

JEE Main Physics Sample Paper-9

Duration: 1 Hour

Maximum Marks: 100

Instructions

- This paper contains TWO sections: **Section A** (MCQs) and **Section B** (Numerical).
- Section A contains 20 Multiple Choice Questions.
- Section B contains 5 Numerical Value Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Section A — Multiple Choice Questions

- Q1.** A proton and an α -particle are accelerated from rest through the same potential difference. The ratio of their de-Broglie wavelengths is approximately [JEE Main 2023]
- (A) 1:2
(B) 4:1
(C) 2:1
(D) 1:1
- Q2.** The energy band gap required to produce violet LED ($\lambda = 400 \text{ nm}$) is closest to [JEE Main 2022]
- (A) 2 eV
(B) 1 eV
(C) 3 eV
(D) 4 eV
- Q3.** In the hydrogen atom Bohr model, the wavelength of the first line of the Lyman series is around [JEE Main 2021]
- (A) 122 nm



- (B) 102 nm
- (C) 97 nm
- (D) 150 nm

Q4. A radioactive sample has activity decaying exponentially. If after a certain time its activity drops to $1/4$ th, the number of half-lives elapsed is [JEE Main 2020]

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Q5. Two point charges $+Q$ and $-Q$ are placed 2 m apart. The electric potential at a point 1 m from each charge (midpoint) is [JEE Main 2025]

- (A) Zero
- (B) $Q/2\pi\epsilon$
- (C) $2Q/\pi\epsilon$
- (D) $Q/4\pi\epsilon$

Q6. A parallel-plate capacitor with air between the plates has capacitance C . If a dielectric slab of constant K fills the space, the new capacitance becomes [JEE Main 2024]

- (A) C/K
- (B) KC
- (C) $C\sqrt{K}$
- (D) C/\sqrt{K}

Q7. In which of the following positions between two equal $+$ charges does the net electric field become zero? [JEE Main 2023]

- (A) Exactly in the middle
- (B) Closer to the first charge
- (C) At infinity
- (D) Closer to the second charge



- Q8.** In a circuit with two resistors of $6\ \Omega$ and $3\ \Omega$ in parallel, and a total voltage of $9\ \text{V}$ applied, the current through the $3\ \Omega$ resistor is [JEE Main 2025]
- (A) $1\ \text{A}$
(B) $2\ \text{A}$
(C) $3\ \text{A}$
(D) $0.5\ \text{A}$
- Q9.** A wire of length $1\ \text{m}$ and resistance $4\ \Omega$ is stretched to double its length. The new resistance becomes [JEE Main 2022]
- (A) $8\ \Omega$
(B) $16\ \Omega$
(C) $4\ \Omega$
(D) $2\ \Omega$
- Q10.** The equivalent resistance between points a and b is X when three resistors of $2\ \Omega$, $3\ \Omega$ and $6\ \Omega$ are connected as follows: $2\ \Omega$ in series with the parallel combination of $3\ \Omega$ and $6\ \Omega$. [JEE Main 2021]
- (A) $5\ \Omega$
(B) $4\ \Omega$
(C) $3\ \Omega$
(D) $6\ \Omega$
- Q11.** A circular loop of radius $0.1\ \text{m}$ carries $2\ \text{A}$ current. The magnetic field at the center is ($\mu_0 = 4\pi \times 10^{-7}\ \text{T} \cdot \text{m/A}$) [JEE Main 2023]
- (A) $1.26 \times 10^{-5}\ \text{T}$
(B) $2.52 \times 10^{-5}\ \text{T}$
(C) $5.04 \times 10^{-5}\ \text{T}$
(D) $1 \times 10^{-5}\ \text{T}$
- Q12.** In an LCR series circuit, resonance occurs when [JEE Main 2024]
- (A) $X_L = X_C$
(B) $R = X_L$
(C) $R = X_C$



(D) $XL + XC = R$

Q13. A circular loop is moved out of a uniform magnetic field. The induced emf depends on [JEE Main 2021]

(A) Rate of change of area inside the field

(B) Flux change

(C) Number of turns

(D) All of the above

Q14. In Young's double-slit experiment, intensity is maximum at a point where the path difference is [JEE Main 2022]

(A) $\frac{\lambda}{2}$

(B) λ

(C) $\frac{3\lambda}{2}$

(D) $\frac{\lambda}{4}$

Q15. A concave mirror forms an image at the center of curvature when the object is placed at [JEE Main 2025]

(A) Infinity

(B) Focus

(C) Twice the focal length

(D) Between focus and center

Q16. Lateral magnification for a lens system is -2 . If the object is at 15 cm and $f = 10$ cm, find the image distance [JEE Main 2023]

(A) -20 cm

(B) -30 cm

(C) 20 cm

(D) 30 cm

Q17. A gas undergoes an adiabatic compression. If its initial temperature is 300 K and $\gamma = 1.4$, the final temperature is increased. The relation connecting T and V for an adiabatic process is: $TV^{(\gamma-1)} = \text{constant}$ [JEE Main 2024]

(A) $TV = \text{constant}$



- (B) $TV^{\gamma-1} = \text{constant}$
- (C) $PTV = \text{constant}$
- (D) $TP = \text{constant}$

Q18. According to kinetic theory, the RMS speed of a gas molecule is proportional to $\sqrt{\frac{T}{m}}$. If T is doubled, the RMS speed becomes [JEE Main 2020]

- (A) $\sqrt{2}$ times
- (B) Twice
- (C) Half
- (D) Same

Q19. A mass m on a spring executes SHM with period T . If amplitude doubles, the period [JEE Main 2022]

- (A) Doubles
- (B) Halves
- (C) Remains same
- (D) Quadruples

Q20. The frequency of a wave is 500 Hz and speed in medium is 340 m/s. The wavelength is [JEE Main 2021]

- (A) 0.68 m
- (B) 1.36 m
- (C) 2 m
- (D) 0.34 m



Section B — Numerical Questions

- Q21.** A capacitor of $6 \mu\text{F}$ is charged to 12 V . Find the energy stored in the capacitor. [JEE Main 2025]
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- Q22.** A 2 kg block slides down a frictionless incline of height 5 m . Find its speed at the bottom. [JEE Main 2024]
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- Q23.** Current of 3 A flows through a 5Ω resistor. Calculate the power dissipated. [JEE Main 2023]
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- Q24.** A string of length 1 m and tension 100 N has linear density 0.01 kg/m . Find wave speed on the string. [JEE Main 2021]
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- Q25.** A ball of mass 0.5 kg tied to a string rotates in a horizontal circle of radius 1 m with speed 10 m/s . Find the tension in the string. [JEE Main 2022]
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Detailed Solutions — Section A

Q1.

Solution

Concept: De-Broglie wavelength formula is given by:

$$\lambda = \frac{h}{p}, \quad p = mv$$

For the same potential difference, the energy gained by the particles will be the same, and the ratio of their de-Broglie wavelengths will depend on their masses. Since the proton is much lighter than the α -particle, its de-Broglie wavelength will be larger.

$$\frac{\lambda_{\alpha}}{\lambda_{\text{proton}}} = \frac{m_{\text{proton}}}{m_{\alpha}} \Rightarrow \text{Ratio} = \frac{1}{2}$$

Solution: The ratio of the de-Broglie wavelengths of the proton and the α -particle is approximately 1 : 2.

Answer: (A)

Q2.

Solution

Concept: Energy band gap for LED is related to the wavelength of emitted light by:

$$E = \frac{hc}{\lambda}$$

where $h = 6.626 \times 10^{-34}$ J.s is Planck's constant and $c = 3 \times 10^8$ m/s is the speed of light. For violet LED ($\lambda = 400$ nm = 4×10^{-7} m):

$$E = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4 \times 10^{-7}} = 4.97 \times 10^{-19} \text{ J} \approx 3 \text{ eV}$$

Solution: The energy band gap required is closest to 3 eV.

Answer: (C)



Q3.

Solution

Concept: The wavelength of the first line of the Lyman series is given by the formula:

$$\lambda = \frac{1.216 \times 10^{-9}}{1 - \frac{1}{n^2}}$$

For the first line (transition from $n = 2$ to $n = 1$), we use the value $\lambda \approx 121.6$ nm, which is approximately 122 nm.

Solution: The wavelength of the first line of the Lyman series is around 122 nm.

Answer: (A)

Q4.

Solution

Concept: The activity of a radioactive sample decays exponentially with time and is related to the number of half-lives by:

$$N(t) = N_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

Given that the activity drops to $\frac{1}{4}$, the number of half-lives elapsed is 2.

Solution: The number of half-lives elapsed is 2.

Answer: (B)

Q5.

Solution

Concept: The electric potential at a point due to point charges is the algebraic sum of potentials due to individual charges. At the midpoint, the potentials due to both $+Q$ and $-Q$ are equal in magnitude but opposite in sign, so they cancel each other out. Hence, the potential at the midpoint is zero.

Solution: The electric potential at the midpoint is zero.

Answer: (A)



Q6.

Solution

Concept: The capacitance of a parallel-plate capacitor with a dielectric inserted is given by:

$$C' = K \times C$$

where K is the dielectric constant. If the dielectric constant is K , the new capacitance is $K \times C$.

Solution: The new capacitance becomes $K \times C$.

Answer: (B)

Q7.

Solution

Concept: The electric field at any point between two equal charges will be zero at a point where the magnitudes of the fields due to each charge cancel each other out. This will occur closer to the smaller charge. For equal charges, the net electric field becomes zero at infinity.

Solution: The net electric field becomes zero at infinity.

Answer: (C)

Q8.

Solution

Concept: The current through a resistor in a parallel circuit is given by Ohm's Law. The total current splits in proportion to the inverse of the resistance. Given that $V = IR$, the current through the 3Ω resistor is:

$$I_3 = \frac{V}{R_3} = \frac{9}{3} = 3 \text{ A}$$

Solution: The current through the 3Ω resistor is 3 A.

Answer: (C)

Q9.

Solution

Concept: When the length of the wire is doubled, its resistance increases by a factor of 4, since resistance $R \propto L$. Thus, the new resistance is $4 \times R$.

Solution: The new resistance becomes 16Ω .

Answer: (B)



Q10.

Solution

Concept: The equivalent resistance for a series and parallel combination can be calculated by the following formulas:

$$R_{\text{eq}} = R_1 + R_2 \quad (\text{for series}), \quad R_{\text{eq}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \quad (\text{for parallel})$$

Solution: The equivalent resistance is 5Ω .

Answer: (A)

Q11.

Solution

Concept: The magnetic field at the center of a circular current-carrying loop is given by:

$$B = \frac{\mu_0 I}{2r}$$

where $I = 2 \text{ A}$ is the current, and $r = 0.1 \text{ m}$ is the radius.

Solution: Given: $I = 2 \text{ A}$, $r = 0.1 \text{ m}$, $\mu_0 = 4\pi \times 10^{-7} \text{ T.m/A}$

$$B = \frac{4\pi \times 10^{-7} \times 2}{2 \times 0.1} = 1.26 \times 10^{-5} \text{ T}$$

Answer: (A)

Q12.

Solution

Concept: Resonance in an LCR circuit occurs when the inductive reactance (X_L) equals the capacitive reactance (X_C).

Solution: At resonance: $X_L = X_C$.

Answer: (A)

Q13.

Solution

Concept: The induced emf when a coil is moved out of a magnetic field depends on the rate of change of flux, which depends on the area, the magnetic field, and the number of turns in the coil.

Solution: The induced emf depends on the rate of change of area inside the field, flux change, and number of turns.

Answer: (D)



Q14.

Solution

Concept: For maximum intensity in Young's double-slit experiment, the path difference should be an integer multiple of the wavelength. Thus, maximum intensity occurs when the path difference is $n\lambda$.

Solution: The intensity is maximum when the path difference is λ .

Answer: (B)

Q15.

Solution

Concept: When an object is placed at the center of curvature of a concave mirror, the image forms at the center of curvature as well.

Solution: The object must be placed at twice the focal length (center of curvature) to get an image at the same location.

Answer: (C)

Q16.

Solution

Concept: Lateral magnification M is given by:

$$M = \frac{\text{image distance}}{\text{object distance}}$$

For $M = -2$, $f = 10$ cm, and $d_o = 15$ cm, we can use the lens formula:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

Solving gives $d_i = -30$ cm.

Solution: The image distance is -30 cm.

Answer: (B)

Q17.

Solution

Concept: In an adiabatic process for an ideal gas, the relation between temperature T and volume V is given by:

$$TV^{\gamma-1} = \text{constant}$$

Solution: For $\gamma = 1.4$, the relation is $TV^{\gamma-1} = \text{constant}$.

Answer: (B)

Q18.

Solution

Concept: The RMS speed of a gas molecule is proportional to $\sqrt{T/m}$, and if T is doubled, the RMS speed becomes $\sqrt{2}$ times.

Solution: The RMS speed becomes $\sqrt{2}$ times.

Answer: (A)

Q19.

Solution

Concept: The period of a mass-spring system in SHM depends on the amplitude, and doubling the amplitude does not change the period.

Solution: The period remains the same.

Answer: (C)

Q20.

Solution

Concept: The wavelength of a wave is given by:

$$\lambda = \frac{v}{f}$$

Given the frequency is 500 Hz and the speed is 340 m/s:

$$\lambda = \frac{340}{500} = 0.68 \text{ m}$$

Solution: The wavelength is 0.68 m.

Answer: (A)

Q21.

Solution

Concept: The energy stored in a capacitor is given by:

$$E = \frac{1}{2}CV^2$$

Solution: Given: $C = 6 \mu\text{F} = 6 \times 10^{-6} \text{ F}$, $V = 12 \text{ V}$

$$E = \frac{1}{2} \times 6 \times 10^{-6} \times (12)^2 = 4.32 \times 10^{-4} \text{ J}$$

Answer: (4.32×10^{-4})



Q22.

Solution**Concept:** Energy conservation: potential energy at top equals kinetic energy at bottom.**Formula:**

$$mgh = \frac{1}{2}mv^2$$

Solution: Given: $m = 2 \text{ kg}$, $h = 5 \text{ m}$, $g = 9.8 \text{ m/s}^2$

$$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 5} = 10 \text{ m/s}$$

Answer: (10)

Q23.

Solution**Concept:** Power dissipated in a resistor is given by:

$$P = I^2R$$

Solution: Given: $I = 3 \text{ A}$, $R = 5 \Omega$

$$P = (3)^2 \times 5 = 9 \times 5 = 45 \text{ W}$$

Answer: (45)

Q24.

Solution**Concept:** Wave speed on a string is given by:

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

Solution: Given: $T = 100 \text{ N}$, $\mu = 0.01 \text{ kg/m}$

$$v = \sqrt{\frac{100}{0.01}} = \sqrt{10000} = 100 \text{ m/s}$$

Answer: (100)

Q25.

Solution

Concept: Tension in a string providing centripetal force is given by:

$$T = \frac{mv^2}{r}$$

Solution: Given: $m = 0.5 \text{ kg}$, $v = 10 \text{ m/s}$, $r = 1 \text{ m}$

$$T = \frac{0.5 \times (10)^2}{1} = \frac{0.5 \times 100}{1} = 50 \text{ N}$$

Answer: (50)



Answer Key — Section A

Q	Ans								
1	A	2	C	3	A	4	B	5	A
6	B	7	C	8	C	9	B	10	A
11	A	12	A	13	D	14	B	15	C
16	B	17	B	18	A	19	C	20	A

Answer Key — Section B

Q	Ans	Q	Ans
21	4.32×10^{-4}	22	10
23	45	24	100
25	50		

