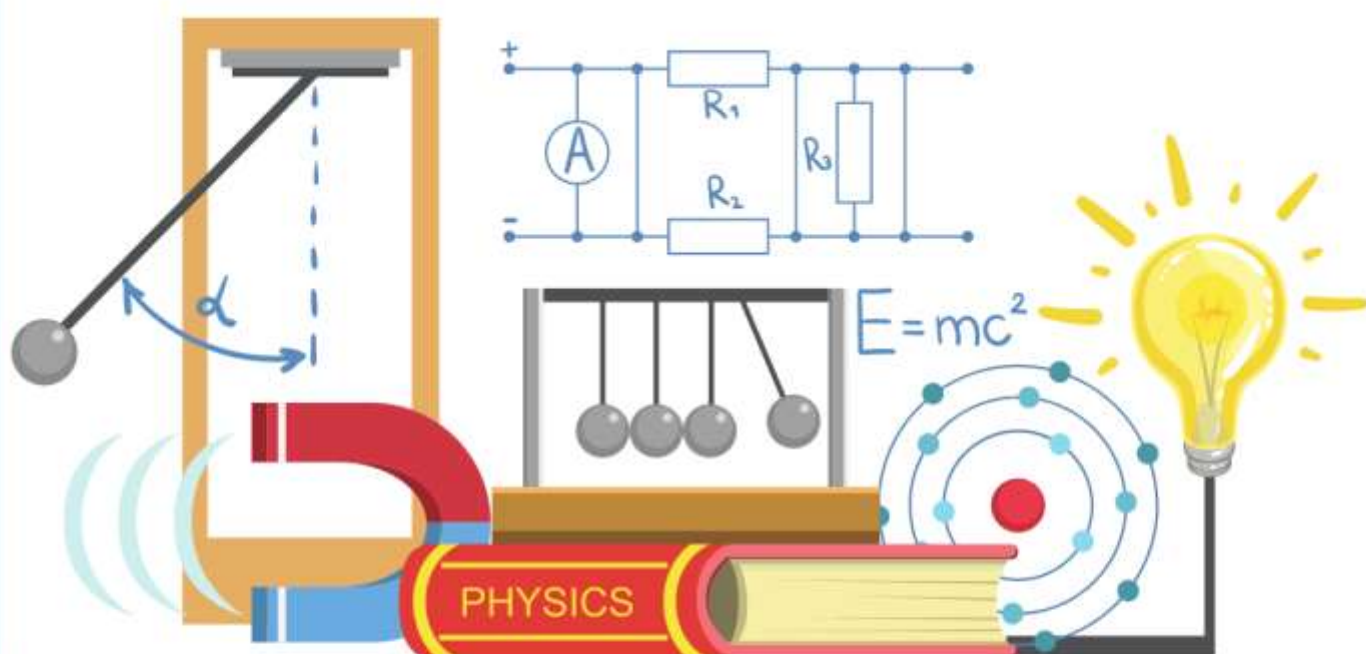




IB Physics HL

Paper 1

Question Bank



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Physics
Higher level
Paper 1

1 hour

Instructions to candidates

- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the physics data booklet is required for this paper.
- The maximum mark for this examination paper is **[40 marks]**



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1. When a skydiver opens her parachute, she is falling with terminal velocity. What is the direction of the velocity and acceleration vector before she reaches the new terminal speed?

A. Velocity: Upwards, Acceleration: Upwards
B. Velocity: Upwards, Acceleration: Downwards
C. Velocity: Downwards, Acceleration: Upwards
D. Velocity: Downwards, Acceleration: Downwards

Answer: C

Since the skydiver has opened their parachute, the motion of the skydiver is now slow and downwards. When an object slows down, its acceleration is always opposite to the direction of its motion. Since the diver is moving down, the direction and magnitude of the velocity vector is downwards. Since her speed is decreasing, the **acceleration vector must point opposite to the velocity vector**.

2. A sports car is accelerated from 0 to 120 km per hour in 4 s. What is the acceleration of the car?

A. 0.9 g
B. 0.4 g
C. 0.3 g
D. 4 g

Answer: A

120 km/h needs to be converted to m/s first since the time is given in seconds. Therefore,
 $120 \text{ km/hr} * (1000 \text{ m}) / (1 \text{ km}) * (60 \text{ min}) / (1 \text{ hr}) * (60 \text{ sec}) / (1 \text{ min}) = 33.333 \text{ m/s}$.

Acceleration is change in velocity/change in time, therefore:

$$(33.333 \text{ m/s} - 0 \text{ m/s}) / 4 = 8.33325 \text{ m/s}^2$$

As the answer is given in g's, we will divide the acceleration by g. $1 \text{ g} = 9.8 \text{ m/s}^2$. Therefore,
 $8.33325 / 9.8 = 0.8503 \text{ g's}$ which is approximately, **0.9 g's**

3. In a flask, energy is transmitted to the water at a rate P. When the water approaches its boiling point, P is raised. What modifications have been made to the water's temperature and rate of evaporation since the change?

A. Temperature increases, Rate of Evaporation increases
B. Temperature increases, Rate of Evaporation stays the same
C. Temperature stays the same, Rate of Evaporation increases
D. Temperature stays the same, Rate of Evaporation stays the same

Answer: C

There is no change in temperature after it reaches boiling point no matter how much the water is heated. However, the rate at which the energy is transmitted increases, therefore, the rate of evaporation also increases.

4. Which of the following statements are true about total internal energy and total intermolecular potential energy of a solid substance when it undergoes sublimation to become a gas?

- A. Internal energy increases, intermolecular potential energy stays the same
- B. Internal energy increases, intermolecular potential energy increases
- C. Internal energy stays the same, intermolecular potential energy stays the same
- D. Internal energy stays the same, intermolecular potential energy increases

Answer: B

The intermolecular potential energy increases because potential energy of any matter depends upon inter molecular space and gases have highest inter molecular space. Furthermore, if the potential energy increases, the internal energy is also bound to increase since the internal energy is the sum of the kinetic and potential energy.

5. What is the phase difference between the displacement and acceleration of a particle executing simple harmonic motion (SHM)?

- A. π
- B. $\pi/3$
- C. $3\pi/4$
- D. 0

Answer: A

Since $y = A \sin \phi$ and $a = -\omega^2 A \sin \phi$

$$-\sin \phi = \sin(\phi + \pi)$$

So, acceleration is a phase π ahead of displacement

6. There is a flow of charge through a liquid. 0.15 C of negative ions and 0.15 C of positive ions move facing each other. What is the magnitude of the electric current flowing through the liquid?

- A. 0.075
- B. 0
- C. 0.15
- D. 0.3

Answer: D

Since the charged ions have separate magnitudes and are facing each other, the electric current flowing through the liquid is the sum of both charges. This is because they are oppositely charged ions.

7. A particle has a charge of ne . It is accelerated through a potential difference V . How is the work done on the particle calculated?

- A. neV
- B. ne/V
- C. V/ne
- D. eV/n

Answer: A

Work done is calculated by multiplying the charge with the potential difference. Therefore, the work done of the particle is calculated by $ne \times V$

8. A proton traveling at velocity v enters a magnetic and electric field. There is no proton deflection. With a velocity of v , an electron and an alpha particle enter the same space. Which of the following statements are true with regards to the alpha and electron's paths?

- A. Path of electron is not deflected, path of alpha particle is not deflected
- B. Path of electron is deflected, path of alpha particle is not deflected
- C. Path of electron is deflected, path of alpha particle is deflected
- D. Path of electron is not deflected, path of alpha particle is deflected

Answer: A

Neither alpha-particle will be deflected nor electron will be deflected because net force on both particles will be zero.

9. If a particle with an atomic number Z undergoes a beta-plus (β^+) decay, what is the atomic number of the nuclide produced and the other particle emitted?

- A. Atomic number ($Z-1$), Other particle is neutrino
- B. Atomic number ($Z-1$), Other particle is antineutrino
- C. Atomic number ($Z+1$), Other particle is neutrino
- D. Atomic number ($Z+1$), Other particle is antineutrino

Answer: A

In a beta plus (β^+) decay, a proton is converted to a neutron and the process creates a positron and an electron neutrino. β^+ decay is also known as positron emission.

10. A beaker has 2 kg of water at room temperature. It is heated on a 450 W hot plate. The specific heat capacity of water is $4200 \text{ J kg}^{-1} \text{ K}^{-1}$. When the temperature of the water reaches a constant value, it is removed from the hot plate. What is the initial rate of change of temperature?

- A. 0.005 K s^{-1}
- B. 0.5 K s^{-1}
- C. 0.05 K s^{-1}
- D. 5 K s^{-1}

Answer: D

The formula for specific heat capacity is $Q = mc\Delta T$. We have Q (power), mass and specific heat capacity. The equation needs to be rearranged to make ΔT the subject of the equation. Therefore, it is $\Delta T = Q/mc$. Substituting the values, we have $450/(4200 \times 2) = 0.05357 \text{ K s}^{-1}$

11. After a metallic surface is exposed to infrared radiation, photoelectrons are released from the same surface. The ultraviolet radiation has the same intensity as the infrared radiation. What will happen to the photoelectrons' kinetic energy and the pace at which they are ejected?

- A. Photoelectrons kinetic energy increases and rate at which they are ejected is constant
- B. Photoelectrons kinetic energy increases and rate at which they are ejected increases
- C. Photoelectrons kinetic energy is constant and rate at which they are ejected increases
- D. Photoelectrons kinetic energy is constant and rate at which they are ejected is constant

Answer: B

Since ultraviolet radiation has a higher frequency than infrared radiation, the kinetic energy of the photoelectrons increases. Ultraviolet radiation also has shorter waves and thus oscillates more rapidly and carries more energy per photon. Since the kinetic energy increases, the rate at which they are ejected also increases.

12. During gamma decay, photons of discrete energy are emitted. What does this mean?

- A. Quantum tunneling
- B. Pair Production
- C. Nuclear energy levels
- D. Atomic energy levels

Answer: C

During gamma decay, an excited nucleus emits a particle therefore showing the existence of nuclear energy levels.

13. A train moving at a constant velocity of 20 m/s approaches a stationary person at a platform. If the frequency of the sound emitted by the train is 800 Hz, what frequency does the person at the platform hear?

- A. 750 Hz
- B. 800 Hz
- C. 850 Hz
- D. 900 Hz

Answer: A

The person at the platform will hear a frequency that is different from the actual frequency emitted by the train, due to the Doppler effect. The formula for the Doppler effect is given by

$f' = f (v \pm v_r) / (v \pm v_s)$, where f is the actual frequency emitted by the train, v is the speed of sound in air, v_s is the velocity of the receiver (person at the platform), and v_s is the velocity of the source (train). Since the train is moving towards the person, the sign before the receiver's velocity is negative. Substituting the given values, we get $f' = 800 (343 - 20) / (343 + 0) = 750 \text{ Hz}$.

14. Two waves with different wavelengths and frequencies are superimposed on each other. What will be the result of this interference?

- A. Destructive interference
- B. Constructive interference
- C. Complete destructive interference
- D. Standing waves

Answer: B

When two waves with different wavelengths and frequencies are superimposed on each other, they may either reinforce or cancel each other out. If the waves are in phase (crest of one wave coincides with the crest of the other wave), they will interfere constructively, resulting in an increase in amplitude. If the waves are out of phase (crest of one wave coincides with the trough of the other wave), they will interfere destructively, resulting in a decrease in amplitude. In general, the interference between two waves is dependent on the phase difference between them. Complete destructive interference occurs when the two waves are completely out of phase, resulting in a net amplitude of zero.

15. An object is projected with an initial velocity of 10 m/s at an angle of 60° to the horizontal. What is the maximum height reached by the object?

- A. 2.5 m
- B. 5.0 m
- C. 7.5 m
- D. 10.0 m

Answer: C

The maximum height reached by the object can be calculated using the formula $h = (v^2 \sin^2 \theta) / (2g)$, where v is the initial velocity, θ is the angle of projection, and g is the acceleration due to gravity. Substituting the given values, we get $h = (10^2 \sin^2 60^\circ) / (2 \times 9.81) = 7.5 \text{ m}$.

16. A current-carrying wire is placed in a uniform magnetic field. What is the direction of the force on the wire?

- A. Along the direction of the current
- B. Opposite to the direction of the current
- C. Along the direction of the magnetic field
- D. Perpendicular to both the current and the magnetic field

Answer: D

The direction of the force on a current-carrying wire in a magnetic field is given by the right-hand rule. If the thumb of the right hand points in the direction of the current, and the fingers point in the direction of the magnetic field, then the direction in which the palm faces will be the direction of the force. Since the thumb of the right hand points in the direction of the current, and the fingers point in the direction of the magnetic field, the force will be perpendicular to both the current and the magnetic field.

17. An object of mass 2 kg is placed on a horizontal surface. The coefficient of static friction between the object and the surface is 0.6. What is the minimum force required to start the object moving?

- A. 5.88 N
- B. 9.81 N
- C. 11.76 N
- D. 13.72 N

Answer: C

The minimum force required to start the object moving is given by the formula $F = \mu_s N$, where μ_s is the coefficient of static friction and N is the normal force exerted on the object by the surface. Since the object is on a horizontal surface, the normal force is equal to the weight of the object, which is $2 \times 9.81 = 19.62$ N. Substituting the given values, we get $F = 0.6 \times 19.62 = 11.76$ N.

18. An ideal gas is compressed isothermally. What happens to the pressure and volume of the gas?

- A. Pressure increases, volume increases
- B. Pressure increases, volume decreases
- C. Pressure decreases, volume increases
- D. Pressure decreases, volume decreases

Answer: B

According to Boyle's law, for an ideal gas at a constant temperature, the product of pressure and volume is constant. Therefore, if the volume of the gas is decreased (i.e., compressed), the pressure must increase to maintain the constant product. Since the compression is isothermal, the temperature of the gas remains constant throughout the process. Therefore, the pressure and volume of the gas are inversely proportional to each other, and as one increases, the other must decrease. Hence, the correct option is B.

19. A diver jumps from a diving board into a swimming pool. What happens to the potential energy and kinetic energy of the diver during the jump?

- A. Potential energy decreases, kinetic energy decreases
- B. Potential energy decreases, kinetic energy increases
- C. Potential energy increases, kinetic energy decreases
- D. Potential energy increases, kinetic energy increases

Answer: A

When the diver jumps from the diving board, the potential energy of the diver decreases, as the diver moves closer to the surface of the pool. At the same time, the kinetic energy of the diver increases, as the diver gains speed while falling towards the pool. Therefore, the correct option is A.

20. Which of the following statements is true about electromagnetic waves?

- A. They require a medium to propagate
- B. They have both electric and magnetic components
- C. They have a frequency range of 0 Hz to 20 Hz
- D. They are longitudinal waves

Answer: B

Electromagnetic waves consist of oscillating electric and magnetic fields that are perpendicular to each other and to the direction of propagation of the wave. They do not require a medium to propagate and can travel through vacuum. Electromagnetic waves have a wide frequency range, ranging from radio waves with frequencies of less than 1 Hz to gamma rays with frequencies greater than 10^{19} Hz. Electromagnetic waves are transverse waves, and not longitudinal waves.

21. Which of the following statements is true about a concave mirror?

- A. It always forms a virtual image
- B. It always forms a real image
- C. The focal length is negative
- D. The focal length is positive

Answer: C

A concave mirror can form both real and virtual images depending on the position of the object relative to the mirror. When the object is placed beyond the center of curvature of the mirror, a real inverted image is formed, while when the object is placed between the mirror and the focal point, a virtual upright image is formed. The focal length of a concave mirror is negative, as the mirror converges the incident rays of light towards a point behind the mirror, known as the focal point. Therefore, the correct option is C.

22. A current-carrying wire is placed in a magnetic field. What is the direction of the force on the wire?

- A. Parallel to the magnetic field
- B. Perpendicular to the magnetic field
- C. Anti-parallel to the magnetic field
- D. Random direction

Answer: B

When a current-carrying wire is placed in a magnetic field, a force is exerted on the wire. The direction of the force is perpendicular to both the current in the wire and the magnetic field. Therefore, the correct option is B.

23. What is the SI unit of power?

- A. Joule
- B. Watt
- C. Newton
- D. Pascal

Answer: B

Power is the rate at which work is done or energy is transferred, and is measured in watts (W). One watt is defined as the power required to do work at a rate of one joule per second ($1\text{ W} = 1\text{ J/s}$).

24. A convex lens is used to form an image of an object. What is the nature of the image formed?

- A. Real and inverted
- B. Virtual and inverted
- C. Real and upright
- D. Virtual and upright

Answer: B

A convex lens always forms a virtual, upright, and diminished image of an object. The image is formed on the same side of the lens as the object, and cannot be projected onto a screen.

25. An electron is moving at a speed of 3.0×10^7 m/s. What is the de Broglie wavelength of the electron?

- A. 1.5×10^{-10} m
- B. 2.5×10^{-10} m
- C. 4.5×10^{-10} m
- D. 6.5×10^{-10} m

Answer: A

The de Broglie wavelength of a particle is given by the formula $\lambda = h/mv$, where h is Planck's constant, m is the mass of the particle, and v is its velocity. For an electron, the mass is 9.11×10^{-31} kg, and Planck's constant is 6.626×10^{-34} J s. Substituting the given values, we get $\lambda = 6.626 \times 10^{-34} / (9.11 \times 10^{-31} \times 3.0 \times 10^7) \approx 1.5 \times 10^{-10}$ m.

26. Which of the following is true about an object in uniform circular motion?

- A. The net force on the object is always zero
- B. The velocity of the object is always constant
- C. The acceleration of the object is always tangential to its path
- D. The angular momentum of the object is always conserved.

Answer: C

In uniform circular motion, the velocity of the object is constantly changing direction, which means there must be an acceleration acting on the object. This acceleration is always

directed towards the center of the circular path, and is called centripetal acceleration. Therefore, option C is correct.

27. A capacitor with capacitance C is charged to a potential difference V . What is the energy stored in the capacitor?

- A. CV
- B. $\frac{1}{2} CV^2$
- C. $\frac{1}{2} C^2V$
- D. $\frac{1}{2} CV^3$

Answer: B

The energy stored in a capacitor is given by the formula $U = \frac{1}{2} CV^2$, where C is the capacitance of the capacitor and V is the potential difference across it. Substituting the given values, we get $U = \frac{1}{2} CV^2$, which is option B.

28. Which of the following statements is true about a thermodynamic system in thermal equilibrium?

- A. The temperature of the system is uniform throughout
- B. The pressure of the system is uniform throughout
- C. The entropy of the system is decreasing
- D. The internal energy of the system is decreasing

Answer: A

In thermal equilibrium, a thermodynamic system has reached a state where there is no net transfer of heat between different parts of the system or with the surroundings. This means that the temperature of the system is uniform throughout, as there are no temperature differences between different parts of the system. Option A is therefore correct.

29. What is the maximum number of electrons that can occupy an energy level with $n = 3$?

- A. 2
- B. 8
- C. 18
- D. 32

Answer: B

The maximum number of electrons that can occupy an energy level is given by the formula $2n^2$, where n is the principal quantum number. Therefore, for $n = 3$, the maximum number of electrons is $2 \times 3^2 = 18$. However, this includes all the sublevels within the $n = 3$ energy level, which are s, p, and d. The s sublevel can hold a maximum of 2 electrons, the p sublevel can hold a maximum of 6 electrons, and the d sublevel can hold a maximum of 10 electrons. Therefore, the maximum number of electrons that can occupy an energy level with $n = 3$ is $2 + 6 = 8$, which is option B.

30. Which of the following is true about a nuclear fusion reaction?

- A. It releases energy when two small nuclei combine to form a larger nucleus
- B. It requires extremely high temperatures and pressures to occur
- C. It is the process that powers the Sun
- D. All of the above

Answer: D

Nuclear fusion is a process where two atomic nuclei combine to form a larger nucleus, releasing a large amount of energy in the process. This process requires extremely high temperatures and pressures to overcome the electrostatic repulsion between the positively charged nuclei, which is why it is difficult to achieve in practical applications. Nuclear fusion is the process that powers the Sun and other stars, and it is being researched as a potential source of clean, renewable energy on Earth. Therefore, all of the statements in options A, B, and C are true, and the correct answer is option D.

31. Which of the following is true about beta decay?

- A. It occurs when a nucleus emits a beta particle, which is a high-energy electron
- B. It is caused by the weak nuclear force
- C. It can change the atomic number of the nucleus
- D. All of the above

Answer: D

Beta decay is a type of radioactive decay that occurs when a nucleus emits a beta particle, which is a high-energy electron. This process is caused by the weak nuclear force, which is one of the four fundamental forces of nature. Beta decay can change the atomic number of the nucleus, since the emission of a beta particle involves the conversion of a neutron to a proton. Therefore, all of the statements in options A, B, and C are true, and the correct answer is option D.

32. A student is conducting an experiment to investigate the relationship between the resistance of a wire and its length. The student measures the resistance of a 1 m length of wire to be 5 Ω . What would the resistance of a 2 m length of wire be, assuming the wire has a uniform cross-sectional area and resistivity?

- A. 5 Ω
- B. 10 Ω
- C. 20 Ω
- D. 40 Ω

Answer: C

The resistance of a wire is given by the equation $R = (\rho L)/A$, where ρ is the resistivity of the wire, L is the length of the wire, and A is the cross-sectional area of the wire. Since the wire has a uniform cross-sectional area and resistivity, we can assume that ρ and A are constant. Therefore, if the length of the wire is doubled, the resistance will also double. Thus, the resistance of a 2 m length of wire would be 10 Ω .

33. Which of the following correctly describes the photoelectric effect?

- A. Light causes the ejection of electrons from a metal surface
- B. Light causes the acceleration of electrons in a metal surface
- C. Light causes the bonding of electrons to a metal surface
- D. Light causes the transfer of electrons from one metal surface to another

Answer: A

The photoelectric effect is the phenomenon where light causes the ejection of electrons from a metal surface. This occurs when light, in the form of photons, strikes the surface of a metal and transfers energy to electrons, causing them to overcome the work function and escape the metal.

34. Which of the following correctly describes the direction of the magnetic force on a charged particle moving in a magnetic field?

- A. Perpendicular to both the magnetic field and the direction of motion of the particle
- B. Parallel to the magnetic field and perpendicular to the direction of motion of the particle
- C. Parallel to both the magnetic field and the direction of motion of the particle
- D. Perpendicular to the magnetic field and parallel to the direction of motion of the particle.

Answer: A

The direction of the magnetic force on a charged particle moving in a magnetic field is given by the right-hand rule. If the thumb of the right hand points in the direction of the velocity of the particle, and the fingers point in the direction of the magnetic field, then the palm points in the direction of the magnetic force. This force is always perpendicular to both the magnetic field and the direction of motion of the particle.

35. Which of the following is not a characteristic of a perfect black body?

- A. It absorbs all radiation incident upon it
- B. It emits radiation that is independent of the temperature of the body
- C. It emits radiation at all wavelengths
- D. It reflects all radiation incident upon it

Answer: D

A perfect black body is an idealized object that absorbs all radiation incident upon it and emits radiation that is independent of the temperature of the body. This radiation is also emitted at all wavelengths, making it a perfect emitter of radiation. A perfect black body does not reflect any radiation incident upon it, as this would violate its idealized properties.

36. Which of the following statements about the Heisenberg uncertainty principle is true?

- A. It states that the position and momentum of a particle can be measured simultaneously with arbitrary precision
- B. It states that the position and momentum of a particle cannot be measured simultaneously with arbitrary precision

- C. It applies only to particles with high mass and low velocity
- D. It applies only to particles with low mass and high velocity

Answer: B

The Heisenberg uncertainty principle is a fundamental principle of quantum mechanics that states that the position and momentum of a particle cannot be measured simultaneously with arbitrary precision. This is because the act of measuring one property affects the other, creating an uncertainty in both measurements.

37. Which of the following phenomena is explained by the wave-particle duality of matter?

- A. The photoelectric effect
- B. Electron diffraction
- C. Magnetic fields
- D. Electric fields

Answer: B

Wave-particle duality is a fundamental concept of quantum mechanics that states that matter exhibits both wave-like and particle-like behavior, depending on how it is observed. Electron diffraction is a phenomenon that can only be explained by treating electrons as waves. This is because electrons diffract when they encounter a slit or a grating, just like waves.

38. An object is moving in a circular path of radius R with a constant speed v . Which of the following statements is true about the acceleration of the object?

- A. The acceleration is always zero
- B. The acceleration is always directed towards the center of the circle
- C. The acceleration is always tangential to the circle
- D. The acceleration is always perpendicular to the velocity of the object

Answer: B

The acceleration is always directed towards the center of the circle. When an object moves in a circular path with a constant speed, it experiences a centripetal acceleration that is always directed towards the center of the circle. Therefore, option B is correct.

39. Two point charges of equal magnitude and opposite sign are placed 1 meter apart. What is the electric field strength at a point on the line joining the two charges that is 0.5 meters away from each charge?

- A. Zero
- B. Non-zero but less than the electric field strength at the midpoint
- C. Equal to the electric field strength at the midpoint
- D. Greater than the electric field strength at the midpoint

Answer: C

By symmetry, the electric field at a point on the line joining the two charges that is equidistant from the charges (i.e., at the midpoint) is directed along the line and has the

same magnitude due to the principle of superposition. Since the point in question is 0.5 meters away from each charge, the electric field strength at that point is also half the electric field strength at the midpoint, which is $E = kq/(0.5)^2$, where q is the magnitude of the charge and k is the Coulomb constant. Therefore, option C is right.

40. A wire of length L carries a current I . What is the magnitude of the magnetic field B at a point on the axis of the wire that is a distance r from the center of the wire?

- A. Zero
- B. Proportional to r
- C. Inversely proportional to r
- D. Proportional to $1/r^2$

Answer: D

The magnetic field at a point on the axis of a long, straight wire carrying a current I is given by the equation $B = \mu_0 I / (2\pi r)$, where μ_0 is the magnetic constant and r is the distance from the center of the wire to the point. Therefore, the magnitude of the magnetic field is proportional to $1/r$, which means it is inversely proportional to r^2 . Therefore, option D is correct.

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