Eduncle

IIT JAM

Physics (PH)

Model Paper with Answer Key

Based on Exam Pattern

Eduncle.com
Mpa 44, 2nd Floor, Above Bank Of India, Rangbari Main Road,
Mahaveer Nagar 2nd, Near Amber Dairy, Kota, Rajasthan, 324005
Website: www.eduncle.com | **Email:** Info@Eduncle.com

Toll Free: 1800-120-1021

Physics (PH)

Model Paper with Answer Key

Duration : 180 minutes **Maximum Marks : 100**

Read the following instructions carefully.

1. This test paper has a total of 60 questions carrying 100 marks. The entire question paper is divided into **Three Sections A, B** and **C.** All sections are compulsory. Questions in each section are of different types.

2. **Section – A** contains **Multiple Choice Questions (MCQ).** Each MCQ type question has four choices out of which only one choice is the correct answer. This section has 30 Questions and carry a total of 50 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.30 carry 2 marks each.

3. **Section – B** contains **Multiple Select Questions (MSQ).** Each MSQ type question is similar to MCQ but with a difference that there may be one or more than one choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct choices only and no wrong choices. This section has 10 Questions and carry 2 marks each with a total of 20 marks.

4. **Section – C** contains **Numerical Answer Type Questions (NAT).** For these NAT type questions, the answer is a real number which needs to be entered using the virtual numerical keypad on the monitor. No choices will be shown for these type of questions. This section has 20 Questions and carry a total of 30 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.20 carry 2 marks each.

SECTION-(A) MULTIPLE CHOICE QUESTIONS (MCQ)

1. The velocity V and displacement x of a particle executing simple harmonic motion are related as $\frac{Vdv}{dx} = -w^2x$ with the initial condition V = V_o at x = 0, find the velocity V when the displacement becomes x ?

(A) $V = \sqrt{V_0^{\,2} + w^2x^2}$ (B) $V = \sqrt{V_0^{\,2} - w^2x^2}$

(C) $V = \left[V_0^{\,3} + w^3x^3\right]^{1/3}$ (D) $V = \left[V_0 - \left\{\left(w^3x^3\right)e^{x^3}\right\}^{1/3}\right]$

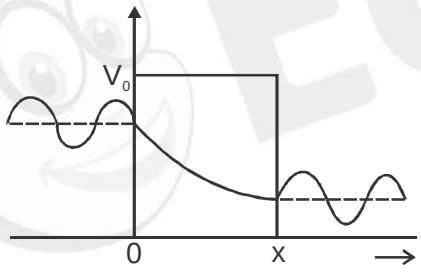
2. The length of a metal wire is l_1 when the tension in it is T_1 and is l_2 when the tension is T_2. The natural length of the wire is _____

(A) $\frac{l_1 + l_2}{2}$ (B) $\sqrt{l_1 l_2}$

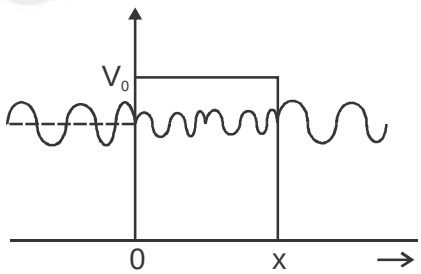
(C) $\frac{l_1T_2 - l_2T_1}{T_2 - T_1}$ (D) $\frac{l_1T_2 + l_2T_1}{T_2 + T_1}$

3. A particle travelling along the positive X-axis with energy E incident on a potential barrier (V_o), which of the following represent the correct wave-form for V_o > E ?

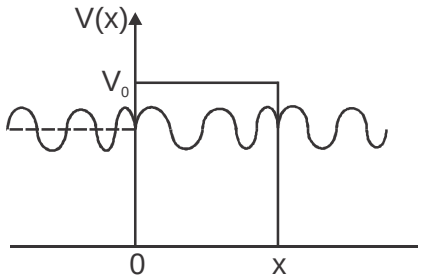
(A)



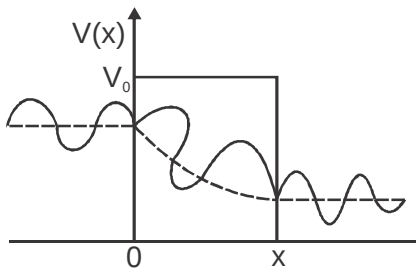
(B)



(C)



(D)



4. A parallel beam of light travelling in water (refractive index = 4/3) is refracted by a spherical air bubble of radius 2mm situated in water. Assuming the light rays to be parallel, find the position of the final image ?

(A) 5 mm (B) 6 mm

(C) – 6 mm (D) – 5 mm

SECTION-(B) MULTIPLE SELECT QUESTIONS (MSQ)

1. If we introduce the operators

$$a = \sqrt{\frac{mw}{2\hbar}}\left(q + \frac{ip}{mw}\right)$$

And $$a^{+} = \sqrt{\frac{mw}{2\hbar}}\left(q - \frac{ip}{mw}\right)$$

Then which relation is correct:-

(A) $a^{+}a = \frac{H}{\hbar w} - \frac{1}{2}$ (B) $\left[a^{+}a, a\right] = -a$

(C) $\left[a^{+}a, a\right] = a$ (D) $\left[a, a^{+}\right] = -1$

2. Using Boolean Algebra techniques, verify the correct expressions:-

(A) AB + A(B + C) + B(B + C) = AC + CB

(B) $\bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + A\bar{B}C + ABC = \bar{A}\bar{C} + \bar{B}C + AB$

(C) AB + A(B + C) + B(B + C) = AC + B

(D) $\bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + A\bar{B}C + ABC = AC + A\bar{B} + \bar{B}\bar{C}$

3. What are the Eigen values of given matrix ?

$$A = \begin{bmatrix} 5 & 0 & 0 \\ 0 & 1 & -i \\ 0 & i & -1 \end{bmatrix}$$

(A) 5 (B) 5, 2, -2

(C) $\sqrt{2}$ (D) $-\sqrt{2}$

4. The independent solution of the equations :

$$\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = 0 \text{ are :}$$

(A) e^{-3x}, e^{-4x}, e^{-5x} (B) e^{-x}

(C) $2e^{-x}$, $3e^{-2x}$, $4e^{-3x}$ (D) e^{-2x}, e^{-3x}

SECTION-(C) NUMERICAL ANSWER TYPE QUESTIONS (NAT)

1. If the operator $\hat{A} = i(\hat{x}^2 + 1)\frac{d}{dx} + i\,\hat{x}$ is Hermition, then calculate the probability of finding the particle (Which satisfies $\hat{A}\Psi(x) = 0$) in the region $-1 \le x \le 1$.

2. Determine the output voltage of an op-amp for input voltages of V_{i_1} = 150 μV, V_{i_2} = 140 μV. The amplifier has differential gain of A_2 = 4000 and value of CMRR is 100. (Answer in mV).

3. In a material two energy have a wavelength separation of 1 μm. What would be the effective temperature when the upper level is twice as densely populated as the lower level ?

4. Calculate the volume of the surface integral $\int\int \vec{F} \cdot \hat{n}\, ds$ where s is the surface the sphere $\boxed{x^2 + y^2 + z^2 = 4}$ and $\hat{n}$ is the unit outward normal to the sphere and $\vec{F} = \hat{i}x + \hat{j}y + \hat{k}z$?

5. A certain gas obeys the equation of state PV = RT + bP.
Calculate ΔU, Q and W, when 1 mole of the gas expands reversibly at 300 K from 0.220 to 20.02 for isothermal case ?

6. The wavelength of the L_α x-rays spectral line of platinum (atomic number 78) is 1.321 Å. An unknown substance units L_α x-rays of wavelength 4.174 Å. Calculate the atomic number of the unknown substance. Given b = 7.4 for L_α line ?

7. Find the directional derivative of $\vec{V}^2$ where $\vec{V} = \hat{i}xy^2 + \hat{j}zy^2 + \hat{k}xz^2$ the point (2, 0, 3) is the direction of the outward normal to the sphere $x^2 + y^2 + z^2 = 14$ at the points (3, 4, 0) ?

8. Determine the d.c. bias voltage V_{CE} and the current I_C for the voltage divider configuration as given in the figure.