06/04/2023
Evening

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# Memory Based
# Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

# JEE (Main)-2023 (Online) Phase-2

## (Physics, Chemistry and Mathematics)

**IMPORTANT INSTRUCTIONS:**

(1) The test is of **3 hours** duration.

(2) The Test Booklet consists of 90 questions. The maximum marks are 300.

(3) There are **three** parts in the question paper consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each part (subject) has two sections.

(i) **Section-A:** This section contains 20 multiple choice questions which have only one correct answer. Each question carries **4 marks** for correct answer and **–1 mark** for wrong answer.

(ii) **Section-B:** This section contains 10 questions. In Section-B, attempt any **five questions out of 10.** The answer to each of the questions is a numerical value. Each question carries **4 marks** for correct answer and **–1 mark** for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

# PHYSICS

## SECTION - A

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer:**

1. An object starts moving with an initial speed 10 m/s and acceleration 2 m/s$^2$ along positive $x$-direction. The time taken to attain 60 m/s speed is

(1) 25 s (2) 20 s

(3) 30 s (4) 15 s

**Answer (1)**

**Sol.** $v = u + at$

$60 = 10 + (2)t$

$t = 25$ s

2. Potential energy of an electron is defined as $U = \frac{1}{2} mw^2x^2$ and follows Bohr's law. Radius of orbital as function of $n$ depends on ($w$ is some constant)

(1) $n^2$ (2) $\frac{1}{\sqrt{n}}$

(3) $\sqrt{n}$ (4) $n^{2/3}$

**Answer (3)**

**Sol.** $U = \frac{1}{2}mw^2x^2$

$mvx = \frac{nh}{2\pi}$

$\frac{mv^2}{x} = mw^2x$

$\Rightarrow \quad v = wx$

$\Rightarrow \quad x^2 \propto n$

or $\quad x \propto \sqrt{n}$

3. If $W$ is the weight on the surface of earth then weight of same body at a height $\frac{R_e}{4}$ above the surface of earth is equal to ($R_e$ :- Radius of earth)

(1) $\frac{4}{5}W$ (2) $\frac{16}{25}W$

(3) $\frac{25}{16}W$ (4) $\frac{5}{4}W$

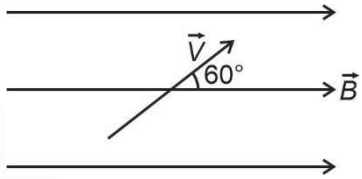
**Answer (2)**

**Sol.** $g' = \frac{g \times R^2}{\frac{25}{16}R^2} = \frac{16g}{25}$

$W' = \frac{16W}{25}$

4. A proton is projected with speed $v$ in magnetic field $B$ of magnitude 1 T if angle between velocity and magnetic field is 60° as shown below. Kinetic energy of proton is 2 eV (Mass of proton = 1.67 × 10$^{-27}$ kg, $e$ = 1.6 × 10$^{-19}$ C).

The pitch of the path of proton is approximately




(1) 6.28 × 10$^{-2}$ m (2) 6.28 × 10$^{-4}$ m

(3) 3.14 × 10$^{-2}$ m (4) 3.14 × 10$^{-4}$ m

**Answer (2)**

**Sol.** $R = \left(\frac{mv\sin 60°}{qB}\right)$

$T = \left(\frac{2\pi m}{qB}\right)$ K.E $= \frac{1}{2}mv^2$

Pitch $= v\cos\theta \times \left(\frac{2\pi m}{qB}\right)$ $\sqrt{\frac{2K}{m}} = v$

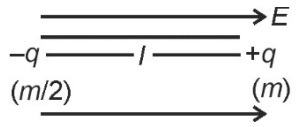
$= \sqrt{\frac{2K}{m}} \times \frac{1}{2} \times \frac{2\pi m}{qB}$

$= \frac{\pi}{eB} \cdot \sqrt{2Km} = \frac{3.14}{1.6 \times 10^{-19} \times 1} \times \sqrt{2 \times 2 \times (1.6)^2 \times 10^{-46}}$

$= \frac{3.14}{1.6 \times 10^{-19}} \times 2 \times 1.6 \times 10^{-23}$

= 6.28 × 10$^{-4}$ m

5. An electric dipole is shown in the figure. If it is displaced angularly by a small angle with respect to electric field, then angular frequency of oscillation is given by

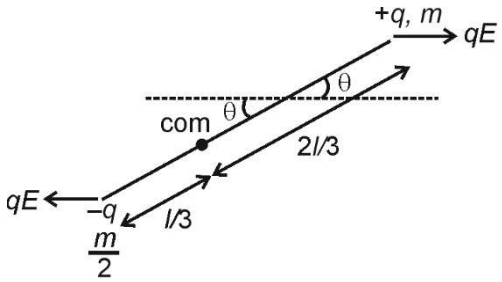



(1) $\sqrt{\frac{6qE}{ml}}$ (2) $\sqrt{\frac{3qE}{ml}}$

(3) $\sqrt{\frac{2qE}{ml}}$ (4) $\sqrt{\frac{qE}{ml}}$

**Answer (1)**

**Sol.**




$\tau_{com} = qEl\sin\theta$

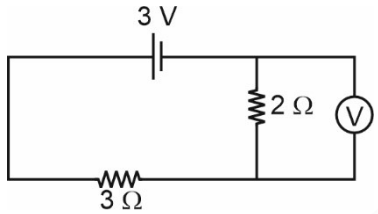
$\because$ θ is very small

$\tau_{com} = qEl\theta$

$$\left(\frac{m}{2}\times\frac{l^2}{9}+m\frac{4l^2}{9}\right)\alpha = qEl\theta$$

$$\alpha = \frac{6qE}{ml}\theta$$

6.




In the circuit shown reading of the ideal voltmeter used is equal to _____ volts

(1) 3 V (2) 1.8 V

(3) 1.2 V (4) Zero

**Answer (3)**

**Sol.** Current through 2 Ω resistance

$= \frac{3}{5}\text{A} = 0.6\text{ A}$

$\Rightarrow V_{2\Omega} = 0.6 \times 2 = 1.2$ V

$\Rightarrow$ Reading of voltmeter = 1.2 V

7. Find the ratio of root mean square speed of oxygen gas molecules to that of hydrogen gas molecules, if temperature of both the gases are same.

(1) $\frac{1}{4}$ (2) $\frac{1}{16}$

(3) $\frac{1}{32}$ (4) $\frac{1}{8}$

**Answer (1)**

**Sol.** $v_{rms} = \sqrt{\frac{3RT}{M}}$

$$v_{rms} \propto \frac{1}{\sqrt{M}}$$

$$\frac{(v_{rms})_{O_2}}{(v_{rms})_{H_2}} = \sqrt{\frac{2}{32}} = \frac{1}{4}$$

8. In amplitude modulation with carrier frequency ($A_c$) and modulant frequency ($A_m$), modulation index is 60%. If $A_c - A_m = 3$ V then $A_c + A_m$ is equal to _____.

(1) 6 V (2) 12 V

(3) 4 V (4) 15 V

**Answer (2)**

**Sol.** $\mu = 0.6$

$$\frac{A_m}{A_c} = 0.6$$

$$\frac{A_c - A_m}{A_c + A_m} = \frac{2}{8} = \frac{1}{4}$$

$\Rightarrow A_c + A_m = 12$ V

9. For two different photosensitive material having work function ϕ and 2ϕ respectively, are illuminated with light of sufficient energy to emit electron. If the graph of stopping potential versus frequency is drawn, for these two different photosensitive materials the ratio of slope of graph for these two materials is

(1) 1 : 1 (2) 1 : 2

(3) 1 : 4 (4) 4 : 1

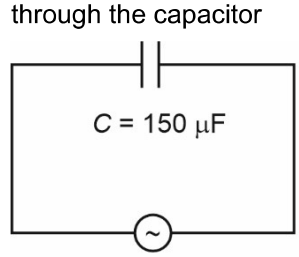
**Answer (1)**

**Sol.** $eV = h\nu - \phi$

$$V = \left(\frac{h}{e}\right)\nu - \phi$$

Slope $= \left(\frac{h}{e}\right)$ is independent of material so ratio is 1 : 1.

10. In the given AC circuit, find maximum current through the capacitor




$E = 36 \sin(120\pi t)$ V

(1) 0.65 πA (2) 0.35 πA

(3) 0.2 πA (4) 0.8 πA

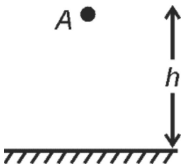
**Answer (1)**

**Sol.** $i_0 = \frac{E_0}{X_C} = E_0\,\omega C$

$= 36 \times 120\pi \times 150 \times 10^{-6}$ A

$= 0.65\ \pi$A

11. An object $A$ is released from a height $h$ such that the ratio of its speed before striking the ground and after striking the ground is 4 : 1. If loss of kinetic energy is $\frac{x}{4}\%$ then value of $x$ is




(1) 225 (2) 50
(3) 375 (4) 25

**Answer (3)**

**Sol.** $\frac{V_{before}}{V_{after}} = \frac{4}{1}$

$\frac{KE_{before}}{KE_{after}} = \frac{16}{1}$

$\frac{\Delta KE}{KE_{before}} = \frac{15}{16}$

$= \frac{15}{16} \times 100\%$

$= \frac{375}{4}\%$

12. **Assertion (A) :** When tooth paste is pressed, it follows Pascal's principle.

**Reason (R) :** When pressure is applied on a fluid it is distributed constantly throughout the fluid in all direction and on the wall of the container.

(1) A is correct and R is the correct explanation of A
(2) A is correct and R is wrong explanation of A
(3) A is correct, R is wrong
(4) Both A and R are false

**Answer (1)**

**Sol.** Reason (R) is the Pascal's principle and which gives correct explanation of A.

13. **Assertion (A) :** In forward biased p-n junction, diffusion current is from p-region to n-region.

**Reason (R) :** Diffusion takes place due to concentration gradient.

(1) Both (A) and (R) are true, (R) is the correct explanation of (A)
(2) Both (A) and (R) are true, (R) is not the correct explanation of (A)
(3) (A) is true, (R) is false
(4) Both (A) and (R) are false

**Answer (1)**

**Sol.** Diffusion takes place due to concentration gradient.

14. Radius of first orbit in H-atom is $a_0$. Then, de Broglie wavelength of electron in the third orbit is

(1) $3\pi a_0$ (2) $6\pi a_0$
(3) $9\pi a_0$ (4) $12\pi a_0$

**Answer (2)**

**Sol.** $\lambda = \frac{4}{mv}$

$= \frac{2\pi r}{n}$

$= \frac{2\pi a_0 n^2}{n}$

$= 2\pi a_0 (n)$

$= 6\pi a_0$

15. Choose the incorrect statement from the given statements.

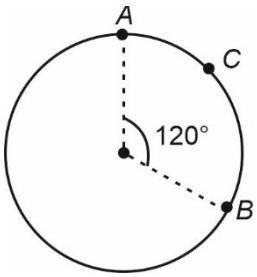
(A) Planets revolve around the Sun with constant linear speed.
(B) Energy of planet in elliptical orbit is constant.
(C) Satellite in circular motion have constant energy.
(D) Body falling towards the Earth results in negligible displacement of the Earth.

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

**Answer (1)**

**Sol.** Planet revolves around the Sun in elliptical orbit with variable speed.

16. A particle moves from $A$ to $B$ via $C$ with uniform speed of $\pi$ m/s. Average velocity during the journey is equal to




(1) $\sqrt{3}$ m/s

(2) $\frac{\sqrt{3}}{2}$ m/s

(3) $\frac{3\sqrt{3}}{2}$ m/s

(4) 2 m/s

**Answer (3)**

**Sol.** Displacement

$= 2R \times \sin 60° = \sqrt{3}\,R$

Time $= \frac{2\pi R}{3} \times \frac{1}{\pi} = \frac{2R}{3}$ seconds

$\Rightarrow$ Average velocity

$= \frac{\sqrt{3}R \times 3}{2R} = \frac{3\sqrt{3}}{2}$ m/s

17. The temperature of body drops from 60°C to 40°C in 7 min. The surrounding temperature is 10°C. The temperature of body drops from 40°C to $T$°C in 7 min. Find the value of $T$

(1) 16°C (2) 20°C
(3) 28°C (4) 36°C

**Answer (3)**

**Sol.** $\frac{60-40}{7} = K(50-10)$

$\frac{40-T}{7} = K\left(\frac{40+T}{2} - 10\right)$

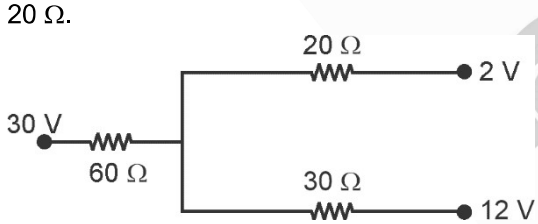
$\Rightarrow \frac{20}{40-T} = \left(\frac{40 \times 2}{T+20}\right)$

$\Rightarrow T + 20 = 160 - 4T$

$\Rightarrow 5T = 140$

$T = \frac{140}{5} = 28°C$

18. In the given circuit, find the current passing through 20 Ω.




(1) 0.45 A (2) 0.23 A
(3) 0.40 A (4) 0.78 A

**Answer (3)**

**Sol.** Let $x$ be the potential at the node

$\frac{30-x}{60} + \frac{2-x}{20} + \frac{12-x}{30} = 0$

$\frac{1}{2} + \frac{1}{10} + \frac{4}{10} = \frac{x}{60} + \frac{x}{20} + \frac{x}{30}$

$\frac{10}{10} = \frac{2x + 6x + 4x}{120}$

$120 = 12x$

$x = 10$ V

$i = \frac{10-2}{20} = \frac{8}{20} = 0.4$ A

19. Average energy density of an EM wave with electric field amplitude $E_0$ and magnetic field amplitude $B_0$ is equal to

(1) $\frac{1}{2}\varepsilon_0 E_0^2$ (2) $\frac{B_0^2}{\mu_0}$
(3) $\varepsilon_0 E_0^2$ (4) $\frac{1}{2}\mu_0 E_0^2$

**Answer (1)**

**Sol.** Total energy $= \frac{1}{4}\varepsilon_0 E_0^2 + \frac{1}{4}\frac{B^2}{\mu_0}$

and $\varepsilon_0 E_0^2 = \frac{B^2}{\mu_0}$

$\Rightarrow$ total energy $= \frac{1}{2}\varepsilon_0 E_0^2$

20.

## SECTION - B

**Numerical Value Type Questions:** This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. A solid sphere and a ring have equal masses and equal radius of gyration. If both are rotating about the axis passing through the centre of mass, then the ratio of radius is $\sqrt{\frac{x}{2}}$ then find the value of $x$.

**Answer (5)**

**Sol.** $\frac{2}{5}mR_1^2 = mK_1^2$ and $mR_2^2 = K_2$

$K_1 = \sqrt{\frac{2}{5}}R_1$ $K_2 = R_2$

$K_2 = R_2$ $K_1 = K_2$

$\sqrt{\frac{2}{5}}R_1 = R_2 \Rightarrow \frac{R_1}{R_2} = \sqrt{\frac{5}{2}}$

22.
23.
24.
25.
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30.