WBJEE Physics Sample Paper-20

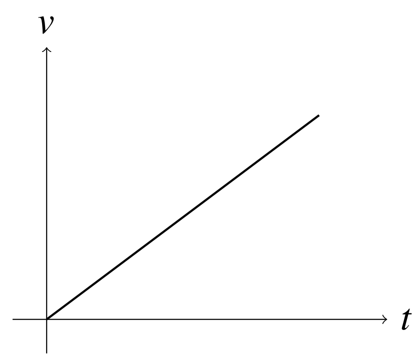
Duration: 60 Minutes **Maximum Marks: 50**

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. The velocity-time graph of a particle is shown below.



The motion of the particle is:

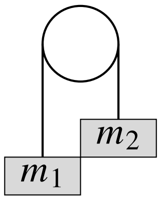
(A) Uniformly accelerated

(B) Uniform velocity

(C) Retarded

(D) Oscillatory

Q2. Two masses are connected using a light string over a pulley.



If $m_2 > m_1$, then:

(A) m_2 moves downward

(B) m_1 moves downward

(C) Both remain at rest

(D) Tension becomes zero

Q3. Angular acceleration is defined as rate of change of:

(A) Angular velocity

(B) Linear velocity

(C) Torque

(D) Angular momentum

Q4. The potential energy of a satellite orbiting Earth is:

(A) Negative

(B) Positive

(C) Zero

(D) Infinite

Q5. Stress is defined as:

(A) Force per unit area

(B) Force per unit volume

(C) Energy per unit area

(D) Pressure per unit volume

Q6. A liquid drop tends to become spherical due to:

(A) Surface tension

(B) Viscosity

(C) Elasticity

(D) Pressure

Q7. In an adiabatic process:

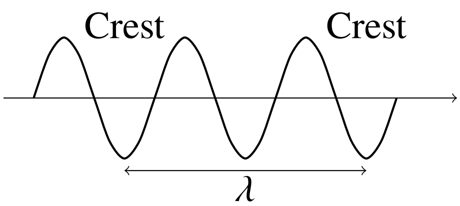
(A) Heat exchanged is zero

(B) Temperature remains constant

(C) Pressure remains constant

(D) Volume remains constant

Q8. The distance between two consecutive crests is:



This distance is called:

(A) Wavelength

(B) Amplitude

(C) Frequency

(D) Time period

Q9. Electric field lines originate from:

(A) Positive charge

(B) Negative charge

(C) Neutral body

(D) Earth

Q10. When dielectric is inserted between capacitor plates, capacitance:

(A) Increases

(B) Decreases

(C) Becomes zero

(D) Remains unchanged

Q11. Current is the rate of flow of:

(A) Charge

(B) Energy

(C) Momentum

(D) Resistance

Q12. The magnetic field inside a long solenoid is:

(A) Uniform

(B) Zero

(C) Circular

(D) Random

Q13. A transformer cannot operate with:

(A) DC current

(B) AC current

(C) Alternating voltage

(D) Changing magnetic flux

Q14. The speed of electromagnetic waves in vacuum is:

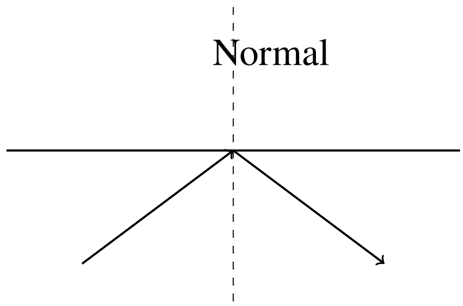
(A) 3×10^8 m/s

(B) 3×10^6 m/s

(C) 3×10^5 m/s

(D) 3×10^3 m/s

Q15. A ray diagram for total internal reflection is shown.



Total internal reflection occurs when light travels:

(A) From denser to rarer medium

(B) From rarer to denser medium

(C) Through vacuum only

(D) Parallel to surface

Q16. The energy of a photon is proportional to:

(A) Frequency

(B) Wavelength

(C) Amplitude

(D) Intensity only

Q17. The nucleus of an atom contains:

(A) Protons and neutrons

(B) Electrons only

(C) Neutrons only

(D) Protons and electrons

Q18. In an n-type semiconductor, majority carriers are:

(A) Electrons

(B) Holes

(C) Protons

(D) Neutrons

Q19. An AND gate gives HIGH output only when:

(A) Both inputs are HIGH

(B) Both inputs are LOW

(C) Inputs are different

(D) One input is HIGH

Q20. The SI unit of resistivity is:

(A) $\Omega\,\text{m}$

(B) Ω/m

(C) $\Omega\,\text{m}^{-1}$

(D) Ω^2

Q21. A scalar quantity among the following is:

(A) Pressure

(B) Force

(C) Velocity

(D) Displacement

Q22. If the radius of Earth becomes double keeping mass same, acceleration due to gravity becomes:

(A) One-fourth

(B) Double

(C) Half

(D) Four times

Q23. Viscosity of liquids generally decreases with increase in:

(A) Temperature

(B) Pressure

(C) Density

(D) Volume

Q24. The slope of pressure-volume graph gives:

(A) Rate of pressure change with volume

(B) Work done directly

(C) Internal energy

(D) Temperature

Q25. Frequency of a wave is measured in:

(A) Hertz

(B) Pascal

(C) Newton

(D) Joule

Q26. Two charges repel each other because they are:

(A) Like charges

(B) Unlike charges

(C) Neutral

(D) Grounded

Q27. Kirchhoff's junction law is based on conservation of:

(A) Charge

(B) Energy

(C) Momentum

(D) Mass

Q28. The force between two parallel current carrying conductors is:

(A) Attractive for same direction currents

(B) Repulsive always

(C) Zero always

(D) Independent of current

Q29. The focal length of a plane mirror is:

(A) Infinite

(B) Zero

(C) Positive finite

(D) Negative finite

Q30. Polarization proves that light is:

(A) Transverse

(B) Longitudinal

(C) Particle only

(D) Scalar

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

Q31. The de Broglie wavelength of a particle increases when its momentum:

(A) Decreases

(B) Increases

(C) Becomes zero only

(D) Remains constant

Q32. Radioactivity is unaffected by:

(A) Temperature

(B) Time

(C) Nature of nucleus

(D) Decay constant

Q33. A Zener diode is mainly used for:

(A) Voltage regulation

(B) Amplification

(C) Rectification

(D) Oscillation

Q34. Modulation is done to:

(A) Transmit signals efficiently

(B) Reduce frequency to zero

(C) Eliminate carrier wave

(D) Increase noise

Q35. The dimensional formula of work is:

(A) ML^2T^{-2}

(B) MLT^{-2}

(C) $ML^{-1}T^{-2}$

(D) M^0LT^{-1}

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

Q36. Which of the following are properties of conductors?

(A) They contain free electrons

(B) Electric field inside conductor is zero in electrostatic equilibrium

(C) Resistance is always infinite

(D) Charges reside on outer surface

Q37. For a body moving in uniform circular motion:

(A) Speed remains constant

(B) Velocity changes continuously

(C) Acceleration acts towards center

(D) Kinetic energy changes continuously

Q38. Which of the following are characteristics of sound waves?

(A) They are mechanical waves

(B) They require medium

(C) They can travel in vacuum

(D) They exhibit reflection

Q39. In photoelectric effect:

(A) Increasing intensity increases photoelectric current

(B) Increasing frequency can increase kinetic energy

(C) Threshold frequency exists

(D) Emission occurs after long delay

Q40. Which of the following are true for alternating current?

(A) Direction changes periodically

(B) RMS value can be defined

(C) Frequency is measured in hertz

(D) It always has zero average power

Detailed Solutions

Q1.

Solution

Concept: A velocity-time graph plots the velocity of an object as a function of time. The slope of this graph represents the rate of change of velocity, which is acceleration.
If the slope is constant and positive, the acceleration is constant and positive (uniformly accelerated motion).
If the slope is constant and negative, the acceleration is constant and negative (uniformly retarded motion).
If the slope is zero, the velocity is constant (uniform velocity).
If the slope is non-linear, the acceleration is changing.

Solution: The given graph is a straight line passing through the origin with a positive slope.
The equation of a straight line passing through the origin is $y = mx$, where m is the slope.
In this case, the velocity (v) is plotted on the y-axis and time (t) on the x-axis. So, $v = mt$.
The slope $m = \frac{\Delta v}{\Delta t}$ is constant and positive.
This means that the acceleration, which is the slope of the velocity-time graph, is constant and positive.
Therefore, the motion of the particle is uniformly accelerated.

Uniformly accelerated: The acceleration is constant. This matches our observation of a straight line with a constant slope.
Uniform velocity: This would be represented by a horizontal line (zero slope).
Retarded: This implies deceleration (negative acceleration), which would be a line with a negative slope.
Oscillatory: This would involve a repeating pattern, usually sinusoidal or similar, not a single straight line.

Final Answer: $\boxed{Uniformly accelerated}$

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept:
This scenario describes an Atwood machine, a simple system consisting of two masses connected by a light inextensible string passing over a frictionless pulley. The motion of the masses is determined by the gravitational forces acting on them and the tension in the string.

Let m_1 and m_2 be the masses, T be the tension in the string, and g be the acceleration due to gravity.
For mass m_1: The net force is $T - m_1 g$ (if moving upwards).
For mass m_2: The net force is $m_2 g - T$ (if moving downwards).

According to Newton's second law, the net force equals mass times acceleration ($F_{net} = ma$). If the masses are accelerating, they will have the same magnitude of acceleration a.

Solution:
Given that $m_2 > m_1$.
Since m_2 is the larger mass, the gravitational force pulling m_2 downwards ($m_2 g$) will be greater than the gravitational force pulling m_1 downwards ($m_1 g$).
The tension T in the string is the same throughout (assuming a light string and frictionless pulley).

Consider the forces acting on the system: Downward force on m_2: $m_2 g$
Upward force on m_2: T
Downward force on m_1: $m_1 g$
Upward force on m_1: T

Since $m_2 > m_1$, the net force pulling the system downwards is $(m_2 g - m_1 g)$. This net force will cause acceleration. The direction of acceleration will be such that the larger mass goes down and the smaller mass goes up.

Applying Newton's second law:
For m_2 moving downwards: $m_2 g - T = m_2 a$
For m_1 moving upwards: $T - m_1 g = m_1 a$

Adding these two equations:
$(m_2 g - T) + (T - m_1 g) = m_2 a + m_1 a$
$m_2 g - m_1 g = (m_1 + m_2)a$
$a = \dfrac{(m_2 - m_1)g}{m_1 + m_2}$

Since $m_2 > m_1$, $(m_2 - m_1)$ is positive, so a is positive. This confirms acceleration occurs.
The direction of acceleration is downwards for m_2 and upwards for m_1.

Therefore, m_2 moves downward, and m_1 moves upward.

Final Answer: $\boxed{m_2 \text{ moves downward}}$

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept: Angular acceleration (α) is the rate of change of angular velocity (ω) with respect to time (t). It describes how quickly the angular velocity of a rotating object changes.
Mathematically, it is defined as:
$\alpha = \frac{d\omega}{dt}$

Angular velocity (ω) is the rate of change of angular displacement (θ) with respect to time: $\omega = \frac{d\theta}{dt}$.

Torque (τ) is the rotational analogue of force and is responsible for causing angular acceleration: $\tau = I\alpha$, where I is the moment of inertia.
Angular momentum (L) is the rotational analogue of linear momentum and is related to angular velocity and moment of inertia: $L = I\omega$.

Solution: Based on the definitions:
Angular acceleration (α) is the rate of change of angular velocity (ω).
Linear velocity (v) is related to angular velocity by $v = \omega r$, but angular acceleration is not directly defined as the rate of change of linear velocity.
Torque (τ) causes angular acceleration ($\tau = I\alpha$), but it is not the rate of change of torque.
Angular momentum ($L = I\omega$) is related to angular velocity, but angular acceleration is the rate of change of angular velocity itself, not angular momentum.

Therefore, angular acceleration is defined as the rate of change of angular velocity.

Final Answer: $\boxed{Angularvelocity}$

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept: The gravitational potential energy (U) of a body of mass m at a distance r from the center of a massive object of mass M (like the Earth) is given by:

$U = -\frac{GMm}{r}$

where G is the gravitational constant.

The potential energy is defined to be zero at an infinite distance ($r \to \infty$). Since the gravitational force is attractive, work must be done against this force to move an object from a finite distance to infinity. If the object is at a finite distance, it is bound by gravity, and its potential energy is negative.

For a satellite orbiting the Earth, the distance r from the center of the Earth is finite. Therefore, the gravitational potential energy will be negative.

Solution: The formula for gravitational potential energy is $U = -\frac{GMm}{r}$.
Here, G is the gravitational constant, M is the mass of the Earth, m is the mass of the satellite, and r is the distance of the satellite from the center of the Earth.
Since G, M, m, and r are all positive quantities (for a satellite orbiting Earth), the term $\frac{GMm}{r}$ is positive.
The negative sign in the formula indicates that the potential energy is negative.

This negative potential energy signifies that the satellite is gravitationally bound to the Earth. To escape Earth's gravity, the satellite would need to gain an amount of energy equal to its negative potential energy to reach zero potential energy at infinity.

Final Answer: $\boxed{Negative}$

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept: Stress is a measure of the internal forces that particles within a continuous material exert on each other. It is defined as the force acting per unit area within the material. When an external force is applied to a deformable body, it causes internal resistance within the material. This internal resistance distributed over the cross-sectional area is called stress.

There are different types of stress, such as tensile stress, compressive stress, and shear stress, depending on the type of force applied. However, the fundamental definition of stress involves force and area.

Solution: Stress (σ) is formally defined as the internal resistance force per unit cross-sectional area.

$\sigma = \frac{F}{A}$

where F is the internal force acting on a cross-section, and A is the area of that cross-section.

Let's check the options:
Force per unit area: This matches the definition of stress.
Force per unit volume: This is not the definition of stress.
Energy per unit area: This is related to surface tension.
Pressure per unit volume: Pressure is force per unit area, so this is not stress.

Therefore, stress is defined as force per unit area.

Final Answer: $\boxed{Force per unit area}$

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept: Surface tension is a property of liquids that causes the surface of the liquid to behave like a stretched elastic membrane. It arises from the cohesive forces between liquid molecules. At the surface, molecules are pulled inwards by neighboring molecules, creating an inward force that minimizes the surface area. This tendency to minimize surface area is what makes liquids form spherical drops.

The work done to increase the surface area of a liquid is called surface energy. Surface tension is often defined as the surface energy per unit area.

Solution: A liquid drop tends to assume a spherical shape because a sphere has the minimum surface area for a given volume. This is a direct consequence of surface tension. The cohesive forces between the liquid molecules pull the surface molecules inwards, reducing the surface area. This reduction in surface area leads to a state of lower potential energy, making the spherical shape the most stable configuration.

Let's consider the other options:
Viscosity: Viscosity is a measure of a fluid's resistance to flow. It does not directly cause a liquid drop to become spherical.
Elasticity: Elasticity is the property of a material to deform under stress and return to its original shape when the stress is removed. While surface tension can be thought of as an elastic property of the surface, it is the cause of the spherical shape, not the property itself.
Pressure: Pressure differences can influence the shape of a liquid surface (e.g., in a bubble), but the fundamental tendency of a free liquid surface to minimize its area and become spherical is due to surface tension.

Therefore, the spherical shape of a liquid drop is due to surface tension.

Final Answer: $\boxed{Surfacetension}$

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept: An adiabatic process is a thermodynamic process in which there is no heat exchange between the system and its surroundings. This is typically achieved by insulating the system thoroughly or by carrying out the process very rapidly so that there isn't enough time for heat transfer to occur.

The first law of thermodynamics states: $\Delta U = Q - W$, 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. For an adiabatic process, $Q = 0$. Therefore, $\Delta U = -W$. This means any work done by the system comes at the expense of its internal energy, and any work done on the system increases its internal energy.

Solution: In an adiabatic process, the defining characteristic is that no heat is exchanged with the surroundings. Heat exchanged is zero: This is the definition of an adiabatic process ($Q = 0$). Correct.

Temperature remains constant: In an adiabatic process, if work is done by the system (expansion), its internal energy decreases, and thus its temperature decreases (e.g., in the expansion of a gas in an adiabatic cylinder). If work is done on the system (compression), its internal energy increases, and its temperature rises (e.g., in adiabatic compression of air). So, temperature is generally not constant. Incorrect.

Pressure remains constant: Pressure can change significantly during an adiabatic process (e.g., in adiabatic expansion, pressure decreases). Incorrect.

Volume remains constant: If volume remains constant, no work is done ($W = 0$). If $Q = 0$ and $W = 0$, then $\Delta U = 0$, meaning temperature and pressure would remain constant. However, this is an isochoric process, not generally an adiabatic one. Adiabatic processes typically involve volume changes. Incorrect.

Therefore, the defining characteristic of an adiabatic process is that the heat exchanged is zero.

Final Answer: $\boxed{Heatexchangediszero}$

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept: A wave is a disturbance that propagates through a medium or space, transferring energy. A wave is often visualized by its displacement from its equilibrium position over time and space.
Crest: The point on a wave with the maximum value or upward displacement.
Trough: The point on a wave with the minimum value or downward displacement.
Wavelength (λ): The spatial period of a periodic wave, the distance over which the wave's shape repeats. For a transverse wave, it is the distance between two consecutive corresponding points of the same phase, such as two adjacent crests or two adjacent troughs.
Amplitude: The maximum displacement or magnitude of oscillation on either side of the equilibrium position.
Frequency (ν or f): The number of waves that pass a point in a unit of time.
Time period (T): The time taken for one complete wave cycle to pass a point.

Solution: The diagram shows a wave where two points of maximum upward displacement (crests) are marked. The horizontal distance between these two consecutive crests represents one complete cycle of the wave in space. This distance is the definition of wavelength.

Wavelength: The distance between two consecutive crests (or troughs) is the wavelength. Correct.
Amplitude: Amplitude is the maximum displacement from the equilibrium position (vertical distance), not the horizontal distance between crests.
Frequency: Frequency is the number of cycles per unit time, a temporal property, not a spatial distance.
Time period: Time period is the time for one complete cycle, a temporal property.

Final Answer: $\boxed{Wavelength}$

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: Electric field lines are imaginary lines that represent the direction of the electric field at each point in space. They are a visual tool to understand the behavior of electric fields.

Properties of electric field lines:
1. Origin and Termination: Electric field lines originate from positive charges and terminate on negative charges.
2. Direction: The tangent to an electric field line at any point gives the direction of the electric field at that point.
3. Density: The density of field lines (how close they are together) represents the strength of the electric field. Where field lines are denser, the field is stronger.
4. Never Intersect: Electric field lines never intersect each other. If they did, it would imply that the electric field has two different directions at the same point, which is impossible.
5. Continuous: Field lines are continuous curves in regions where there are no charges.

Solution: Based on the properties of electric field lines:
Positive charge: Electric field lines emanate outwards from positive charges, indicating the direction of the electric field. Correct.
Negative charge: Electric field lines converge inwards towards negative charges, indicating the direction of the electric field. While field lines terminate on negative charges, their origin is usually considered positive charges or infinity.
Neutral body: If a body is neutral, it does not have an net charge to be a source or sink of field lines, unless it is placed in an external electric field.
Earth: The Earth has a net charge and can act as a source or sink, but the fundamental origin of electric field lines is from a positive charge.

The primary source of electric field lines is positive charges.

Final Answer: $\boxed{Positive charge}$

Answer: (A)

Go Back to Question 9

Q10.

Solution

Concept: A capacitor is an electrical component that stores electrical energy in an electric field. It consists of two conductive plates separated by an insulating material called a dielectric. The capacitance (C) of a capacitor depends on its physical dimensions and the properties of the dielectric material.

The capacitance of a parallel-plate capacitor is given by $C = \frac{\epsilon A}{d}$, where ϵ is the permittivity of the dielectric material, A is the area of the plates, and d is the distance between the plates.

The permittivity of a material is a measure of how it affects an electric field. For vacuum, it's ϵ_0. For a dielectric material, it's $\epsilon = \epsilon_r \epsilon_0$, where ϵ_r is the relative permittivity or dielectric constant (which is always greater than 1 for any dielectric material).

Solution: When a dielectric material is inserted between the plates of a capacitor, the permittivity (ϵ) of the material between the plates increases compared to the permittivity of vacuum or air (if the capacitor was initially filled with air or vacuum).

Since capacitance $C = \frac{\epsilon A}{d}$, and ϵ increases when a dielectric is inserted (because $\epsilon_r > 1$), the capacitance C will also increase.

The dielectric material reduces the electric field between the plates for a given charge, allowing more charge to be stored at the same voltage.

Increases: Because the permittivity of the dielectric is greater than that of vacuum/air. Correct.

Decreases: This would happen if the material somehow reduced the electric field more than it increased the charge storage capability, which is not the case for dielectrics.

Becomes zero: This is highly unlikely and would mean no charge storage.

Remains unchanged: This would imply the dielectric has no effect on the capacitance, which is false.

Final Answer: $\boxed{Increases}$

Answer: (A)

Go Back to Question 10

Q11.

Solution

Concept: Electric current (I) is defined as the rate of flow of electric charge. It quantifies how much charge passes through a particular point or cross-sectional area of a conductor per unit of time. Mathematically, current is given by:
$I = \frac{dQ}{dt}$
where dQ is the amount of charge that flows in time dt. The SI unit of current is the Ampere (A), which is defined as one Coulomb of charge per second (1 A = 1 C/s).

Solution: The fundamental definition of electric current is the rate at which electric charge flows.
Charge: Current is the flow of charge. So, current is directly related to the rate of charge flow. Correct.
Energy: Energy is the capacity to do work and is related to current and voltage (Power = VI, Energy = Power × time), but current itself is not the flow of energy.
Momentum: Momentum is mass in motion ($p = mv$). While moving charges have momentum, current is specifically about the *rate* of charge flow.
Resistance: Resistance is a property of a material that opposes the flow of current. It is not what flows to constitute current.

Therefore, current is the rate of flow of charge.

Final Answer: $\boxed{Charge}$

Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept: A solenoid is a coil of wire wound into a tightly packed helix. When an electric current flows through the wire, it generates a magnetic field.
The magnetic field inside a long solenoid is approximately uniform and directed along the axis of the solenoid. The magnitude of this field is given by $B = \mu_0 n I$, where μ_0 is the permeability of free space, n is the number of turns per unit length, and I is the current flowing through the solenoid.
Outside the solenoid, the magnetic field is much weaker and is considered negligible for a very long solenoid.

Solution: For a long solenoid, the magnetic field lines are very nearly parallel to the axis of the solenoid and are uniformly distributed across the cross-section. This means the magnetic field is approximately uniform inside the solenoid.

Let's consider the options: Uniform: This is the characteristic magnetic field inside a long solenoid. Correct.
Zero: The magnetic field is not zero inside a current-carrying solenoid; it is significant.
Circular: Magnetic field lines are circular around a straight current-carrying wire, but inside a solenoid, they are predominantly axial.
Random: The magnetic field inside a long solenoid is very ordered and uniform, not random.

Final Answer: $\boxed{Uniform}$

Answer: (A)

Go Back to Question 12

Q13.

Solution

Concept: A transformer is a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. It is used to increase (step-up) or decrease (step-down) AC voltages. A transformer works on the principle of mutual induction between two coils wound on a common magnetic core.

For a transformer to operate, there must be a changing magnetic flux linking the primary and secondary coils. This changing flux is induced by a changing current in the primary coil, which in turn produces a changing magnetic field. According to Faraday's law of electromagnetic induction, a changing magnetic flux through a coil induces an electromotive force (EMF) in that coil.

Solution: Let's analyze the requirements for a transformer's operation:
DC current: If a DC current flows through the primary coil, it produces a constant magnetic field. A constant magnetic field does not induce a changing magnetic flux. Therefore, no EMF is induced in the secondary coil, and the transformer cannot step-up or step-down the voltage. A transformer with DC current will essentially act as a simple inductor with a constant current, not transferring energy inductively.
AC current: An AC current in the primary coil constantly changes in magnitude and direction, producing a continuously changing magnetic field and thus a changing magnetic flux in the core. This changing flux then induces an AC voltage in the secondary coil.
Alternating voltage: An alternating voltage applied to the primary coil will cause an alternating current to flow, leading to a changing magnetic flux. This is essential for transformer operation.
Changing magnetic flux: This is the fundamental principle of electromagnetic induction on which transformers operate. A changing magnetic flux through the coils is necessary to induce voltages.

Therefore, a transformer cannot operate with DC current because it does not produce the necessary changing magnetic flux.

Final Answer: $\boxed{DCcurrent}$

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept: Electromagnetic waves, such as light, radio waves, X-rays, etc., are disturbances that propagate through space and time, carrying energy. In a vacuum (empty space), all electromagnetic waves travel at the same speed, which is a fundamental physical constant. This speed is denoted by c.

The speed of light in a vacuum is approximately $299,792,458$ meters per second. For practical purposes and in many physics contexts, this value is often rounded to 3×10^8 meters per second.

Solution: The speed of electromagnetic waves in a vacuum is a universal constant.
The accepted value is $c \approx 299,792,458$ m/s.
This is commonly approximated as 3×10^8 m/s.

Let's look at the options:
3×10^8 m/s: This is the correct value.
3×10^6 m/s: This value is too low.
3×10^5 m/s: This is approximately the speed of sound in air, not electromagnetic waves.
3×10^3 m/s: This value is significantly too low.

Final Answer: $\boxed{3 \times 10^8 \text{ m/s}}$

Answer: (A)

Go Back to Question 14

Q15.

Solution

Concept: Total internal reflection (TIR) is an optical phenomenon that occurs when a ray of light strikes a boundary between two media at an angle of incidence greater than a certain limiting angle, called the critical angle. For TIR to occur, two conditions must be met:
1. Light must be traveling from an optically denser medium to an optically rarer medium.
2. The angle of incidence must be greater than the critical angle ($\theta_i > \theta_c$).

When these conditions are met, the light ray is completely reflected back into the denser medium, and no light is transmitted into the rarer medium. The diagram shows light rays approaching an interface and reflecting back into the medium from which they came. The dashed line represents the normal to the surface.

Solution: The diagram implicitly shows light originating from a medium, striking an interface, and reflecting back into the same medium. This is the hallmark of total internal reflection. For this to happen, the light must be traveling from a medium of higher refractive index (denser) to a medium of lower refractive index (rarer).

Let's analyze the options:
From denser to rarer medium: This is the first and essential condition for total internal reflection. If the angle of incidence is greater than the critical angle, TIR occurs. Correct.
From rarer to denser medium: When light travels from rarer to denser, it bends towards the normal. Total internal reflection cannot occur in this case; some light will always be refracted into the denser medium.
Through vacuum only: While light travels fastest in vacuum and refracts when entering other media, TIR is a phenomenon at the interface between two media, not solely within vacuum.
Parallel to surface: If light travels parallel to the surface, it means the angle of incidence is 90 degrees. This scenario might relate to glancing incidence, but the condition for TIR is specifically about the angle of incidence relative to the normal and the optical densities of the media.

Therefore, total internal reflection occurs when light travels from a denser to a rarer medium, and the angle of incidence exceeds the critical angle.

Final Answer: $\boxed{From denser to rarer medium}$

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept: The photoelectric effect is the emission of electrons from a material when light shines on it. The energy of a photon, which is the quantum of light, is directly related to its frequency. This relationship is given by Planck's equation:
$E = h\nu$
where E is the energy of the photon, h is Planck's constant, and ν is the frequency of the light. Since the speed of light (c) is related to frequency (ν) and wavelength (λ) by $c = \nu\lambda$, frequency is inversely proportional to wavelength ($\nu = c/\lambda$). Thus, the energy of a photon is also inversely proportional to its wavelength: $E = hc/\lambda$.

Solution: From Planck's equation, the energy of a photon (E) is directly proportional to its frequency (ν).
$E \propto \nu$

Frequency: As stated by Planck's equation, energy is directly proportional to frequency. Correct. Wavelength: Energy is inversely proportional to wavelength ($E \propto 1/\lambda$). Amplitude: Amplitude is related to the intensity of light (number of photons or energy density), but the energy of an individual photon is determined by its frequency, not the overall amplitude of the light wave. Intensity only: Intensity is related to the total energy of the light beam, which is the number of photons multiplied by the energy per photon. So, intensity is related to frequency and the number of photons, but the energy of a *single* photon is determined by its frequency.

Therefore, the energy of a photon is proportional to its frequency.

Final Answer: $\boxed{Frequency}$

Answer: (A)

Go Back to Question 16

Q17.

Solution

Concept: An atom consists of a nucleus at the center and electrons orbiting the nucleus. The nucleus contains protons (positively charged) and neutrons (neutral). The electrons (negatively charged) orbit the nucleus.
The atomic number (Z) of an element is equal to the number of protons in the nucleus. The mass number (A) of an atom is the total number of protons and neutrons in the nucleus ($A = Z + N$, where N is the number of neutrons).
Isotopes are atoms of the same element (same number of protons) but with different numbers of neutrons.

Solution: The nucleus is the central part of an atom. It is composed of:
Protons: Positively charged particles.
Neutrons: Neutral particles.

Electrons orbit the nucleus and carry a negative charge.

Therefore, the nucleus of an atom contains protons and neutrons.

Final Answer: $\boxed{Protonsandneutrons}$

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept: Semiconductors are materials with electrical conductivity between that of a conductor and an insulator. They can be intrinsic (pure) or extrinsic (doped). Extrinsic semiconductors are created by adding impurities to an intrinsic semiconductor to increase the number of charge carriers.

There are two types of extrinsic semiconductors:

1. n-type semiconductor: Created by doping with pentavalent impurities (e.g., Phosphorus, Arsenic). These impurities donate extra electrons, making electrons the majority charge carriers and holes the minority charge carriers.

2. p-type semiconductor: Created by doping with trivalent impurities (e.g., Boron, Gallium). These impurities create "holes" (absence of an electron) in the semiconductor's valence band. Holes act as positive charge carriers and are the majority charge carriers, while electrons are the minority charge carriers.

Solution: In an n-type semiconductor, the impurity atoms added are typically pentavalent (having five valence electrons, like Phosphorus or Arsenic). When these pentavalent atoms are substituted into the semiconductor crystal lattice (which usually has elements with four valence electrons like Silicon or Germanium), four of their valence electrons form covalent bonds with the surrounding semiconductor atoms. The fifth valence electron of the impurity atom is loosely bound and can easily be excited into the conduction band, becoming a free electron. These extra electrons provided by the dopant atoms are the majority charge carriers in an n-type semiconductor.

Electrons: These are the majority charge carriers in an n-type semiconductor. Correct. Holes: These are the majority charge carriers in a p-type semiconductor and minority carriers in an n-type semiconductor.

Protons and Neutrons: These are subatomic particles within the atomic nucleus and are not directly involved as charge carriers in semiconductor conductivity.

Final Answer: $\boxed{Electrons}$

Answer: (A)

Go Back to Question 18

Q19.

Solution

Concept: Logic gates are fundamental building blocks of digital circuits. An AND gate is a digital logic gate that implements logical conjunction. The output of an AND gate is HIGH (1) if and only if all of its inputs are HIGH (1). If any input is LOW (0), the output is LOW (0).

The truth table for a two-input AND gate (with inputs A and B, and output Y) is:
The logical expression for a two-input AND gate is $Y = A \cdot B$ (or $Y = AB$).

Solution: Looking at the truth table or the logical expression for a two-input AND gate: The output Y is HIGH (1) only in the case where both input A and input B are HIGH (1). In all other cases (both inputs LOW, or one input HIGH and the other LOW), the output Y is LOW (0).

Therefore, an AND gate gives a HIGH output only when both inputs are HIGH.

Final Answer: $\boxed{Both inputs are HIGH}$

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept: Resistivity (ρ) is an intrinsic property of a material that quantifies how strongly it resists or conducts electric current. It is a measure of how difficult it is for electric charge carriers to move through a material. Resistivity is related to resistance (R) by the formula $R = \rho\frac{L}{A}$, where L is the length of the conductor and A is its cross-sectional area.

To find the SI unit of resistivity, we can rearrange the formula:
$\rho = R\frac{A}{L}$

Now, let's determine the units:
Resistance (R) is measured in Ohms (Ω).
Area (A) is measured in square meters (m^2).
Length (L) is measured in meters (m).

Solution: Substituting the units into the formula for resistivity:
$[\rho] = [\Omega] \times \frac{[\mathrm{m}^2]}{[\mathrm{m}]}$
$[\rho] = [\Omega] \times [\mathrm{m}]$
$[\rho] = \Omega\,\mathrm{m}$

So, the SI unit of resistivity is Ohm-meter ($\Omega\,\mathrm{m}$).

Let's check the options:
$\Omega\,\mathrm{m}$: This is the correct unit for resistivity.
Ω/m: This would be the unit for conductivity divided by length, not resistivity.
$\Omega\,\mathrm{m}^{-1}$: This would be the unit for conductance per unit length or conductivity.
Ω^2: This unit is not standard for resistivity.

Final Answer: $\boxed{\Omega\,\mathrm{m}}$

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept: A scalar quantity is a physical quantity that is completely described by its magnitude alone. It does not have any direction associated with it. Examples include mass, temperature, time, speed, distance, and energy.

A vector quantity, on the other hand, requires both magnitude and direction to be fully described. Examples include force, velocity, displacement, and acceleration.

Solution: Let's examine each quantity:
Pressure: Pressure is defined as force per unit area ($P = F/A$). While force is a vector, pressure is a scalar quantity because the force is distributed over an area, and we are concerned with the magnitude of the force perpendicular to the area, not its direction in space (at a point, pressure acts equally in all directions). Scalar.
Force: Force is a vector quantity, as it has both magnitude and direction.
Velocity: Velocity is a vector quantity, as it has both magnitude (speed) and direction.
Displacement: Displacement is a vector quantity, representing the change in position from an initial point to a final point, including both distance and direction.

Therefore, pressure is a scalar quantity among the given options.

Final Answer: $\boxed{Pressure}$

Answer: (A)

Go Back to Question 21

Q22.

Solution

Concept: The acceleration due to gravity (g) at the surface of a planet is given by the formula:
$$g = \frac{GM}{R^2}$$
where G is the gravitational constant, M is the mass of the planet, and R is the radius of the planet.

This formula shows that the acceleration due to gravity is directly proportional to the mass (M) and inversely proportional to the square of the radius (R^2).

Solution: In this problem, the mass of the Earth (M) is kept constant, but the radius (R) is doubled.
Let the new radius be $R' = 2R$.
Let the new acceleration due to gravity be g'.
The original acceleration due to gravity is $g = \frac{GM}{R^2}$.
The new acceleration due to gravity will be:
$$g' = \frac{GM}{(R')^2}$$
Substitute $R' = 2R$:
$$g' = \frac{GM}{(2R)^2}$$
$$g' = \frac{GM}{4R^2}$$

Now, compare g' with g:
$$g' = \frac{1}{4}\left(\frac{GM}{R^2}\right)$$
$$g' = \frac{1}{4}g$$

So, if the radius of the Earth becomes double while keeping the mass the same, the acceleration due to gravity becomes one-fourth of its original value.

Final Answer: $\boxed{One - fourth}$

Answer: (A)

Go Back to Question 22

Q23.

Solution

Concept: Viscosity is a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. For liquids, viscosity is primarily due to the cohesive forces between molecules.

Liquids: In liquids, viscosity generally decreases with increasing temperature. As temperature rises, molecules gain kinetic energy, move more vigorously, and the cohesive forces between them weaken. This reduced cohesion allows the liquid to flow more easily, thus decreasing its viscosity.
Gases: For gases, viscosity generally increases with increasing temperature. This is because higher temperatures lead to more frequent collisions between gas molecules, increasing the momentum transfer, which is the source of viscosity in gases.

Solution: We are considering the viscosity of liquids.
Temperature: As temperature increases, the kinetic energy of liquid molecules increases, weakening the intermolecular cohesive forces. This leads to easier flow, hence lower viscosity. Correct.
Pressure: The effect of pressure on the viscosity of liquids is generally small. In most cases, increasing pressure slightly increases the viscosity of liquids due to reduced molecular spacing.
Density: While density is related to molecular spacing and cohesive forces, the direct relationship with viscosity is more strongly linked to temperature.
Volume: Changes in volume are usually a consequence of temperature or pressure changes and do not directly cause a change in viscosity.

Therefore, the viscosity of liquids generally decreases with an increase in temperature.

Final Answer: $\boxed{Temperature}$

Answer: (A)

Go Back to Question 23

Q24.

Solution

Concept: A pressure-volume (P-V) graph plots pressure (P) on the y-axis and volume (V) on the x-axis. The area under a P-V curve represents the work done by or on the system during a thermodynamic process.

Work done (W): For a process where volume changes, the work done by the gas is given by the integral of pressure with respect to volume: $W = \int P\,dV$. Geometrically, this integral represents the area under the P-V curve.
Rate of pressure change with volume: This would be the slope of the P-V graph, dP/dV.
Internal energy and Temperature: These are state variables that depend on the thermodynamic state (P, V, T) of the system, but the area under the P-V graph specifically represents work done.

Solution: The work done by a gas during a thermodynamic process is defined as the integral of pressure with respect to volume. On a pressure-volume graph, this integral corresponds to the area under the curve representing the process.
$W = \int_{V_1}^{V_2} P\,dV$

This area represents the work done by the gas if the volume is increasing ($V_2 > V_1$) and work done on the gas if the volume is decreasing ($V_2 < V_1$).

Let's examine the options:
Rate of pressure change with volume: This is the slope of the P-V graph (dP/dV), not the area.
Work done directly: The area under the P-V graph directly represents the work done. Correct.
Internal energy: Internal energy (U) is a state function and depends on temperature and the number of moles. It is not directly given by the area under a P-V graph.
Temperature: Temperature is also a state variable and is not directly given by the area under a P-V graph.
Final Answer: $\boxed{Workdonedirectly}$

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept: Frequency is a measure of how often a periodic event occurs. In the context of waves, it is the number of complete cycles or oscillations that pass a given point per unit of time. The SI unit for frequency is the Hertz (Hz), which is defined as one cycle per second (1 Hz = 1 s^{-1}).

Solution: The unit of frequency is Hertz (Hz).
Hertz (Hz): This is the SI unit of frequency. Correct.
Pascal (Pa): This is the SI unit of pressure.
Newton (N): This is the SI unit of force.
Joule (J): This is the SI unit of energy or work.

Final Answer: $\boxed{Hertz}$

Answer: (A)

Go Back to Question 25

Q26.

Solution

Concept: In electrostatics, electric charges interact with each other. Like charges (both positive or both negative) repel each other, while unlike charges (one positive and one negative) attract each other. This is described by Coulomb's Law.

Solution: The fundamental principle governing the interaction between electric charges states:
Like charges repel.
Unlike charges attract.

Therefore, two charges repel each other because they are like charges (both positive or both negative).

Let's examine the options:
Like charges: This is the condition for repulsion. Correct.
Unlike charges: This causes attraction.
Neutral: A neutral object does not have a net charge and does not experience electrostatic repulsion or attraction from another charge based on its neutrality alone (though it can be polarized).
Grounded: Grounding is a process of connecting an object to the Earth to neutralize its charge, but it doesn't inherently mean the two charges are like.

Final Answer: $\boxed{Likecharges}$

Answer: (A)

Go Back to Question 26

Q27.

Solution

Concept: Kirchhoff's junction rule (also known as Kirchhoff's first law or the current law) deals with the conservation of electric charge at a junction (or node) in an electrical circuit. It states that the total current entering a junction is equal to the total current leaving the junction. Mathematically, $\sum I_{in} = \sum I_{out}$. This is a direct consequence of the principle of conservation of charge.

Kirchhoff's loop rule (or Kirchhoff's second law) deals with the conservation of energy around a closed loop in a circuit. It states that the sum of the voltage drops around any closed loop in a circuit is equal to the sum of the voltage rises, so the net change in electric potential around a closed loop is zero.

Solution: Kirchhoff's junction law is a statement of the conservation of electric charge. At any junction in a circuit, charge cannot accumulate or disappear; it must be conserved. Therefore, the rate at which charge flows into the junction must equal the rate at which charge flows out. This rate of charge flow is precisely the electric current.

Charge: Conservation of charge is the fundamental principle behind the junction rule. Correct.
Energy: Conservation of energy is the principle behind Kirchhoff's loop rule.
Momentum: Conservation of momentum is relevant in collisions and mechanics.
Mass: Conservation of mass is generally true, but charge conservation is the specific principle for the junction rule.

Final Answer: $\boxed{Charge}$

Answer: (A)

Go Back to Question 27

Q28.

Solution

Concept: The force between two parallel conductors carrying currents is due to the magnetic field produced by each current.
If the currents are in the same direction, the magnetic field produced by one conductor exerts a force on the other conductor that tends to pull them together. Thus, the force is attractive. If the currents are in opposite directions, the magnetic field produced by one conductor exerts a force on the other conductor that tends to push them apart. Thus, the force is repulsive.

The magnitude of the force per unit length (F/L) between two parallel wires carrying currents I_1 and I_2, separated by a distance d, is given by: $\frac{F}{L} = \mu_0 \frac{I_1 I_2}{2\pi d}$

Solution: Based on the established principles of electromagnetism regarding parallel current-carrying conductors:
Attractive for same direction currents: When currents in two parallel wires flow in the same direction, they attract each other. Correct.
Repulsive always: Repulsion occurs only when currents are in opposite directions.
Zero always: The force is generally not zero unless one of the currents or the distance is infinite, or if there's a specific arrangement that cancels forces.
Independent of current: The force is directly dependent on the magnitude of the currents (I_1 and I_2).

Therefore, the force between two parallel current-carrying conductors is attractive when the currents are in the same direction.

Final Answer: $\boxed{Attractive for same direction currents}$

Answer: (A)

Go Back to Question 28

Q29.

Solution

Concept: A plane mirror is a flat, highly reflective surface. It forms images based on the principle of reflection, where the angle of incidence equals the angle of reflection.
Key characteristics of images formed by a plane mirror:
Nature: The image is always virtual. This means the reflected rays diverge, and the image appears to be formed behind the mirror. It cannot be projected onto a screen.
Position: The image is formed behind the mirror at the same distance from the mirror as the object is in front of it.
Size: The image is always the same size as the object (erect and of same size).
Orientation: The image is laterally inverted (left and right are reversed), but it is upright (erect).

The focal length of a plane mirror is considered to be infinite. This is because the rays reflected from a plane mirror remain parallel to each other (or diverge from a point at infinity), rather than converging or diverging from a focal point at a finite distance.

Solution: Since a plane mirror is flat, it does not have a focal point at a finite distance like curved mirrors. Rays parallel to the mirror's surface would essentially be reflected such that they remain parallel or diverge as if from infinity.
The mirror formula for spherical mirrors is $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$. For a plane mirror, as the object distance u goes to infinity (for parallel rays) or as the curvature goes to zero, the focal length f tends to infinity.
Therefore, the focal length of a plane mirror is infinite.

Let's check the options:
Infinite: This is the correct focal length for a plane mirror. Correct.
Zero: A focal length of zero implies infinite convergence power, which is not the case.
Positive finite: This applies to convex mirrors.
Negative finite: This applies to concave mirrors.

Final Answer: $\boxed{Infinite}$

Answer: (A)

Go Back to Question 29

Q30.

Solution

Concept: Dispersion of light is the phenomenon where white light splits into its constituent colors when it passes through a medium like a prism. This happens because the refractive index of the medium varies slightly for different wavelengths (colors) of light.
Generally, for transparent materials, the refractive index (n) decreases as the wavelength (λ) increases. This means shorter wavelengths (like violet) are refracted more than longer wavelengths (like red).
The deviation (δ) of light through a prism depends on the angle of incidence, prism angle, and refractive index. For a given prism, colors with higher refractive indices experience greater deviation.

The order of colors in the visible spectrum from longest wavelength to shortest wavelength is: Red, Orange, Yellow, Green, Blue, Indigo, Violet (ROYGBIV).
Red light has the longest wavelength and therefore the lowest refractive index.
Violet light has the shortest wavelength and therefore the highest refractive index.

Solution: Since the refractive index is lower for red light and higher for violet light, red light will deviate less from its original path when passing through the prism, while violet light will deviate the most.

Red: Longest wavelength, lowest refractive index, least deviation. Correct.
Violet: Shortest wavelength, highest refractive index, most deviation.
Green and Blue: Have intermediate wavelengths and deviations.

Therefore, red light deviates the least in a prism.

Final Answer: $\boxed{Red}$

Answer: (A)

Go Back to Question 30

Q31.

Solution

Concept: The de Broglie wavelength (λ) of a particle is inversely proportional to its momentum (p). This relationship is given by the de Broglie equation:

$$\lambda = \frac{h}{p}$$

where h is Planck's constant.

Momentum (p) is given by $p = mv$, where m is the mass of the particle and v is its velocity.

Solution: The de Broglie wavelength is given by $\lambda = \frac{h}{p}$.

From this equation, we can see that the wavelength (λ) is inversely proportional to the momentum (p).

If the momentum (p) decreases, the wavelength (λ) must increase to keep the equation balanced.

If the momentum (p) increases, the wavelength (λ) must decrease.

Therefore, the de Broglie wavelength of a particle increases when its momentum decreases.

Let's check the options:

Decreases: If momentum decreases, wavelength increases. Correct.

Increases: If momentum increases, wavelength decreases.

Becomes zero only: Momentum cannot become zero unless the particle is at rest, which implies infinite wavelength according to the formula.

Remains constant: This would imply momentum also remains constant, which contradicts the premise of changing wavelength.

Final Answer: $\boxed{Decreases}$

Answer: (A)

Go Back to Question 31

Q32.

Solution

Concept: Radioactivity is a nuclear process. The rate at which a radioactive substance decays is determined by its decay constant (λ), which is specific to the element and isotope. The half-life ($T_{1/2} = \ln(2)/\lambda$) is a measure of this decay rate.

External conditions such as temperature, pressure, chemical state, and the passage of time do not affect the nuclear decay process. The decay rate is an intrinsic property of the nucleus itself.

Solution: Radioactive decay is a fundamentally nuclear phenomenon. The stability of an atomic nucleus is determined by the forces within it, primarily the strong nuclear force and the electromagnetic force between protons. These nuclear forces are not significantly influenced by external factors like temperature, pressure, or the chemical bonding of the atom.

Let's consider the options:
Temperature: Nuclear decay is unaffected by temperature.
Time: Decay happens over time, but the *rate* of decay (half-life) is constant over time. Time itself doesn't affect the radioactivity rate.
Nature of nucleus: Radioactivity is a property *of* the nucleus. The decay constant and half-life are determined by the specific nature of the nucleus (e.g., its composition of protons and neutrons, and the forces holding it together). So, the rate is dependent on the nucleus's nature.
Decay constant: The decay constant is a direct measure of the rate of radioactivity. Radioactivity is defined by the decay constant, not unaffected by it.

The question asks what radioactivity is unaffected by. Temperature is an external physical condition that does not influence the nuclear decay rate. While time is the variable over which decay occurs, the rate itself is constant over time. The nature of the nucleus is the cause of radioactivity, and the decay constant is its measure.

In the context of typical physics questions, temperature is consistently cited as a factor that does not affect radioactive decay.

Final Answer: $\boxed{Temperature}$

Answer: (A)

Go Back to Question 32

Q33.

Solution

Concept: A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is a fundamental component in modern electronics.
Amplification: A small input signal can control a larger output signal, increasing its amplitude. This is a key function of transistors.
Rectification: This is the process of converting AC to DC, typically done using diodes.
Oscillation: While transistors can be used in circuits that generate oscillations (oscillators), oscillation itself is not the primary function of a single transistor.
Reflection: This is a phenomenon related to waves bouncing off surfaces.

Solution: The primary and most fundamental use of transistors in electronic circuits is for amplification. By applying a small voltage or current to the control terminal (base or gate), a much larger current or voltage can be controlled between the other two terminals (collector-emitter or drain-source). This allows for the strengthening of weak signals. Transistors can also act as switches, which is crucial for digital logic, but amplification is considered a core analog function.

Final Answer: $\boxed{Amplification}$

Answer: (A)

Go Back to Question 33

Q34.

Solution

Concept: Modulation is a process used in telecommunications to encode information onto a carrier wave. This is typically done by varying one or more properties of the carrier wave (such as its amplitude, frequency, or phase) in accordance with the information signal.

The main purpose of modulation is to enable efficient transmission of signals, especially over long distances. High-frequency carrier waves are chosen because they:

1. Can be transmitted effectively over long distances.
2. Can carry more information (higher bandwidth).
3. Allow for the use of smaller antennas.
4. Help in multiplexing (transmitting multiple signals on different carrier frequencies simultaneously).

Solution: Modulation is essential for transmitting signals, especially those with lower frequencies (like audio signals), over long distances using electromagnetic waves.

Transmit signals efficiently: By using a high-frequency carrier wave, modulation allows signals to be transmitted effectively through the atmosphere or space, overcome limitations of antenna size, and achieve longer ranges. Correct.

Reduce frequency to zero: Modulation shifts the original signal's frequency to the carrier wave's frequency; it does not reduce it to zero.

Eliminate carrier wave: The carrier wave is essential; it's what carries the information. Modulation modifies the carrier, not eliminates it.

Increase noise: While noise is a concern in communication, modulation itself is designed to improve signal-to-noise ratio and efficient transmission, not to increase noise.

Therefore, modulation is done to transmit signals efficiently.

Final Answer: $\boxed{Transmit signals efficiently}$

Answer: (A)

Go Back to Question 34

Q35.

Solution

Concept: Work is done when a force causes displacement. In physics, work (W) is defined as the product of the force (F) applied in the direction of displacement and the magnitude of the displacement (d).

$W = F \cdot d$

If the force is not parallel to the displacement, work is the dot product of the force and displacement vectors: $W = \vec{F} \cdot \vec{d}$.

To find the dimensional formula of work, we need the dimensions of force and displacement.

Force (F): The SI unit of force is Newton (N), and its dimensional formula is $[MLT^{-2}]$. (Mass × Acceleration)

Displacement (d): The SI unit of displacement is meter (m), and its dimensional formula is $[L]$.

Solution: Substitute the dimensions of force and displacement into the definition of work:

$[W] = [\text{Force}] \times [\text{Displacement}]$

$[W] = [MLT^{-2}] \times [L]$

$[W] = ML^{1+1}T^{-2}$

$[W] = ML^2T^{-2}$

So, the dimensional formula of work is $[ML^2T^{-2}]$. This is the same as the dimensional formula for energy (e.g., kinetic energy, potential energy).

Let's check the options:

ML^2T^{-2}: This matches our derived formula for work. Correct.

MLT^{-2}: This is the dimensional formula for force.

$ML^{-1}T^{-2}$: This is the dimensional formula for pressure gradient or stress/length.

M^0LT^{-1}: This represents velocity with dimensions of length per time.

Final Answer: $\boxed{ML^2T^{-2}}$

Answer: (A)

Go Back to Question 35

Q36.

Solution

Concept: Conductors are materials that allow electric charge to flow easily through them. This is primarily due to the presence of free electrons in their atomic structure. In electrostatic equilibrium, the net electric field inside a conductor must be zero. Also, any excess charge placed on a conductor resides on its outer surface.

Solution: Let's analyze each property:

1. They contain free electrons: Metals, which are excellent conductors, have a large number of valence electrons that are not bound to individual atoms but can move freely throughout the material. This makes them good conductors of electricity. Correct.
2. Electric field inside conductor is zero in electrostatic equilibrium: In electrostatic equilibrium, any net charge on a conductor will redistribute itself until the electric field inside the conductor is zero. If there were an electric field, free charges would move, and the conductor would not be in equilibrium. Correct.
3. Resistance is always infinite: Infinite resistance means no current can flow, which is characteristic of insulators, not conductors. Conductors have low resistance. Incorrect.
4. Charges reside on outer surface: Any excess charge placed on a conductor, or any charge that results from induction or conduction, will distribute itself on the outermost surface of the conductor in electrostatic equilibrium. This is to minimize the potential energy of the system, which is achieved when the electric field inside is zero. Correct.

Therefore, the properties of conductors include the presence of free electrons, zero electric field inside in electrostatic equilibrium, and charges residing on the outer surface.

Final Answer: $\boxed{Theycontainfreeelectrons, Electricfieldinsideconductoriszeroinelectrostaticequilibrium}$

Answer: (A,B,D)

Go Back to Question 36

Q37.

Solution

Concept: Uniform circular motion is the motion of an object in a circular path at constant speed.
Key characteristics:
Speed: The magnitude of velocity remains constant.
Velocity: Velocity is a vector quantity (magnitude + direction). In uniform circular motion, the direction of velocity is always tangent to the circular path and continuously changes.
Acceleration: Since the velocity changes (due to change in direction), there is always an acceleration. This acceleration is directed towards the center of the circle (centripetal acceleration) and has a constant magnitude given by $a = v^2/r$.
Kinetic Energy: Kinetic energy ($KE = \frac{1}{2}mv^2$) depends on speed. If the speed is constant, the kinetic energy is also constant.

Solution: Let's analyze each statement for uniform circular motion:
1. Speed remains constant: By definition, uniform circular motion means the speed (magnitude of velocity) is constant. Correct.
2. Velocity changes continuously: Although the speed is constant, the direction of motion is always tangent to the circle, and this direction is continuously changing. Therefore, the velocity vector changes continuously. Correct.
3. Acceleration acts towards center: The acceleration in uniform circular motion is centripetal acceleration, which is always directed towards the center of the circle. Correct.
4. Kinetic energy changes continuously: Kinetic energy ($KE = \frac{1}{2}mv^2$) depends on the square of the speed. Since the speed is constant in uniform circular motion, the kinetic energy also remains constant. Incorrect.

Therefore, the statements that are true for a body moving in uniform circular motion are that speed remains constant, velocity changes continuously, and acceleration acts towards the center.

Final Answer: $\boxed{Speed remains constant, Velocity changes continuously, Acceleration acts towards center}$

Answer: (A,B,C)

Go Back to Question 37

Q38.

Solution

Concept: Sound waves are mechanical waves that propagate through a medium by causing vibrations in that medium. They are different from electromagnetic waves.
Characteristics of sound waves:
Mechanical Waves: They require a medium (solid, liquid, or gas) to travel. They cannot travel through a vacuum.
Reflection: Sound waves can reflect off surfaces, which is the principle behind echoes.
Other Wave Phenomena: Sound waves also exhibit refraction, diffraction, and interference.

Solution: Let's evaluate each characteristic:
1. They are mechanical waves: Sound waves are indeed mechanical waves because they are disturbances that propagate through a material medium by causing vibrations of the particles of that medium. Correct.
2. They require medium: As mechanical waves, sound waves need a medium (like air, water, or solids) to travel. They cannot travel through a vacuum. Correct.
3. They can travel in vacuum: This is incorrect. Mechanical waves cannot travel through a vacuum. Electromagnetic waves (like light) can travel through a vacuum. Incorrect.
4. They exhibit reflection: When sound waves encounter a boundary between two different media, a portion of the wave is reflected back into the original medium. This is how echoes are produced. Correct.

Therefore, sound waves are mechanical waves, require a medium, and exhibit reflection.

Final Answer: $\boxed{Theyaremechanicalwaves, Theyrequiremedium, Theyexhibitreflection}$

Answer: (A,B,D)

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Q39.

Solution

Concept: The photoelectric effect is the emission of electrons from a material when light shines on it. Key observations and explanations include:
Intensity: Increasing the intensity of light (number of photons) increases the number of electrons emitted, thus increasing the photoelectric current.
Frequency: Increasing the frequency of light increases the energy of the photons. If the photon energy exceeds the work function of the material, electrons are emitted. Higher frequency means higher photon energy, which can lead to higher kinetic energy of the emitted electrons. Threshold Frequency: There is a minimum frequency of light (ν_0), called the threshold frequency, below which no photoelectric emission occurs, regardless of the intensity. This is because the energy of individual photons is insufficient to overcome the work function of the material.
Delay: Photoelectric emission is virtually instantaneous when light of sufficient frequency strikes the surface, with no significant delay. This supports the photon theory of light.

Solution: Let's analyze each statement regarding the photoelectric effect:
1. Increasing intensity increases photoelectric current: Intensity is proportional to the number of photons. More photons mean more electrons can be emitted (if the frequency is above the threshold), leading to a higher photoelectric current. Correct.
2. Increasing frequency can increase kinetic energy: The kinetic energy of the emitted electrons is given by $KE = h\nu - \phi$. If the frequency (ν) increases, and $\nu > \nu_0$, the photon energy ($h\nu$) increases, leading to a higher kinetic energy of the emitted electrons. Correct.
3. Threshold frequency exists: This is a fundamental observation of the photoelectric effect. Below a certain frequency (ν_0), no electrons are emitted, no matter how intense the light is. Correct.
4. Emission occurs after long delay: The photoelectric emission is practically instantaneous, which is a key piece of evidence supporting the photon model of light, contradicting classical wave theory which predicted a delay. Incorrect.

Therefore, the correct statements are that increasing intensity increases photoelectric current, increasing frequency can increase kinetic energy, and a threshold frequency exists.

Final Answer: $\boxed{Increasingintensityincreasesphotoelectriccurrent, Increasingfrequencycanincreasekine}$

Answer: (A,B,C)

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Q40.

Solution

Concept: Alternating Current (AC) is an electric current that periodically reverses direction and changes its magnitude continuously over time.
Key characteristics of AC:
Direction: The direction of current flow reverses periodically.
Magnitude: The magnitude changes continuously, typically following a sinusoidal pattern. RMS Value: The root-mean-square (RMS) value of an AC current is a measure of its effective value, equivalent to the DC current that would produce the same amount of heating. For a sinusoidal AC, $I_{RMS} = I_{peak}/\sqrt{2}$.
Frequency: The number of complete cycles per second, measured in Hertz (Hz).
Power: The average power dissipated by an AC circuit depends on the resistance and the RMS values of voltage and current. For a purely resistive load, the average power is non-zero. For reactive components (inductors and capacitors), the average power can be zero over a full cycle if the current and voltage are out of phase.

Solution: Let's evaluate each statement for alternating current:
1. Direction changes periodically: This is the defining characteristic of AC. The current flows first in one direction and then reverses, completing a cycle. Correct.
2. RMS value can be defined: The RMS value provides a way to quantify the effective magnitude of an AC current or voltage, particularly for power calculations. Correct.
3. Frequency is measured in hertz: The frequency of an AC signal indicates how many cycles occur per second, and its unit is Hertz (Hz). Correct.
4. It always has zero average power: This is not always true. For a purely resistive circuit, the average power dissipated is non-zero ($P_{avg} = V_{rms}I_{rms}$). For circuits with reactive components (inductors and capacitors), the average power over a full cycle can be zero because energy is stored and returned to the circuit, but this is not universally true for all AC circuits or all aspects of AC power. For example, power is delivered to a resistor in an AC circuit. Incorrect.

Therefore, the true statements for alternating current are that its direction changes periodically, its RMS value can be defined, and its frequency is measured in Hertz.

Final Answer: $\boxed{Directionchangesperiodically, RMSvaluecanbedefined, Frequencyismeasuredinhertz}$

Answer: (A,B,C)

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Answer Key

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