y_1=4\sin(\omega t+kx)$
$y_2=-4\cos(\omega t+kx)$
$=-4\sin(\omega t+kx+3\pi/2)$
$\Delta\varphi=3\pi/2.$

8. A wave equation is $y=0.1\sin[100\pi t-kx]$ and wave velocity is 100m/s, its number is equal to _____
a) 1/m
b) 2/m
c) π/m
d) 2π/m

Answer: c
Explanation: $y=0.1\sin[100\pi t-kx]$
$y=A\sin(\omega t-kx)$
$\omega=100\pi$
Wave number$=\omega/v=100\pi/100=\pi/m.$

9. A particle on the trough of a wave at any instant will come to the mean position after a time (T=time period).
a) T/2

b) T/4
c) T
d) 2T

Answer: b
Explanation: Time taken by a particle to move from trough to the mean position=T/4.

10. A string is tied on a sonometer, second end is hanging downward through a pulley with tension T. The velocity of the transverse wave produced is proportional to _____
a) $1/\sqrt{T}$
b) $\sqrt{T}$
c) T
d) 1/T

Answer: b
Explanation: $v=\sqrt{(T/m)}$
$v \propto \sqrt{T}$.

11. The fundamental frequency of a sonometer wire is n. If the tension is made 3 times and length and diameter are also increased 3 times, the new frequency will be _____
a) 3n
b) $n/3\sqrt{3}$
c) n/3
d) $\sqrt{3}$ n

Answer: b
Explanation: $n=1/LD\times\sqrt{(T/\pi\rho)}$
$n'=1/(3L\times3D)\times\sqrt{(3T/\pi\rho)}=\sqrt{3}/9\times n=1/(3\sqrt{3})$ n.

TOPIC 2.4 WAVE EQUATION. LASERS : POPULATION OF ENERGY LEVELS, EINSTEIN'S A AND B COEFFICIENTS DERIVATION

1. Which of the following is the correct expression for the relation between Einstein's coefficients A and B?
a) $\frac{8\pi v^3 h}{c^3}$
b) $\frac{8\pi v^2 h}{c^3}$
c) $\frac{8\pi v^2 h}{c^2}$
d) $\frac{8\pi h v}{c^3}$

Answer: a
Explanation: The expression $\frac{8\pi v^3 h}{c^3}$ is the correct expression for the relation between the two Einstein's coefficients. This expression is known as the Einstein's relation.

2. What is the relationship between B_{21} and B_{12}?
a) $B_{12} > B_{21}$
b) $B_{12} < B_{21}$
c) $B_{12} = B_{21}$
d) No specific relation

Answer: c
Explanation: B_{21} is the coefficient for the stimulated emission while B_{12} is the coefficient for stimulated absorption. Both the processes are mutually reverse processes and their probabilities are equal. Therefore, $B_{12} = B_{21}$.

3. Which of the following Einstein's coefficient represents spontaneous emission?
a) A_{12}
b) A_{21}
c) B_{12}
d) B_{21}

Answer: b
Explanation: A_{21} represents the spontaneous emission of photons. A_{12} signifies spontaneous absorption.B_{12} is for stimulated absorption while B_{21} is for stimulated emission.

4. The correct expression for the rate of stimulated emission is _____
a) $R_{se} = A_{21}N_2$
b) $R_{se} = A_{21}uN_2$

c) $R_{se} = B_{21}N_2$
d) $R_{se} = B_{21}uN_2$

Answer: d
Explanation: The stimulates emission is directly proportional to the energy density u, of the external radiation field. Also, stimulated emission rate increases with the increase in number N_2 of exited atoms.

5. Which law is used for achieving the relation between the Einstein's coefficients?
a) Heisenberg's Uncertainty Principle
b) Planck's radiation law
c) Einstein's equation
d) Quantum law

Answer: b
Explanation: Planck's radiation law, which gives the energy density $u = \frac{8\pi h v^3}{c^3}\frac{1}{e^{\alpha}-1}$, is used as the formula resembles the one for the energy density of the external radiation field in stimulated emission, $u = \frac{A_{21}}{B_{21}(\frac{B_{12}}{B_{21}}e^{\alpha}-1)}$.

6. The probability of spontaneous emission increases rapidly with the energy difference between the two states.
a) True
b) False

Answer: a
Explanation: From Einstein's relation we know that the ratio of Einstein's coefficients is $\frac{8\pi v^3 h}{c^3}$. Thus, the ration of Einstein's coefficients is proportional to the cube of the frequency. Hence, the probability of spontaneous emission increases rapidly with the energy difference between the two states.

7. If the frequency of emitted photon is 10 Hz, the ratio of Einstein's coefficient is

a) $2.177 \text{ X } 10^{-51}$
b) $3.177 \text{ X } 10^{-51}$
c) $5.177 \text{ X } 10^{-51}$
d) $6.177 \text{ X } 10^{-51}$

Answer: d
Explanation: We know Einstein's relation = $\frac{8\pi v^3 h}{c^3}$
v = 10 Hz, h = $6.63 \text{ X } 10^{-34}$ Js, c = $3 \text{ X } 10^8$m/s
Therefore, the ratio of Einstein's coefficients is: $6.177 \text{ X } 10^{-51}$.

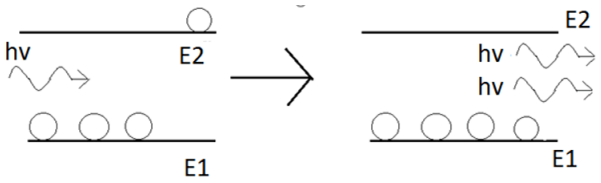
8. What is the unit of the coefficient of spontaneous emission?
a) s^{-1}
b) s
c) J^{-1}
d) J

Answer: a
Explanation: For spontaneous emission, the expression for the rate is = $A_{21}N_2$, where N_2 is the number of particles in exited state. As the unit of rate is Number of particles per second, the unit of A_{21} is s^{-1}.

9. What is the unit for the coefficient of stimulated emission?
a) s^{-2}
b) $m^3 s^{-2}$
c) $J^{-1} m^3$
d) $J^{-1} m^3 s^{-2}$

Answer: d
Explanation: For stimulated emission, the expression for the rate is $B_{21}uN_2$ where u stands for the energy density and N is the number of exited atoms. Therefore, the unit of B turns out to be $J^{-1} m^3 s^{-2}$.

10. Which Einstein's coefficient should be used in this case?



a) A_{12}
b) A_{21}
c) B_{12}
d) B_{21}

Answer: d
Explanation: The given figure shows stimulated emission. Hence, the Einstein coefficient for stimulated emission is B_{21}. If it had been spontaneous emission, then A_{21} would have been used.

TOPIC 2.5 RESONANT CAVITY, OPTICAL AMPLIFICATION (QUALITATIVE)

1. A cylindrical cavity resonator can be constructed using a circular waveguide.
a) shorted at both the ends
b) open at both the ends
c) matched at both the ends
d) none of the mentioned

Answer: a
Explanation: A cylindrical cavity resonator is formed by shorting both the ends of the cylindrical cavity because open ends may result in radiation losses in the cavity.

2. The dominant mode in the cylindrical cavity resonator is TE_{101} mode.
a) true
b) false

Answer: b
Explanation: The dominant mode of propagation in a circular waveguide is TE_{111} mode. Hence, the dominant mode of resonance in a cylindrical cavity made of a circular waveguide is TE_{111} mode. In a cylindrical resonator, the mode of propagation depends on the length of the cavity.

3. Circular cavities are used for microwave frequency meters.
a) true
b) false

Answer: a
Explanation: Circular cavities are used for microwave frequency meters. The cavity is constructed with a movable top wall to allow the mechanical tuning of the resonant frequency.

4. The mode of the circular cavity resonator used in frequency meters is:
a) TE_{011} mode
b) TE_{101} mode
c) TE_{111} mode
d) TM_{111} mode

Answer: a
Explanation: Frequency resolution of a frequency meter is determined from its quality factor. Q factor of TE_{011} mode is much greater than the quality factor of the dominant mode of propagation.

5. The propagation constant of TEmn mode of propagation for a cylindrical cavity resonator is:
a) $\sqrt{(k^2-(p_{nm}/a)^2)}$
b) $\sqrt{p_{nm}/a}$
c) $\sqrt{(k^2+(p_{nm}/a)^2)}$
d) none of the mentioned

Answer: a
Explanation: The propagation constant for a circular cavity depends on the radius of the cavity, and the wave number. If the mode of propagation is known and the dimension of the cavity is known then the propagation constant can be found out.

6. A circular cavity resonator is filled with a dielectric of 2.08 and is operating at 5GHz of frequency. Then the wave number is:
a) 181
b) 151
c) 161
d) 216

Answer: b
Explanation: Wave number for a circular cavity resonator is given by the expression $2\pi f_{011}\sqrt{\in_r}/C$. substituting the given values in the above expression; the wave number of the cavity resonator is 151.

7. Given that the wave number of a circular cavity resonator is 151 (TE_{011} mode), and the length of the cavity is twice the radius of the cavity, the radius of the circular cavity operating at 5GHz frequency is:
a) 2.1 cm
b) 1.7 cm
c) 2.84 cm
d) insufficient data

Answer: d
Explanation: For a circular cavity resonator, wave number is given by $\sqrt{((p_{01}/a)^2 + (\pi/d)^2)}$. P_{01} for the given mode of resonance is 3.832. Substituting the given values the radius of the cavity is 2.74 cm.

8. The loss tangent for a circular cavity resonator is 0.0004.Then the unloaded Q due to dielectric loss is:
a) 1350
b) 1560
c) 560
d) 2500

Answer: d
Answer: Unloaded Q due to the dielectric loss in a circular cavity resonator is the reciprocal of the loss tangent. Hence, taking the reciprocal of the loss tangent, unloaded Q due to dielectric loss is 2500.

9. A circular cavity resonator has a wave number of 151, radius of 2.74 cm, and surface resistance of 0.0184Ω. If the cavity is filled with a dielectric of 2.01, then unloaded Q due to conductor loss is:
a) 25490
b) 21460
c) 29390
d) none of the mentioned

Answer: c
Explanation: Unloaded Q of a circular resonator due to conductor loss is given by $ka/2R_s$. is the intrinsic impedance of the medium. Substituting the given values in the equation for loaded Q, value is 29390.

10. If unloaded Q due to conductor loss and unloaded Q due to dielectric loss is 29390 and 2500 respectively, then the total unloaded Q of the circular cavity is:
a) 2500
b) 29390
c) 2300
d) 31890

Answer: c
Explanation: The total unloaded Q of a circular cavity resonator is given by the expression $(Q_c^{-1} + Q_d^{-1})^{-1}$. Substituting the given values in the above expression, the total unloaded Q for the resonator is 2300.

TOPIC 2.6 SEMICONDUCTOR LASERS: HOMOJUNCTION AND HETEROJUNCTION

1. A perfect semiconductor crystal containing no impurities or lattice defects is called as

_____
a) Intrinsic semiconductor
b) Extrinsic semiconductor
c) Excitation
d) Valence electron

Answer: a
Explanation: An intrinsic semiconductor is usually un-doped. It is a pure semiconductor. The number of charge carriers is determined by the semiconductor material properties and not by the impurities.

2. The energy-level occupation for a semiconductor in thermal equilibrium is described by the _____
a) Boltzmann distribution function
b) Probability distribution function
c) Fermi-Dirac distribution function
d) Cumulative distribution function

Answer: c
Explanation: For a semiconductor in thermal equilibrium, the probability P(E) that an electron gains sufficient thermal energy at an absolute temperature so as to occupy a particular energy level E, is given by the Fermi-Dirac distribution. It is given by-
$P(E) = 1/(1+\exp(E-E_F/KT))$
Where K = Boltzmann constant, T = absolute temperature, E_F = Fermi energy level.

3. What is done to create an extrinsic semiconductor?
a) Refractive index is decreased
b) Doping the material with impurities
c) Increase the band-gap of the material
d) Stimulated emission

Answer: b
Explanation: An intrinsic semiconductor is a pure semiconductor. An extrinsic semiconductor is obtained by doping the material with impurity atoms. These impurity atoms create either free electrons or holes. Thus, extrinsic semiconductor is a doped semiconductor.

4. The majority of the carriers in a p-type semiconductor are _____
a) Holes
b) Electrons
c) Photons
d) Neutrons

Answer: a
Explanation: The impurities can be either donor impurities or acceptor impurities. When acceptor impurities are added, the excited electrons are raised from the valence band to the acceptor impurity levels leaving positive charge carriers in the valence band. Thus, p-type semiconductor is formed in which majority of the carriers are positive i.e. holes.

5. _____ is used when the optical emission results from the application of electric field.
a) Radiation
b) Efficiency
c) Electro-luminescence
d) Magnetron oscillator

Answer: c
Explanation: Electro-luminescence is encouraged by selecting an appropriate semiconductor material. Direct band-gap semiconductors are used for this purpose. In band-to-band recombination, the energy is released with the creation of photon. This emission of light is known as electroluminescence.

6. In the given equation, what does p stands for?

$p = 2\pi\hbar k$

a) Permittivity
b) Probability
c) Holes
d) Crystal momentum

Answer: d
Explanation: The given equation is a relation of crystal momentum and wave vector. In the given equation, h is the Planck's constant, k is the wave vector and p is the crystal momentum.

7. The recombination in indirect band-gap semiconductors is slow.

a) True
b) False

Answer: a
Explanation: In an indirect band-gap semiconductor, the maximum and minimum energies occur at different values of crystal momentum. However, three-particle recombination process is far less probable than the two-particle process exhibited by direct band-gap semiconductors. Hence, the recombination in an indirect band-gap semiconductor is relatively slow.

8. Calculate the radioactive minority carrier lifetime in gallium arsenide when the minority carriers are electrons injected into a p-type semiconductor region which has a hole concentration of $10^{18}cm^{-3}$. The recombination coefficient for gallium arsenide is $7.21*10^{-10}cm^3s^{-1}$.
a) 2ns
b) 1.39ns
c) 1.56ns
d) 2.12ms

Answer: b
Explanation: The radioactive minority carrier lifetime ςrconsidering the p-type region is given by-
$ς_r = [B_rN]^{-1}$ where Br = Recombination coefficient in cm^3s^{-1} and N = carrier concentration in n-region.

9. Which impurity is added to gallium phosphide to make it an efficient light emitter?
a) Silicon
b) Hydrogen
c) Nitrogen
d) Phosphorus

Answer: c
Explanation: An indirect band-gap semiconductor may be made into an electro-luminescent material by the addition of impurity centers which will convert it into a direct band-gap material. The introduction of nitrogen as an impurity into gallium phosphide makes it an effective emitter of light. Such conversion is only achieved in materials where the direct and indirect band-gaps have a small energy difference.

10. Population inversion is obtained at a p-n junction by _____
a) Heavy doping of p-type material
b) Heavy doping of n-type material
c) Light doping of p-type material
d) Heavy doping of both p-type and n-type material

Answer: d
Explanation: Population inversion at p-n junction is obtained by heavy doping of both p-type and n-type material. Heavy p-type doping with acceptor impurities causes a lowering of the Fermi-level between the filled and empty states into the valence band. Similarly n-type doping causes Fermi-level to enter the conduction band of the material.

11. A GaAs injection laser has a threshold current density of $2.5*10^3Acm^{-2}$ and length and width of the cavity is 240μm and 110μm respectively. Find the threshold current for the device.
a) 663 mA
b) 660 mA
c) 664 mA
d) 712 mA

Answer: b
Explanation: The threshold current is denoted by I_{th}. It is given by-
$I_{th} = J_{th}$ * area of the optical cavity
Where J_{th} = threshold current density
Area of the cavity = length and width.

12. A GaAs injection laser with an optical cavity has refractive index of 3.6. Calculate the reflectivity for normal incidence of the plane wave on the GaAs-air interface.
a) 0.61

b) 0.12
c) 0.32
d) 0.48

Answer: c
Explanation: The reflectivity for normal incidence of the plane wave on the GaAs-air interface is given by-
$r = ((n-1)/(n+1))^2$ where r=reflectivity and n=refractive index.

13. A homo-junction is an interface between two adjoining single-crystal semiconductors with different band-gap energies.
a) True
b) False

Answer: b
Explanation: The photo-emissive properties of a single p-n junction fabricated from a single-crystal semiconductor material are called as homo-junction. A hetero-junction is an interface between two single-crystal semiconductors with different band-gap energies. The devices which are fabricated with hetero-junctions are said to have hetero-structure.

14. How many types of hetero-junctions are available?
a) Two
b) One
c) Three
d) Four

Answer: a
Explanation: Hetero-junctions are classified into an isotype and an-isotype. The isotype hetero-junctions are also called as n-n or p-p junction. The an-isotype hetero-junctions are called as p-n junction with large band-gap energies.

15. The _____ system is best developed and is used for fabricating both lasers and LEDs for the shorter wavelength region.
a) InP
b) GaSb
c) GaAs/GaSb
d) GaAs/Alga AS DH

Answer: d
Explanation: For DH device fabrication, materials such as GaAs, Alga AS are used. The band-gap in this material may be tailored to span the entire wavelength band by changing the AlGa composition. Thus, GaAs/ Alga As DH system is used for fabrication of lasers and LEDs for shorter wavelength region (0.8μm-0.9μm).

TOPIC 2.7 FIBER OPTICS: PRINCIPLE, NUMERICAL APERTURE AND ACCEPTANCE ANGLE

1. What is the principle of fibre optical communication?
a) Frequency modulation
b) Population inversion
c) Total internal reflection
d) Doppler Effect

Answer: c
Explanation: In optical fibres, the light entering the fibre does not encounter any new surfaces, but repeatedly they hit the same surface. The reason for confining the light beam inside the fibres is the total internal reflection.

2. What is the other name for a maximum external incident angle?
a) Optical angle
b) Total internal reflection angle
c) Refraction angle
d) Wave guide acceptance angle

Answer: d
Explanation: Only this rays which pass within the acceptance angle will be totally reflected. Therefore, light incident on the core within the maximum external incident angle

can be coupled into the fibre to propagate. This angle is called a wave guide acceptance angle.

3. A single mode fibre has low intermodal dispersion than multimode.
a) True
b) False

Answer: a
Explanation: In both single and multimode fibres the refractive indices will be in step by step. Since a single mode has less dispersion than multimode, the single mode step index fibre also has low intermodal dispersion compared to multimode step index fibre.

4. How does the refractive index vary in Graded Index fibre?
a) Tangentially
b) Radially
c) Longitudinally
d) Transversely

Answer: b
Explanation: The refractive index of the core is maximum along the fibre axis and it gradually decreases. Here the refractive index varies radially from the axis of the fibre. Hence it is called graded index fibre.

5. Which of the following has more distortion?
a) Single step-index fibre
b) Graded index fibre
c) Multimode step-index fibre
d) Glass fibre

Answer: c
Explanation: When rays travel through longer distances there will be some difference in reflected angles. Hence high angle rays arrive later than low angle rays. Therefore the signal pulses are broadened thereby results in a distorted output.

6. In which of the following there is no distortion?
a) Graded index fibre
b) Multimode step-index fibre
c) Single step-index fibre
d) Glass fibre

Answer: a
Explanation: The light travels with different speeds in different paths because of the variation in their refractive indices. At the outer edge it travels faster than near the centre But almost all the rays reach the exit end at the same time due to the helical path. Thus, there is no dispersion in the pulses and hence the output is not a distorted output.

7. Which of the following loss occurs inside the fibre?
a) Radiative loss
b) Scattering
c) Absorption
d) Attenuation

Answer: b
Explanation: Scattering is a wavelength dependent loss. Since the glass used in the fabrication of fibres, the disordered structure of glass will make some vibrations in the refractive index inside the fibre. This causes Rayleigh scattering.

8. What causes microscopic bend?
a) Uniform pressure
b) Non-uniform volume
c) Uniform volume
d) Non-uniform pressure

Answer: d
Explanation: Micro-bends losses are caused due to non-uniformities inside the fibre. This micro-bends in fibre appears due to non-uniform pressures created during the cabling of fibre.

9. When more than one mode is propagating, how is it dispersed?
a) Dispersion
b) Inter-modal dispersion

c) Material dispersion
d) Waveguide dispersion

Answer: b
Explanation: When more than one mode is propagating through a fibre, then inter modal dispersion will occur. Since many modes are propagating, they will have different wavelengths and will take different time to propagate through the fibre.

10. A fibre optic telephone transmission can handle more than thousands of voice channels.
a) True
b) False

Answer: a
Explanation: Optical fibre has larger bandwidth hence it can handle a large number of channels for communication.

11. Which of the following is known as fibre optic back bone?
a) Telecommunication
b) Cable television
c) Delay lines
d) Bus topology

Answer: d
Explanation: Each computer on the network is connected to the rest of the computers by the optical wiring scheme called bus topology, which is an application known as fibre optic back bone.

12. Calculate the numerical aperture of an optical fibre whose core and cladding are made of materials of refractive index 1.6 and 1.5 respectively.
a) 0.55677
b) 55.77
c) 0.2458
d) 0.647852

Answer: a
Explanation: Numerical aperture = $\sqrt{n1^2 - n2^2}$
Numerical aperture = 0.55677.

13. A step-index fibre has a numerical aperture of 0.26, a core refractive index of 1.5 and a core diameter of 100micrometer. Calculate the acceptance angle.
a) 1.47°
b) 15.07°
c) 2.18°
d) 24.15°

Answer: b
Explanation: sin i = (Numerical aperture)/n
sin i = 15.07°.

TOPIC 2.8 TYPES OF OPTICAL FIBRES (MATERIAL, REFRACTIVE INDEX, MODE)

TOPIC 2.9 LOSSES ASSOCIATED WITH OPTICAL FIBERS

1. Multimode step index fiber has

_____

a) Large core diameter & large numerical aperture
b) Large core diameter and small numerical aperture
c) Small core diameter and large numerical aperture
d) Small core diameter & small numerical aperture

Answer: a
Explanation: Multimode step-index fiber has large core diameter and large numerical aperture. These parameters provides efficient coupling to inherent light sources such as LED's.

2. A typically structured glass multimode step index fiber shows as variation of attenuation in range of _____

a) 1.2 to 90 dB km^{-1} at wavelength 0.69μm
b) 3.2 to 30 dB km^{-1} at wavelength 0.59μm
c) 2.6 to 50 dB km^{-1} at wavelength 0.85μm
d) 1.6 to 60 dB km^{-1} at wavelength 0.90μm

Answer: c
Explanation: A multimode step index fibers show an attenuation variation in range of 2.6 to 50dBkm^{-1}. The wide variation in attenuation is due to the large differences both within and between the two overall preparation methods i.e. melting and deposition.

3. Multimode step index fiber has a large core diameter of range is _____
a) 100 to 300 μm
b) 100 to 300 nm
c) 200 to 500 μm
d) 200 to 500 nm

Answer: a
Explanation: A multimode step index fiber has a core diameter range of 100 to 300μm. This is to facilitate efficient coupling to inherent light sources.

4. Multimode step index fibers have a bandwidth of _____
a) 2 to 30 MHz km
b) 6 to 50 MHz km
c) 10 to 40 MHz km
d) 8 to 40 MHz km

Answer: b
Explanation: Multimode step index fibers have a bandwidth of 6 to 50 MHz km. These fibers with this bandwidth are best suited for short -haul, limited bandwidth and relatively low-cost application.

5. Multimode graded index fibers are manufactured from materials with

_____
a) Lower purity
b) Higher purity than multimode step index fibers.
c) No impurity
d) Impurity as same as multimode step index fibers.

Answer: b
Explanation: Multimode graded index fibers have higher purity than multimode step index fiber. To reduce fiber losses, these fibers have more impurity.

6. The performance characteristics of multimode graded index fibers are

_____
a) Better than multimode step index fibers
b) Same as multimode step index fibers
c) Lesser than multimode step index fibers
d) Negligible

Answer: a
Explanation: Multimode graded index fibers use a constant grading factor. Performance characteristics of multimode graded index fibers are better than those of multimode step index fibers due to index graded and lower attenuation.

7. Multimode graded index fibers have overall buffer jackets same as multimode step index fibers but have core diameters

_____
a) Larger than multimode step index fibers
b) Smaller than multimode step index fibers
c) Same as that of multimode step index fibers
d) Smaller than single mode step index fibers

Answer: b
Explanation: Multimode graded index fibers have smaller core diameter than multimode step index fibers. A small core diameter helps the fiber gain greater rigidity to resist bending.

8. Multimode graded index fibers with wavelength of 0.85μm have numerical aperture of 0.29 have core/cladding diameter of _____
a) 62.5 μm/125 μm

b) 100 µm/140 µm
c) 85 µm/125 µm
d) 50 µm/125µm

Answer: b
Explanation: Multimode graded index fibers with numerical aperture 0.29 having a core/cladding diameter of 100µm/140µm. They provide high coupling frequency LED's at a wavelength of 0.85 µm and have low cost. They are also used for short distance application.

9. Multimode graded index fibers use incoherent source only.
a) True
b) False

Answer: b
Explanation: Multimode graded index fibers are used for short haul and medium to high bandwidth applications. Small haul applications require LEDs and low accuracy lasers. Thus either incoherent or incoherent sources like LED's or injection laser diode are used.

10. In single mode fibers, which is the most beneficial index profile?
a) Step index
b) Graded index
c) Step and graded index
d) Coaxial cable

Answer: b
Explanation: In single mode fibers, graded index profile is more beneficial as compared to step index. This is because graded index profile provides dispersion-modified-single mode fibers.

11. The fibers mostly not used nowadays for optical fiber communication system are _____
a) Single mode fibers
b) Multimode step fibers
c) Coaxial cables
d) Multimode graded index fibers

Answer: a
Explanation: Single mode fibers are used to produce polarization maintaining fibers which make them expensive. Also the alternative to them are multimode fibers which are complex but accurate. So, single-mode fibers are not generally utilized in optical fiber communication.

12. Single mode fibers allow single mode propagation; the cladding diameter must be at least _____
a) Twice the core diameter
b) Thrice the core diameter
c) Five times the core diameter
d) Ten times the core diameter

Answer: d
Explanation: The cladding diameter in single mode fiber must be ten times the core diameter. Larger ratios contribute to accurate propagation of light. These dimension ratios must be there so as to avoid losses from the vanishing fields.

13. A fiber which is referred as non-dispersive shifted fiber is?
a) Coaxial cables
b) Standard single mode fibers
c) Standard multimode fibers
d) Non zero dispersion shifted fibers

Answer: b
Explanation: A standard single mode fiber having step index profile is known as non-dispersion shifted fiber. As these fibers have a zero dispersion wavelength of 1.31µm and so are preferred for single-wavelength transmission in O-band.

14. Standard single mode fibers (SSMF) are utilized mainly for operation in _____
a) C-band
b) L-band
c) O-band
d) C-band and L-band

Answer: c
Explanation: SSMFs are utilized for operation in O-band only. It shows high dispersion in the range of 16 to 20ps/nm/km in C-band and L-band. So SSMFs are used in O-band.

15. Fiber mostly suited in single-wavelength transmission in O-band is?
a) Low-water-peak non dispersion-shifted fibers
b) Standard single mode fibers
c) Low minimized fibers
d) Non-zero-dispersion-shifted fibers

Answer: b
Explanation: Standard single mode fibers with a step index profile are called non dispersion shifted fiber and it is particularly used for single wavelength transmission in O-band and as if has a zero-dispersion wavelength at 1.31μm.

TOPIC 2.10 FIBRE OPTIC SENSORS: PRESSURE AND DISPLACEMENT.

1. OTDR stands for _____
a) Optical time domain reflectometer
b) Optical transfer data rate
c) Optical time data registers
d) None of the mentioned

Answer: a
Explanation: OTDR is the short form of optical time domain reflectometer.

2. Which of the following is not correct for fibre optic sensors?
a) Immune to electro magnetic interference
b) Immune to radiation hazard
c) Can be used in harsh environments
d) None of the mentioned

Answer: d
Explanation: All of the mentioned are qualities of fibre optic sensors.

3. Fluoride glass is used with _____
a) IR waves
b) UV rays
c) Normal light
d) All of the mentioned

Answer: a
Explanation: Flouride glass is suitable for IR rays of wavelength upto 3200 nm.

4. Silica glass of hydroxyl concentration can be used for _____ of wavelength.
a) 100 nm to 250 nm
b) 250 nm to 800 nm
c) 800 nm to 1500 nm
d) 100 nm to 3400 nm

Answer: b
Explanation: Silica glass with hydroxyl concentration is used for wavelength 250 nm to 800 nm.

5. General spectral range for silica glass is _____
a) Less than 200 nm
b) Between 200 nm to 2200 nm
c) Between 2000 nm to 5000 nm
d) Greater than 3000 nm

Answer: b
Explanation: General spectral range of silica glass is 200 nm to 2200 nm.

6. Epoxy material in fibre optics is intended for _____
a) Better optical properties
b) Better reflection
c) Better sealing
d) Reducing noise

Answer: c
Explanation: Polished epoxy seal provides liquid and air tight seal.

7. Plastics optical cables can be used for _____
a) Short range
b) Medium range of distance

c) Long range of distance
d) Very high range of distance

Answer: a
Explanation: Plastic optical cables are manufacturing for short range purposes.

8. Which of the following represents loss associated with glass fibres?
a) 3 dB/Km
b) 10 dB/Km
c) 0 dB/Km
d) 50 dB/Km

Answer: a
Explanation: Glass fibres have a net loss of 3 dB on every single kilometre.

9. Loss associated with plastic fibre is less than glass fibres.
a) True
b) False

Answer:b
Explanation: Loss associated with plastic fibre is about 100-1250 dB/Km and it is several times larger than glass fibres.

10. Cladding in glass fibre have high refractive index than the core.
a) True
b) False

Answer: b
Explanation: Cladding in glass fibre is always kept at a low refractive index than the core.

UNIT III THERMAL PHYSICS

TOPIC 3.1 TRANSFER OF HEAT ENERGY

1. The transfer of heat between two bodies in direct contact is called
a) radiation
b) convection
c) conduction
d) none of the mentioned

Answer: c
Explanation: This is the definition of conduction.

2. Heat flow into a system is taken to be ____, and heat flow out of the system is taken as ____
a) positive, positive
b) negative, negative
c) negative, positive
d) positive, negative

Answer: d
Explanation: The direction of heat transfer is taken from the high temperature system to the low temperature system.

3. In the equation, dQ=TdX
a) dQ is an inexact differential
b) dX is an exact differential
c) X is an extensive property
d) all of the mentioned

Answer: d
Explanation: This is because heat transfer is a path function.

4. The transfer of heat between a wall and a fluid system in motion is called
a) radiation
b) convection
c) conduction
d) none of the mentioned

Answer: b
Explanation: This is the definition of convection.

5. For solids and liquids, specific heat
a) depends on the process
b) is independent of the process

c) may or may not depend on the process
d) none of the mentioned

Answer: b
Explanation: It is the property of specific heat.

6. The specific heat of the substance is defined as the amount of heat required to raise a unit mass of the substance through a unit rise in temperature.
a) true
b) false

Answer: a
Explanation: c=Q/(m*Δt).

7. Heat and work are
a) path functions
b) inexact differentials
c) depend upon the path followed
d) all of the mentioned

Answer: d
Explanation: It is an important point to remember regarding heat and work transfer.

8. Latent heat is taken at
a) constant temperature
b) constant pressure
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: The latent heat is heat transfer required to cause a phase change in a unit mass of substance at a constant pressure and temperature.

9. Which of the following is true?
a) latent heat of fusion is not much affected by pressure
b) latent heat of vaporization is highly sensitive to pressure
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: It is a general fact about latent heat.

10. Heat transfer and work transfer are
a) boundary phenomena
b) energy interactions
c) energy in the transit
d) all of the mentioned

Answer: d
Explanation: It is an important point to remember regarding heat and work transfer.

TOPIC 3.2 THERMAL EXPANSION OF SOLIDS AND LIQUIDS

1. A faulty thermometer has its fixed points marked as 5° and 95°. The temperature of a body as measured by the faulty thermometer is 59°. Find the correct temperature of the body on a Celsius scale.
a) 60°C
b) 40°C
c) 20°C
d) 0°C

Answer: a
Explanation: $(T_C-0)/(100-0)$=(Temperature on faulty scale-Lower fixed point)/(Upper fixed point-Lower fixed point)
$(T_C-0)/100=(59-5)/(95-5)=54/90$
T_C=60°C.

2. Temperature is a microscopic concept.
a) True
b) False

Answer: b
Explanation: Temperature is a macroscopic concept. It is related to the average kinetic energy of a large number of molecules forming a system. It is not possible to define the temperature for a single molecule.

3. The thermometer bulb should have

_____

a) High heat capacity
b) No heat capacity
c) Small heat capacity
d) Varying heat capacity

Answer: c
Explanation: The thermometer bulb having small heat capacity will absorb less heat from the body whose temperature is to be measured. Hence the temperature of that body will practically remain unchanged.

4. Calorie is defined as the amount of heat required to raise the temperature of 1g of water by 1°C and it is defined under which of the following conditions?
a) From 14.5°C to 15.5°C at 760mm of Hg
b) From 98.5°C to 99.5°C at 760mm of Hg
c) From 13.5°C to 14.5°C at 76mm of Hg
d) From 3.5°C to 4.5°C at 76mm of Hg

Answer: a
Explanation: One calorie is defined as the heat required to raise the temperature of 1g of water from 14.5°C to 15.5° at 760mm of Hg.

5. Compared to burn due to air at 100°C, a burn due to steam at 100°C is _____
a) More dangerous
b) Less dangerous
c) Equally dangerous
d) Not dangerous

Answer: a
Explanation: Compared to burn due to air at 100°C, a burn due to steam at 100°C is more dangerous due to the additional heat possessed by steam.

6. 540g of ice at 0°C is mixed with 540g of water at 80°C. What is the final temperature of the mixture?
a) 0°C
b) 40°C
c) 80°C
d) Less than 0°C

Answer: a
Explanation: Heat gained by ice = Heat lost by water at 80°C
$540\times80+540\times1\times\theta=540\times1\times(80-\theta)$
$\theta=0°C$.

7. An ideal black body is thrown into a furnace. The black body is room temperature. It is observed that _____
a) Initially, it is darkest body and at later times the brightest
b) At all times it is the darkest body
c) It cannot be distinguished at all times
d) Initially, it is the darkest body and at later it cannot be distinguished

Answer: a
Explanation: Initially at lower temperature, it absorbs the entire radiations incident upon it. So, it is the darkest body. At later times, when it attains the temperature of the furnace, the black body radiates maximum energy. It appears brightest of all bodies.

8. If the sun were to increase in temperature from T to 2T and its radius from R to 2R, then the ratio of the radiant energy received on earth to what it was previously, will be _____
a) 4
b) 16
c) 32
d) 64

Answer: d
Explanation: Energy radiated by the sun per second,
$E = \sigma AT^4 = \sigma\times4\pi R^2\times T^4$
When its radius and temperature change to 2R and 2T respectively,
$E' = \sigma\times4\pi(2R)^2\times(2T)^4$
$E'/E = 64$.

9. On a hilly region, water boils at 95°C. What is the temperature expressed in Fahrenheit?
a) 100°F

b) 203°F
c) 150°F
d) 20.3°F

Answer: b
Explanation: (F-32)/9=C/5=95/5
F = 171+32 = 203°F.

10. A composite rod made of copper ($1.8\times10^{(-5)}$ $K^{(-1)}$) and steel ($\alpha=1.2\times10^{(-5)}$ $K^{(-1)}$) is heated. Then _____
a) It bends with steel on concave side
b) It bends with copper on concave side
c) It does not expand
d) Data is insufficient

Answer: a
Explanation: $\alpha_{copper}>\alpha_{steel}$
Copper expands more than steel. So rod bends with copper on convex side and steel on concave side.

11. Temperatures of two stars are in ratio 3:2. If wavelength of maximum intensity of first body is 4000 Å, what is corresponding wavelength of second body?
a) 9000 Å
b) 6000 Å
c) 2000 Å
d) 8000 Å

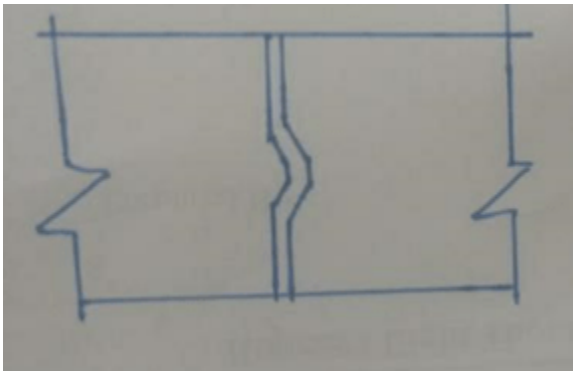
Answer: b
Explanation: $((\lambda_m)')/\lambda_m = T/T' = 3/2$
$(\lambda_m)'=3/2\ \lambda_m$
$(\lambda_m)'=3/2\times4000=6000$Å.

12. A piece of blue glass heated to a high temperature and a piece of red glass at room temperature, are taken inside a room that is dimly lit, then _____
a) The blue piece will look blue and red will look as usual
b) Red looks brighter and blue looks ordinary blue
c) Blue shines like brighter red compared to the red pieces
d) Both the pieces will look equally red

Answer: c
Explanation: According to Stefan's law, E is proportional to T^4
As the temperature of blue glass is more than that of red glass, so it will appear brighter than red glass.

TOPIC 3.3 EXPANSION JOINTS

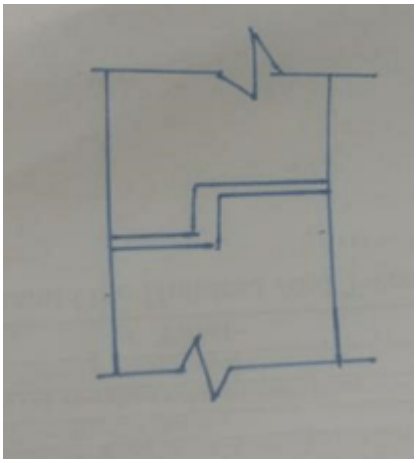
1. Identify the given joint in Concrete Structures.



a) Horizontal construction joint
b) Vertical construction joint
c) Expansion construction joint
d) Water tank joint

Answer: a
Explanation: The construction joints are provided at locations were the construction is stopped either at the end of the day or for any other reason. The provisions of the construction joint become necessary to ensure proper bond between the old work and the new work.

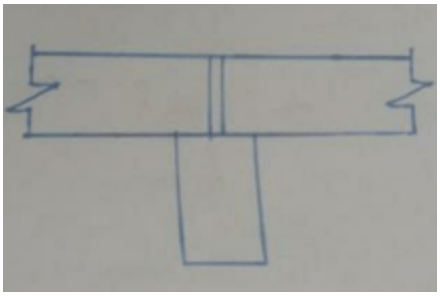
2. Identify the given joint in Concrete Structures.



a) Horizontal construction joint
b) Expansion construction joint
c) Vertical construction joint
d) Water tank joint

Answer: c
Explanation: The construction joint maybe horizontal or vertical. For an inclined or curved member of the joint should be at right angle to the axis of the member. It is necessary to determine the location of construction joints well in advance for the viewpoint of structural stability.

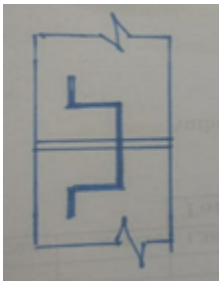
3. Identify the given type of joint in Concrete Structures.



a) L beam construction joint
b) T beam construction joint
c) Expansion joint
d) Contraction Joint

Answer: b
Explanation: In case of T-beams, the ribs should be filled with concrete first and in the slabs forming the flanges can be filled up to the centre of the ribs. If a construction joint between slab and beam becomes unavoidable especially as in the case of long and deep beams, that T beams are used.

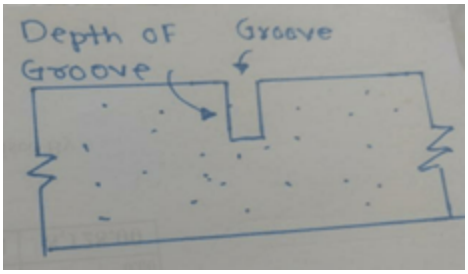
4. Identify the given joint in Concrete Structures.



a) Expansion joint
b) Contraction Joint
c) Water tank joint
d) Vertical construction joint

Answer: c
Explanation: For water tanks and other structured which store water, the strips of copper, aluminium, galvanized iron or other corrosion resistant material known as water stops or waterbars, are placed in construction joint as shown in given figure above.

5. Identify the given joint in Concrete Structures.



a) Partial contraction joint
b) Complete Contraction Joint
c) Horizontal construction joint
d) Dummy joint

Answer: d
Explanation: Above figure shows another form of contraction joint. It is also known as a dummy joint and in this case, a groove of 3 mm width is created in the concrete member to act as a joint. The groove is filled with the joint filler and its depth is about 1/3 to 1/5 of the total thickness of the member.

6. For water tanks and other structure which store water, the strips of copper, aluminium, galvanized iron or other collision resistance material, known as the _____
a) Joints
b) Waterstops
c) Dowels
d) Fillers

Answer: b
Explanation: The function of waterstops is to seal the joint against the passage of water. The waterstop may also be the natural and synthetic rubber or polyvinyl chloride(PVC).

7. The expansion and contraction joints generally consist of some elastic material, known as _____ which should be compressible, rigid, cellular and Resilient.
a) Keys
b) Joint filler
c) Keys
d) Fillers

Answer: b
Explanation: The usual joint filler are built-in strips of metal, bitumen treated felt, cane fibre board, cork bound with rubber or resin, dehydrated cork, natural cork, softwood free from knots, etc.

8. The _____ are provided in expansion and contraction joints to transfer the load.
a) Dowels
b) Fillers
c) Joint filler
d) Waterbars

Answer: a
Explanation: The contraction joints are installed to allow for shrinkage movement in the structure. It may either be a complete contraction joint or a partial construction joint. In the former case, there is complete discontinuity of both concrete and steel.

9. The _____ is the most effective process of repairing concrete work which has been damaged due to inferior work or other reasons.
a) Grouting
b) Scraping
c) Dewatering
d) Guniting

Answer: d
Explanation: In Guniting, the surface to be treated is cleaned and washed. The nozzle is generally kept at a distance of about 750 mm to 850 mm from the surface to be treated and velocity of nozzle values from 120 m/sec to 160 m/sec.

10. The _____ is a mixture of cement and sand, the usual proportion being 1:3.
a) Mortar
b) Slurry
c) Gunite
d) Concrete

Answer: c
Explanation: A cement gun is used to deposit the Gunite mixture on the concrete surface under pressure of about 20 N/cm^2 to 30 N/cm^2. The cement is mixed with slightly moist sand and the necessary water is added as the mixture comes out from the cement gun.

TOPIC 3.4 BIMETALLIC STRIPS

1. Measurement of elevated temperatures is defined as _____
a) Thermometry
b) Pyrometry
c) Metallography
d) Radiography

Answer: b
Explanation: Pyrometry deals with elevated temperatures, generally around 950 F. The apparatus that is used in this process is known as a pyrometer. Thermometry generally deals with the measurement of temperatures below 950 F.

2. What temperature does the dark red color generally deal with?
a) 950 F
b) 1150 F
c) 1175 F
d) 1300 F

Answer: b
Explanation: Temperature of metals can be estimated by simply looking at the color of the hot body. Dark red is assigned a temperature of 1150 F, whereas for faint red, dark cherry, and cherry red it is 950 F, 1175 F, and 1300 F in that order.

3. What temperature is the dark orange color associated with?
a) 1475 F
b) 1650 F
c) 1750 F
d) 1800 F

Answer: b
Explanation: Temperature of metals can be estimated by simply looking at the color of the hot body. Dark orange is associated with a temperature of about 1150 F, while for bright cherry, orange, and yellow it is 1475 F, 1750 F, and 1800 F correspondingly.

4. Bimetallic strips are employed in _____ thermometers.
a) Vapor-pressure
b) Liquid-expansion
c) Metal-expansion
d) Resistance

Answer: c
Explanation: Bimetallic strips made by bonding of high-expansion and low-expansion metals are used in the common thermostat. When used as an industrial temperature indicator, these can be bent into a coil.

5. Bimetallic strips contain _____ as a metal.
a) Muntz metal
b) Yellow brass
c) Bronze
d) Aluminum

Answer: b
Explanation: Bimetallic strips include invar as one metal and yellow brass as another. For higher temperatures, nickel alloy can be used. These can be used in temperatures ranging from -100 F to 1000 F.

6. Why is invar used in bimetallic strips?
a) Low density
b) Low coefficient of expansion
c) High-temperature resistance
d) High abrasion resistance

Answer: b
Explanation: Most bimetallic strips are composed of invar and yellow brass as metal. Invar has the advantage of low coefficient of expansion, whereas yellow brass has the ability to be used at low temperatures.

7. _____ is commonly used in liquid-expansion thermometers.
a) Bourdon tube
b) Spinning rotor gauge
c) McLeod gauge
d) Manometer

Answer: a
Explanation: Liquid-expansion thermometers consist of a bulb and an expansible device. The bulb is exposed to the temperature that needs to be measured and usually, a Bourdon tube is used as an expansion device. These are connected by capillary tubing and are filled with a medium.

8. Resistance thermometer generally makes use of _____ for the measurement of resistance.
a) Potentiometer
b) Adruino
c) Diode bridge
d) Wheatstone bridge

Answer: d
Explanation: Resistance thermometers are based on the principle of increase in electrical resistance with increasing temperature. It consists of a resistance coil mounted in a protecting tube which is connected to a resistance measuring instrument. Generally, Wheatstone bridge is used in this process.

9. Which of these materials is not used for resistance coils?
a) Nickel
b) Copper
c) Titanium
d) Platinum

Answer: c
Explanation: Resistance coils are generally made of nickel, copper, or platinum. Nickel and copper can be used in the temperature range of 150-500 F, whereas platinum can be used between -350 to 1100 F.

10. Liquid expansion thermometers are filled with _____
a) Mercury
b) Amalgam
c) Gallium
d) Cesium

Answer: a
Explanation: The liquid-expansion thermometer has the entire system filled with an organic liquid or mercury. Mercury is used at a temperature range of -35 to 950 F. Alcohol and creosote are used at -110 to 160 F, and 20 to 400 F respectively.

TOPIC 3.5 THERMAL CONDUCTION, CONVECTION AND RADIATION

1. The sun shines on a 150 m^2 road surface so it is at 45°C. Below the 5cm thick asphalt(average conductivity of 0.06 W/m K), is a layer of rubbles at 15°C. Find the rate of heat transfer to the rubbles.
a) 5300 W
b) 5400 W
c) 5500 W
d) 5600 W

Answer: b
Explanation: There is conduction through the asphalt layer.
heat transfer rate = k A $\Delta T/\Delta x$ = 0.06 × 150 ×(45-15)/0.05
= 5400 W.

2. A pot of steel(conductivity 50 W/m K), with a 5 mm thick bottom is filled with liquid water at 15°C. The pot has a radius of 10 cm and is now placed on a stove that delivers 250 W as heat transfer. Find the temperature on the outer pot bottom surface assuming the inner surface to be at 15°C.
a) 15.8°C
b) 16.8°C
c) 18.8°C
d) 19.8°C

Answer: a
Explanation: Steady conduction, Q = k A $\Delta T/\Delta x \Rightarrow \Delta T = Q \Delta x / kA$
$\Delta T = 250 \times 0.005/(50 \times \pi/4 \times 0.2^2) = 0.796$
T = 15 + 0.796 = 15.8°C.

3. A water-heater is covered with insulation boards over a total surface area of 3 m^2. The inside board surface is at 75°C and the outside being at 20°C and the conductivity of material being 0.08 W/m K. Find the thickness of board to limit the heat transfer loss to 200 W ?
a) 0.036 m
b) 0.046 m
c) 0.056 m
d) 0.066 m

Answer: d
Explanation: Steady state conduction through board.

$Q = k\ A\ \Delta T/\Delta x \Rightarrow \Delta T = Q\ \Delta x\ /\ kA$
$\Delta x = 0.08 \times 3 \times (75 - 20)/200 = 0.066$ m.

4. On a winter day with atmospheric air at −15°C, the outside front wind-shield of a car has surface temperature of +2°C, maintained by blowing hot air on the inside surface. If the wind-shield is 0.5 m^2 and the outside convection coefficient is 250 W/Km^2, find the rate of energy loss through front wind-shield.
a) 125 W
b) 1125 W
c) 2125 W
d) 3125 W

Answer: c
Explanation: Q (conv) = h A ΔT = 250 × 0.5 × [2 − (−15)] = 250 × 0.5 × 17 = 2125 W.

5. A large heat exchanger transfers a total of 100 MW. Assume the wall separating steam and seawater is 4 mm of steel, conductivity 15 W/m K and that a maximum of 5°C difference between the two fluids is allowed. Find the required minimum area for the heat transfer.
a) 180 m^2
b) 280 m^2
c) 380 m^2
d) 480 m^2

Answer: d
Explanation: Steady conduction
$Q = k\ A\ \Delta T/\Delta x \Rightarrow A = Q\ \Delta x\ /\ k\Delta T$
A = 100 × 10^6 × 0.004 / (15 × 5) = 480 m^2.

6. The black grille on the back of a refrigerator has a surface temperature of 35°C with a surface area of 1 m^2. Heat transfer to the room air at 20°C takes place with convective heat transfer coefficient of 15 W/Km^2. How much energy is removed during 15 minutes of operation?
a) 202.5 kJ
b) 212.5 kJ
c) 222.5 kJ
d) 232.5 kJ

Answer: a
Explanation: Q = hA ΔT Δt, Q = 15 × 1 × (35-20)×15×60 = 202500 J = 202.5 kJ.

7. A small light bulb (25 W) inside a refrigerator is kept on and 50 W of energy from the outside seeps into the refrigerated space. How much of temperature difference to the ambient(at 20°C) must the refrigerator have in its heat exchanger having an area of 1 m^2 and heat transfer coefficient of 15 W/Km^2 to reject the leak of energy.
a) 0°C
b) 5°C
c) 10°C
d) 15°C

Answer: b
Explanation: Total energy that goes out = 50+25 = 75 W
75 = hAΔT = 15 × 1 × ΔT hence ΔT = 5°C.

8. As the car slows down, the brake shoe and steel drum continuously absorbs 25 W. Assume a total outside surface area of 0.1 m^2 with a convective heat transfer coefficient of 10 W/Km^2 to the air at 20°C. How hot does the outside brake and drum surface become when steady conditions are reached?
a) 25°C
b) 35°C
c) 45°C
d) 55°C

Answer: c
Explanation: ΔT = heat / hA hence ΔT = [T(BRAKE) − 20] = 25/(10 × 0.1) = 25°C
T(BRAKE) = 20 + 25 = 45°C.

9. A burning wood in the fireplace has a surface temperature of 450°C. Assume the emissivity to be 1 and find the radiant emission of energy per unit area.
a) 15.5 kW/m^2

b) 16.5 kW/m^2
c) 17.5 kW/m^2
d) 18.5 kW/m^2

Answer: a
Explanation: Q /A = 1 × σ T^4
= 5.67 × 10^{-8}×(273.15 + 450)^4
= 15505 W/m^2 = 15.5 kW/m^2.

10. A radiant heat lamp is a rod, 0.5 m long, 0.5 cm in diameter, through which 400 W of electric energy is deposited. Assume the surface emissivity to be 0.9 and neglecting incoming radiation, find the rod surface temperature?
a) 700K
b) 800K
c) 900K
d) 1000K

Answer: d
Explanation: Outgoing power equals electric power
T^4= electric energy / εσA
= 400 / (0.9 × 5.67 ×10^{-8}× 0.5 × π × 0.005)
= 9.9803 ×10^11 K^4 ⇒ T = 1000K.

11. A water-heater is covered up with insulation boards over a total surface area of 3 m^2. The inside board surface is at 75°C and the outside surface is at 20°C and the board material has a conductivity of 0.08 W/m K. How thick a board should it be to limit the heat transfer loss to 200 W ?
a) 0.066 m
b) 0.166 m
c) 0.266 m
d) 0.366 m

Answer: a
Explanation: Steady state conduction through a single layer board.
Δx = kA(ΔT)/Q
Δx = (0.08*3)*(75-20)/200 = 0.066 m.

12. Find the rate of conduction heat transfer through a 1.5 cm thick hardwood board, k = 0.16 W/m K, with a temperature difference between the two sides of 20°C.
a) 113 W/m^2
b) 213 W/m^2
c) 230 W/m^2
d) 312 W/m^2

Answer: b
Explanation: . q = .Q/A = k ΔT/Δx = 0.16 Wm /K × 20K/0.015 m = 213 W/m^2.

13. A 2 m^2 window has a surface temperature of 15°C and the outside wind is blowing air at 2°C across it with a convection heat transfer coefficient of h = 125 W/m2K. What is the total heat transfer loss?
a) 2350 W
b) 1250 W
c) 2250 W
d) 3250 W

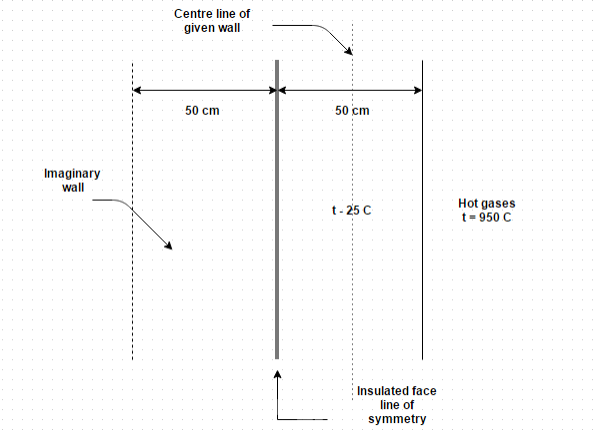
Answer: d
Explanation: .Q = h A ΔT = 125 W/m2K × 2 m2 × (15 – 2) K = 3250 W.

14. A radiant heating lamp has a surface temperature of 1000 K with ε = 0.8. How large a surface area is needed to provide 250 W of radiation heat transfer?
a) 0.0035 m2
b) 0.0045 m2
c) 0.0055 m2
d) 0.0065 m2

Answer: c
Explanation: .Q = εσAT^4
A = .Q/(εσT4) = 250/(0.8 × 5.67 × 10-8 × 10004)
= 0.0055 m^2.

TOPIC 3.6 HEAT CONDUCTIONS IN SOLIDS

1. A flat wall of fire clay, 50 cm thick and initially at 25 degree Celsius, has one of its faces suddenly exposed to a hot gas at 950 degree Celsius. If the heat transfer coefficient on the hot side is 7.5 W/m^2 K and the other face of the wall is insulated so that no heat passes out of that face, determine the time necessary to raise the center of the wall to 350 degree Celsius. For fire clay brick



Thermal conductivity = 1.12 W/m K
Thermal diffusivity = 5.16 * 10^{-7} m^2/s
a) 43.07 hours
b) 53.07 hours
c) 63.07 hours
d) 73.07 hours

Answer: a
Explanation: $t - t_a/t_0 - t_a = 0.86$. Also, $\alpha T/l^2 = 0.32$.

2. Glass spheres of 2 mm radius and at 500 degree Celsius are to be cooled by exposing them to an air stream at 25 degree Celsius. Find maximum value of convective coefficient that is permissible. Assume the following property values
Density = 2250 kg/m^3
Specific heat = 850 J/kg K
Conductivity = 1.5 W/m K
a) 245 W/m^2K
b) 235 W/m^2K
c) 225 W/m^2K
d) 215 W/m^2K

Answer: c
Explanation: l = volume/surface area = r/3. So, h = (0.1) (k) (3)/r.

3. The transient response of a solid can be determined by the equation. (Where, P is density, V is volume, c is specific heat and A is area)
a) $-4 p V c = h A (t - t_0)$
b) $-3 p V c = h A (t - t_0)$
c) $-2 p V c = h A (t - t_0)$
d) $-p V c = h A (t - t_0)$

Answer: d
Explanation: It can be determined by relating rate of change of internal energy with conductive heat exchange at the surface.

4. A 2 cm thick steel slab heated to 525 degree Celsius is held in air stream having a mean temperature of 25 degree Celsius. Estimate the time interval when the slab temperature would not depart from the mean value of 25 degree Celsius by more than 0.5 degree Celsius at any point in the slab. The steel plate has the following thermal physical properties
Density = 7950 kg/m^3
C_P = 455 J/kg K
K = 46 W/m K
a) 6548 s
b) 6941 s
c) 4876 s
d) 8760 s

Answer: b
Explanation: $t - t_a/t_I - t_a$ = exponential (- h A T/p V c). Now A/V = 100 per meter.

5. An average convective heat transfer coefficient for flow of air over a sphere has been measured by observing the temperature-time history of a 12 mm diameter copper sphere (density = 9000 kg/m^3 and c = 0.4 k J/kg K) exposed to air at 30 degree Celsius. The temperature of the sphere was measured

by two thermocouples one located at the center and the other near the surface. The initial temperature of the ball was 75 degree Celsius and it decreased by 10 degree Celsius in 1.2 minutes. Find the heat transfer coefficient

a) 27.46 W/m^2 K

b) 21.76 W/m^2 K

c) 29.37 W/m^2 K

d) 25.13 W/m^2 K

Answer: d

Explanation: $t - t_a/t_I - t_a$ = exponential (- h A T/p V c). So, h = 25.13 W/m^2 K.

6. Transient condition means

a) Conduction when temperature at a point varies with time

b) Very little heat transfer

c) Heat transfer with a very little temperature difference

d) Heat transfer for a short time

Answer: a

Explanation: The term transient or unsteady state designates a phenomenon which is time dependent.

7. Which of the following is not correct in a transient flow process?

a) The state of matter inside the control volume varies with time

b) There can be work and heat interactions across the control volume

c) There is no accumulation of energy inside the control volume

d) The rate of inflow and outflow of mass are different

Answer: c

Explanation: In transient heat conduction there is accumulation of energy inside the control volume.

8. A cylindrical stainless steel (k = 25 W/m K) ingot, 10 cm in diameter and 25 cm long, passes through a heat treatment furnace which is 5 meter in length. The initial ingot temperature is 90 degree Celsius, the furnace gas is at 1260 degree Celsius and the combined radiant and convective surface coefficient is 100 W/m^2 K. Determine the maximum speed with which the ingot moves through the furnace if it must attain 830 degree Celsius temperature. Take thermal diffusivity as 0.45 * 10^{-5} m^2/s

a) . 000116 m/s

b) .000216 m/s

c) . 000316 m/s

d) . 000416 m/s

Answer: b

Explanation: $t - t_a/t_I - t_a$ = exponential (- h A T/p V c). Now, A/V = 2(r + L)/r L = 0.48 per cm. Also, T = 1158.53 second so required velocity is 0.25/1158.53.

9. The curve for unsteady state cooling or heating of bodies is

a) Hyperbolic curve asymptotic both to time and temperature axis

b) Exponential curve asymptotic both to time and temperature axis

c) Parabolic curve asymptotic to time axis

d) Exponential curve asymptotic to time axis

Answer: d

Explanation: α/α_0 = exponential [- h A T/p c V], which represents an exponential curve.

10. What is the wavelength band for TV rays?

a) 1 * 10^3 to 34 * 10^{10} micron meter

b) 1 * 10^3 to 2 * 10^{10} micron meter

c) 1 * 10^3 to 3 * 10^{10} micron meter

d) 1 * 10^3 to 56 * 10^{10} micron meter

Answer: b

Explanation: This is the maximum and minimum wavelength for TV rays.

TOPIC 3.7 THERMAL CONDUCTIVITY

TOPIC 3.8 FORBE'S AND LEE'S DISC METHOD: THEORY AND EXPERIMENT

1. Thermal conductivity is defined as the heat flow per unit time
a) When the temperature gradient is unity
b) Across the wall with no temperature
c) Through a unit thickness of the wall
d) Across unit area where the temperature gradient is unity

Answer: d
Explanation: Thermal conductivity of a material is because of migration of free electrons and lattice vibrational waves.

2. Mark the matter with least value of thermal conductivity
a) Air
b) Water
c) Ash
d) Window glass

Answer: a
Explanation: For air, it is .024 W/ m degree i.e. lowest.

3. Which one of the following forms of water have the highest value of thermal conductivity?
a) Boiling water
b) Steam
c) Solid ice
d) Melting ice

Answer: c
Explanation: For ice, it is 2.25 W/m degree i.e. maximum.

4. The average thermal conductivities of water and air conform to the ratio
a) 50:1
b) 25:1
c) 5:1
d) 15:1

Answer: b
Explanation: For water, it is 0.55-0.7 W/m degree and for air it is .024 W/m degree.

5. Identify the very good insulator
a) Saw dust
b) Cork
c) Asbestos sheet
d) Glass wool

Answer: d
Explanation: Glass wool has a lowest thermal conductivity of 0.03 W/m degree amongst given option.

6. Most metals are good conductor of heat because of
a) Transport of energy
b) Free electrons and frequent collision of atoms
c) Lattice defects
d) Capacity to absorb energy

Answer: b
Explanation: For good conductors, there must be electrons that are free to move.

7. Heat conduction in gases is due to
a) Elastic impact of molecules
b) Movement of electrons
c) EM Waves
d) Mixing of gases

Answer: a
Explanation: If there is elastic collision then after sometime molecules regain its natural position.

8. The heat energy propagation due to conduction heat transfer will be minimum for
a) Lead
b) Water
c) Air
d) Copper

Answer: c
Explanation: It is because air has lowest

value of thermal conductivity amongst given options.

9. Cork is a good insulator because
a) It is flexible
b) It can be powdered
c) Low density
d) It is porous

Answer: d
Explanation: Cork has thermal conductivity in the range of 0.05-0.10 which is very low so it can be porous.

10. Choose the false statement
a) For pure metal thermal conductivity is more
b) Thermal conductivity decreases with increase in the density of the substance
c) Thermal conductivity of dry material is lower than that of damp material
d) Heat treatment causes variation in thermal conductivity

Answer: b
Explanation: Thermal conductivity increase with increase in the density of a substance.

TOPIC 3.9 CONDUCTION THROUGH COMPOUND MEDIA (SERIES AND PARALLEL)

1. A composite wall generally consists of
a) One homogenous layer
b) Multiple heterogeneous layers
c) One heterogeneous layer
d) Multiple homogenous layers

Answer: b
Explanation: Walls of houses where bricks are given a layer of plaster on either side.

2. Three metal walls of the same thickness and cross sectional area have thermal conductivities k, 2k and 3k respectively. The temperature drop across the walls (for same heat transfer) will be in the ratio
a) 3:2:1
b) 1:1:1
c) 1:2:3
d) Given data is insufficient

Answer: a
Explanation: As, $\delta_1 = \delta_2 = \delta_3$ and cross sectional areas are same i.e. temperature drop varies inversely with thermal conductivity.

3. A composite wall is made of two layers of thickness δ_1 and δ_2 having thermal conductivities k and 2k and equal surface area normal to the direction of heat flow. The outer surface of composite wall are at 100 degree Celsius and 200 degree Celsius. The minimum surface temperature at the junction is 150 degree Celsius. What will be the ratio of wall thickness?
a) 1:1
b) 2:1
c) 1:2
d) 2:3

Answer: c
Explanation: $Q = k_1 A_1 d t_1 / \delta_1 = k_2 A_2 d t_2 / \delta_2$ Also areas are same.

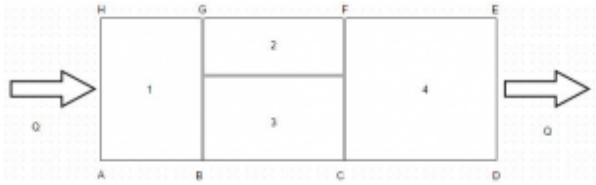
4. Let us say thermal conductivity of a wall is governed by the relation $k = k_0 (1 + \alpha t)$. In that case the temperature at the mid-plane of the heat conducting wall would be
a) Av. of the temperature at the wall faces
b) More than average of the temperature at the wall faces
c) Less than average of the temperature at the wall faces
d) Depends upon the temperature difference between the wall faces

Answer: b
Explanation: k_0 is thermal conductivity at 0 degree Celsius. Here β is positive so it is more than average of the temperature at the wall faces.

5. Heat is transferred from a hot fluid to a cold one through a plane wall of thickness (δ), surface area (A) and thermal conductivity (k). The thermal resistance is
a) $1/A\ (1/h_1 + \delta/k + 1/h_2)$
b) $A\ (1/h_1 + \delta/k + 1/h_2)$
c) $1/A\ (h_1 + \delta/k + h_2)$
d) $A\ (h_1 + \delta/k + 1/h_2)$

Answer: a
Explanation: Net thermal resistance will be summation of resistance through plane wall and from left side and right side of the wall.

6. Find the heat flow rate through the composite wall as shown in figure. Assume one dimensional flow and take



$k_1 = 150$ W/m degree
$k_2 = 30$ W/m degree
$k_3 = 65$ W/m degree
$k_4 = 50$ W/m degree
AB = 3 cm, BC = 8 cm and CD = 5 cm. The distance between middle horizontal line from the top is 3 cm and from the bottom is 7 cm
a) 1173.88 W
b) 1273.88 W
c) 1373.88 W
d) 1473.88 W

Answer: b
Explanation: $Q = d\ t/\ R_T$. $R_T = R_1 + R_{eq} + R_2 = 0.02 + 0.01469 + 0.1 = 0.2669$ degree/W.

7. A pipe carrying steam at 215.75 degree Celsius enters a room and some heat is gained by surrounding at 27.95 degree Celsius. The major effect of heat loss to surroundings will be due to
a) Conduction
b) Convection
c) Radiation
d) Both conduction and convection

Answer: c
Explanation: As there is temperature difference so radiation suits well.

8. "Radiation cannot be affected through vacuum or space devoid of any matter". True or false
a) True
b) False

Answer: b
Explanation: It can be affected only by air between molecules and vacuum of any matter.

9. A composite slab has two layers having thermal conductivities in the ratio of 1:2. If the thickness is the same for each layer then the equivalent thermal conductivity of the slab would be
a) 1/3
b) 2/3
c) 2
d) 4/3

Answer: d
Explanation: 2(1) (2)/1+2 = 4/3.

10. A composite wall of a furnace has two layers of equal thickness having thermal conductivities in the ratio 2:3. What is the ratio of the temperature drop across the two layers?
a) 2:3
b) 3:2
c) 1:2
d) $\log_e 2 : \log_e 3$

Answer: b
Explanation: We know that temperature is inversely proportional to thermal conductivity, so the ratio is 2:3.

TOPIC 3.10 THERMAL INSULATION

1. According to Indian Standards, it is recommended that the overall thermal transmittance of a roof should not be more than _____ kcal/m^2 h deg C.
a) 2.00
b) 5.00
c) 7.00
d) 9.00

Answer: a
Explanation: According to Indian Standards, it is recommended that the overall thermal transmittance of a roof should not be more than 2.00 kcal/m^2 h deg C. It is also recommended that the thermal dampness of a roof should be less than 75%.

2. The process of direct transmission of heat through a material is known as _____
a) Conduction
b) Radiation
c) Thermal insulation
d) Thermal energy

Answer: a
Explanation: The process of direct transmission of heat through a material is known as conduction. The amount of heat transfer by this process depends on various factors like temperature difference, the conductivity of the medium, the time for which the flow takes place etc.

3. Thermal insulation keeps the room cool in winters and hot in summers.
a) True
b) False

Answer: b
Explanation: Thermal insulation keeps the room hot in winters and cool in summers which results in comfortable living. It minimises heat transfer and helps in saving fuel to maintain the desired temperature in the room.

4. The amount of heat flow through a unit area of material of unit thickness in one hour, when the temperature difference is maintained at 1°C is known as _____ of the material.
a) Thermal conductivity
b) Thermal resistivity
c) Thermal conductance
d) Thermal resistance

Answer: a
Explanation: The amount of heat flow through a unit area of material of unit thickness in one hour, when the temperature difference is maintained at 1°C is known as the thermal conductivity. It is denoted by k. Its units are W/(mK).

5. The reciprocal of thermal conductivity is known as _____
a) Thermal conductance
b) Surface resistance
c) Specific conductance
d) Thermal resistivity

Answer: d
Explanation: The reciprocal of thermal conductivity is known as thermal resistivity. It is given by 1/k. Its units are (mK)/W.

6. Which of the following is the correct relationship between thermal resistance and thermal conductivity?
a) R = k/L
b) R = k.L
c) R = L/k
d) R = L^2/k

Answer: c
Explanation: Thermal resistance and thermal conductivity are related by the equation R = L/k. Here, R is the thermal resistance, k is the thermal conductivity and L is the thickness. Thermal resistance is the reciprocal of thermal conductance.

7. Surface resistance is the reciprocal of _____
a) Surface coefficient
b) Surface resistivity
c) Surface conductance
d) Surface conductivity

Answer: a
Explanation: Surface resistance is the reciprocal of the surface coefficient. It is given by 1/f where f denotes the surface coefficient. Its units are $(m^2K)/W$.

8. Thermal damping is given by the equation D = (T-t/T) x 100. Here, T denotes _____
a) Outside temperature range
b) Inside temperature range
c) Total outside and inside temperature range
d) Thickness

Answer: a
Explanation: Thermal damping is given by the equation D = (T-t/T) x 100. Here, T denotes outside temperature range and t denotes inside temperature range. Also, thermal damping is denoted by D.

9. Which of the following is the correct relation between thermal transmittance and thermal time constant?
a) T = Q x U
b) T = k/U
c) T = Q/U
d) T = U/Q

Answer: c
Explanation: Thermal transmittance and thermal time constant are related by the equation T = Q/U. Here, T denotes the thermal time constant, U is the thermal transmittance and Q is the quantity of heat stored.

10. Which of the following is not a quality of a good thermal insulating material?
a) It should be durable
b) It should have a low thermal resistance
c) It should be readily available
d) It should be fireproof

Answer: b
Explanation: A good thermal insulating material should be durable. It should have high thermal resistance. It should be fireproof and readily available.

11. Reflective sheet materials used as thermal insulating material have _____ reflectivity and _____ emissivity.
a) High, high
b) High, low
c) Low, low
d) Low, high

Answer: b
Explanation: Reflective sheet materials used as thermal insulating material have high reflectivity and low emissivity. Because of this property, it offers high heat resistance.

12. Thermal insulation of roofs can be obtained by covering the top exposed surface of the roof with _____
a) 2.5 cm thick layer of mud mortar
b) 2.5 cm thick layer of coconut pitch cement concrete
c) 7.5 cm thick layer of mud mortar
d) 7.5 m thick layer of coconut pitch cement concrete

Answer: b
Explanation: Thermal insulation of roofs can be obtained by covering the top exposed surface of the roof with 2.5 cm thick layer of coconut pitch cement concrete. Coconut pitch cement concrete is prepared by mixing coconut pitch with water and cement.

13. Presence of moisture in the thermal insulating material increases thermal insulation while the presence of air spaces decreases thermal insulation.
a) True
b) False

Answer: b
Explanation: Presence of moisture in the thermal insulating material decreases thermal insulation while the presence of air spaces increases thermal insulation. The choice of the thermal insulating material depends on various factors like cost of material, area to be covered, coat of heating or cooling, etc.

14. According to the Indian Standards, it is recommended that thermal damping of a wall should not be less than _____
a) 40%
b) 50%
c) 60%
d) 80%

Answer: c
Explanation: According to the Indian Standards, it is recommended that the thermal damping of a wall should not be less than 60%. Hence, it is also recommended that the thermal time constant should not be less than 16 h.

15. According to Indian Standards, overall thermal transmittance of a wall should not be more than _____ kcal/m^2 h deg C.
a) 1.3
b) 2.2
c) 3.7
d) 4.6

Answer: b
Explanation: According to Indian Standards, overall thermal transmittance of a wall should not be more than 2.2 kcal/m^2 h deg C. Heat insulation of exposed walls can be achieved by increasing the thickness of the wall.

TOPIC 3.11 APPLICATIONS: HEAT EXCHANGERS, REFRIGERATORS, OVENS AND SOLAR WATER HEATERS.

1. What is solar water heater?
a) Use solar energy to heat water
b) Use solar energy to generate current which is then used to heat water
c) Use water to generate heat
d) Use solar energy to generate steam

Answer: a
Explanation: Solar water heater is a system that converts sunlight into heat. This heat is then used to heat water. As the water gets heated, steam may be produced but the purpose of solar water is to heat water and not produce steam. It does not generate current.

2. Which of the following determines complexity and size of solar water heating system?
a) Food
b) Changes in ambient temperature
c) Chemicals
d) Solar radiation constant

Answer: b
Explanation: Changes in ambient temperature during day-night cycle is one of the factors that determines the complexity and size of solar water heating system. Food, chemicals and solar radiation constant does not influence the complexity and size of the system.

3. What is freeze protection in a solar water heating system?
a) Ensures that the system is frozen
b) Prevents the operation of drainback system
c) Prevents damage to system due to freezing of transfer fluid
d) Ensures that the transfer fluid is frozen

Answer: c
Explanation: Freeze protection in a solar water system prevents the system being damaged due to freezing of transfer fluid. It does not prevent the operation of drainback system.

4. What are drainback systems in solar water heating system?
a) The system that reverses the direction of flow of transfer fluid
b) The system that tracks the sun
c) The system that pumps excess transfer fluid
d) The system that drains the transfer fluid

Answer: d
Explanation: Drainback systems are systems that drain the transfer fluid particularly to ensure freeze protection. This prevents the freezing of transfer fluid and any unwanted damage to the system.

5. How does freeze-tolerance work?
a) By expansion of pipes carrying transfer fluid
b) By compression of pipes carrying transfer fluid
c) By increasing the temperature of pipes carrying transfer fluid
d) By increasing the pressure inside pipes carrying transfer fluid

Answer: a
Explanation: Freeze-tolerance works by expansion of pipes carrying the transfer fluid. The low pressure pipes are made of silicone rubber that expands on freezing.

6. Which of the following metals are used to make pipes of low cost solar water heating system?
a) Gold
b) Copper
c) Polymer
d) Silver

Answer: b
Explanation: Copper is used to make pipes of low cost solar water heating systems. Though silver and gold are good thermal conductors they are expensive. Polymer is not a metal.

7. Direct solar water heating systems _____
a) offer great overheating protection
b) are called pumped systems
c) offer no overheating protection
d) offer great freeze protection

Answer: c
Explanation: Direct solar water heating systems are also called compact systems. They offer little or no overheating protection unless they have a heat export pump.

8. How is the heat transferred from transfer fluid to potable water in indirect solar water heating systems?
a) By directly exposing the substance to sunlight
b) By using an electrical heater
c) By circulating potable water through the collector
d) By using heat exchanger

Answer: d
Explanation: An indirect solar water heating system uses a heat exchanger to transfer heat from the transfer fluid to the potable water. It does not expose the transfer fluid directly to the sunlight and does not use an electrical heater.

9. How is water heated in a direct solar water heating system?
a) By circulating potable water through the collector
b) By directly exposing water to sunlight
c) By using convection from a different transfer fluid
d) By using heat exchanger

Answer: a
Explanation: In a direct solar water heating system, the potable water is the transfer fluid. Hence, it is heated by circulating through the collector. Indirect solar water heating systems use a heat exchanger.

10. Passive systems rely on heat-driven convection.

a) False
b) True

Answer: b
Explanation: Passive systems rely on heat-driven convection. If not, they also use heat pipes to circulate the working fluid through the collector and heat it. Hence, they are cheap and are easily maintained.

11. Which of the following is an example of direct solar water heating system?
a) Pressurised antifreeze system
b) Pumped systems to circulate transfer fluid
c) Convection heat storage system
d) Drainback system

Answer: c
Explanation: Convection heat storage system is similar to an integrated collector storage system. Both these systems are examples of direct solar water heating systems.

12. How is the heat transfer fluid (HTF) heated in bubble pump systems?
a) By subjecting the closed HTF circuit to high pressure
b) By subjecting the closed HTF circuit to high pressure and by increasing the volume
c) By subjecting the closed HTF circuit to low pressure and by decreasing the volume
d) By subjecting the closed HTF circuit to low pressure

Answer: d
Explanation: In a bubble pump system, the heat transfer fluid circuit is subjected to a low pressure. This causes the liquid to boil at low temperatures as the sun heats it. The volume is not changed.

13. Batch collectors reduce heat loss by thermally insulating the storage tank.
a) True
b) False

Answer: a
Explanation: Batch collectors reduce heat loss by thermally insulating the storage tank. This is done by covering the tank in a glass-topped box that allows heat from sun to reach the water tank and traps it – greenhouse effect.

14. Overheat protection is done by passing hot water through collector during night.
a) False
b) True

Answer: b
Explanation: Overheat protection is done by passing hot water through collector during night or when there is less sunlight. This is extremely effective in direct or thermal store plumbing and ineffective in evacuated-tube collectors.

UNIT IV QUANTUM PHYSICS

TOPIC 4.1 BLACK BODY RADIATION

1. As the wavelength of the radiation decreases, the intensity of the black body radiations _____
a) Increases
b) Decreases
c) First increases then decrease
d) First decreases then increase

Answer: c
Explanation: In the case of Black Body radiations, as the body gets hotter the wavelength of the emitted radiation decreases. However, the intensity first increases up to a specific wavelength than starts decreasing, as the wavelength continues to decrease.

2. The radiations emitted by hot bodies are called as _____
a) X-rays
b) Black-body radiation
c) Gamma radiations
d) Visible light

Answer: b
Explanation: The phenomenon of black—body radiations was given by Max Planck. He stated that hot bodies emit radiation over a wide range of wavelengths. An ideal body is the one that emits and absorbs radiation of all frequencies. Such a body called a Black Body and the radiations are called Black body radiations.

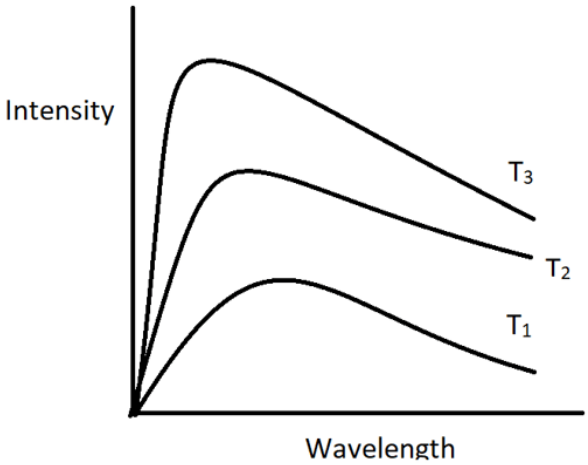
3. An iron rod is heated. The colors at different temperatures are noted. Which of the following colors shows that the iron rod is at the lowest temperature?
a) Red
b) Orange
c) White
d) Blue

Answer: a
Explanation: As the body gets hotter, the frequency of the emitted radiation keeps on increasing. Blue color has the highest frequency out of red, orange and white. Thus, as the iron rod gets heated first it would become red, then orange, then white and then finally blue.

4. A black body is defined as a perfect absorber of radiations. It may or may not be a perfect emitter of radiations.
a) True
b) False

Answer: b
Explanation: A black body is defined as the one which is a perfect absorber as well as a perfect emitter of radiations. Such a body would absorb all the radiations falling on it and would emit all of them when heated.

5. From the figure, what's the relation between T_1, T_2, and T_3?



a) $T_1 > T_2 > T_3$
b) $T_3 > T_2 > T_2$
c) $T_3 > T_1 > T_2$
d) $T_2 > T_1 > T_3$

Answer: b
Explanation: We already know, as the temperature of the body is higher, the intensity of the black body radiations would be higher. Thus, from the graph, the radiations with temperature T_3 has the highest intensity followed by the one with temperature T_2 and then T_1. Thus, $T_3 > T_2 > T_1$.

6. Electromagnetic wave theory of light could not explain Black Body radiations.
a) True
b) False

Answer: a
Explanation: According to electromagnetic theory, the absorption and the emission should be continuous. As the wavelength keeps decreasing, the intensity of the emitted radiations should keep increasing to infinity. Such is not the case with Black Body Radiations.

7. The unit of absorptive power is
_____

a) T
b) Ts^{-1}
c) Ts
d) No unit

Answer: d
Explanation: Absorptive power can be defined as the ratio of energy absorbed per unit area upon energy incident per unit time per unit area. For a black body, it's absorptive power is equal to one.

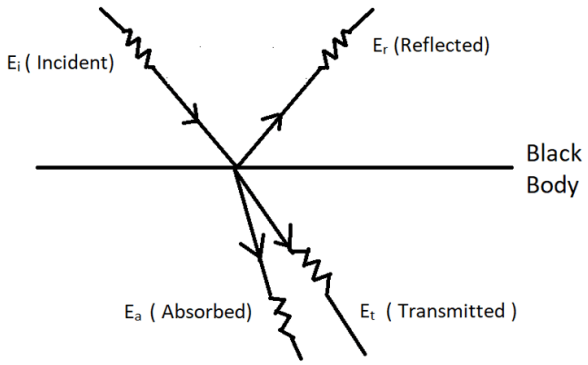
8. For an object other than a black body, it's emissivity, e is _____
a) 1
b) $0 < e < 1$
c) $e > 1$
d) $e = 0$

Answer: b
Explanation: Emissivity is the ratio of emissive power of any object and the emissive power of the black body having the same temperature and surface area as the object. Thus, for a black body, it is equal to 1. For any other object, it is less than 1.

9. What relation between emissivity, e, and Absorptive Power, a, is given by Kirchhoff's law?
a) $e < a$
b) $e > a$
c) $e = a$
d) no specific relation

Answer: c
Explanation: Kirchhoff's law states that for any object the emissivity is always equal to absorptive power. For a black body, both of them are equal to one.

10. What is the relation between the Energies as shown in the figure?



a) $E_r = 0$
b) $E_a = 0$
c) $E_t = E_i$
d) $E_i = E_r$

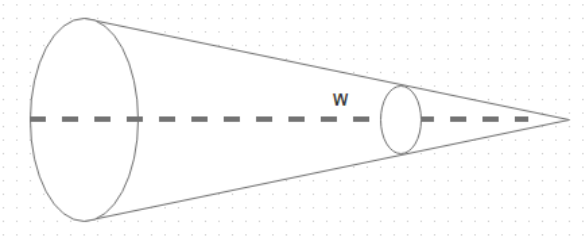
Answer: a
Explanation: As a black body is a perfect absorber, the reflected energy and the transmitted energy should be zero. Also, the energy of the incident radiation should be equal to the energy absorbed.

TOPIC 4.2 PLANCK'S THEORY (DERIVATION)

1. The energy emitted by a black surface should not vary in accordance with
a) Wavelength
b) Temperature
c) Surface characteristics
d) Time

Answer: d
Explanation: It is time independent. For a prescribed wavelength, the body radiates much more energy at elevated temperatures.

2. In the given diagram let r be the length of the line of propagation between the radiating and the incident surfaces. What is the value of solid angle W?



a) A sin α
b) A cos α
c) 2A cos α
d) 2A cos α

Answer: b
Explanation: The solid angle is defined by a region by the rays of a sphere, and is measured as A_n/r^2.

3. Likewise the amount of emitted radiation is strongly influenced by the wavelength even if temperature of the body is
a) Constant
b) Increasing
c) Decreasing
d) It is not related with temperature

Answer: a
Explanation: Temperature must remain constant in order to emit radiation.

4. A small body has a total emissive power of 4.5 kW/m^2. Determine the wavelength of emission maximum
a) 8.46 micron m
b) 7.46 micron m
c) 6.46 micron m
d) 5.46 micron m

Answer: d
Explanation: $(Wavelength)_{max}\ t = 2.8908 * 10^{-3}$.

5. The sun emits maximum radiation of 0.52 micron meter. Assuming the sun to be a black body, Calculate the emissive ability of the sun's surface at that temperature
a) $3.47 * 10^7\ W/m^2$
b) $4.47 * 10^7\ W/m^2$
c) $5.47 * 10^7\ W/m^2$
d) $6.47 * 10^7\ W/m^2$

Answer: c
Explanation: $E = \sigma_b t^4 = 5.47 * 10^7\ W/m^2$.

6. The law governing the distribution of radiant energy over wavelength for a black body at fixed temperature is referred to as
a) Kirchhoff's law
b) Planck's law
c) Wein's formula
d) Lambert's law

Answer: b
Explanation: This law gives a relation between energy over wavelength.

7. The Planck's constant h has the dimensions equal to
a) $M L^2 T^{-1}$
b) $M L T^{-1}$
c) $M L T^{-2}$
d) M L T

Answer: a
Explanation: It has unit equal to J s and its value is $6.626 * 10^{-34}$.

8. Planck's law is given by
a) $(E)_b = 2 \pi c^2 h\ (Wavelength)^{-5}/[c\ h/k\ (Wavelength)\ T] - 2$
b) $(E)_b = \pi c^2 h$ [exponential [c h/k (Wavelength) T] – 3].
c) $(E)_b = 2 \pi c^2 h\ (Wavelength)^{-5}$/exponential [c h/k (Wavelength) T] – 1
d) $(E)_b = 2 c^2 h\ (Wavelength)^{-5}$/exponential [c h/k (Wavelength) T] – 6

Answer: c
Explanation: Planck suggested the following law for the spectral distribution of emissive power.

9. A furnace emits radiation at 2000 K. Treating it as a black body radiation, calculate the monochromatic radiant flux density at 1 micron m wavelength
a) $5.81 * 10^7$ W/m^2
b) $4.81 * 10^7$ W/m^2
c) $3.81 * 10^7$ W/m^2
d) $2.81 * 10^7$ W/m^2

Answer: d
Explanation: $(E)_b = C_1$ (Wavelength)$^{-5}$/exponential [C_2/ (Wavelength) T] – 1.

10. A metal sphere of surface area 0.0225 m^2 is in an evacuated enclosure whose walls are held at a very low temperature. Electric current is passed through resistors embedded in the sphere causing electrical energy to be dissipated at the rate of 75 W. If the sphere surfaces temperature is measured to be 560 K, while in steady state, calculate emissivity of the sphere surface
a) 0.498
b) 0.598
c) 0.698
d) 0.798

Answer: b
Explanation: E = e A σ b T.

TOPIC 4.3 COMPTON EFFECT: THEORY AND EXPERIMENTAL VERIFICATION

1. Which of the following is the characteristic of a black body?
a) A perfect absorber but an imperfect radiator
b) A perfect radiator but an imperfect absorber
c) A perfect radiator and a perfect absorber
d) A perfect conductor

Answer: c
Explanation: When the radiations are made to pass through a black body, it undergoes multiple reflections and is completely absorbed. When it is placed in a temperature bath of fixed temperature, the heat radiations will come out. Thus a black body is a perfect absorber and a perfect reflector.

2. The energy distribution is not uniform for any given temperature in a perfect black body.
a) True
b) False

Answer: a
Explanation: At different temperatures, when a perfect black body is allowed to emit radiations, then the distribution of energy for different wavelengths at various temperatures is not uniform.

3. Rayleigh-Jean's law holds good for which of the following?
a) Shorter wavelength
b) Longer wavelength
c) High temperature
d) High energy

Answer: b
Explanation: According to this law, the energy distribution is directly proportional to the absolute temperature and is inversely proportional to the fourth power of the wavelength. Therefore longer the wavelength, greater is the energy distribution.

4. Wien's displacement law holds good only for shorter wavelength.
a) False
b) True

Answer: b
Explanation: This law states that, the product of the wavelength, corresponding to maximum energy and the absolute temperature, is constant. If ʎ is less, then 1/ʎ will be great. Therefore $e^{(hc/ʎKT)}$ will be great.

5. Which of the following does not affect the photon?
a) Magnetic or electric field
b) Light waves
c) Gravity
d) Current

Answer: a
Explanation: Photons have no charge. They can interact with charged particles but not with themselves. This is why photons are neutral and not affected by magnetic or electric fields.

6. What is Compton shift?
a) Shift in frequency
b) Shift in charges
c) Shift in radiation
d) Shift in wavelength

Answer: d
Explanation: When a photon collides with an electron at rest, the photon gives its energy to the electron. Therefore the scattered photon will have higher wavelength compared to the wavelength of the incident photon. This shift in wavelength is called Compton shift.

7. Compton shift depends on which of the following?
a) Incident radiation
b) Nature of scattering substance
c) Angle of scattering
d) Amplitude of frequency

Answer: c
Explanation: From the theory of Compton effect it is deducted that change in wavelength
$\Delta\lambda = h/mc\ (1-\cos\theta)$. This equation shows that the change in wavelength is independent of the incident radiation as well as the nature of scattering substance. The shift depends only on the angle of scattering.

8. Which of the following is called as non-mechanical waves?
a) Magnetic waves
b) Electromagnetic waves
c) Electrical waves
d) Matter waves

Answer: b
Explanation: The waves which travel in the form of oscillating electric and magnetic waves are called electromagnetic waves. Such waves do not require any material for their propagation and are called non-mechanical waves.

9. Which of the following is associated with an electron microscope?
a) Matter waves
b) Electrical waves
c) Magnetic waves
d) Electromagnetic waves

Answer: a
Explanation: The waves associated with microscopic particles when they are in motion are called matter waves. Electron microscope makes use of the matter waves associated with fast moving electrons.

10. A radio station broadcasts its programme at 219.3 metre wavelength. Determine the frequency of radio waves if velocity of radio waves is 3×10^8 m/s.
a) 7.31×10^{-7} Hz
b) 1.954×10^{-6} Hz
c) 1.368×10^{6} Hz
d) 6.579×10^{10} Hz

Answer: c
Explanation: λ = velocity/frequency
Frequency = velocity/λ
Therefore, frequency = 1.368×10^6 Hz.

11. Calculate the de-Broglie wavelength of an electron which has been accelerated from rest on application of potential of 400volts.
a) 0.1653 Å
b) 0.5125 Å
c) 0.6135 Å
d) 0.2514 Å

Answer: c
Explanation: de-Broglie wavelength = h/ $\sqrt{(2\times m\times e\times V)}$
De-Broglie wavelength = $(6.625\times10^{-14})/\sqrt{(2\times9.11\times10^{-31}\times1.6\times10^{-19}\times400)}$
Wavelength = 0.6135 Å.

TOPIC 4.4 WAVE PARTICLE DUALITY

1. When a pebble is dropped into a pond of still water, what happens?
a) Particles move
b) Waves move
c) The pebble moves
d) Water moves

Answer: b
Explanation: When a pebble is thrown in still water, a circular pattern of alternate crests spread out. The kinetic energy makes the particles to oscillate which comes in contact with it. The energy gets transferred to the particles of the next layer which also begins to oscillate. Thus it is the disturbance or waves that move forward and not the particles of the medium.

2. Mechanical waves are called elastic waves.
a) True
b) False

Answer: a
Explanation: Waves which require a medium for their propagation are called mechanical waves. They are also called elastic waves because they depend on the elastic properties of a medium.

3. What are the essential properties a medium must possess for the propagation of mechanical waves?
a) Stable pressure
b) Maximum friction
c) Constant temperature
d) Minimum friction

Answer: d
Explanation: The friction force amongst the particles of the medium should be negligibly small so that they continue oscillating for a sufficiently long time and the wave travels a sufficiently long distance through the medium

4. Transverse waves can be formed in fluids.
a) True
b) False

Answer: b
Explanation: Transverse waves travel in the form of crests and troughs. They involve changes in the shape of the medium. So they can be transmitted through media which have rigidity. As fluids do not sustain shearing stress, transverse waves cannot be formed in them.

5. Which of the following waves can be transmitted through solids, liquids and gases?
a) Transverse waves
b) Electromagnetic waves
c) Mechanical waves
d) Longitudinal waves

Answer: d
Explanation: Longitudinal waves involve changes in the volume and density of the medium. Since all media can sustain compressive stress, longitudinal waves can be transmitted through all the three types of media.

6. For an aluminium the modulus of rigidity is 2.1×10^{10} N/m^2 and density is 2.7×10^3 kg/m^3. Find the speed of transverse waves in the medium.
a) 27.9×10^3 m/s
b) 2.79×10^3 m/s
c) 25.14×10^3 m/s
d) 24.1×10^3 m/s

Answer: b
Explanation: Speed = $\sqrt{(\eta/p)}$
Speed = 2.79×10^3 m/s.

7. Sound travels through a gas under which of the following condition?
a) Isothermal condition
b) Non-isothermal condition
c) Adiabatic condition
d) Transverse condition

Answer: c
Explanation: The compressions and rarefactions are formed so rapidly that the heat generated in the regions of compressions does not get time to pass into the regions of rarefactions so as to equalize the temperature. So when sound travels through gas, the temperature remains constant. Therefore, it is adiabatic.

8. What kind of wave is formed in organ pipes?
a) Transverse stationary waves
b) Electromagnetic waves
c) Mechanical waves
d) Longitudinal stationary waves

Answer: d
Explanation: When two identical longitudinal waves travelling in opposite directions overlap, a longitudinal stationary wave is formed. Thus, the waves produced in organ pipes are longitudinal stationary waves.

9. A wave transmits momentum. Can't it transfer angular momentum?
a) Yes
b) No

Answer: b
Explanation: A wave transmitting momentum cannot transmit angular momentum because a transfer of angular momentum means the action of a torque which causes rotator motion.

10. What is the most fundamental property of wave?
a) Temperature
b) Pressure
c) Frequency
d) Wavelength

Answer: c
Explanation: When a wave travels from one medium to other, its wavelength as well as velocity may change. This is the reason that frequency is the fundamental property of a wave.

11. Which of the following is also known as pressure waves?
a) Transverse waves
b) Longitudinal waves
c) Mechanical waves
d) Stationary waves

Answer: b
Explanation: Longitudinal waves travel in a medium as series of alternate compressions and rarefactions and hence are called pressure waves.

12. In which medium sound travels faster?
a) Solid
b) Liquid
c) Gas
d) Water vapour

Answer: a
Explanation: Sound travels in solid with the highest speed because the coefficient of elasticity of solids is much greater than the coefficient of elasticity of liquids and gases.

TOPIC 4.5 ELECTRON DIFFRACTION

1. TEM and SEM are the same microscopy techniques.
a) True
b) False

Answer: a
Explanation: Transmission electron microscopy (TEM) and scanning electron microscopy (SEM) are the different types of

electron microscopy. These use electrons for casting the images of an object.

2. The resolving power of TEM is derived from _____
a) electrons
b) specimens
c) power
d) ocular system

Answer: a
Explanation: The resolving power of a transmission electron microscope is derived from the wave-like property of electrons that pass through the specimen. In SEM, the electrons reflect back from the specimen.

3. The cathode of transmission electron microscope consists of a _____
a) tungsten wire
b) bulb
c) iron filament
d) gold wire

Answer: a
Explanation: The cathode of a transmission electron microscope (TEM) is located on top of the column, it contains a tungsten wire filament that is heated to provide the source of electrons.

4. The resolution attainable with standard TEM is less than the theoretical value.
a) True
b) False

Answer: a
Explanation: The resolution that can be attained with a standard transmission electron microscope is about two orders of magnitude less than the theoretical value. This is due to spherical aberration of electron-focusing lenses.

5. During TEM, a vacuum is created inside the _____
a) room of operation
b) specimen
c) column
d) ocular system

Answer: c
Explanation: To prevent the premature scattering of electrons by collision with the gas molecules, a vacuum is generated through which the electrons travel, in the column prior to operation.

6. Which of the following component of TEM focuses the beam of electrons on the sample?
a) ocular lens
b) condenser lens
c) stage
d) column

Answer: b
Explanation: The condenser lens focuses the electron beam on to the specimen, in case of transmission electron microscope. The specimen is supported on the grid holder and placed inside the column.

7. Image formation in electron microscope is based on _____
a) column length
b) electron number
c) differential scattering
d) specimen size

Answer: c
Explanation: In case of the electron microscope, the image formation is based on the differential scattering of the electrons by parts of the specimen. The scattering of electrons is proportional to the size nuclei of the atoms that make up the sample.

8. The biological materials have little intrinsic capability to _____
a) scatter electrons
b) stain
c) remain viable
d) be captured

Answer: a
Explanation: The insoluble materials of cells contain atoms of low atomic number such as carbon, hydrogen, oxygen and nitrogen. The biological materials therefore have very little intrinsic capability of scattering the electrons.

9. Glutaraldehyde is a _____
a) metal
b) fixative
c) non-metal
d) atomic species

Answer: b
Explanation: Glutaraldehyde and osmium tetroxide are common fixatives used in the transmission electron microscopy for the fixation of biological specimens. They stain as well as keep the sectioned specimens in a state of similarity with the living counterpart.

10. Osmium is a _____
a) non metal
b) heavy metal
c) alloy
d) light metal

Answer: b
Explanation: Osmium is a heavy metal that reacts with fatty acids leading to the preservation of membranes. Osmium tetroxide is used as a fixative in transmission electron microscopy.

11. In TEM, the tissue is stained by floating on drops of _____
a) hydrocarbons
b) slow-molecular weight stains
c) heavy metal soutions
d) oil immersion

Answer: c
Explanation: The tissue is stained by floating on drops of uranyl acetate and lead citrate (heavy metal solutions). These solutions when bound to the specimen, provide the density required to scatter the electron beam.

12. Shadow casting is a technique of visualizing _____
a) isolated particles
b) mounts
c) shoot tips
d) root tips

Answer: a
Explanation: Shadow casting is a technique of viewing isolated particles. The particles are made to cast shadows after their placement in sealed chambers. The chamber contains a filament of carbon and a heavy metal.

TOPIC 4.6 CONCEPT OF WAVE FUNCTION AND ITS PHYSICAL SIGNIFICANCE

TOPIC 4.7 SCHRODINGER'S WAVE EQUATION

TOPIC 4.8 TIME INDEPENDENT AND TIME DEPENDENT EQUATIONS

1. Which of the following is the correct expression for the Schrödinger wave function?
a) $i\hbar\frac{d\Psi}{dt} = -i\frac{\hbar}{2m}\frac{\partial\Psi}{\partial x} + U\Psi$
b) $i\hbar\frac{d\Psi}{dt} = -i\frac{\hbar}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$
c) $i\hbar\frac{d\Psi}{dt} = -i\frac{\hbar^z}{2m}\frac{\partial\Psi}{\partial x} + U\Psi$
d) $i\hbar\frac{d\Psi}{dt} = -i\frac{\hbar^z}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$

Answer: d
Explanation: The correct expression for the Schrödinger wave equation is $i\hbar\frac{d\Psi}{dt} = -i\frac{\hbar^z}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$. Schrodinger equation is a basic principle in itself.

2. For a quantum wave particle, E = _____
a) ℏ k
b) ℏ ω

c) ℏ ω/2
d) ℏ k/2

Answer: b
Explanation: The Energy of a wave particle is given as ℏ ω while the momentum of the particle is given as ℏ k. These are the desired relation.

3. Schrodinger Wave equation can be derived from Principles of Quantum Mechanics.
a) True
b) False

Answer: b
Explanation: Schrodinger equation is a basic principle in itself. It cannot be derived from other principles of physics. Only, it can be verified with other principles.

4. Which of the following can be a wave function?
a) tan x
b) sin x
c) cot x
d) sec x

Answer: b
Explanation: Out of all the given options, sin x is the only function, that is continuous and single-valued. All the rest of the functions are either discontinuous or double-valued.

5. Which of the following is not a characteristic of wave function?
a) Continuous
b) Single valued
c) Differentiable
d) Physically Significant

Answer: d
Explanation: The wave function has no physical significance. It merely helps in determining the state of a particle. It is the square of the wave function that has a physical significance.

6. Find the function, f(x), for which X f(x) = $-\frac{i}{\hbar}a^2 p_x f(x)$, where a is the real quantity.
a) ke^{-x^2}
b) $ke^{-x^2/2a}$
c) $ke^{-x^2/2a^2}$
d) $ke^{-x^2/2a}$

Answer: c
Explanation: Now, given that, X f(x) = $-\frac{i}{\hbar}a^2 p_x f(x)$.
X f(x) = $-\frac{i}{\hbar}a^2 p_x f(x)/dx$
df/f = $-xdx/a^2$
ln f = $-x^2/2a^2 + C$
f = $ke^{-x^2/2a^2}$.

7. dΨ/dx must be zero.
a) True
b) False

Answer: b
Explanation: For a wave function, dΨ/dx, must be continuous and single-valued everywhere, just like Ψ. Also, Ψ must be normalizable.

8. Any wave function can be written as a linear combination of _____
a) Eigen Vectors
b) Eigen Values
c) Eigen Functions
d) Operators

Answer: c
Explanation: A wave function describes the state of a particle. It does not have a physical significance. Moreover, it can be written as a linear combination of Eigen functions, i.e., Ψ(x) = AF(x) + BG(x).

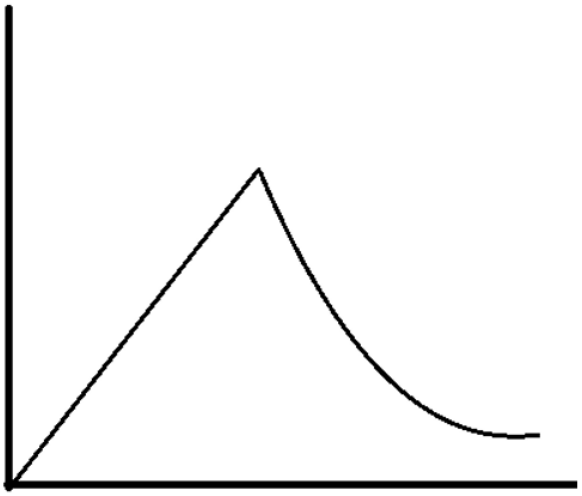
9. The Schrödinger is a differential equation.
a) True
b) False

Answer: b
Explanation: The Schrodinger wave equation

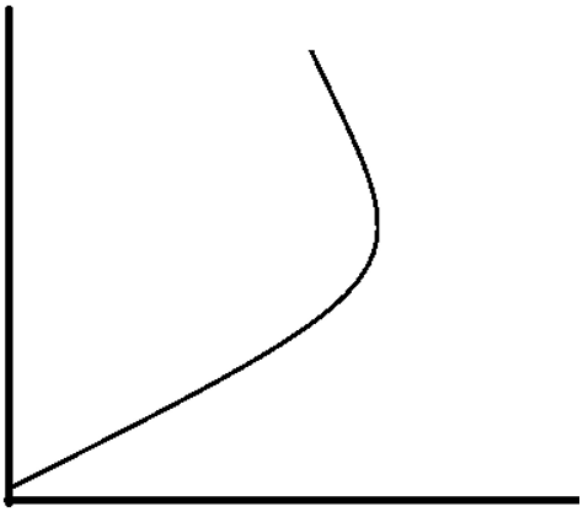
generated is a partial differential equation. It is a basic principle in itself and cannot be derived from other principles of physics. There are two types of partial differential equation time dependent form and steady-state form.

10. Which of the following can be a solution of Schrodinger equation?

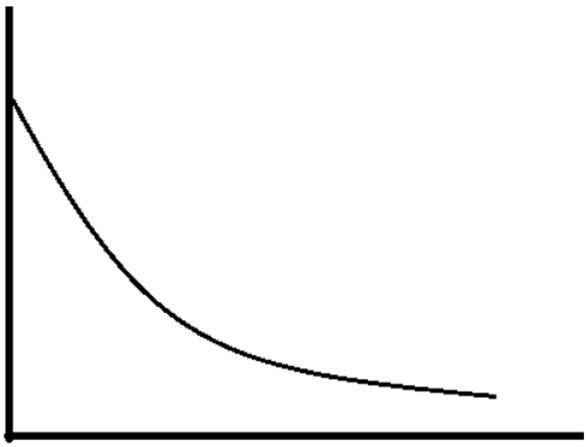
a)



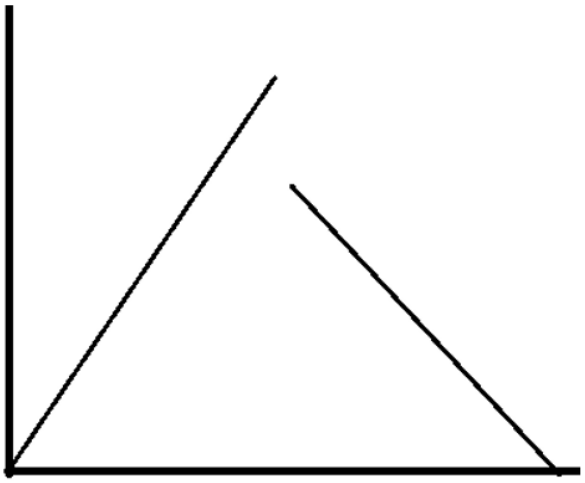
b)



c)

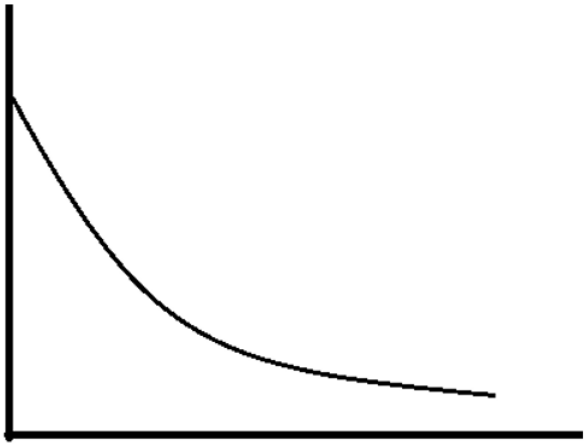


d)



Answer: c

Explanation: Out of the following, only the below diagram can be the solution of the Schrodinger Wave equation. because other diagram does not have a continuous dΨ/dx. Some diagrams are double valued and discontinuous also.



TOPIC 4.9 PARTICLE IN A ONE-DIMENSIONAL RIGID BOX

1. The walls of a particle in a box are supposed to be _____
a) Small but infinitely hard
b) Infinitely large but soft
c) Soft and Small
d) Infinitely hard and infinitely large

Answer: d
Explanation: The simplest quantum-mechanical problem is that of a particle in a box with infinitely hard walls and are infinitely large.

2. The wave function of the particle lies in which region?
a) $x > 0$
b) $x < 0$
c) $0 < X < L$
d) $x > L$

Answer: c
Explanation: The particle cannot exist outside the box, as it cannot have infinite amount of energy. Thus, it's wave function is between 0 and L, where L is the length of the side of the box.

3. The particle loses energy when it collides with the wall.
a) True
b) False

Answer: b
Explanation: The total energy of the particle inside the box remains constant. It does not loses energy when it collides with the wall.

4. The Energy of the particle is proportional to _____
a) n
b) n^{-1}
c) n^2
d) n^{-2}

Answer: c
Explanation: In a particle inside a box, the energy of the particle is directly proportional to the square of the quantum state in which the particle currently is.

5. For a particle inside a box, the potential is maximum at x = _____
a) L
b) 2L
c) L/2
d) 3L

Answer: a
Explanation: In a box with infinitely high barriers with infinitely hard walls, the potential is infinite when x = 0 and when x = L.

6. The Eigen value of a particle in a box is _____
a) L/2
b) 2/L
c) $\sqrt{L/2}$
d) $\sqrt{2/L}$

Answer: d
Explanation: The wave function for the particle in a box is normalizable, when the value of the coefficient of sin is equal to $\sqrt{2/L}$. It is the Eigen value of the wave function.

7. Particle in a box can never be at rest.
a) True
b) False

Answer: a
Explanation: If the particle in a box has zero energy, it will be at rest inside the well and it violates the Heisenberg's Uncertainty Principle. Thus, the minimum energy possessed by a particle is not equal to zero.

8. What is the minimum Energy possessed by the particle in a box?
a) Zero

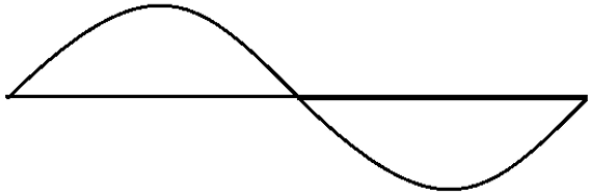
b) $\frac{\pi^2\hbar^2}{2mL^2}$
c) $\frac{\pi^2\hbar^2}{2mL}$
d) $\frac{\pi^2\hbar}{2mL}$

Answer: b
Explanation: The minimum energy possessed by a particle inside a box with infinitely hard walls is equal to $\frac{\pi^2\hbar^2}{2mL^2}$. The particle can never be at rest, as it will violate Heisenberg's Uncertainty Principle.

9. The wave function of a particle in a box is given by _____
a) $\sqrt{\frac{2}{L}}sin\frac{nx}{L}$
b) $\sqrt{\frac{2}{L}}sin\frac{n\pi x}{L}$
c) $\sqrt{\frac{2}{L}}sin\frac{x}{L}$
d) $\sqrt{\frac{2}{L}}sin\frac{\pi x}{L}$

Answer: b
Explanation: The wave function for the particle in a box is given by: $\sqrt{\frac{2}{L}}sin\frac{n\pi x}{L}$. The Energy possessed by the particle is given by: $\frac{n^2\pi^2\hbar^2}{2mL^2}$.

10. The wave function for which quantum state is shown in the figure?



a) 1
b) 2
c) 3
d) 4

Answer: b
Explanation: The shown wave function is for the 2nd principal quantum number, i.e., it is the wave function for the state when n = 2.

11. Calculate the Zero-point energy for a particle in an infinite potential well for an electron confined to a 1 nm atom.
a) 3.9 X 10^{-29} J
b) 4.9 X 10^{-29} J
c) 5.9 X 10^{-29} J
d) 6.9 X 10^{-29} J

Answer: c
Explanation: Here, m = 9.1 X 10^{-31} kg, L = 10^{-9}m.
Therefore, E = $\frac{\pi^2\hbar^2}{2mL^2}$
= 3.14 X 3.14 X 1.05 X 1.05 X 10^{-68}/ 2 X 9.1 X 10^{-31} X 10^{-9}
= 5.9 X 10^{-29} J.

TOPIC 4.10 TUNNELLING (QUALITATIVE)

1. Tunneling is required in case of

_____
a) Laying pavement
b) Laying road
c) On ground passage
d) Underground passage

Answer: d
Explanation: Tunnel can be defined as artificial underground passage, which is created for different purposes. It is required in case of highways, railways, sewerage and water supply.

2. The line at which the tunnel wall breaks from sloping outward can be given as

_____
a) Spring line
b) Oval line
c) Centre line
d) Middle line

Answer: a
Explanation: Spring line is determined as the line at which the wall breaks from sloping outward to sloping inward toward the crown.

This acts as a barrier between the outward and inward regions.

3. Which of the following should be considered while aligning a tunnel?
a) Atmospheric conditions
b) Hydrological conditions
c) Climatic conditions
d) Surface limits

Answer: b
Explanation: The determination of the alignment for tunnel can be done based on geological and hydrological conditions, cross-section and length of the continuous tunnel, time of consideration and limit of the surface.

4. Among the following, which doesn't belong to tunnel classification?
a) Firm ground
b) Running ground
c) Rocky ground
d) Soft ground

Answer: c
Explanation: Tunneling has been classified based on the type of strata present. It includes firm ground, soft ground and running ground. These will determine the bearing capacity of the soil.

5. Which method can be adopted if full face excavation is not possible?
a) Back bearing method
b) Plotting
c) Trenching
d) Benching

Answer: d
Explanation: In case of no possibility of full face excavation, top heading method is adopted for having a better output. Benching process is also adopted for digging small tunnels.

6. Among the following, which can be adopted for providing support for soft strata?
a) Bents of aluminum
b) Bents of iridium
c) Bents of steel
d) Bents of plastic

Answer: c
Explanation: The provision of soft strata must be done for withstanding the excavation. It can be provided by bents of wood, bents of steel, liner plates and poling, which are placed to retain material between the adjacent bents.

7. A steel cylinder which is pushed in the soft soil is determined as _____
a) Jar born
b) Shield
c) Rod
d) Pole

Answer: b
Explanation: In the case of soft grounds, tunneling can be dangerous and cave-ins are common. To prevent this, an iron or steel cylindrical element called shield is placed in the soft soil, which can crave the hole perfectly.

8. Which method can be adopted in case of rock tunneling?
a) Full face method
b) Benching
c) Tracing
d) Back bearing method

Answer: a
Explanation: Rock tunneling involves the same principle as of the tunneling in the ground. Those include full face method, top heading method and drift method. Based on the conditions of the area, these can be adopted.

9. Which of the following can act as an alternative for blasting?
a) Tunneling
b) Continuous blasting
c) Sequential blasting
d) Fire-setting

Answer: d
Explanation: Blasting is the conventional method which is adopted in case of rock tunneling. In the case of fire-setting, tunnel is heated with fire and then cooled with water. Rapid expansion and contraction weakens and rock and tends to break.

10. Which of the following involves in the sequence of rocky strata?
a) Marking profile
b) Placing rocks
c) Improving foul gases
d) Recording values

Answer: a
Explanation: Rocky strata involve usage of blasting method for developing tunnels. The sequence contains marking profile, loading explosive, removing foul gases, checking, scaling, mucking and bolting.

TOPIC 4.11 SCANNING TUNNELLING MICROSCOPE.

1. Which of the following is used in electron microscope?
a) electron beams
b) magnetic fields
c) light waves
d) electron beams and magnetic fields

Answer: d
Explanation: Electron Microscope uses electron beams and magnetic fields to produce the image, whereas the light microscope uses light waves and glass lenses. In electron microscopy, a much higher resolution is obtained with extremely short wavelength of the electron beam.

2. Electron Microscope can give a magnification up to _____
a) 400,000X
b) 100,000X
c) 15000X
d) 100X

Answer: a
Explanation: The resolving power of the electron microscope is more than 100 times that of the light microscope, and it produces useful magnification up to 400,000X. It is possible to resolve objects as small as 10 Angstrom.

3. Which of the following are true for electron microscopy?
a) specimen should be thin and dry
b) image is obtained on a phosphorescent screen
c) electron beam must pass through evacuated chamber
d) specimen should be thin and dry, image is obtained on a phosphorescent screen and electron beam must pass through evacuated chamber

Answer: d
Explanation: Since electrons can travel only in high vacuum, the entire electron path through the instrument must be evacuated; specimens must be completely dehydrated prior to examination. Only very thin specimens can be observed in the conventional electron microscope since the penetrating power of electrons through matter is weak. The magnified image may be viewed on a phosphorescent or fluorescent screen.

4. Degree of scattering in transmission electron microscope is a function of _____
a) wavelength of electron beam used
b) number of atoms that lie in the electron path
c) number and mass of atoms that lie in the electron path
d) mass of atoms that lie in the electron path

Answer: c
Explanation: In a transmission electron microscope, contrast results from the differential scattering of electrons by the specimen, the degree of scattering being a

function of the number and mass of atoms that lie in the electron path.

5. Negative Staining is used for examining _____
a) virus particles
b) protein molecules
c) bacterial flagella
d) virus particles, protein molecules and bacterial flagella

Answer: d
Explanation: In negative-staining the electron opacity of the surrounding field is increased by using an electron-dense material such as phosphotungstic acid as a stain. Negative staining is particularly valuable for the examination of very small structures such as virus particles, protein molecules and bacterial flagella.

6. Which among the following helps us in getting a three-dimensional picture of the specimen?
a) Transmission Electron Microscope
b) Scanning Electron Microscope
c) Compound Microscope
d) Simple Microscope

Answer: b
Explanation: The scanning electron microscope lacks the resolving power obtainable with the transmission electron microscope but has the advantage of revealing a striking three-dimensional picture. The surface topography of a specimen can be revealed with clarity and depth of field not possible by any other method.

7. The secondary electrons radiated back in scanning microscope is collected by?
a) specimen
b) anode
c) vacuum chamber
d) cathode

Answer: b
Explanation: In scanning electron microscope (SEM), the surface of the specimen is irradiated with a very narrow beam of electrons. Such irradiations causes low energy (secondary) electrons to be ejected from the specimen which can then be collected on a positively-charged plate or anode thereby generating an electric signal.

8. On what factors do the intensity of secondary electrons depend upon?
a) shape of the irradiated object
b) chemical composition of the irradiated object
c) number of electrons ejected
d) size and chemical composition of the irradiated object, number of electrons ejected and on the number of electrons reabsorbed by surrounding

Answer: d
Explanation: The irradiations in SEM causes secondary electrons to be ejected from the specimen thereby generating a signal that is proportional to the number of electrons striking the anode. The intensity or the number of secondary electrons depends on the shape and the chemical composition of the irradiated object and also on the number of electrons ejected and the number of electrons reabsorbed by surrounding.

9. Where do we obtain the magnified image of the specimen in SEM?
a) cathode ray tube
b) phosphorescent screen
c) anode
d) scanning generator

Answer: a
Explanation: In TEM, the image is obtained on a phosphorescent screen but in SEM the magnified image of the surface topography of the specimen is obtained on the cathode ray tube. The electronic signals generated scan the specimen in a raster pattern in the manner of a television system to produce an image on a cathode ray tube.

10. Which of the following techniques are used in Transmission Electron Microscopy (TEM) for examining cellular structure?
a) Negative-Staining
b) Shadow Casting
c) Ultrathin Sectioning
d) Negative-Staining, Shadow Casting, Ultrathin Sectioning, Freeze-Etching

Answer: d
Explanation: Numerous techniques are available for use with electron microscopy which extends its usefulness in characterizing cellular structure. Some of them are Negative-Staining (which increases the electron opacity of surrounding), Shadow Casting (helps in producing three-dimensional structure of the object), Ultrathin Sectioning and Freeze-Etching.

UNIT V CRYSTAL PHYSICS

TOPIC 5.1 SINGLE CRYSTALLINE, POLYCRYSTALLINE AND AMORPHOUS MATERIALS

1. Which of the following properties is generally exhibited by amorphous solids?
a) Anisotropy
b) Glass-transition
c) Equal strength of all bonds
d) All of the mentioned

Answer: b
Explanation: Due to random organization of particles, amorphous solids have the same physical properties along all directions, or are isotropic. Random organization of particles also results in unequal bond strengths. Upon cooling, amorphous solids turn into a brittle glass-like state from a flexible rubber-like state. This is called glass-transition.

2. Metal glass was first prepared at:
a) California Institute of Technology
b) Massachusetts Institute of Technology
c) Technion
d) University of Michigan

Answer: a
Explanation: Metal glass or amorphous metal was reportedly first produced by W. Klement (Jr.), Willens and Duwez in 1960 at Caltech. It was prepared by rapid cooling (~ 1 MK/s) of molten metal alloys.

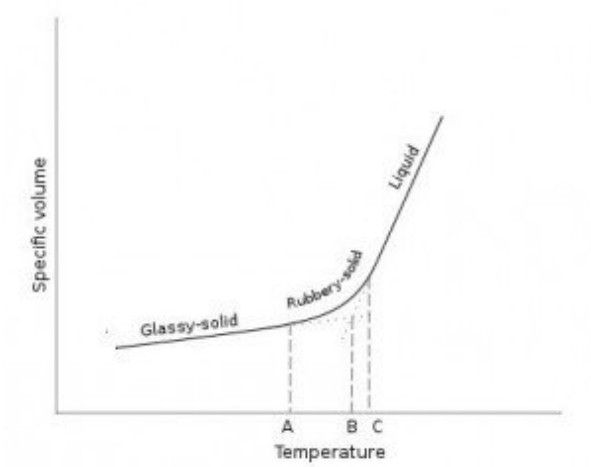
3. Polycrystalline solids are isotropic.
a) True
b) False

Answer: a
Explanation: Anisotropy is a characteristic behavior shown by ideal crystals. However, the presence of flaws like grain boundaries causes the solid to deviate from crystalline properties.

4. Metal glasses differ from their crystalline counterparts in many ways. Chief application(s) of metal glasses include(s):
a) Bullet-proof glasses
b) Power transformers
c) Conducting wires
d) All of the mentioned

Answer: b
Explanation: Amorphous metals are not transparent and have relatively lower electrical conductivity. However, most metal glasses possess high magnetic susceptibility and low coercivity.

5. Consider the following cooling diagram for an amorphous solid.



Glass-transition temperature is represented as:
a) A
b) B
c) C
d) None of the mentioned

Answer: b
Explanation: An exact melting point does not exist for amorphous solids. An approximate glass-transition temperature is defined by extrapolating the cooling curve as shown.

6. Soda-lime glass is the most common type of glass. The component present in largest w/w percentage is:
a) SiO_2
b) Al_2O_3
c) Na_2O
d) CaO

Answer: a
Explanation: Glass inherits its transparency from crystalline SiO_2, also called quartz. However, quartz has very high and narrow glass-transition. To overcome this, small amount of Na_2 is added. CaO is also added to prevent water-solubility imparted by soda.

7. Lead-oxide glass is called “crystal glass” because:
a) It contains crystalline Pb
b) It contains SiO_2 crystals
c) It contains PbO crystals
d) None of the mentioned

Answer: d
Explanation: Well, crystal glass is amorphous, not crystalline. This glass earns its name from its excellent decorative properties and high refractive index.

8. Crystallinity increases with increasing rate of cooling of a liquid.
a) True
b) False

Answer: b
Explanation: When a liquid is cooled rapidly, the particles get less time to move and arrange themselves in an orderly fashion and hence the crystallinity of the resulting solid decreases.

TOPIC 5.2 SINGLE CRYSTALS: UNIT CELL, CRYSTAL SYSTEMS, BRAVAIS LATTICES, DIRECTIONS AND PLANES IN A CRYSTAL, MILLER INDICES

1. Which of the following is not true for crystallographic axes?
a) They must be parallel to the edges of the unit cell
b) They must be perpendicular to each other
c) They must originate at one of the vertices of the cell
d) They form a right-handed co-ordinate system
View answer

Answer: b
Explanation: The axes must be parallel to the edges of the unit cell, which in case of some crystal systems like monoclinic, hexagonal etc. are not mutually perpendicular.

2. The point coordinate indices q, r, and s are multiples of:

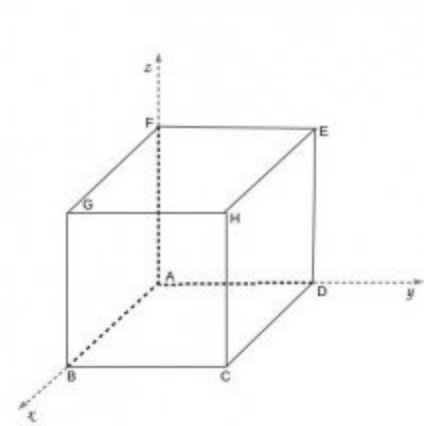
a) Unit cell edge lengths
b) Distance between nearest neighbours
c) Cosine of angles between unit cell edges
d) None of the mentioned
View answer

Answer: a
Explanation: Point coordinate indices are the fractions which when multiplied by the corresponding unit cell edge lengths, provide the location of a given point in the crystallographic coordinate system.

3. The point coordinates of the vertex just opposite to the origin are
a) 0 0 0
b) 0 0 1
c) 0 1 1
d) 1 1 1
View answer

Answer: d
Explanation: Since the opposite vertex is located at distances equal to the edge lengths along the coordinate axes.

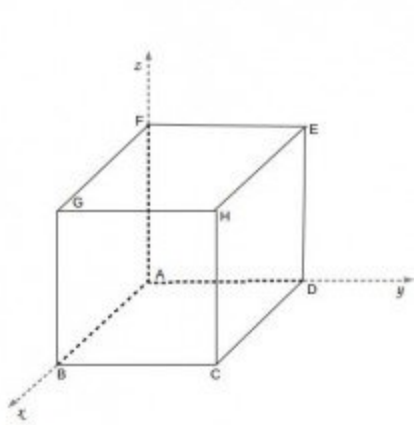
4. If x, y, and z are three positive axes of the crystallographic coordinate system with origin at point A, then which line points in the direction [1 0 $\bar{1}$] ?



a) AD
b) CH
c) FB
d) GE
View answer

Answer: c
Explanation: Moving 1 unit along positive x-axis, 0 units along positive y-axis, 1 unit along negative z-axis points in a direction parallel to line FB.

5. In the following diagram, what is the direction cosine of the line EB?



a) [1 $\bar{1}\bar{1}$]
b) [111]
c) [1 1 1]
d) [1 0 0]
View answer

Answer: a
Explanation: One can reach from point E to B by traversing 1 unit along each of positive x, negative y, and negative z-axis, where one unit along any axis equals the corresponding edge length.

6. In cubic crystals, crystallographic directions are arranged in families. Which of the following directions does not belong to the family <110>?
a) [1 0 1]

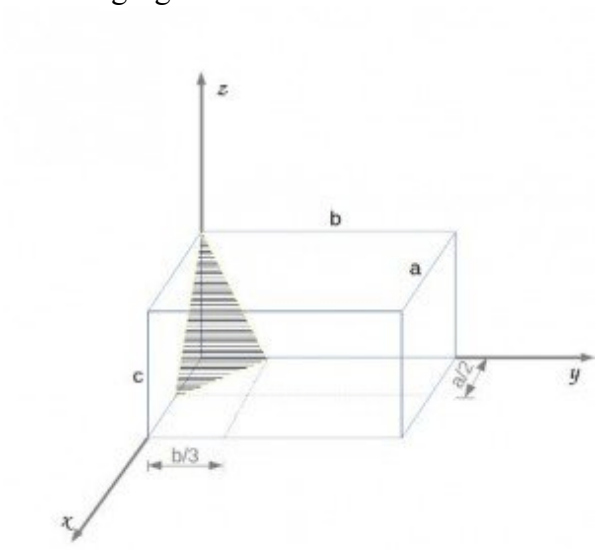
b) [$\bar{1}$1 0]
c) [10 $\bar{1}$]
d) None of the mentioned
View answer

Answer: d
Explanation: Since the cubic lattice is symmetrical about all the three axes, the above directions are equivalent irrespective of order & sign and are part of same direction family.

7. Convert [2 $\overline{1}\overline{1}$1] from four-index system to three-index system.
a) [2 1 0]
b) [3 $\bar{0}$ 1]
c) [$\bar{1}$11]
d) [$\bar{1}$2 1]
View answer

Answer: b
Explanation: [u v t w] can be converted to [U V W] using the formula: i) U = 2u+v ii) V = 2v+u iii) W = w. Four-index systems are generally used for hexagonal lattices.

8. Miller indices of the hatched plane in the following figure are:



a) (2 3 1)
b) (3 2 1)
c) (3 2 0)
d) (1 1 1)
View answer

Answer: a
Explanation: If a plane intercepts the coordinate axes at distances A, B, and C from the origin, then Miller indices are given by multiplying (a/A b/B c/C) by a suitable factor so as to obtain integers.

9. Which of the following is a property of Miller indices?
a) They uniquely identify a plane
b) They are always positive
c) They are not fractions
d) None of the mentioned
View answer

Answer: c
Explanation: Two or more planes can have same Miller indices which can be negative, zero or positive depending on the intercept on the axes. If the ratios of intercepts to lattice constants come out be fractional, then they are scaled to lowest integers to be represented as Miller indices.

10. Miller indices for perpendicular planes are always the same.
a) True
b) False
View answer

Answer: b
Explanation: It is true only for cubic lattices. For other systems, there is no simple relationship between planes with the same Miller indices.

TOPIC 5.3 INTER-PLANAR DISTANCES

1. X-rays have larger wavelengths than which of the following?
a) Gamma rays
b) Beta rays
c) Microwave

d) Visible light
View answer

Answer: a
Explanation: Larger wavelengths mean less energy. Only gamma rays have higher energy (or shorter wavelengths) than x-rays. Beta rays are actually streaming of particles and have much less energy than x-rays.

2. X-ray diffraction patterns are used for studying crystal structure of solids because
a) They have very high energy, hence they can penetrate through solids
b) They are electromagnetic radiation, and hence do not interact with matter (crystals)
c) Their wavelengths are comparable to inter-atomic distances
d) Their high frequency enables rapid analysis
View answer

Answer: c
Explanation: For diffraction to occur, the obstacle size should be comparable to the wavelength of the incident radiation.

3. For destructive interference to take place, the path difference between the two waves should be:
a) nλ
b) 2nλ
c) (n + 1/2)λ
d) (2n + 1)λ
View answer

Answer: a
Explanation: Constructive interference occurs when the phase difference between two interfering waves is an integral multiple of 2π. Also, the ratio of path difference to wavelength equals that of phase difference to 2π.

4. Bragg's law is not a sufficient condition for diffraction by crystalline solids.
a) True
b) False
View answer

Answer: a
Explanation: Atoms present at non-corner positions may result in out-of-phase scattering at Bragg angles.

5. The Miller indices h, k, and l of parallel planes in a BCC lattice should satisfy which of the following X-ray diffraction reflection rules?
a) h + k + l should be even
b) h, k, and l should all be either even or odd
c) h, k, and l should form Pythagoras triplet
d) all planes allow reflections
View answer

Answer: a
Explanation: If the sum of Miller indices becomes odd for a BCC lattice, destructive interference occurs.

6. Minimum interplanar spacing required for Bragg's diffraction is:
a) λ/4
b) λ/2
c) λ
d) 2λ
View answer

Answer: b
Explanation: Maximum value of incident angle can be 90° for which sine is 1. Hence d = λ/2 (nλ = 2.d.sinθ)

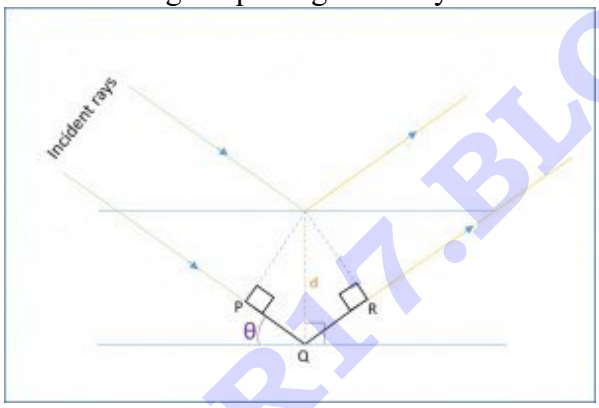
7. Laue's model pictures XRD as reflection from parallel crystalline planes. Reflection is different from refraction as:
a) diffraction occurs throughout the bulk
b) intensity of diffracted beams is less
c) diffraction in crystals occurs only at Bragg's angles
d) all of the mentioned
View answer

Answer: d
Explanation: Reflection is a surface

phenomenon, and large portions of the incident waves can be reflected. Moreover, reflection can occur at any angle of incidence whereas diffraction patterns (alternative dark and bright bands) occur only at Bragg's angles.

8. In Bragg's equation [$n\lambda = 2.d.\sin\theta$], θ is the angle between:
a) specimen surface and incident rays
b) normal to specimen surface and incident rays
c) parallel lattice surfaces d distance apart and incident rays
d) normal to parallel lattice surfaces d distance apart and incident rays
View answer

Answer: c
Explanation: In the following figure, one can easily deduce that the path difference (PQ + QR) between the two incident waves is $2.d.\sin\theta$ using simple trigonometry.



9. In the powder method of XRD, the intensities of various bright lines are compared to determine the crystal structure. For simple cubic lattice the ratio of intensities at first two maxima are:
a) $^1/_2$
b) $^3/_4$
c) $^1/_2$
d) None of the mentioned
View answer

Answer: a
Explanation: For simple cubic lattice, the intensities at subsequent maxima are in the ratio 1:2:3:4:5:6:8

10. K-alpha x-rays have shorter wavelengths than K-beta x-rays?
a) True
b) False
View answer

Answer: b
Explanation: K-alpha is formed from a transfer of electrons from L shell to K while K-beta result from M-to-K transition. Hence K-alpha lines have lower energy (or longer wavelength).

TOPIC 5.4 COORDINATION NUMBER AND PACKING FACTOR FOR SC, BCC, FCC, HCP AND DIAMOND STRUCTURES

1. Lead is a metallic crystal having a _____ structure.
a) FCC
b) BCC
c) HCP
d) TCP

Answer: a
Explanation: Crystalline solids are classified as either metallic or non-metallic. Pb, along with Cu, Ag, Al, and Ni, has a face-centered cubic structure.

2. Which of the following has a HCP crystal structure?
a) W
b) Mo
c) Cr
d) Zr

Answer: d
Explanation: Crystalline solids are classified

as either metallic or non-metallic. W, Mo, and Cr are examples of the body-centered cubic structure of crystals. The HCP structure is found in Mg, Zn, Ti, Cd, Zr, and others.

3. Amorphous solids have _____ structure.
a) Regular
b) Linear
c) Irregular
d) Dendritic

Answer: c
Explanation: Materials in which the molecule is the basic structural solid and has an irregular structure is known as amorphous solid. Crystalline solids, on the other hand, usually are arranged in a regular manner.

4. At _____ iron changes its BCC structure to FCC.
a) 308^{o}C
b) 568^{o}C
c) 771^{o}C
d) 906^{o}C

Answer: d
Explanation: Similar to metallic crystals, a few non-metallic crystals also change form due to temperature and pressure differences. This process is termed as polymorphism. Iron changes from BCC at room temperature to FCC form at 906^{o}C.

5. At room temperature, tin is formed into _____
a) Gray tin
b) White tin
c) Red tin
d) Yellow tin

Answer: b
Explanation: Similar to metallic crystals, a few non-metallic crystals also change form due to temperature and pressure differences. Tin crystallizes in a non-metallic diamond structure (gray tin) at low temperatures. At room temperature, it forms a metallic structure (white tin).

6. Which of the following is a property of non-metallic crystals?
a) Highly ductile
b) Less brittle
c) Low electrical conductivity
d) FCC structure

Answer: c
Explanation: Non-metallic crystals are less ductile and have low electrical conductivity. On the other hand, metallic crystals are differing since they are more ductile and have high electrical conductivity.

7. Which of the following is not an amorphous material?
a) Glass
b) Plastics
c) Lead
d) Rubbers

Answer: c
Explanation: Materials in which the molecule is the basic structural solid and has an irregular structure are known as amorphous solid. Most amorphous materials are polymers such as plastics and rubbers. The most common amorphous material is glass.

8. The crystal lattice has a _____ arrangement.
a) One-dimensional
b) Two-dimensional
c) Three-dimensional
d) Four-dimensional

Answer: c
Explanation: Lattice is defined as the regular geometrical arrangement of points in crystal space. Space or crystal lattice is a three-dimensional network of imaginary lines connecting the atoms.

9. The smallest portion of the lattice is known as _____
a) Lattice structure
b) Lattice point
c) Bravais crystal
d) Unit cell

Answer: d
Explanation: Lattice is defined as the regular geometrical arrangement of points in crystal space. The unit cell is the smallest portion of the lattice, which when repeated in all directions gives rise to a lattice structure.

10. Bravais lattice consists of _____ space lattices.
a) Eleven
b) Twelve
c) Thirteen
d) Fourteen

Answer: d
Explanation: There are fourteen ways in which points can be arranged in a space so that each has identical surroundings. These fourteen space lattices constitute the Bravais space lattices.

11. A unit cell that contains lattice points only at the corners is known as _____
a) Primitive unit cell
b) Secondary unit cell
c) Layered unit cell
d) Derived unit cell

Answer: a
Explanation: If a unit cell chosen contains lattice points only at its corners, it is called a primitive or simple unit cell. It contains only one lattice point since each point at the eight corners is shared equally with adjacent unit cells.

12. The axial relationship of a monoclinic crystal system is given as _____
a) $a = b = c$
b) $a = b \neq c$
c) $a \neq b = c$
d) $a \neq b \neq c$

Answer: d
Explanation: The crystal system is a format by which crystal structures are classified. Each crystal system is defined by the relationship between edge lengths a, b, and c. For monoclinic, orthorhombic, and triclinic systems, the axial relationship is given by $a \neq b \neq c$.

13. The axial relationship of a rhombohedral crystal system is given as _____
a) $a = b = c$
b) $a = b \neq c$
c) $a \neq b = c$
d) $a \neq b \neq c$

Answer: a
Explanation: The crystal system is a format by which crystal structures are classified. Each crystal system is defined by the relationship between edge lengths a, b, and c. For cubic and rhombohedral systems, the axial relationship is given by $a = b = c$.

14. The interracial angles of a hexagonal crystal system are given by _____
a) $\alpha = \beta = \Upsilon = 90o$
b) $\alpha = \beta = 90o\ \Upsilon = 120o$
c) $\alpha = \beta = \Upsilon \neq 90o$
d) $\alpha \neq \beta \neq \Upsilon \neq 90o$

Answer: b
Explanation: The crystal system is a system by which crystal structures are classified. Each crystal system is defined by the relationship between edge lengths a, b, and c and interaxial angles α, β, and Υ. For hexagonal system, the interaxial angles are given by $\alpha = \beta = 90o\ \Upsilon = 120o$.

15. The interracial angles of a triclinic crystal system are given by _____
a) $\alpha = \beta = \Upsilon = 90o$
b) $\alpha = \beta = 90o\ \Upsilon = 120o$

c) $\alpha = \beta = \Upsilon \neq 90o$
d) $\alpha \neq \beta \neq \Upsilon \neq 90o$

Answer: d
Explanation: The crystal system is a system by which crystal structures are classified. Each crystal system is defined by the relationship between edge lengths a, b, and c and interaxial angles α, β, and Υ. For the triclinic system, the interaxial angles are given by $\alpha \neq \beta \neq \Upsilon \neq 90o$.

16. What is the atomic radius of a BCC crystal structure?
a) a/2
b) a/4
c) a√2/4
d) a√3/4

Answer: d
Explanation: Atomic radius is defined as half the distance between the centers of two neighboring atoms. The atomic radius of a simple cube and HCP is a/2 respectively, whereas it is a√2/4 and a√3/4 for FCC and BCC respectively.

17. What is the coordination number of a simple cubic structure?
a) 6
b) 8
c) 10
d) 12

Answer: a
Explanation: Coordination number is defined as the number of nearest neighboring atoms in crystals. The coordination number for the simple cubic structure is 6, whereas it is 8 and 12 for BCC and FCC respectively.

18. What is the atomic packing factor of BCC structure?
a) 0.54
b) 0.68
c) 0.74
d) 0.96

Answer: b
Explanation: The density of packing in a crystal is determined using the atomic packing factor (APF). The APF of FCC and HCP structures is 0.74, and 0.54 for simple cubic structure, whereas it is 0.68 for BCC structure.

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TOPIC 5.5 CRYSTAL IMPERFECTIONS: POINT DEFECTS, LINE DEFECTS

1. Which of the following is a point defect in crystals?
a) Edge dislocation
b) Interstitialcies
c) Grain boundaries
d) Cracks

Answer: b
Explanation: Crystal defects are classified as point defects, line defects, and boundary defects. Point defects include vacancies, impurities, interstitialcies, and electronic defects.

2. How can the number of defects be determined?
a) $Ne^{-E_d/kT}$
b) Ne^{-E_d}
c) $e^{-E_d/kT}$
d) $N^{-E_d/kT}$

Answer: a
Explanation: The number of defects at equilibrium at a definite temperature can be

determined using the equation $Ne^{(-E^d/kT)}$. It is denoted by nd. Here, N stands for the total number of atomic spots and Ed is the activation energy.

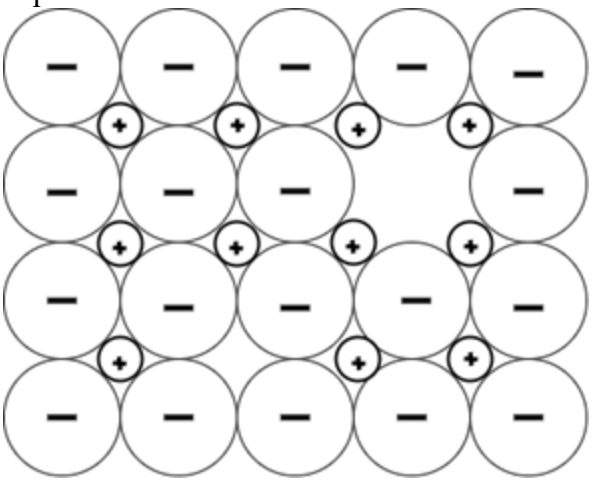
3. The defect that occurs due to a displacement of an ion is known as

_____

a) Vacancy defect
b) Schottky defect
c) Frankel defect
d) Interstitial defect

Answer: c
Explanation: Frankel defect occurs due to a displacement of an ion from the crystal lattice. It is related to the interstitial defect, where an ion simply occupies a position between regular atoms.

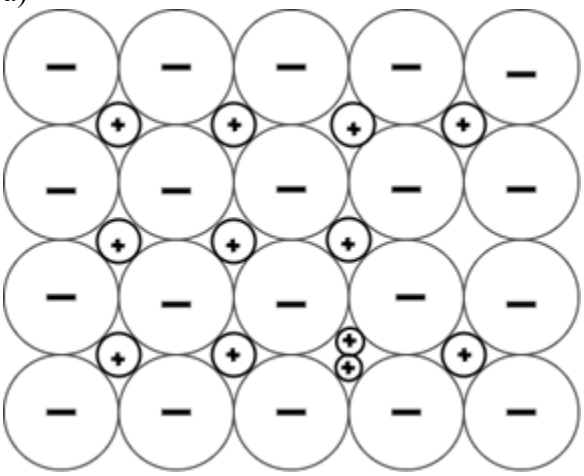
4. Which defect does the following figure depict?



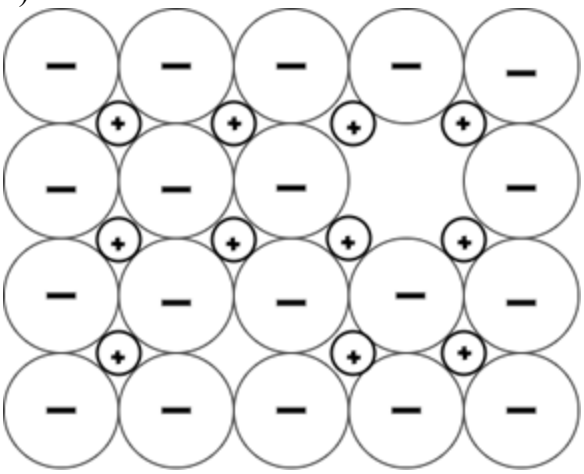
a) Vacancy defect
b) Schottky defect
c) Frankel defect
d) Interstitial defect

Answer: b
Explanation: When a pair of positive and negative ions both disappear from a crystal lattice, the effect is called a Schottky defect. It is closely related to vacancy defects where simply an ion is missing.

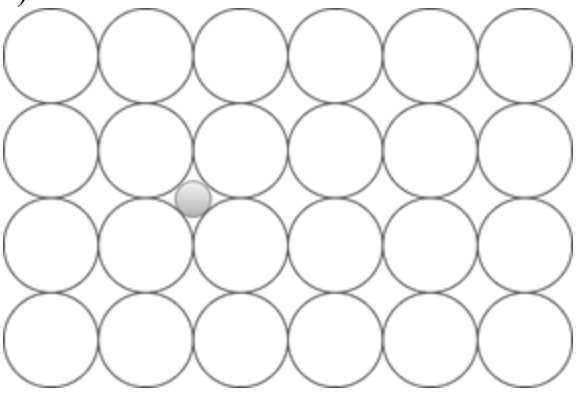
5. Which of these is a Frankel defect?
a)



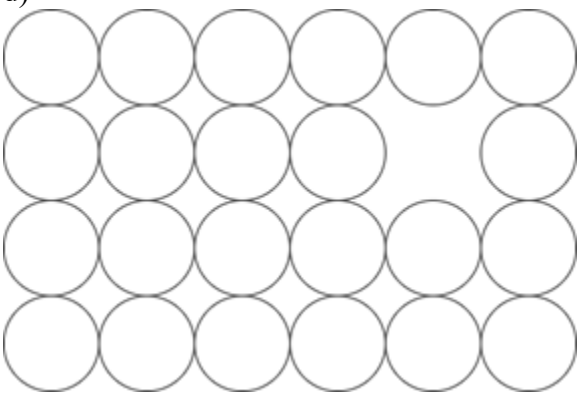
b)



c)

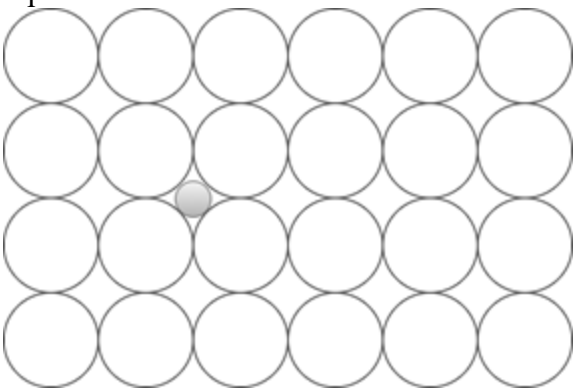


d)



Answer: a
Explanation: Frankel defect occurs due to a displacement of an ion from the crystal lattice while retaining all of the ions, unlike other defects. It is related to the interstitial defect, where an ion simply occupies a position between regular atoms.

6. Which defect does the following diagram represent?



a) Vacancy defect
b) Schottky defect
c) Frankel defect
d) Interstitial defect

Answer: d
Explanation: Interstitial defects occur when an atom occupies an empty position in a crystal lattice. Self-interstitial effects occur due to their own atoms, while others occur due to a foreign substance.

7. _____ occurs when a foreign substance replaces an atom in a crystal.
a) Vacancy defect
b) Substitutional impurity
c) Frankel defect
d) Interstitial impurity

Answer: b
Explanation: A substitutional impurity occurs due to the occupation of a foreign atom in place of an atom in a crystal. On the other hand, interstitial impurities occur when a regular atom occupies a random space in the crystal lattice.

8. A disturbance in a region between two ideal parts of a crystal is known as _____
a) Boundary defect
b) Point defect
c) Line defect
d) Volume defect

Answer: c
Explanation: Line defect is regarded as a disturbed region between two perfect parts of a crystal. They may be of either edge dislocation type or screw dislocation.

9. In screw dislocation, the Burger's vector lies _____ to the dislocation line.
a) Perpendicular
b) Parallel
c) At an angle
d) Sideways

Answer: b
Explanation: The Burger's vector in screw dislocation lies parallel to the dislocation line along the axis of a line of atoms in the same plane. On the other hand, it lies at an angle for edge dislocation.

10. Generation of dislocations can be identified using _____
a) Schottky mechanism
b) Burger's vector
c) Twist
d) Frank-Read mechanism

Answer: d
Explanation: The Frank-Read mechanism

uses the Frank-Read source and its operation as a dislocation multiplier. The Frank-Read source contains a fixed lined at the X and Y nodes. Under the application of stress, the dislocation line expands and is further operated until it becomes readable.

11. What are one-dimensional defects?
a) Boundary defect
b) Point defect
c) Line defect
d) Volume defect

Answer: c
Explanation: When compared geometrically, line defects are seen as one-dimensional defects. Line defects are also known as dislocations, with common types as edge and screw dislocations.

12. What are two-dimensional defects?
a) Boundary defect
b) Point defect
c) Line defect
d) Volume defect

Answer: a
Explanation: The defects that occur on the surface of a material are known as surface or boundary defects. Geometrically, they are regarded as two-dimensional defects.

13. How is the dislocation energy defined?
a) J m^{-1}
b) J m^{-2}
c) m^{-2}
d) N m^{-1}

Answer: a
Explanation: Dislocation energy is defined ad joule per meter and is denoted by E. Dislocation density is defined as meter per cubic meter or simply as per meter square.

TOPIC 5.6 BURGER VECTORS, STACKING FAULTS - ROLE OF IMPERFECTIONS IN PLASTIC DEFORMATION

1. Which one of the following, is a line imperfection?
a) Grain boundary
b) Tilt boundary
c) Dislocation
d) Stacking fault

Answer: c
Explanation: Dislocations look like lines in the lattice, which are one dimensional. So it falls under the category of line imperfections. While grain boundary, tilt boundary and stacking fault are surface imperfections.

2. What is the range of dislocation density in pure and unhardened metals?
a) $10^{10} – 10^{12}$ m^{-2}
b) $10^{14} – 10^{16}$ m^{-2}
c) $10^{4} – 10^{6}$ m^{-2}
d) $10^{8} – 10^{10}$ m^{-2}

Answer: a
Explanation: Pure unhardened metals (real crystal) contain large number of dislocations of the order of$10^{10} – 10^{12}$ m^{-2}. So these can easily be deformed.

3. What is unit of dislocation density?
a) m
b) m^{-2}
c) kg/m^3
d) m^{-3}

Answer: b
Explanation: Dislocation density is defined as number of lines in a unit volume. So the unit of dislocation density is m/m^3 or m^{-2}.

4. Dislocations are responsible for _____
a) Increase in strength
b) Decrease in strength

c) Increase or decrease in strength depending on dislocation density
d) Don't affect strength of metal

Answer: c
Explanation: If dislocation density is in range $10^{10} – 10^{12}$ m^{-2}, it decreases the strength by easy plastic deformation. On the other hand, if it exceeds to 1016 m^{-2}, these causes strengthening of metal by interaction to imperfections.

5. The number of dislocations increases drastically during _____
a) Solidification
b) Plastic deformation
c) Elastic deformation
d) Heat treatment

Answer: b
Explanation: Dislocations increase in number drastically during plastic deformation. It is due to the formation of a Frank-Read source.

6. Positive edge dislocation is denoted by _____
a) ↶
b) ↷
c) ⊥
d) ⊤

Answer: c
Explanation: Positive edge dislocation is represented as '⊥' (inverted ⊤) because the extra half plane lies above the shear plane. '⊤' is used for negative edge dislocation. '↶' and '↷' are used to represent screw dislocations.

7. Edge dislocation introduces shear strain only.
a) True
b) False

Answer: b
Explanation: Edge dislocations cause compressive, tensile and shear lattice strains. While screw dislocations cause shear strain only.

8. What term is used for the defect, produced by an array of dislocations that produces a small difference in orientation between the adjoining lattices?
a) Tilt boundary
b) Twist boundary
c) Free surface
d) Low angle grain boundary

Answer: d
Explanation: The array of dislocations produces an angular mismatch between the lattices, which is referred to as low angle grain boundary. These have an angle less than 10^0.

9. Which statement is false?
a) Plastic deformation decreases dislocation density.
b) Strain hardening is the increase of dislocation density with plastic deformation.
c) Slip plane is the crystallographic plane of dislocation motion.
d) Dislocation can change its plane of motion by climb on high temperatures.

Answer: a
Explanation: Plastic deformation increases the dislocation density. Plastic deformation causes generation of dislocations due to the Frank-Read source. All other statements are correct.

10. Most crystalline materials have dislocations in their as formed state.
a) True
b) False

Answer: a
Explanation: Crystalline materials have dislocations due to stresses (mechanical, thermal …) associated with the forming processes. Thus forming processes are the source of dislocations.

11. Dislocation density can vary from _____ to _____ in metals.
a) $10^5 – 10^{12}$ cm^{-2}
b) $10^5 – 10^{12}$ m^{-2}
c) $10^8 – 10^{10}$ cm^{-2}
d) $10^6 – 10^{10}$ cm^{-2}

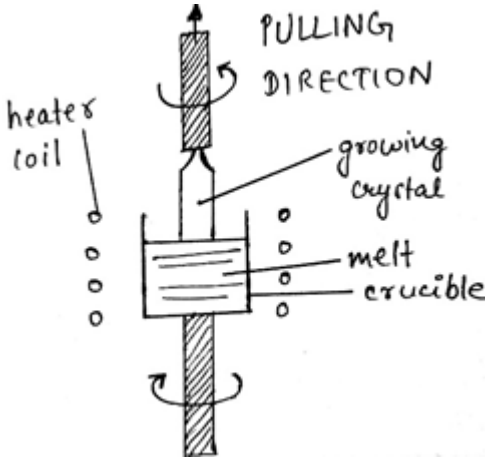
Answer: a
Explanation: Dislocation density varies in metals from 10^5 cm^{-2} (in carefully solidified metal) to 10^{12} cm^{-2} (in heavily deformed metal). It depends on various parameters as degree of deformation, temperature etc.

12. Large plastic deformation corresponds to _____ of grains along the direction of applied stress.
a) Growth
b) Rupture
c) Recrystallization
d) Elongation

Answer: d
Explanation: Larger plastic deformation leads to elongation of grains. This becomes possible due to the presence of dislocations.

TOPIC 5.7 GROWTH OF SINGLE CRYSTALS: SOLUTION AND MELT GROWTH TECHNIQUES.

1. The diagram given below represents which of the following method?



a) Bridgman method
b) Stockbarger method
c) Czochralski method
d) Zone melting method

Answer: c
Explanation: Czochralski method is basically a method for the growth of a single crystal from a melt of the same composition. It is also widely used for the growth of the crystals of semiconducting materials, Si, Ge, GaAs, etc. It has also been used to produce laser generator materials such as $Ca(NbO_3)_2$ doped with neodymium.

2. In the process of Czochralski method which of the following relation is appropriate between the melt and the growing crystals?
a) Melt and the growing crystals are usually not related to each other
b) Melt and the growing crystals are usually rotated counterclockwise
c) Melt and the growing crystals are usually rotated clockwise
d) Melt and the growing crystals are usually kept at a constant position

Answer: b
Explanation: The melt and the growing crystals are usually rotated counterclockwise during pulling in the process of Czochralski, in order to maintain a constant temperature, melt uniformity, etc.

3. Which of the following statements is appropriate for Stockbarger method?
a) Solidification is achieved by passing the melt through a concentration gradient
b) Solidification is achieved by passing the melt through a temperature gradient
c) Liquefaction is achieved by passing the melt through a concentration gradient
d) Liquefaction is achieved by passing the melt through a temperature gradient

Answer: b
Explanation: Stockbarger method is based on solidification of stoichiometric melt but in these, oriented solidification of the melt is achieved by effectively passing the melt through a temperature gradient such that crystallization occurs at the cooler end. Thus this method is achieved by arranging for a relative displacement of the melt and a temperature gradient.

4. Which of the following statements describes best the Bridgman method?
a) Melt is outside the temperature furnace, solidification begins at the hotter end
b) Melt is inside the temperature furnace, solidification occurs at the cooler end
c) Melt is inside the temperature furnace, solidification occurs at the hotter end
d) Solidification is achieved by passing the melt through a temperature gradient

Answer: b
Explanation: In the Bridgman method, the melt is inside a temperature gradient furnace and the furnace is gradually cooled so that the solidification begins at the cooler end. In this method, it is again advantageous to use a seed crystal and atmospheric control may be necessary.

5. In the zone melting method _____ of the charge is melted at any one time. Fill up the correct option for the blank space from the choices given below.
a) Large part
b) Small part
c) Solid part
d) Anionic part

Answer: b
Explanation: In zone melting method the thermal profile through the furnace is such that only a small part of the charge is melted at any one time. Initially, that part of the charge in contact with the seed crystal is melted. As the boat is pulled through the furnace, oriented solidification onto the seed occurs and at the same time, more of the charge melts.

6. Which one of the following principle has been used in the zone melting method?
a) Impurities concentrate in the solid than in liquid phase
b) Impurities concentrate in the liquid phase than in gaseous phase
c) Impurities concentrate in the liquid phase than in the solid phase
d) Impurities concentrate in the gaseous phase than in the solid phase

Answer: c
Explanation: Zone melting method make the use of the principle that impurities usually concentrate in the liquid rather than in the solid phase. Impurities are therefore ‘swept out’ of the crystal by the moving molten zone. The method has been used for the purification and crystal growth of the high melting metals such as tungsten.

7. Which one of the following statements is correct for precipitation method?
a) Growth of the crystal from a solvent of same composition to the crystals
b) Growth of the crystal from the solute of same composition to the crystal
c) Growth of the crystal from the gaseous species of different composition to the crystal
d) Growth of the crystal from a solvent of different composition to the crystals.

Answer: d
Explanation: In contrast to the methods like

zone melting, Stockbarger etc method in which melts solidify to get crystals that have the same composition as the melt, precipitation methods involves the growth of the crystals from a solvent of different composition to the crystals. The solvent may be one of the constituents of the desired crystal example, crystallization of salt hydrate crystals using water as the solvent.

8. In the precipitation method for the growth of the crystal, the solvent melts are often known as_____
a) Electrolyte
b) α-particle
c) β- particle
d) Fluxes

Answer: d
Explanation: In the precipitation method which used for the growth of crystals from the solvent of different composition to the crystals, the solvent melts are often called as fluxes since they effectively reduce the melting point of the crystals by a considerable amount. The method has recently been used to grow crystals of β- and β" alumina solid electrolytes using a borate flux.

9. When was the Verneuil flame fusion method first used?
a) 1207
b) 2016
c) 1503
d) 1904

Answer: d
Explanation: The Verneuil flame fusion method was used in 1904 for growing crystals of high melting oxides, including artificial gemstones such as ruby and sapphire.

10. Which of the following method has been used to prepare the single crystals of CaO using plasma torch?
a) Stockbarger method
b) Zone melting method
c) Verneuil flame fusion method
d) Bridgman method

Answer: c
Explanation: Verneuil flame fusion method has been recently used to prepare the single crystals of CaO with a melting point equal to 2600◦C by using a plasma torch to melt the CaO powder. The starting material in the form of a fine powder is passed through an oxyhydrogen flame or some other high temperature torch or furnace after melting has taken place, the droplets fall onto the surface of the growing crystals where they solidify.

11. What is the advantage of using Czochralski, Bridgman- Stockbarger and Verneuil method?
a) Gives small crystals
b) High tech apparatus
c) Rapid growth rates
d) Uses plasma torch

Answer: c
Explanation: The above methods are melt growth methods which are used for the growth of crystals. Advantages of using these melt growth methods are, t gives large crystals, allows rapid growth rates, and requires very simple apparatus. While the disadvantage can be in the crystal quality which can be poor with inhomogeneities and large defect concentrations.

12. What is the disadvantage of using a solution growth method for the growth of the crystals?
a) Rapid growth rates
b) Simple apparatus
c) Slow growth rates
d) Isothermal conditions

Answer: c
Explanation: Solution growth methods like the water crystallization, flux growth, hydrothermal method etc, which are used for the growth of the crystals have the disadvantage that it leads to very slow growth

rates, face problems of contamination by container or flux. However, the advantage of using such methods are that it allows isothermal conditions with slow growth rates give quality crystals of low defect concentration.