

WBJEE Physics Sample Paper-11

Duration: 60 Minutes

Maximum Marks: 50

Instructions

- This paper contains **40** Multiple Choice Questions divided into **3 Sections**.
- **Section 1 (Q1–Q30):** Each correct answer carries **+1 mark**. Incorrect answer: **–0.25** marks. Only **one** correct option.
- **Section 2 (Q31–Q35):** Each correct answer carries **+2 marks**. Incorrect answer: **–0.5** marks. Only **one** correct option.
- **Section 3 (Q36–Q40):** Each correct answer carries **+2 marks**. **No negative marking**. One or **more** correct options may be correct; full marks only if all correct options are marked.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Section–A — 30 Questions × 1 Mark Each
(Negative Marking: –0.25) [Single Correct]

Q1. A particle starts from rest and moves with uniform acceleration. If it travels 20 m in the first 2 s, the acceleration is:

- (A) 5 m/s^2
- (B) 10 m/s^2
- (C) 15 m/s^2
- (D) 20 m/s^2

Q2. The horizontal range of a projectile becomes maximum when the angle of projection is:

- (A) 30°
- (B) 45°



- (C) 60°
- (D) 90°

Q3. A block of mass 2 kg is placed on a rough horizontal surface with coefficient of friction 0.5. The minimum force required to move the block is ($g = 10 \text{ m/s}^2$):

- (A) 5 N
- (B) 10 N
- (C) 15 N
- (D) 20 N

Q4. The work done by centripetal force in uniform circular motion is:

- (A) Positive
- (B) Negative
- (C) Zero
- (D) Infinite

Q5. The escape velocity from Earth depends on:

- (A) Mass of Earth
- (B) Mass of object
- (C) Shape of object
- (D) Colour of object

Q6. The maximum acceleration of a particle executing SHM is proportional to:

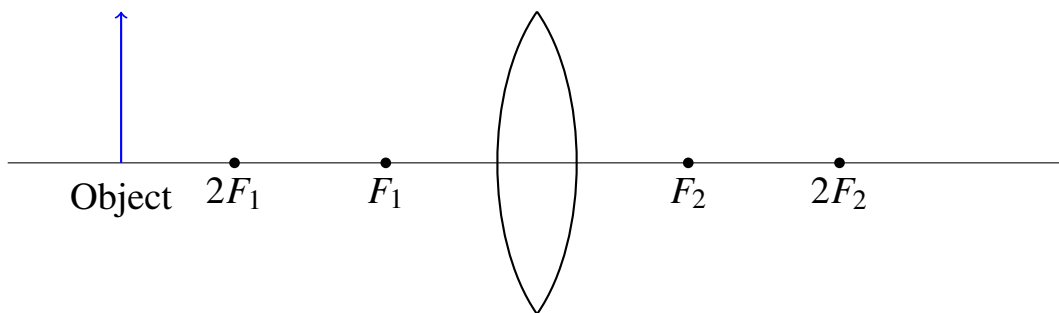
- (A) Amplitude
- (B) Frequency
- (C) Square of angular frequency
- (D) Both (A) and (C)



- Q7.** According to Bernoulli's theorem, the sum of pressure energy, kinetic energy and potential energy per unit volume remains:
- (A) Variable
 - (B) Constant
 - (C) Zero
 - (D) Infinite
- Q8.** For an adiabatic process, the heat exchanged with surroundings is:
- (A) Positive
 - (B) Negative
 - (C) Zero
 - (D) Infinite
- Q9.** The speed of a transverse wave on a stretched string depends on:
- (A) Tension in string
 - (B) Length of string only
 - (C) Mass per unit length
 - (D) Amplitude only
- Q10.** The apparent frequency increases when:
- (A) Source moves towards observer
 - (B) Medium temperature increases
 - (C) Source moves away
 - (D) Observer moves away



Q11. An object is placed beyond $2F_1$ of a convex lens as shown in the figure. The nature of the image formed is:



- (A) Virtual, erect and magnified
- (B) Real, inverted and diminished
- (C) Real, erect and magnified
- (D) Virtual, inverted and diminished

Q12. The refractive index of water with respect to air is 1.33. The speed of light in water is nearly:

- (A) 2.25×10^8 m/s
- (B) 3×10^8 m/s
- (C) 1.5×10^8 m/s
- (D) 4×10^8 m/s

Q13. In Young's double slit experiment, fringe width increases if:

- (A) Wavelength increases
- (B) Screen distance increases
- (C) Slit separation decreases
- (D) All of these

Q14. The electric field intensity at a point due to a point charge varies as:

- (A) r
- (B) $\frac{1}{r}$



(C) $\frac{1}{r^2}$

(D) $\frac{1}{r^3}$

Q15. Two capacitors of capacitances $4 \mu\text{F}$ and $6 \mu\text{F}$ are connected in parallel. The equivalent capacitance is:

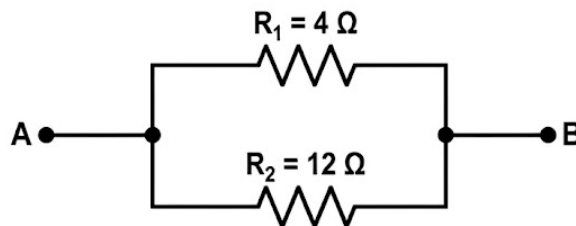
(A) $2.4 \mu\text{F}$

(B) $5 \mu\text{F}$

(C) $10 \mu\text{F}$

(D) $24 \mu\text{F}$

Q16. Find the equivalent resistance between A and B:



(A) 2Ω

(B) 3Ω

(C) 4Ω

(D) 16Ω

Q17. The sensitivity of a potentiometer can be increased by:

(A) Increasing current

(B) Decreasing potential gradient

(C) Increasing resistance only

(D) Increasing emf only



- Q18.** The force on a current carrying conductor in magnetic field is maximum when angle between them is:
- (A) 0°
 - (B) 30°
 - (C) 60°
 - (D) 90°
- Q19.** The magnetic field at the centre of a circular current carrying coil increases when:
- (A) Current increases
 - (B) Radius decreases
 - (C) Number of turns increases
 - (D) All of these
- Q20.** According to Faraday's law, induced emf is proportional to rate of change of:
- (A) Charge
 - (B) Current
 - (C) Magnetic flux
 - (D) Resistance
- Q21.** The rms value of AC voltage is 220 V. The peak voltage is:
- (A) 220 V
 - (B) 311 V
 - (C) 440 V
 - (D) 155 V
- Q22.** A step-up transformer increases:
- (A) Voltage



- (B) Current
- (C) Power
- (D) Frequency

Q23. The speed of electromagnetic waves in vacuum is:

- (A) 3×10^8 m/s
- (B) 3×10^6 m/s
- (C) 3×10^4 m/s
- (D) 3×10^2 m/s

Q24. The stopping potential in photoelectric effect depends upon:

- (A) Intensity
- (B) Frequency
- (C) Area of metal
- (D) Distance from source

Q25. The radius of Bohr orbit is proportional to:

- (A) n
- (B) n^2
- (C) $\frac{1}{n}$
- (D) \sqrt{n}

Q26. The SI unit of radioactive activity is:

- (A) Curie
- (B) Becquerel
- (C) Rutherford
- (D) Tesla



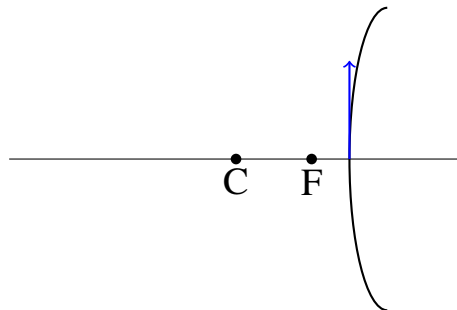
Q27. A p-type semiconductor is obtained by doping silicon with:

- (A) Phosphorus
- (B) Arsenic
- (C) Boron
- (D) Germanium

Q28. The output of XOR gate is 1 when inputs are:

- (A) Both 0
- (B) Both 1
- (C) Different
- (D) Same

Q29. The following figure represents a concave mirror. The image formed for object between pole and focus is:



- (A) Real and inverted
- (B) Virtual and erect
- (C) Real and diminished
- (D) Virtual and inverted

Q30. Diffraction becomes significant when slit width is comparable to:

- (A) Frequency
- (B) Wavelength
- (C) Amplitude



(D) Velocity

Section-B — 5 Questions × 1 Mark Each
(Negative Marking: -0.5) [Single Correct]

Q31. Young's modulus is defined as the ratio of:

- (A) Stress to strain
- (B) Strain to stress
- (C) Force to area
- (D) Pressure to volume

Q32. The gravitational potential at infinity is taken as:

- (A) Positive
- (B) Negative
- (C) Unity
- (D) Zero

Q33. The centripetal force acting on a body in circular motion is directed:

- (A) Tangentially
- (B) Away from centre
- (C) Towards centre
- (D) Vertically upward

Q34. The process of recovering original signal from modulated wave is called:

- (A) Modulation
- (B) Amplification
- (C) Demodulation
- (D) Rectification



Q35. Heat transfer through vacuum takes place mainly by:

- (A) Conduction
- (B) Convection
- (C) Radiation
- (D) Diffusion

**Section C — 5 Questions × 2 Marks Each (No
Negative Marking) [One or More Correct]**

Q36. Which of the following quantities are scalar quantities?

- (A) Work
- (B) Energy
- (C) Momentum
- (D) Speed

Q37. For a body in uniform circular motion, which of the following are correct?

- (A) Speed remains constant
- (B) Velocity remains constant
- (C) Acceleration acts towards centre
- (D) Kinetic energy remains constant

Q38. Which of the following are electromagnetic waves?

- (A) X-rays
- (B) Microwaves
- (C) Sound waves
- (D) Radio waves



Q39. Which of the following statements regarding photoelectric effect are correct?

- (A) Emission is instantaneous
- (B) Threshold frequency exists
- (C) Stopping potential depends on intensity
- (D) Kinetic energy depends on frequency

Q40. Which of the following statements regarding semiconductors are correct?

- (A) Conductivity increases with temperature
- (B) Silicon is a semiconductor
- (C) Pure semiconductors are called intrinsic semiconductors
- (D) Insulators have smaller band gap than semiconductors



Detailed Solutions

Q1.

Solution

Concept: We use the equations of motion for uniform acceleration. Specifically, the equation relating distance, initial velocity, acceleration, and time: $s = ut + \frac{1}{2}at^2$.

Solution: Step 1: Identify the given information.

The particle starts from rest, so its initial velocity (u) is 0 m/s.

The distance traveled (s) is 20 m.

The time taken (t) is 2 s.

We need to find the acceleration (a).

Step 2: Apply the relevant kinematic equation.

$$s = ut + \frac{1}{2}at^2$$

Step 3: Substitute the given values into the equation.

$$20 = (0)(2) + \frac{1}{2}a(2)^2$$

$$20 = 0 + \frac{1}{2}a(4)$$

$$20 = 2a$$

Step 4: Solve for acceleration (a).

$$a = \frac{20}{2}$$

$$a = 10 \text{ m/s}^2$$

The acceleration of the particle is 10 m/s^2 .

Final Answer: 10 m/s^2

Answer: (B)

[Go Back to Question 1](#)



Q2.

Solution

Concept: The horizontal range (R) of a projectile launched with initial velocity v_0 at an angle θ with the horizontal is given by the formula: $R = \frac{v_0^2 \sin(2\theta)}{g}$, where g is the acceleration due to gravity. For the range to be maximum, the term $\sin(2\theta)$ must be maximum.

Solution: Step 1: Recall the formula for the horizontal range of a projectile.

$$R = \frac{v_0^2 \sin(2\theta)}{g}$$

Step 2: Determine the condition for maximum range.

The range R is maximum when $\sin(2\theta)$ is maximum. The maximum value of the sine function is 1.

Step 3: Find the angle θ for which $\sin(2\theta) = 1$.

$$\sin(2\theta) = 1$$

$$2\theta = \sin^{-1}(1)$$

$$2\theta = 90^\circ$$

$$\theta = \frac{90^\circ}{2}$$

$$\theta = 45^\circ$$

Therefore, the horizontal range of a projectile is maximum when the angle of projection is 45° .

Final Answer:

Answer: (B)

[Go Back to Question 2](#)



Q3.

Solution

Concept: To move a block placed on a rough horizontal surface, an external force must overcome the force of static friction. The maximum static friction ($f_{s,max}$) is given by $f_{s,max} = \mu_s N$, where μ_s is the coefficient of static friction and N is the normal force. The minimum force required to move the block is equal to the maximum static friction.

Solution: Step 1: Identify the given information.

Mass of the block (m) = 2 kg

Coefficient of friction (μ_s) = 0.5

Acceleration due to gravity (g) = 10 m/s²

Step 2: Calculate the normal force (N) acting on the block.

Since the block is on a horizontal surface, the normal force is equal to the gravitational force acting on the block.

$$N = mg$$

$$N = (2 \text{ kg})(10 \text{ m/s}^2)$$

$$N = 20 \text{ N}$$

Step 3: Calculate the maximum static friction force ($f_{s,max}$).

$$f_{s,max} = \mu_s N$$

$$f_{s,max} = (0.5)(20 \text{ N})$$

$$f_{s,max} = 10 \text{ N}$$

Step 4: Determine the minimum force required to move the block.

The minimum force required to move the block is equal to the maximum static friction force.

Minimum force = $f_{s,max} = 10 \text{ N}$.

Final Answer: 10 N

Answer: (B)

[Go Back to Question 3](#)



Q4.

Solution

Concept: Work done (W) by a force is defined as the dot product of the force vector (\mathbf{F}) and the displacement vector (\mathbf{d}): $W = \mathbf{F} \cdot \mathbf{d} = Fd \cos \phi$, where ϕ is the angle between the force and displacement vectors. In uniform circular motion, the centripetal force is always directed towards the center of the circle, while the instantaneous displacement is tangential to the circle.

Solution: Step 1: Understand the nature of centripetal force.

The centripetal force is responsible for changing the direction of the velocity of the object, keeping it in a circular path. It always acts radially inwards, towards the center of the circle.

Step 2: Understand the nature of displacement in uniform circular motion.

In uniform circular motion, the object moves along the circumference of a circle. At any instant, the displacement is along the tangent to the circle at that point.

Step 3: Determine the angle between the centripetal force and the displacement.

The centripetal force is radial (towards the center), and the displacement is tangential. A radius is always perpendicular to the tangent at the point of intersection. Therefore, the angle (ϕ) between the centripetal force and the instantaneous displacement is 90° .

Step 4: Calculate the work done.

Using the formula for work done, $W = Fd \cos \phi$:

$$W = Fd \cos(90^\circ)$$

Since $\cos(90^\circ) = 0$,

$$W = Fd \times 0$$

$$W = 0$$

The work done by the centripetal force in uniform circular motion is zero. This is because the centripetal force does not change the kinetic energy of the object; it only changes its direction.

Final Answer:

Answer: (C)

[Go Back to Question 4](#)



Q5.

Solution

Concept: The escape velocity (v_e) from a celestial body is the minimum speed that an object needs to escape from its gravitational influence and move into outer space, never to return. The formula for escape velocity from a spherical body of mass M and radius R is given by $v_e = \sqrt{\frac{2GM}{R}}$, where G is the universal gravitational constant.

Solution: Step 1: Recall the formula for escape velocity.

$$v_e = \sqrt{\frac{2GM}{R}}$$

Step 2: Analyze the dependencies in the formula.

From the formula, the escape velocity depends on:

- G : The universal gravitational constant.
- M : The mass of the celestial body (e.g., Earth).
- R : The radius of the celestial body (e.g., Earth).

Step 3: Identify what the escape velocity does NOT depend on.

The formula does not contain the mass of the object being projected (m). Therefore, the escape velocity is independent of the mass of the object.

Step 4: Conclude the factors on which escape velocity depends.

The escape velocity from Earth depends on the Mass of Earth, the Radius of Earth, and the Gravitational constant.

Final Answer: Mass of Earth

Answer: (A)

[Go Back to Question 5](#)



Q6.

Solution

Concept: For a particle executing simple harmonic motion (SHM), the displacement (x) from the mean position as a function of time (t) is given by $x(t) = A \cos(\omega t + \phi)$, where A is the amplitude and ω is the angular frequency.

The velocity (v) is the first derivative of displacement with respect to time:
 $v(t) = \frac{dx}{dt} = -A\omega \sin(\omega t + \phi)$.

The acceleration (a) is the second derivative of displacement with respect to time (or the first derivative of velocity): $a(t) = \frac{dv}{dt} = -A\omega^2 \cos(\omega t + \phi)$.

Solution: Step 1: Write down the expression for acceleration in SHM.

$$a(t) = -A\omega^2 \cos(\omega t + \phi)$$

Step 2: Determine the maximum value of acceleration.

The maximum value of $\cos(\omega t + \phi)$ is 1.

Therefore, the maximum acceleration (a_{max}) is the magnitude of $-A\omega^2 \times 1$, which is $a_{max} = A\omega^2$.

Step 3: Analyze the proportionality of maximum acceleration.

From $a_{max} = A\omega^2$, we can see that the maximum acceleration is directly proportional to the amplitude (A) and the square of the angular frequency (ω^2).

Step 4: Relate angular frequency to frequency.

The angular frequency (ω) is related to the linear frequency (f) by $\omega = 2\pi f$.

$$\text{So, } \omega^2 = (2\pi f)^2 = 4\pi^2 f^2.$$

$$\text{Thus, } a_{max} = A(4\pi^2 f^2) = (4\pi^2 A) f^2.$$

This shows that a_{max} is proportional to the amplitude A and also proportional to the square of the frequency (f^2). However, the question asks what it is proportional to from the given options. The term 'frequency' itself is often understood as linear frequency in such contexts.

Step 5: Check the proportionality with the given options.

- Proportional to Amplitude (A): Yes, $a_{max} \propto A$.
- Proportional to Frequency (f): No, it's proportional to f^2 .
- Proportional to Square of angular frequency (ω^2): Yes, $a_{max} \propto \omega^2$.
- Both (A) and (C): Since a_{max} is proportional to both amplitude and the square of angular frequency, this is the most comprehensive answer.

Final Answer: Both (A) and (C)

Answer: (D)

[Go Back to Question 6](#)



Q7.

Solution

Concept: Bernoulli's theorem is a statement of the conservation of energy for a fluid in motion. It relates the pressure, velocity, and elevation of a fluid. For an ideal fluid (inviscid, incompressible, and steady flow), Bernoulli's equation states that the sum of the static pressure, the dynamic pressure, and the hydrostatic pressure is constant along a streamline.

Solution: Step 1: State Bernoulli's theorem.

Bernoulli's theorem for fluid flow states that for a fluid in steady flow, the sum of its pressure energy per unit volume, kinetic energy per unit volume, and potential energy per unit volume is constant.

Step 2: Write down Bernoulli's equation.

Mathematically, Bernoulli's equation is expressed as:

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

Where:

- P is the static pressure.
- $\frac{1}{2}\rho v^2$ is the dynamic pressure (kinetic energy per unit volume).
- ρgh is the hydrostatic pressure (potential energy per unit volume).
- ρ is the density of the fluid.
- v is the fluid velocity.
- g is the acceleration due to gravity.
- h is the height above a reference level.

Step 3: Interpret the meaning of the equation.

The equation shows that the sum of these three terms is always constant along a streamline. If one term increases, at least one of the other terms must decrease to maintain the constant sum.

Step 4: Conclude the nature of the sum.

According to Bernoulli's theorem, the sum of pressure energy, kinetic energy, and potential energy per unit volume remains constant.

Final Answer:

Answer: (B)

[Go Back to Question 7](#)



Q8.

Solution

Concept: An adiabatic process is a thermodynamic process in which there is no heat transfer into or out of the system. This means that the system is thermally insulated from its surroundings. The first law of thermodynamics states that $\Delta U = Q - W$, where ΔU is the change in internal energy, Q is the heat added to the system, and W is the work done by the system.

Solution: Step 1: Recall the definition of an adiabatic process.

In thermodynamics, an adiabatic process is defined as a process where the heat exchange between the system and its surroundings is zero. Mathematically, this means $Q = 0$.

Step 2: Apply the first law of thermodynamics.

The first law of thermodynamics is given by:

$$\Delta U = Q - W$$

Step 3: Substitute the condition for an adiabatic process.

Since $Q = 0$ for an adiabatic process, the first law becomes:

$$\Delta U = 0 - W$$

$$\Delta U = -W$$

Step 4: Interpret the result.

This equation implies that any change in the internal energy of the system is due solely to the work done by or on the system. If the system does work on the surroundings ($W > 0$), its internal energy decreases ($\Delta U < 0$). If work is done on the system by the surroundings ($W < 0$), its internal energy increases ($\Delta U > 0$).

Step 5: Conclude the heat exchanged.

By definition, for an adiabatic process, the heat exchanged with the surroundings (Q) is zero.

Final Answer:

Answer: (C)

[Go Back to Question 8](#)



Q9.

Solution

Concept: The speed of a transverse wave on a stretched string depends on the properties of the string, specifically the tension in the string and its linear mass density (mass per unit length). The formula for the speed (v) of a transverse wave on a string is given by $v = \sqrt{\frac{T}{\mu}}$, where T is the tension in the string and μ is the mass per unit length of the string.

Solution: Step 1: Recall the formula for the speed of a transverse wave on a string.

The speed of a transverse wave (v) on a stretched string is given by:

$$v = \sqrt{\frac{T}{\mu}}$$

Step 2: Analyze the variables in the formula.

- T : Tension in the string. This is the force stretching the string.
- μ : Linear mass density of the string, which is the mass per unit length (m/L).

Step 3: Identify the factors influencing the speed.

From the formula, the speed of the wave is directly proportional to the square root of the tension (T) and inversely proportional to the square root of the mass per unit length (μ).

Step 4: Consider other possible factors.

The frequency (f) and amplitude (A) of the wave are related to how the wave is generated and its characteristics, but they do not determine the speed at which the wave propagates along the string. The speed is a property of the medium (the string).

Step 5: Conclude the dependencies.

Therefore, the speed of a transverse wave on a stretched string depends on the tension in the string and the mass per unit length.

Final Answer: Tension in string

Answer: (A)

[Go Back to Question 9](#)



Q10.

Solution

Concept: The Doppler effect describes the change in frequency or wavelength of a wave in relation to an observer who is moving relative to the wave source. When the source and the observer are moving towards each other, the perceived frequency increases. When they are moving away from each other, the perceived frequency decreases.

Solution: Step 1: Recall the principle of the Doppler effect.

The Doppler effect states that the observed frequency of a wave is different from the emitted frequency if there is relative motion between the source and the observer.

Step 2: Analyze the scenarios of relative motion and their effect on apparent frequency.

- Source moves towards observer: The wave crests are emitted more frequently towards the observer. This leads to a shorter perceived wavelength and thus a higher apparent frequency.
- Observer moves towards source: The observer encounters wave crests more frequently. This means the observer is moving into the oncoming waves, leading to a higher apparent frequency.
- Source moves away from observer: The wave crests are spread out in the direction of the observer. This leads to a longer perceived wavelength and thus a lower apparent frequency.
- Observer moves away from source: The observer is moving away from the oncoming wave crests, so they encounter them less frequently. This leads to a lower apparent frequency.

Step 3: Identify the condition for increased apparent frequency.

The apparent frequency increases when there is relative motion towards each other between the source and the observer.

Step 4: Evaluate the given options.

- Source moves towards observer: Apparent frequency increases.
- Observer moves towards source: Apparent frequency increases.
- Source moves away: Apparent frequency decreases.
- Observer moves away: Apparent frequency decreases.

Step 5: Select the options where apparent frequency increases.

Both "Source moves towards observer" and "Observer moves towards source" result in an increase in apparent frequency.

Final Answer:

Answer: (A)

[Go Back to Question 10](#)



Q11.

Solution

Concept: When an object is placed beyond $2F_1$ of a convex lens, the rays from the object refract through the lens and converge on the other side to form an image. The nature and position of the image depend on the object's position relative to the focal points (F_1, F_2) and the optical center.

Solution: Step 1: Rules for a convex lens:

- A ray parallel to the principal axis passes through F_2 after refraction.
- A ray through the optical center goes undeviated.

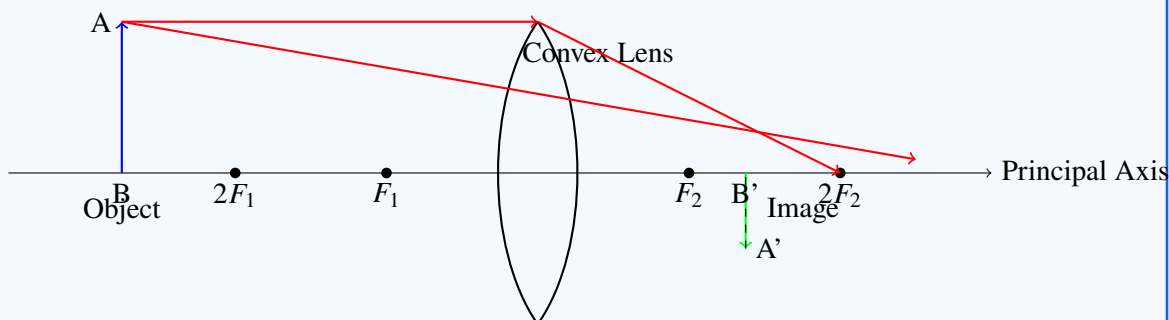
Step 2: The object AB is placed beyond $2F_1$.

Step 3: Draw two rays from point A :

- One parallel to the principal axis, refracting through F_2 .
- One through the optical center, travelling undeviated.

Step 4: The refracted rays meet between F_2 and $2F_2$ to form image $A'B'$.

Step 5: Since the image is formed on the opposite side of the lens, it is real and inverted. It is also diminished because the object is beyond $2F_1$.



The diagram shows the object placed beyond $2F_1$. A ray parallel to the principal axis passes through F_2 . A ray through the optical center is undeviated. These rays intersect between F_2 and $2F_2$ to form an inverted and diminished image.

Final Answer: Real, inverted and diminished

Answer: (B)

[Go Back to Question 11](#)



Q12.

Solution

Concept: The refractive index of a medium (n) with respect to vacuum (or air, approximately) is defined as the ratio of the speed of light in vacuum (c) to the speed of light in that medium (v). The formula is $n = \frac{c}{v}$.

Solution: Step 1: Identify the given information.

Refractive index of water with respect to air (n_{water}) = 1.33

Speed of light in vacuum (c) = 3×10^8 m/s (This is a known constant).

Step 2: Write down the formula relating refractive index, speed of light in vacuum, and speed of light in the medium.

$$n = \frac{c}{v}$$

Step 3: Rearrange the formula to solve for the speed of light in water (v).

$$v = \frac{c}{n}$$

Step 4: Substitute the given values and calculate the speed of light in water.

$$v = \frac{3 \times 10^8 \text{ m/s}}{1.33}$$

Step 5: Perform the division.

$$v \approx 2.2556 \times 10^8 \text{ m/s}$$

Rounding to two decimal places gives 2.26×10^8 m/s. Among the given options, 2.25×10^8 m/s is the closest value.

Final Answer: 2.25×10^8 m/s

Answer: (A)

[Go Back to Question 12](#)



Q13.

Solution

Concept: In Young's double-slit experiment (YDSE), the fringe width (β) is the distance between the centers of two consecutive bright or dark fringes. The formula for fringe width is given by $\beta = \frac{\lambda D}{d}$, where λ is the wavelength of light, D is the distance between the slits and the screen, and d is the separation between the double slits.

Solution: Step 1: Recall the formula for fringe width in YDSE.

$$\beta = \frac{\lambda D}{d}$$

Step 2: Analyze how changes in the parameters affect the fringe width.

- Wavelength (λ): From the formula, $\beta \propto \lambda$. If the wavelength increases, the fringe width increases.
- Screen distance (D): From the formula, $\beta \propto D$. If the screen distance increases, the fringe width increases.
- Slit separation (d): From the formula, $\beta \propto \frac{1}{d}$. If the slit separation decreases, the fringe width increases.

Step 3: Evaluate the given options.

- Wavelength increases: Fringe width increases.
- Screen distance increases: Fringe width increases.
- Slit separation decreases: Fringe width increases.

Step 4: Conclude which conditions lead to an increase in fringe width.

All three conditions mentioned in options A, B, and C lead to an increase in fringe width. Therefore, option D, "All of these," is the correct answer.

Final Answer:

Answer: (D)

[Go Back to Question 13](#)



Q14.

Solution

Concept: The electric field intensity (E) at a point in space due to a point charge (q) is the force experienced by a unit positive test charge placed at that point. Coulomb's law describes the force between two point charges. The electric field intensity due to a point charge is given by the formula $E = \frac{kq}{r^2}$, where k is Coulomb's constant, q is the magnitude of the point charge, and r is the distance from the charge to the point.

Solution: Step 1: Recall the formula for the electric field intensity due to a point charge. The magnitude of the electric field intensity (E) at a distance (r) from a point charge (q) is given by:

$$E = \frac{kq}{r^2}$$

Step 2: Analyze the dependence of E on r .

In the formula $E = \frac{kq}{r^2}$, k and q are constants for a given point charge. The electric field intensity E is directly proportional to kq and inversely proportional to the square of the distance r .

So, $E \propto \frac{1}{r^2}$.

Step 3: Interpret the proportionality.

This means that as the distance r from the point charge increases, the electric field intensity decreases rapidly, specifically with the square of the distance.

Final Answer: $\frac{1}{r^2}$

Answer: (C)

[Go Back to Question 14](#)



Q15.

Solution

Concept: When capacitors are connected in parallel, the equivalent capacitance is the sum of the individual capacitances. The formula for equivalent capacitance (C_{eq}) in a parallel combination is

$$C_{eq} = C_1 + C_2 + C_3 + \dots$$

Solution: Step 1: Identify the given capacitances.

Capacitance of the first capacitor (C_1) = $4 \mu\text{F}$

Capacitance of the second capacitor (C_2) = $6 \mu\text{F}$

Step 2: Determine the type of connection.

The capacitors are connected in parallel.

Step 3: Apply the formula for equivalent capacitance in parallel.

$$C_{eq} = C_1 + C_2$$

Step 4: Substitute the given values and calculate the equivalent capacitance.

$$C_{eq} = 4\mu\text{F} + 6\mu\text{F}$$

$$C_{eq} = 10\mu\text{F}$$

The equivalent capacitance of the two capacitors connected in parallel is $10 \mu\text{F}$.

Final Answer: $10\mu\text{F}$

Answer: (C)

[Go Back to Question 15](#)



Q16.

Solution

Concept: The given circuit shows two resistors connected in parallel. To find the equivalent resistance of resistors connected in parallel, we use the formula: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

Solution: Step 1: Identify the components and their connection.

We have two resistors: $R_1 = 4\Omega$ and $R_2 = 12\Omega$. They are connected in parallel between points A and B.

Step 2: Apply the formula for equivalent resistance in parallel.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Step 3: Substitute the given resistance values.

$$\frac{1}{R_{eq}} = \frac{1}{4\Omega} + \frac{1}{12\Omega}$$

Step 4: Find a common denominator to add the fractions. The least common denominator for 4 and 12 is 12.

$$\begin{aligned}\frac{1}{R_{eq}} &= \frac{3}{12\Omega} + \frac{1}{12\Omega} \\ \frac{1}{R_{eq}} &= \frac{3+1}{12\Omega} \\ \frac{1}{R_{eq}} &= \frac{4}{12\Omega}\end{aligned}$$

Step 5: Simplify the fraction.

$$\frac{1}{R_{eq}} = \frac{1}{3\Omega}$$

Step 6: Invert both sides to find R_{eq} .

$$R_{eq} = 3\Omega$$

The equivalent resistance between A and B is 3Ω .

Final Answer: 3Ω

Answer: (B)

[Go Back to Question 16](#)



Q17.

Solution

Concept: A potentiometer is used to measure potential difference accurately. Its sensitivity is defined as the potential difference per unit length along the potentiometer wire. A higher sensitivity means a smaller potential difference can be measured accurately. The potential gradient (G) of a potentiometer is given by $G = \frac{V}{L}$, where V is the potential difference applied across the potentiometer wire of length L . Sensitivity is inversely proportional to the potential gradient.

Solution: Step 1: Define sensitivity of a potentiometer.

Sensitivity of a potentiometer is its ability to detect small potential differences. It is defined as the potential drop per unit length of the potentiometer wire.

$$\text{Sensitivity} \propto \frac{1}{\text{Potential Gradient}}$$

Step 2: Understand the relationship between potential gradient and its components.

The potential gradient (G) is given by $G = \frac{IR_{\text{wire}}}{L}$, where I is the current flowing through the wire and R_{wire} is the total resistance of the wire of length L .

Alternatively, if a battery of voltage V is applied across the wire of length L , then $G = \frac{V}{L}$.

Step 3: Analyze how to increase sensitivity.

To increase sensitivity, we need to decrease the potential gradient (G).

- Decreasing potential gradient means either decreasing the voltage (V) applied across the wire (while keeping L constant) or increasing the length (L) of the wire (while keeping V constant).
- This implies that the potential drop per unit length should be small.

Step 4: Evaluate the given options.

- Increasing current (I): If the current increases, and L and R_{wire} are constant, the potential gradient ($G = IR/L$) will increase, thus decreasing sensitivity.
- Decreasing potential gradient: If the potential gradient decreases, the sensitivity increases. This is the correct condition.
- Increasing resistance only: If only the resistance of the wire increases, and current and length are kept constant, the potential gradient might increase or decrease depending on other factors. However, the primary goal is to decrease potential gradient.
- Increasing emf only: Increasing the emf (V) applied across the wire (while keeping L constant) will increase the potential gradient ($G = V/L$), thus decreasing sensitivity.

Step 5: Conclude the factor that increases sensitivity.

Decreasing the potential gradient directly leads to increased sensitivity. This can be achieved by using a longer wire or reducing the voltage across the wire.

Final Answer: Decreasing potential gradient

Answer: (B)

[Go Back to Question 17](#)



Q18.

Solution

Concept: The magnetic force (\mathbf{F}) experienced by a current-carrying conductor of length L placed in a magnetic field \mathbf{B} is given by $\mathbf{F} = I(\mathbf{L} \times \mathbf{B})$, where I is the current. The magnitude of this force is given by $F = ILB \sin \theta$, where θ is the angle between the direction of the current (represented by the vector \mathbf{L}) and the magnetic field \mathbf{B} .

Solution: Step 1: Write down the formula for the magnetic force on a current-carrying conductor. The magnitude of the force is $F = ILB \sin \theta$.

Step 2: Determine the condition for maximum force.

The force F is maximum when the term $\sin \theta$ is maximum. The maximum value of $\sin \theta$ is 1.

Step 3: Find the angle θ for which $\sin \theta = 1$.

$$\sin \theta = 1$$

This occurs when $\theta = 90^\circ$.

Step 4: Conclude the angle for maximum force.

The force on a current-carrying conductor in a magnetic field is maximum when the angle between the conductor (current direction) and the magnetic field is 90° .

Final Answer:

Answer: (D)

[Go Back to Question 18](#)



Q19.

Solution

Concept: The magnetic field at the center of a circular current-carrying coil is given by the formula $B = \frac{\mu_0 n I}{2R}$, where μ_0 is the permeability of free space, n is the number of turns in the coil, I is the current flowing through the coil, and R is the radius of the coil.

Solution: Step 1: Recall the formula for the magnetic field at the center of a circular coil.

$$B = \frac{\mu_0 n I}{2R}$$

Step 2: Analyze how changes in the parameters affect the magnetic field B .

- Current (I): From the formula, $B \propto I$. If the current increases, the magnetic field increases.
- Radius (R): From the formula, $B \propto \frac{1}{R}$. If the radius decreases, the magnetic field increases.
- Number of turns (n): From the formula, $B \propto n$. If the number of turns increases, the magnetic field increases.

Step 3: Evaluate the given options.

- Current increases: Magnetic field increases.
- Radius decreases: Magnetic field increases.
- Number of turns increases: Magnetic field increases.

Step 4: Conclude which conditions lead to an increase in the magnetic field.

All three conditions mentioned in options A, B, and C lead to an increase in the magnetic field at the center of the coil. Therefore, option D, "All of these," is the correct answer.

Final Answer:

Answer: (D)

[Go Back to Question 19](#)



Q20.

Solution

Concept: Faraday's law of electromagnetic induction states that the magnitude of the induced electromotive force (emf) in any closed circuit is directly proportional to the time rate of change of the magnetic flux through the circuit. Mathematically, this is expressed as $\mathcal{E} = -\frac{d\Phi_B}{dt}$, where \mathcal{E} is the induced emf and Φ_B is the magnetic flux.

Solution: Step 1: State Faraday's law of electromagnetic induction.

Faraday's law states that the induced emf in a circuit is proportional to the rate at which the magnetic flux through the circuit changes.

Step 2: Write the mathematical expression for Faraday's law.

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

Step 3: Interpret the formula.

- \mathcal{E} is the induced electromotive force (emf).
- $\frac{d\Phi_B}{dt}$ is the rate of change of magnetic flux with respect to time.

Step 4: Identify the quantity to which induced emf is proportional.

The formula clearly shows that the induced emf (\mathcal{E}) is directly proportional to the rate of change of magnetic flux ($\frac{d\Phi_B}{dt}$).

Step 5: Evaluate the given options.

- Charge: Induced emf is not directly proportional to the rate of change of charge.
- Current: While induced emf can cause a current, it's not directly proportional to the rate of change of current.
- Magnetic flux: Induced emf is directly proportional to the rate of change of magnetic flux.
- Resistance: Resistance affects the current produced by the emf, but not the emf itself.

Final Answer:

Answer: (C)

[Go Back to Question 20](#)



Q21.

Solution

Concept: In alternating current (AC) circuits, voltage and current vary sinusoidally with time. The root-mean-square (rms) value is the effective value of the AC voltage or current. For a sinusoidal waveform, the relationship between the rms value (V_{rms}) and the peak value (V_p) is given by $V_{rms} = \frac{V_p}{\sqrt{2}}$.

Solution: Step 1: Identify the given information.

The rms value of the AC voltage (V_{rms}) is 220 V.

Step 2: Recall the relationship between rms voltage and peak voltage for a sinusoidal AC waveform.

$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

Step 3: Rearrange the formula to solve for the peak voltage (V_p).

$$V_p = V_{rms} \times \sqrt{2}$$

Step 4: Substitute the given rms voltage and calculate the peak voltage.

$$V_p = 220 \text{ V} \times \sqrt{2}$$

Step 5: Calculate the value of $\sqrt{2}$ (approximately 1.414).

$$V_p \approx 220 \text{ V} \times 1.414$$

$$V_p \approx 311.08 \text{ V}$$

Rounding to the nearest whole number, the peak voltage is approximately 311 V.

Final Answer:

Answer:

[Go Back to Question 21](#)



Q22.

Solution

Concept: A transformer is a device that transfers electrical energy from one AC circuit to another by electromagnetic induction. It can increase or decrease the voltage and current. A step-up transformer is designed to increase the voltage from the primary coil to the secondary coil, while a step-down transformer decreases the voltage. In an ideal transformer, power is conserved.

Solution: Step 1: Understand the function of a transformer.

A transformer works on the principle of mutual induction and is used to change the voltage and current levels of an AC supply.

Step 2: Differentiate between step-up and step-down transformers.

- A step-up transformer increases the voltage.
- A step-down transformer decreases the voltage.

Step 3: Relate voltage, current, and power in an ideal transformer.

For an ideal transformer, the power in the primary coil is equal to the power in the secondary coil ($P_{primary} = P_{secondary}$). Since power is given by $P = VI$ (Voltage \times Current), if the voltage is increased, the current must decrease proportionally to conserve power, and vice versa.

Step 4: Consider the effect on frequency.

Transformers operate on the principle of electromagnetic induction, which relies on changing magnetic flux. This is possible only with alternating current (AC). The frequency of the AC supply remains the same as it passes through the transformer. It does not change.

Step 5: Conclude what a step-up transformer increases.

A step-up transformer increases the voltage. Consequently, it decreases the current (assuming ideal conditions) and does not change the power or frequency.

Final Answer:

Answer: (A)

[Go Back to Question 22](#)



Q23.

Solution

Concept: Electromagnetic waves are produced by oscillating electric charges and consist of oscillating electric and magnetic fields propagating through space. In a vacuum, these waves travel at a constant speed, which is a fundamental physical constant.

Solution: Step 1: Recall the nature of electromagnetic waves.

Electromagnetic waves are disturbances in electric and magnetic fields that propagate through space.

Step 2: Identify the speed of electromagnetic waves in vacuum.

The speed of electromagnetic waves in a vacuum is denoted by the symbol c and is equal to the speed of light in vacuum. This speed is a fundamental constant.

Step 3: State the value of the speed of light in vacuum.

The speed of light in vacuum is approximately 3×10^8 meters per second (m/s).

Step 4: Relate this to the given options.

The value 3×10^8 m/s matches one of the provided options.

Final Answer: 3×10^8 m/s

Answer: (A)

[Go Back to Question 23](#)



Q24.

Solution

Concept: The photoelectric effect is the emission of electrons from a material when light shines on it. The stopping potential (V_s) is the minimum negative potential applied to the collecting plate that stops the most energetic photoelectrons from reaching it. Einstein's photoelectric equation relates the kinetic energy of the emitted electrons to the energy of the incident photons and the work function of the metal: $K_{max} = h\nu - \phi$. The stopping potential is related to the maximum kinetic energy by $K_{max} = eV_s$. Therefore, $eV_s = h\nu - \phi$.

Solution: Step 1: Stopping potential (V_s) is the minimum reverse potential required to stop the most energetic photoelectrons.

Step 2: Maximum kinetic energy is given by:

$$K_{max} = eV_s$$

Step 3: Einstein's photoelectric equation:

$$K_{max} = h\nu - \phi$$

Step 4: Equating both:

$$eV_s = h\nu - \phi \Rightarrow V_s = \frac{h\nu - \phi}{e}$$

Step 5: From the expression, V_s depends on:

- Frequency of incident light (ν)
- Work function (ϕ) of the metal

Step 6: Among common factors, intensity, area, and distance do not affect V_s .

Conclusion: Stopping potential depends on frequency (and work function), not on intensity, area, or distance.

Final Answer: Frequency

Answer: (B)

[Go Back to Question 24](#)



Q25.

Solution

Concept: In the Bohr model of the atom, electrons orbit the nucleus in specific, quantized energy levels. The radius of these orbits is determined by the principal quantum number (n). For a hydrogen atom, the radius of the n -th Bohr orbit (r_n) is given by the formula $r_n = n^2 a_0$, where a_0 is the Bohr radius (the radius of the first orbit, $n = 1$).

Solution: Step 1: Recall the formula for the radius of the Bohr orbit.

The radius of the n -th orbit in the Bohr model for a hydrogen atom is given by:

$$r_n = n^2 \left(\frac{4\pi\epsilon_0\hbar^2}{m_e e^2} \right)$$

where ϵ_0 is the permittivity of free space, \hbar is the reduced Planck constant, m_e is the mass of the electron, and e is the elementary charge. The term in the parenthesis is the Bohr radius, a_0 .

So, $r_n = n^2 a_0$.

Step 2: Analyze the proportionality.

From the formula $r_n = n^2 a_0$, the radius of the Bohr orbit (r_n) is directly proportional to the square of the principal quantum number (n^2).

Step 3: Identify the proportionality relationship.

The radius of a Bohr orbit is proportional to n^2 .

Step 4: Evaluate the given options.

- n : Proportional to n (linear).
- n^2 : Proportional to n^2 (quadratic).
- $\frac{1}{n}$: Inversely proportional to n .
- \sqrt{n} : Proportional to the square root of n .

Step 5: Select the correct proportionality.

The radius of the Bohr orbit is proportional to n^2 .

Final Answer: n^2

Answer: (B)

[Go Back to Question 25](#)



Q26.

Solution

Concept: Radioactive activity is a measure of the rate at which radioactive decay occurs in a sample of radioactive material. It quantifies the number of nuclear disintegrations per unit time.

Solution: Step 1: Define radioactive activity.

Radioactive activity is the number of nuclear decays per unit time.

Step 2: Identify the SI unit of activity.

The SI unit of activity is the Becquerel (Bq). One Becquerel is defined as one disintegration per second.

Step 3: Consider other units of activity.

- The Curie (Ci) is a non-SI unit of activity, historically used but now largely replaced by the Becquerel. $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$.
- The Rutherford (Rd) is another non-SI unit, defined as 10^6 disintegrations per second.

Step 4: Evaluate the options.

- Curie: A unit of activity, but not the SI unit.
- Becquerel: The SI unit of radioactive activity.
- Rutherford: A unit of activity, but not the SI unit.
- Tesla: The SI unit of magnetic flux density.

Step 5: Conclude the SI unit.

The SI unit for radioactive activity is the Becquerel.

Final Answer:

Answer: (B)

[Go Back to Question 26](#)



Q27.

Solution

Concept: Semiconductors like silicon or germanium are doped with impurities to create p-type or n-type materials. Doping involves adding elements with a different number of valence electrons. In silicon (Group 14), which has 4 valence electrons, doping with an element from Group 15 (like Phosphorus or Arsenic) creates an n-type semiconductor (excess electrons as charge carriers). Doping with an element from Group 13 (like Boron or Aluminum) creates a p-type semiconductor (excess holes as charge carriers).

Solution: Step 1: Understand the structure of silicon.

Silicon is a Group 14 element with 4 valence electrons. In a crystal lattice, each silicon atom forms covalent bonds with four neighboring silicon atoms.

Step 2: Understand the concept of doping to create p-type and n-type semiconductors.

- n-type semiconductor: Formed by doping with a pentavalent impurity (Group 15), which has 5 valence electrons. Four electrons form covalent bonds, and the fifth electron is loosely bound and becomes a free electron (negative charge carrier).

- p-type semiconductor: Formed by doping with a trivalent impurity (Group 13), which has 3 valence electrons. Three electrons form covalent bonds, leaving a deficiency of one electron, creating a "hole" which acts as a positive charge carrier.

Step 3: Examine the given doping elements.

- Phosphorus: A Group 15 element (pentavalent). Doping silicon with phosphorus creates an n-type semiconductor.

- Arsenic: A Group 15 element (pentavalent). Doping silicon with arsenic creates an n-type semiconductor.

- Boron: A Group 13 element (trivalent). Doping silicon with boron creates a p-type semiconductor.

- Germanium: A Group 14 element, similar to silicon. Doping silicon with germanium does not create p-type or n-type semiconductors in the typical sense; it would create an alloy or a different crystalline structure.

Step 4: Identify the element that forms a p-type semiconductor.

Boron, being a trivalent impurity, creates holes in the silicon lattice, thus forming a p-type semiconductor.

Final Answer:

Answer: (C)

[Go Back to Question 27](#)



Q28.

Solution

Concept: An XOR (Exclusive OR) gate is a digital logic gate that produces a high output (1) if and only if an odd number of inputs are high. In other words, the output is 1 when the inputs are different, and 0 when the inputs are the same.

Solution: Step 1: Understand the function of an XOR gate.

An XOR gate outputs a logic 1 when its inputs are different, and a logic 0 when its inputs are the same.

Step 2: Truth table for a 2-input XOR gate

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Step 3: Analyze the condition for the output to be 1.

From the truth table, the output is 1 when the inputs are (0, 1) or (1, 0). In both these cases, the inputs are different.

Step 4: Evaluate the given options.

- Both 0: Inputs are the same, output is 0.
- Both 1: Inputs are the same, output is 0.
- Different: Inputs are different (0 and 1), output is 1.
- Same: Inputs are the same (both 0 or both 1), output is 0.

Step 5: Conclude when the output of an XOR gate is 1.

The output of an XOR gate is 1 when the inputs are different.

Final Answer: Different

Answer: (C)

[Go Back to Question 28](#)



Q29.

Solution

Concept: A concave mirror converges parallel rays of light to a focal point. The center of curvature (C) is twice the focal length (F) from the pole (P). The behavior of image formation depends on the object's position. When an object is placed between the pole (P) and the focal point (F) of a concave mirror, a virtual, erect, and magnified image is formed behind the mirror.

Solution: Step 1: Analyze the diagram and the given information.

The figure shows a concave mirror. The principal axis is drawn. Points C (center of curvature) and F (focal point) are marked, with F between C and the pole (P, which is at the vertex of the mirror, implicitly at (0,0) in this diagram). The object is placed between the pole and the focus.

Step 2: Recall the ray tracing rules for image formation by a concave mirror.

- A ray parallel to the principal axis reflects through the focal point F.
- A ray passing through the focal point F reflects parallel to the principal axis.
- A ray passing through the center of curvature C retraces its path.
- A ray incident on the pole P is reflected symmetrically with respect to the principal axis.

Step 3: Trace the rays for an object between P and F.

Let the object be placed at O between P and F.

- Draw a ray from the top of the object parallel to the principal axis. It reflects and passes through F.
- Draw a ray from the top of the object passing through F. It reflects parallel to the principal axis.
- Draw a ray from the top of the object passing through C. It reflects back along the same path.

Step 4: Locate the image.

When we extend the reflected rays backward (behind the mirror), they appear to diverge from a point. This point is where the virtual image is formed. For an object between P and F, the reflected rays, when extended backward, intersect behind the mirror.

Step 5: Determine the nature of the image.

- The intersection of the extended reflected rays behind the mirror means the image is virtual.
- Since the rays do not actually converge, but only appear to do so, the image is virtual.

Virtual images formed by mirrors are always erect.

- When the object is between P and F, the image is formed further away from the mirror than the object, and it is magnified (larger than the object).

Final Answer: Virtual and erect

Answer: (B)

[Go Back to Question 29](#)



Q30.

Solution

Concept: Diffraction is the phenomenon where waves bend or spread out as they pass through an opening or around an obstacle. This bending is most significant when the size of the opening or obstacle is comparable to the wavelength of the wave. If the opening is much larger than the wavelength, the bending is negligible, and the wave behaves more like a ray.

Solution: Step 1: Define diffraction.

Diffraction is the spreading of waves as they pass through an aperture or around an obstacle.

Step 2: Recall the condition for significant diffraction.

The phenomenon of diffraction becomes significant when the size of the aperture or obstacle is of the same order of magnitude as the wavelength of the wave.

Step 3: Analyze the role of other parameters.

- Frequency: Frequency determines the wavelength ($\lambda = c/f$). So, indirectly related, but wavelength is the direct parameter.
- Amplitude: Amplitude relates to the intensity of the wave, not its bending behavior.
- Velocity: Velocity of the wave in a medium is determined by the medium's properties and the wave's frequency/wavelength. It doesn't directly dictate when diffraction is significant.

Step 4: Evaluate the given options.

The phenomenon of diffraction is most pronounced when the dimensions of the diffracting element (like slit width) are comparable to the wavelength of the wave.

Step 5: Conclude the condition for significant diffraction.

Diffraction becomes significant when the slit width is comparable to the wavelength.

Final Answer:

Answer: (B)

[Go Back to Question 30](#)



Q31.

Solution

Concept: Elasticity is the property of a material to resist deformation under stress and return to its original shape when the stress is removed. Young's modulus (Y) is a measure of the stiffness of an elastic material. It is defined as the ratio of tensile or compressive stress to the corresponding tensile or compressive strain, within the elastic limit.

Solution: Step 1: Define stress and strain.

- Stress is the internal restoring force per unit area. It is the cause of deformation.
- Strain is the measure of deformation, usually defined as the ratio of change in dimension to the original dimension.

Step 2: Recall the definition of Young's modulus.

Young's modulus (Y) is a measure of the elastic properties of a solid material. It is defined as the ratio of the applied stress to the resulting strain, provided the elastic limit is not exceeded.

$$Y = \frac{\text{Stress}}{\text{Strain}}$$

Step 3: Analyze the given options.

- Stress to strain: This matches the definition of Young's modulus.
- Strain to stress: This would be the inverse of Young's modulus (sometimes called modulus of compliance).
- Force to area: This is the definition of stress.
- Pressure to volume: This relates to bulk modulus and compressibility.

Step 4: Conclude the correct definition.

Young's modulus is defined as the ratio of stress to strain.

Final Answer:

Answer: (A)

[Go Back to Question 31](#)



Q32.

Solution

Concept: Gravitational potential at a point is defined as the work done per unit mass in bringing a mass from infinity to that point. By convention, the gravitational potential energy of a mass at infinity is taken to be zero. Since gravity is an attractive force, work must be done by an external agent against gravity to move a mass away from a gravitational source.

Solution: Step 1: Define gravitational potential.

Gravitational potential at a point is the work done per unit mass to bring a test mass from infinity to that point against the gravitational field.

Step 2: Understand the reference point for gravitational potential.

By convention, the gravitational potential and gravitational potential energy at an infinite distance from any mass distribution are taken to be zero.

Step 3: Consider the nature of gravitational force.

Gravity is an attractive force. To move a mass from infinity to a point near a massive object, the gravitational field does positive work (or, conversely, an external agent has to do negative work to bring it slowly).

Step 4: Relate potential to work done.

If gravitational potential is zero at infinity, then bringing a unit mass from infinity to a point requires a certain amount of work. If the potential at a point is V , then the work done by an external agent is $W_{ext} = mV$. Since gravity is attractive, bringing a mass from infinity to a point requires negative work done by the external agent (or positive work done by the gravitational field). Hence, the potential at any point other than infinity must be negative (for a positive mass).

Step 5: Conclude the value of gravitational potential at infinity.

By convention, the gravitational potential at infinity is taken as zero.

Final Answer:

Answer: (D)

[Go Back to Question 32](#)



Q33.

Solution

Concept: Centripetal force is the force required to keep an object moving in a circular path. It is always directed towards the center of the circle. This force is responsible for changing the direction of the velocity vector of the object, not its speed (in uniform circular motion).

Solution: Step 1: Define centripetal force.

Centripetal force is the force that acts on a body moving in a circular path and is directed towards the center around which the body is moving.

Step 2: Understand the purpose of centripetal force.

This force causes the object to continuously change its direction of motion, thus maintaining a circular trajectory. Without centripetal force, the object would move in a straight line tangent to the circle at that point due to inertia.

Step 3: Determine the direction of centripetal force.

The term "centripetal" itself means "center-seeking." Therefore, the force is always directed towards the center of the circular path.

Step 4: Evaluate the given options.

- Tangentially: This is the direction of velocity, not force.
- Away from centre: This would be centrifugal force (a fictitious force in a rotating frame of reference).
- Towards centre: This matches the definition of centripetal force.
- Vertically upward: This is a specific direction in space and not generally related to circular motion unless the motion itself is in a vertical plane with specific orientation.

Step 5: Conclude the direction of centripetal force.

The centripetal force is always directed towards the center of the circle.

Final Answer:

Answer: (C)

[Go Back to Question 33](#)



Q34.

Solution

Concept: In communication systems, information is often transmitted by modifying certain characteristics of a high-frequency carrier wave. This process is called modulation. The reverse process, where the original information signal is extracted from the modulated carrier wave at the receiver, is called demodulation.

Solution: Step 1: Understand the basic processes in signal transmission.

- Modulation: The process of encoding information onto a carrier wave. This is done to make the signal suitable for transmission over long distances and through specific channels.
- Amplification: Increasing the strength of a signal.
- Rectification: Converting alternating current (AC) to direct current (DC).
- Demodulation: The process of extracting the original information signal from a modulated carrier wave. This is essential at the receiver end to retrieve the message.

Step 2: Analyze the question.

The question asks for the process of recovering the original signal from a modulated wave.

Step 3: Match the process with its definition.

Recovering the original signal from a modulated wave is precisely the definition of demodulation.

Step 4: Evaluate the given options.

- Modulation: This is the process of encoding, not decoding.
- Amplification: This increases signal strength but doesn't recover the original signal from modulation.
- Demodulation: This is the process of recovering the original signal.
- Rectification: This is about converting AC to DC, not signal recovery from modulation.

Step 5: Conclude the correct term.

The process of recovering the original signal from a modulated wave is called demodulation.

Final Answer:

Answer: (C)

[Go Back to Question 34](#)



Q35.

Solution

Concept: Heat transfer is the process by which thermal energy is exchanged between physical systems.

There are three main mechanisms of heat transfer: conduction, convection, and radiation.

- Conduction: Heat transfer through direct contact of particles (requires a medium).
- Convection: Heat transfer through the movement of fluids (liquids or gases) (requires a medium).
- Radiation: Heat transfer through electromagnetic waves (does not require a medium).

Solution: Step 1: Understand the definition of vacuum.

A vacuum is a space devoid of matter.

Step 2: Consider the mechanisms of heat transfer.

- Conduction requires a material medium for heat transfer as it involves the transfer of kinetic energy between adjacent particles. Therefore, conduction cannot occur in a vacuum.
- Convection also requires a material medium (a fluid) to carry the heat through the bulk movement of matter. Therefore, convection cannot occur in a vacuum.
- Radiation involves the emission and absorption of electromagnetic waves (like infrared radiation). Electromagnetic waves can travel through a vacuum, carrying energy. For example, the Sun's heat reaches the Earth by radiation through the vacuum of space.
- Diffusion is a general term for the movement of particles from an area of higher concentration to an area of lower concentration, which also requires a medium.

Step 3: Determine which mechanism can transfer heat through a vacuum.

Radiation is the only mechanism of heat transfer that can occur in the absence of a medium.

Step 4: Conclude the main mode of heat transfer through vacuum.

Heat transfer through vacuum takes place mainly by radiation.

Final Answer:

Answer: (C)

[Go Back to Question 35](#)



Q36.

Solution

Concept: Scalar quantities are those that have only magnitude and no direction. Vector quantities, on the other hand, have both magnitude and direction.

Solution: Step 1: Understand the definitions of scalar and vector quantities.

- A scalar quantity is fully described by its magnitude (a number and a unit).
- A vector quantity is described by both magnitude and direction.

Step 2: Examine each quantity.

- Work: Work is defined as the dot product of force and displacement ($W = \mathbf{F} \cdot \mathbf{d}$). The dot product of two vectors results in a scalar. Therefore, work is a scalar quantity.
- Energy: Energy (like kinetic energy, potential energy, thermal energy) is a measure of capacity to do work and has only magnitude. It is a scalar quantity.
- Momentum: Momentum is defined as the product of mass and velocity ($\mathbf{p} = m\mathbf{v}$). Since velocity is a vector, momentum is also a vector quantity.
- Speed: Speed is the magnitude of velocity. Velocity is a vector, but its magnitude (speed) is a scalar.

Step 3: Identify the scalar quantities.

Based on the analysis, Work, Energy, and Speed are scalar quantities. Momentum is a vector quantity.

Final Answer:

Answer:

[Go Back to Question 36](#)



Q37.

Solution

Concept: Uniform circular motion is motion in a circle at a constant speed. However, the velocity is continuously changing direction, which means acceleration is present.

Solution: Step 1: Analyze uniform circular motion.

In uniform circular motion, an object moves along a circular path with a constant speed.

Step 2: Examine each statement.

- Speed remains constant: This is the definition of uniform circular motion. So, this statement is correct.
- Velocity remains constant: Velocity is a vector quantity, having both magnitude (speed) and direction. In circular motion, the direction of velocity is constantly changing (it is always tangential to the circle). Therefore, velocity does not remain constant. This statement is incorrect.
- Acceleration acts towards centre: For an object to move in a circle, there must be a net force directed towards the center of the circle (centripetal force). This force causes an acceleration (centripetal acceleration) that is also directed towards the center. So, this statement is correct.
- Kinetic energy remains constant: Kinetic energy is given by $KE = \frac{1}{2}mv^2$. Since the speed (v) is constant and mass (m) is constant, the kinetic energy remains constant. So, this statement is correct.

Step 3: Identify the correct statements.

The correct statements are that speed remains constant, acceleration acts towards the center, and kinetic energy remains constant.

Final Answer: Speed remains constant, Acceleration acts towards centre, Kinetic energy remains constant

Answer: (A, C, D)

[Go Back to Question 37](#)



Q38.

Solution

Concept: Electromagnetic waves are transverse waves that consist of oscillating electric and magnetic fields propagating through space. They do not require a medium for propagation and travel at the speed of light in vacuum. Examples include radio waves, microwaves, infrared radiation, visible light, ultraviolet light, X-rays, and gamma rays. Sound waves, on the other hand, are mechanical waves and require a medium to propagate.

Solution: Step 1: Understand the nature of electromagnetic waves.

Electromagnetic waves are produced by oscillating charges and consist of oscillating electric and magnetic fields perpendicular to each other and to the direction of propagation. They travel at the speed of light.

Step 2: Examine each option.

- X-rays: X-rays are a form of electromagnetic radiation, highly energetic. They are electromagnetic waves.
- Microwaves: Microwaves are a part of the electromagnetic spectrum, used in microwave ovens and communication. They are electromagnetic waves.
- Sound waves: Sound waves are mechanical waves, meaning they require a medium (like air, water, or solids) to propagate. They are longitudinal waves, not electromagnetic waves.
- Radio waves: Radio waves are the lowest frequency part of the electromagnetic spectrum and are widely used in communication. They are electromagnetic waves.

Step 3: Identify the electromagnetic waves.

X-rays, Microwaves, and Radio waves are all forms of electromagnetic waves. Sound waves are not.

Final Answer: X-rays, Microwaves, Radio waves

Answer: (A, B, D)

[Go Back to Question 38](#)



Q39.

Solution

Concept: The photoelectric effect is a phenomenon where electrons are emitted from a material when light of sufficient frequency shines on it. Key aspects of this effect, explained by Einstein, include the instantaneous nature of emission, the existence of a threshold frequency, and the dependence of electron kinetic energy and stopping potential on photon frequency.

Solution: Step 1: Analyze each statement regarding the photoelectric effect.

- Emission is instantaneous: When light of sufficient frequency strikes a metal surface, electrons are emitted almost instantaneously. The energy is transferred from photons to electrons very quickly, and there is no significant time lag. This statement is correct.
- Threshold frequency exists: For each metal, there is a minimum frequency of incident light (called the threshold frequency, ν_0) below which no photoemission occurs, regardless of the intensity of the light. This is because each photon must have enough energy ($h\nu$) to overcome the work function of the metal (ϕ). This statement is correct.
- Stopping potential depends on intensity: The stopping potential is the reverse voltage required to stop the most energetic photoelectrons. It depends on the maximum kinetic energy of the emitted electrons, which is given by $K_{max} = h\nu - \phi$. Since $K_{max} = eV_s$, $V_s = (h\nu - \phi)/e$. This equation shows that stopping potential depends on the frequency of light (ν) and the work function (ϕ), but NOT on the intensity of the light. Intensity affects the number of emitted electrons, not their energy. This statement is incorrect.
- Kinetic energy depends on frequency: The maximum kinetic energy of the emitted photoelectrons is given by $K_{max} = h\nu - \phi$. This equation shows that K_{max} is directly dependent on the frequency (ν) of the incident light (and the work function ϕ of the metal). This statement is correct.

Step 2: Identify the correct statements.

The correct statements are that emission is instantaneous, a threshold frequency exists, and the kinetic energy depends on frequency.

Final Answer: Emission is instantaneous, Threshold frequency exists, Kinetic energy depends on frequency

Answer: (A, B, D)

[Go Back to Question 39](#)



Q40.

Solution

Concept: Semiconductors are materials with electrical conductivity between that of conductors and insulators. Their conductivity can be significantly altered by temperature and by doping. Intrinsic semiconductors are pure, while extrinsic semiconductors are doped. The band theory explains the electrical properties of solids.

Solution: Step 1: Analyze each statement regarding semiconductors.

- Conductivity increases with temperature: In semiconductors, an increase in temperature provides more thermal energy, exciting more electrons from the valence band to the conduction band, and creating more holes in the valence band. This increases the number of charge carriers, thus increasing conductivity. This statement is correct.
- Silicon is a semiconductor: Silicon is a Group 14 element widely used as a semiconductor material in electronic devices. This statement is correct.
- Pure semiconductors are called intrinsic semiconductors: When a semiconductor material is in its pure form, without any intentional impurities, it is called an intrinsic semiconductor. This statement is correct.
- Insulators have smaller band gap than semiconductors: The band gap is the energy difference between the valence band and the conduction band. In insulators, this band gap is large (typically > 4 eV), meaning a lot of energy is required to excite electrons to the conduction band, resulting in very low conductivity. In semiconductors, the band gap is smaller (typically between 0.1 eV and 3 eV), allowing for easier excitation of electrons and thus higher conductivity compared to insulators. Therefore, insulators have larger band gaps than semiconductors. This statement is incorrect.

Step 2: Identify the correct statements.

The correct statements are that conductivity increases with temperature, silicon is a semiconductor, and pure semiconductors are called intrinsic semiconductors.

Final Answer: Conductivity increases with temperature, Silicon is a semiconductor, Pure semiconductors are called intrinsic semiconductors

Answer: (A, B, C)

[Go Back to Question 40](#)



Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	B	4	C	5	A
6	D	7	B	8	C	9	A	10	A
11	B	12	A	13	D	14	C	15	C
16	B	17	B	18	D	19	D	20	C
21	B	22	A	23	A	24	B	25	B
26	B	27	C	28	C	29	B	30	B
31	A	32	D	33	C	34	C	35	C
36	A, B, D	37	A, C, D	38	A, B, D	39	A, B, D	40	A, B, C

