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JEE MAIN (APRIL) 2023 (12-04-2023-FN)

Memory Based Question Paper

PHYSICS

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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. If a planet has mass equal to 16 times the mass of earth, and radius equal to 4 times that of earth. The ratio of escape speed of planet to that of earth is

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

(3) $\sqrt{2}:1$ (4) 4 : 1

Answer (1)

Sol. $\frac{V_P}{V_e}=\sqrt{\frac{2GM_P}{R_P}}\times\sqrt{\frac{R_e}{2GM_e}}$

$=\sqrt{\frac{16}{4}}=2$

2. Find ratio of de-Broglie wavelength of a proton and an α-particle, when accelerated through a potential difference of 2 V and 4 V respectively.

(1) 4 : 1 (2) 2 : 1

(3) 1 : 8 (4) 16 : 1

Answer (1)

Sol. $\frac{\lambda_p}{\lambda_\alpha}=\frac{\sqrt{2q_\alpha V_\alpha m_\alpha}}{\sqrt{2q_pV_pm_p}}=\sqrt{\frac{2\times4\times4}{1\times2\times1}}=\frac{4}{1}$

3. If a body of mass 5 kg is in equilibrium due to forces F_1, F_2 and F_3. F_2 and F_3 are perpendicular to each other. If F_1 is removed then find the acceleration of body. Given : F_2 = 6 N and F_3 = 8 N

(1) 2 m/s^2 (2) 3 m/s^2

(3) 4 m/s^2 (4) 5 m/s^2

Answer (1)

Sol. $F_{net}=\sqrt{6^2+8^2}=10$ N

$a=\frac{10}{5}=2$ m/s^2

4. If an object cools down from 80°C to 60°C in 5 minutes in a surrounding of temperature 20°C. The time taken to cool from 60°C to 40°C will be (assume Newton's law of cooling to be valid)

(1) $\frac{25}{3}$minutes (2) 5 minutes

(3) $\frac{25}{4}$minutes (4) 9 minutes

Answer (1)

Sol. $\frac{20}{5}=K(70-20)$ ...(1)

also $\frac{20}{t}=K(50-20)$ ...(2)

from (1) and (2)

$t=\frac{25}{3}$minutes

5. Ratio between rms speed of Ar to the most probable speed of O_2 at 27°C is

(1) $\sqrt{\frac{8}{\pi}}$ (2) $\sqrt{\frac{8}{3}}$

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

Answer (2)

Sol. $v_{rms\,Ar}=\sqrt{\frac{3RT}{M}}=\sqrt{\frac{3RT}{18}}$

$v_{mp\,O_2}=\sqrt{\frac{2RT}{M}}=\sqrt{\frac{2RT}{32}}$

$\frac{v_{rms\,Ar}}{v_{mp\,O_2}}=\sqrt{\frac{3}{18}\times\frac{32}{2}}=\sqrt{\frac{16}{6}}=\sqrt{\frac{8}{3}}$

6. A dipole having dipole moment $\vec{M}$ is placed in two magnetic field of strength B_1 and B_2 respectively. If dipole oscillates 60 time in 20 seconds in B_1 magnetic field and 60 oscillations in 30 seconds in B_2 magnetic field. Then find the $\left(\frac{B_1}{B_2}\right)$.

(1) $\frac{3}{2}$ (2) $\frac{2}{3}$

(3) $\frac{4}{9}$ (4) $\frac{9}{4}$

Answer (4)

Sol. $\tau=\vec{M}\times\vec{B}$

$I\alpha=-MB\theta$

$\alpha=-\left(\frac{MB}{I}\right)\theta$

$T=2\pi\sqrt{\frac{I}{MB}}$

$\frac{T_1}{T_2}=\sqrt{\frac{B_2}{B_1}}$

$$\Rightarrow \frac{20}{30}=\sqrt{\frac{B_2}{B_1}}$$

$$\Rightarrow \frac{B_1}{B_2}=\frac{9}{4}$$

7. Mass of body = 500 kg, μ = 0.7. Find work to move 4 km distance when the body moves with velocity 10 m/s.

(1) 3.5×10^6 J (2) 28×10^6 J

(3) 7×10^6 J (4) 14×10^6 J

Answer (4)

Sol. Since v = const. $\Rightarrow F = \mu mg = 0.7 \times 500 \times 10$ = 3500 N

$W = FS = 3.5 \times 10^3 \times 4 \times 10^3 = 14 \times 10^6$ J

8. Suppose a situation in which two planet orbits around the sun in same orbit. If the mass of planet 1 is twice the mass of planet 2, then what do they have same?

(1) Potential energy (2) Kinetic energy

(3) Total energy (4) Velocity

Answer (4)

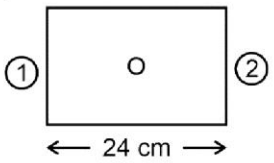
Sol. $v=\sqrt{\frac{GM}{r}}$; M = mass of sun

$\text{P.E.} = -\frac{GMm}{r}$ m, different so different P.E.

$\text{K.E.} = \frac{1}{2}mv^2$ m, different so different K.E.

T.E. will be different.

9. In a ice cube of thickness 24 cm, has bubble trapped in it as shown in figure. If apparent side are 12 cm and 4 cm from side ① and side ② respectively then refractive index of ice cube is



(1) $\frac{4}{3}$ (2) $\frac{3}{2}$

(3) 2 (4) 2.4

Answer (2)

Sol. $\frac{l}{\mu}=12+4=16$ cm

$\frac{24}{16}=\mu$

$\Rightarrow \mu=\frac{3}{2}$

10. **Statement (1):** A truck and a car moving with equal kinetic energy are stopped by equal retarding force. Both will cover equal distance to stop.

Statement (2): A car moving towards east suddenly changes its direction towards north with same speed. Its acceleration is zero.

(1) Both (1) and (2) are true

(2) Both (1) and (2) are false

(3) (1) is true, (2) is false

(4) (1) is false, (2) is true

Answer (3)

Sol. For (1) $v \propto \frac{1}{\sqrt{m}}$, $a \propto \frac{1}{m}$

$\because$ $s=\frac{v^2}{2a} \rightarrow$ independent of mass

For (2) direction is changed, $\therefore$ $a \neq 0$

11. Match the physical quantity in column-I with the respective dimension in column-II and choose the correct option

	Column-I		Column-II
I.	Spring constant	(P)	$[ML^2T^0]$
II.	Moment of inertia	(Q)	$[M^0L^0T^{-1}]$
III.	Angular momentum	(R)	$[ML^0T^{-2}]$
IV.	Angular speed	(S)	$[MLT^{-1}]$

(1) I(P), II(Q), III(R), IV(S)

(2) I(R), II(P), III(Q), IV(S)

(3) I(R), II(S), III(Q), IV(P)

(4) I(R), II(P), III(S), IV(Q)

Answer (4)

Sol. Theoretical

12. The length of a conductor having resistance 160 Ω, is compressed to 25% of its initial value. The new resistance will be

(1) 10 Ω

(2) 20 Ω

(3) 15 Ω

(4) 17 Ω

Answer (1)

Sol. At constant volume, $R \propto \ell^2$

$\therefore$ $\frac{160}{R'}=\frac{\ell^2}{\frac{\ell^2}{16}}$

$\boxed{R'=10\,\Omega}$

13. Statement I : In LCR circuit, by increasing frequency current increases first then decreases
Statement II : Power factor of LCR circuit is one.
Choose the correct option
(1) Statement I is correct and statement II is incorrect
(2) Statement I is incorrect and statement I is correct
(3) Both Statement I and statement II are correct
(4) Both Statement I and statement II are incorrect

Answer (1)

Sol. $I = \frac{V}{Z}$

As ω increases, Z decreases first then increases

$\cos\phi = \left(\frac{R}{Z}\right)$

14. **Assertion (A):** An electrical dipole is enclosed in a closed gaussian surface. The total flux through the enclosed surface is zero.
Reason (R): Net charge inside the enclosed surface is zero.
(1) Both (A) and (R) are correct and (R) is correct explanation of (A)
(2) Both (A) and (R) are correct and (R) is not the correct explanation of (A)
(3) (A) is true, but (R) is false
(4) (A) and (R) both are false

Answer (1)

Sol. $\phi = \frac{q_{in}}{\in_0}$ and q_{in} = 0 inside surface

15. A circular ring is placed in magnetic field of 0.4 T. Suddenly its radius starts shrinking at the rate of 1 mm/s. Find the induced emf in the ring at r = 2 cm.
(1) 16 π μV (2) 8 π μV
(3) 16 π mV (4) 8 π mV

Answer (1)

Sol. $\phi = BA$

$$\varepsilon = \frac{d\phi}{dt} = \frac{BdA}{dt} = \frac{2\pi rBdr}{dt}$$

at r = 2 cm

$$\varepsilon_{induced} = \frac{2\pi\times 2}{100}\times 0.4\times\frac{.1}{1000}$$

$$= \frac{16\pi}{10^6} = 16\pi\times 10^{-6}\ \text{V}$$

16. A body is doing SHM with amplitude A. When it is at $x = +\frac{A}{2}$, find ratio of kinetic energy to potential energy
(1) 1 : 1 (2) 3 : 1
(3) 2 : 1 (4) 4 : 1

Answer (2)

Sol. $\frac{K}{U} = \frac{\frac{1}{2}m\omega^2(A^2 - x^2)}{\frac{1}{2}m\omega^2 x^2}$

$$= \frac{A^2 - x^2}{x^2} = \frac{\frac{3A^2}{4}}{\frac{A^2}{4}} = \frac{3}{1}$$

17. Current flowing in a conductor at 0°C and 100°C is 2 A and 1.2 A respectively. The current at 80°C is
(1) 1.3 A (2) 1.5 A
(3) 1.6 A (4) 1.8 A

Answer (1)

Sol. $\because \quad R \propto \frac{1}{i}$

Let $R = \frac{x}{i}$

also $\frac{\frac{x}{1.2} - \frac{x}{2}}{100 - 0} = \frac{\frac{x}{i} - \frac{x}{2}}{80 - 0}$

$i = \frac{30}{23} \approx 1.3$ A

18. Which of the following is more energetic between Infrared wave and microwave?
(1) IR wave
(2) Microwaves
(3) Both are same energetic
(4) Cannot predict

Answer (1)

Sol. $\because \quad f_{IR} > f_{micro}$

$\therefore \quad E_{IR} > E_{micro}$

IR waves are more energetic.

19. If carnot engines works between freezing point and boiling point of water then the efficiency of carnot engine is
(1) 35% (2) 27%
(3) 22% (4) 17%

Answer (2)

Sol. $\eta = 1 - \frac{T_L}{T_H} = 1 - \left(\frac{273}{373}\right) = \left(\frac{100}{373}\right) \approx 0.27$

20. In closed organ pipe, the resonance consecutive frequencies are in ratio 1 : 3 : 5... and 5th harmonic frequency is 405 Hz. Velocity of sound = 345 m/s. Find length of organ pipe.

(1) $\frac{108}{115}$ m (2) $\frac{81}{115}$ m

(3) $\frac{115}{108}$ m (4) $\frac{115}{81}$ m

Answer (3)

Sol. For 5th harmonic, $f = 5f_0 = 405$

or $5\frac{v}{\lambda} = 405 \Rightarrow 5\left(\frac{345}{4l}\right) = 405$

$\Rightarrow \quad l = \frac{5\times345}{4\times405}$

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 particle is thrown vertically upward with initial velocity of 150 m/s. Find the ratio of its speed at $t = 3$ seconds and $t = 5$ seconds. (take $g = 10$ m/s^2)

Answer (01.20)

Sol. $\frac{v_3}{v_5} = \left(\frac{u - g\times3}{u - g\times5}\right) = \left(\frac{150-30}{150-50}\right) = \frac{120}{100} = 1.2$

22. 64 identical balls made of conducting material each having potential of 10 mV are joined to form a bigger ball. The potential of bigger ball is ____ V.

Answer (00.16)

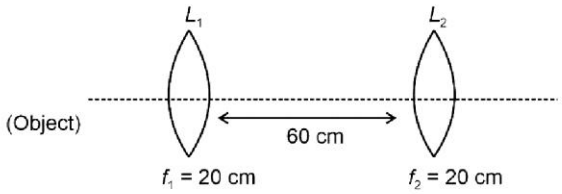
Sol. $64\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3} = \pi R^3 \Rightarrow R = 4r$

Also $Q' = 64Q$

$\because \quad \frac{KQ}{r} = 10 \text{ mV then } V' = \frac{K(64Q)}{4r} = 16\times10 \text{ mV}$

= 160 mV

23. An object placed at very large distance from lens L. The distance of final image formed from L_1 will be _____ m.



Answer (01.00)

Sol. Ist image is formed at focus of L_1 which is at $2f_2$ from lens L_2.

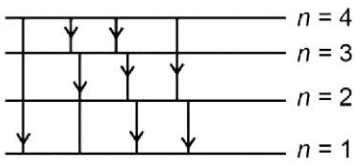
24. A photon of energy 12.75 eV falls a H-atom. Find out no. of spectral lines observed?

Answer (6)

Sol. $\because \Delta E = 13.6\left[1-\frac{1}{n^2}\right]\text{eV}$

For $n = 4$, $\Delta E = 12.75$ eV

In 4 energy level,



no. of spectral lines = $^4C_2 = 6$

25. A uniform solid sphere is rolling without slipping on a horizontal surface. The ratio of translational kinetic energy to the total kinetic energy is 5/x. Find the value of x.

Answer (7)

Sol. $\frac{\text{K.E}_{\text{Trans.}}}{\text{K.E}_{\text{Total}}} = \frac{\frac{1}{2}mR^2\omega^2}{\frac{1}{2}\left(\frac{2}{5}+1\right)mR^2\omega^2} = \frac{5}{7}$

26.

27.

28.

29.

30.