04/04/2024
Evening

Aakash
Medical | IIT-JEE | Foundations

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Memory Based

Answers & Solutions

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

JEE (Main)-2024 (Online) Phase-2

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

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

(2) This test paper consists of 90 questions. Each subject (PCM) has 30 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt any 05 questions out of 10 Questions.

(6) **Section - A (01 – 20)** 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.

(7) **Section - B (21 – 30) contains** 10 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

PHYSICS

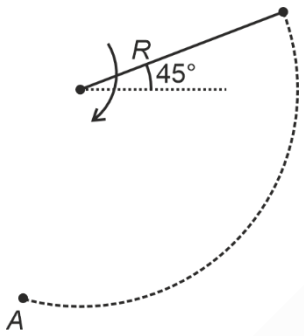
SECTION - A

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. A massless rod has a point mass attached at one end while the other end is hinged. The rod is released from the position shown. The speed of the mass at bottom-most point is

(R = 14 m, g = 10 m/s^2)



(1) $\sqrt{560}$ m/s (2) $\sqrt{280\left(1+\frac{1}{\sqrt{2}}\right)}$ m/s

(3) $\sqrt{280}$ m/s (4) $\sqrt{280\left(1+\frac{1}{\sqrt{3}}\right)}$ m/s

Answer (2)

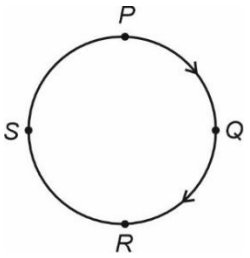
Sol. Conserving energy,

$$v=\sqrt{2g\left[R+R\sin 45^\circ\right]}$$

$$=\sqrt{20\times 14\left(1+\frac{1}{\sqrt{2}}\right)}$$

$$=\sqrt{280\left(1+\frac{1}{\sqrt{2}}\right)}\ \text{m/s}$$

2. P, Q, R, S are 4 symmetric points on a horizontal circle of radius 4 km. What is displacement when a car moves from P to R along the given circular path?



(1) $4\sqrt{2}$ km (2) 4π km

(3) 8 km (4) 4 km

Answer (3)

Sol. $PR = 2r$

3. One mole of an monoatomic ideal gas compressed adiabatically from volume 2 V to V. If initial temperature of gas was T then magnitude work done in this process is

(1) $\frac{3}{2}RT\left(2^{\frac{1}{2}}-1\right)$ (2) $\frac{3}{2}RT\left(2^{\frac{2}{3}}-1\right)$

(3) $\frac{2}{3}RT\left(2^{\frac{2}{3}}-1\right)$ (4) $\frac{2}{3}RT\left(\sqrt{2}-1\right)$

Answer (2)

Sol. $W=-\frac{nR\Delta T}{P-1}$

$\Rightarrow\ T_i=T$

$T_f=T(2)^{\frac{2}{3}}$

$\Delta T=T\left(2^{\frac{2}{3}}-1\right)$

$$W=\frac{RT\left(2^{\frac{2}{3}}-1\right)}{\frac{5}{3}-1}$$

$$=\frac{3}{2}RT\left(2^{\frac{2}{3}}-1\right)$$

4. A 2 kg brick is placed on an inclined plane of inclination 45°. The brick is at rest. The minimum co-efficient of static friction is

(1) 0.5 (2) $\sqrt{3}$

(3) 1 (4) $\frac{1}{\sqrt{3}}$

Answer (3)

Sol. $N = mg\cos45°$

$f_s = mg\sin45°$

$\Rightarrow mg\sin45° \le \mu mg\cos45°$

$\Rightarrow \mu \ge 1.$

5. Correct match for phasors of voltage and current for given elements is

(a) Inductive (p) 

(b) Capacitive (q) 

(c) Resistive (r) 

(1) (a) → (p), (b) → (q), (c) → (r)

(2) (a) → (q), (b) → (p), (c) → (r)

(3) (a) → (p), (b) → (p), (c) → (r)

(4) (a) → (q), (b) → (q), (c) → (r)

Answer (2)

6. With regard to gravitation parameters, the dimensions of T^2 are same as that of

(1) $\frac{r^3}{GM}$ (2) $\frac{GM}{r^3}$

(3) $\frac{r^{3/2}}{GM}$ (4) $\frac{r^2}{GM}$

Answer (1)

Sol. $T^2 = \frac{4\pi^2}{GM}r^3$

7. A point charge q is kept at the centre of the one of the surface of a cube. Flux linked with cube is

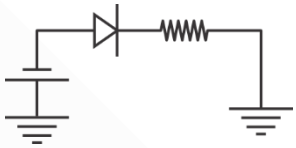
(1) $\frac{q}{\varepsilon_0}$ (2) $\frac{q}{8\varepsilon_0}$

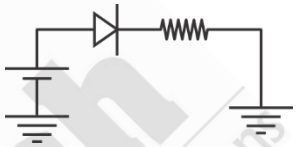
(3) $\frac{q}{2\varepsilon_0}$ (4) $\frac{q}{4\varepsilon_0}$

Answer (3)

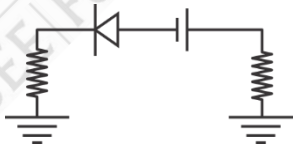
Sol. $\phi = \frac{1}{2}\frac{Q_{in}}{\varepsilon_0} = \frac{q}{2\varepsilon_0}$

8. Which of the following circuits would have the diode in conducting state?

(1) 

(2) 

(3) 

(4) 

Answer (2)

Sol. For conducting state :

$V_p > V_n$.

9. A heater of rating of 50 W – 200 V is connected with source voltage of 100 V. Power consumed by heater is

(1) 100 W (2) 25 W

(3) 50 W (4) 12.5 W

Answer (4)

Sol. $R = \frac{V_r^2}{P_r} = \frac{200 \times 200}{50} = 800\ \Omega$

$$P = \frac{V^2}{R} = \frac{100 \times 100}{800} = 12.5\ \text{W}$$

10. Wavelengths assigned to gamma rays, infra-red rays, UV rays and microwaves are λ_1, λ_2, λ_3 & λ_4 respectively. Then :

(1) $\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4$ (2) $\lambda_1 < \lambda_3 < \lambda_2 < \lambda_4$

(3) $\lambda_1 > \lambda_2 > \lambda_3 > \lambda_4$ (4) $\lambda_2 < \lambda_3 < \lambda_1 < \lambda_4$

Answer (2)

Sol. $\xleftarrow[\text{Increasing Energy}]{\text{Gamma Ray UV Infra Micro}}$

11. The width of the one slit in YDSE is four times the other slit. Then ratio of maximum to the minimum intensity at screen is

(1) 9 : 1 (2) 16 : 1

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

Answer (1)

Sol. $I_1 = I_0$

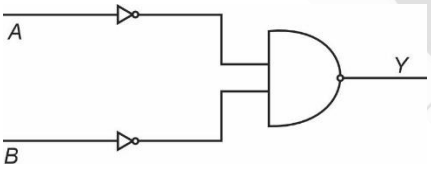
$I_2 = 4I_0$

$$I_{max} = \left[\sqrt{I_0} + \sqrt{4I_0}\right]^2$$

$= 9I_0$

$I_{min} = I_0$

12. The circuit diagram shown is equivalent to



(1) OR (2) NOR

(3) AND (4) NAND

Answer (1)

Sol. $Y = \overline{\overline{A} \cdot \overline{B}} = A + B$

13. **Statement 1 :** In photoelectric effect, number of photoelectrons emitted are proportional to frequency of incident light.

Statement 2 : Maximum kinetic energy of photoelectrons is proportional to frequency of incident light.

(1) Statement 1 is true and Statement 2 is true and correct explanation of 1

(2) Statement 1 is true and Statement 2 is true and not correct explanation of 1

(3) Statement 1 is true and Statement 2 is false

(4) Statement 1 is false and Statement 2 is true

Answer (4)

Sol. $h\nu = h\nu_0 + \text{KE}$

$\nu \uparrow = \text{KE} \uparrow$

14. A metallic rod of length 4 m is rotating about perpendicular bisector of the rod with angular velocity of 2 rad/s in presence of transverse magnetic field of 0.5 T. Potential difference developed across ends of rod is

(1) 16 V

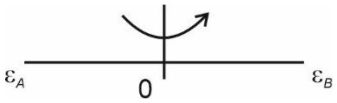
(2) 8 V

(3) 0 V

(4) 32 V

Answer (3)

Sol.



$\varepsilon_A = \varepsilon_B$

$\Delta V_{AB} = 0$

15. **Assertion (A) :** The contact angle depends on material of solid and liquid.

Reason (R) : Height of the liquid in a capillary tube is independent of the radius of the tube.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A)

(2) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(3) (A) is true but (R) is false

(4) (A) is false but (R) is true

Answer (3)

Sol. Contact angle is dependent on materials.

Also, $h = \frac{2s\cos\theta}{\rho g r}$

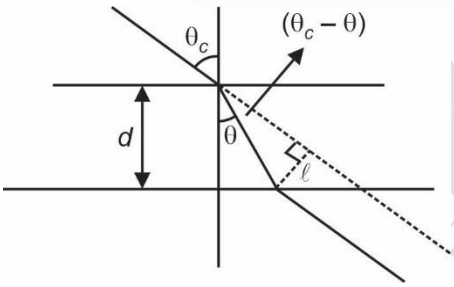
$\Rightarrow$ h depends on r.

16. A ray of light is incident (just close to) at critical angle on slab of thickness $\frac{4}{\sqrt{3}}$ cm. Refractive index of slab is $\sqrt{12}$. The lateral displacement of ray when it emerges from air is

(1) $2\left(1+\frac{\sqrt{11}}{\sqrt{143}}\right)$ cm (2) $2\left(1-\frac{\sqrt{11}}{\sqrt{143}}\right)$ cm

(3) $\left(1+\frac{\sqrt{11}}{\sqrt{143}}\right)$ cm (4) $4\left(1-\frac{\sqrt{11}}{\sqrt{143}}\right)$ cm

Answer (2)



Sol. $\Rightarrow$ $\ell = (d\sec\theta)\sin(\theta_c - \theta)$

$\ell = (d\sec\theta) = \sin\theta_c\cos\theta - d\sec\theta\cos\theta_c\sin\theta$

$= d\sin\theta_c - d\tan\theta\cos\theta_c$

$\Rightarrow$ $\sin\theta_c = \mu\sin\theta$

$\frac{1}{\sqrt{12}} = \sqrt{12}\sin\theta$

$\sin\theta = \frac{1}{12}$ $\cos\theta = \frac{\sqrt{143}}{12}$

and $\sin\theta_c = \frac{1}{\sqrt{12}}$

$\cos\theta_c = \frac{\sqrt{11}}{\sqrt{12}}$

$\ell = 4\sqrt{3}\times\frac{1}{\sqrt{12}} - 4\sqrt{3}\times\frac{1}{\sqrt{143}}\frac{\sqrt{11}}{\sqrt{12}}$

$= 2 - \frac{2\sqrt{11}}{\sqrt{143}}$

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Two point mass m and $2m$ are on straight line. If mass m moves toward centre of mass by distance 2 cm, then the distance must mass $2m$ should move so that centre of mass does not change _____ cm.

Answer (1)

Sol. $m(2m) = 2m(x)$

$x = 1$ cm

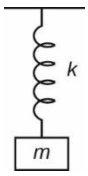
22. A body of mass 4 kg is at a height of R (radius of earth) from surface of earth. The weight of the body is _____ N.

Answer (10)

Sol. $g' = \frac{g}{4} = \frac{5}{2}$ m/s^2

$\Rightarrow$ Weight = mg' = 10 N

23. A mass m is in equilibrium (which is connected with a light spring as shown) and energy associated is E. Instead, if these had been mass of $2m$ then in equilibrium energy associated is E', then $\frac{E'}{E}$ is _____ .



Answer (4)

Sol. $\frac{1}{2}kx^2 - m\varepsilon x = E$

$x = \frac{m\varepsilon}{k}$

$\frac{1}{2}k\frac{m^2\varepsilon^2}{k^2} - m\varepsilon\frac{m\varepsilon}{k} = -\frac{m^2\varepsilon^2}{2k} = \varepsilon$

$\varepsilon \propto m^2$

24. A bar magnet of magnetic moment $M = 0.5\text{A m}^2$ is under the influence of a magnetic field 8 T. Find the work done (J) to move the magnet from stable to unstable equilibrium position.

Answer (8)

Sol. $W = \Delta U$

$\Rightarrow \quad W = 2 \times M \times B$

$= 8$ J

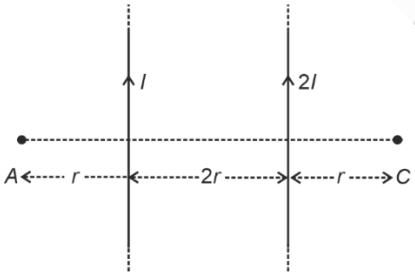
25. For methane, translation degrees of freedom is f_1 while rotational degrees of freedom is f_2. Find $f_1 + f_2$.

Answer (6)

Sol. $f_1 = 3$

$f_2 = 3$ [$\because$ Non-linear]

26. Two infinite straight conductor currying current I and $2I$ separated at distance $2r$ as shown in figure.



The ratio of magnetic field at point A to that of point C is $\frac{x}{7}$, then find x.

Answer (5)

Sol. $B_A = \frac{\mu o I}{2\pi r} + \frac{\mu o(2I)}{2n(3r)} = \frac{\mu o I}{2\pi r} \times \frac{5}{3}$

$B_C = \frac{\mu o(2I)}{2\pi r} + \frac{\mu o I}{2\pi(3r)} = \frac{\mu o I}{2\pi r} \times \frac{7}{3}$

$\frac{B_A}{B_C} = \frac{5}{7}$

27. The position of particle oscillation on x-axis is given as $x = 10\sin\left(\omega t + \frac{\pi}{3}\right)$. If time period of oscillation is 3.14 second, then displacement of particle at $t = 0$ is given as $n\sqrt{3}$ metre, then n is _____

Answer (5)

Sol. $T = \frac{2\pi}{\omega} \Rightarrow \omega = \frac{2\pi}{T} = 2$ rad/sec.

then $x = 10\sin\left(2t + \frac{\pi}{3}\right)$

at $t = 0$

$x = 10\sin\left(\frac{\pi}{3}\right)$

$= 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3}$

28. Two wires A and B of same length and same material ae having radius of cross sections of 2 mm and 4 mm respectively. If resistance of wire B is 2 Ω then resistance of wire A is _____ Ω.

Answer (8)

Sol. $R = \rho\frac{l}{A} = \frac{C}{r^2}$

$\frac{R_A}{R_B} = \frac{4^2}{2^2}$ $R_A = 4 \times 2 = 8\ \Omega$.

29.

30.