01/02/2024
Evening

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Memory Based
Answers & Solutions

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

JEE (Main)-2024 (Online) Phase-1

(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.

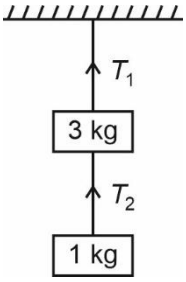
PHYSICS

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. In the figure shown, find the ratio of tensions in the strings, $\frac{T_1}{T_2}$



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

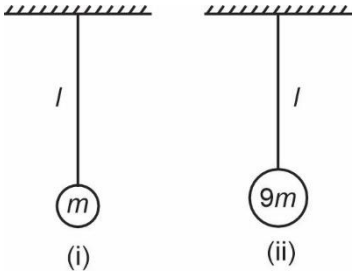
(3) $\frac{1}{3}$ (4) 4

Answer (4)

Sol. $T_2 = 10$ N

$T_1 = 30 + 10 = 40$ N

2. Find the ratio $\left(\frac{T_{(i)}}{T_{(ii)}}\right)$ of time periods of the two pendulums shown.



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

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

Answer (1)

Sol. $T = 2\pi\sqrt{\frac{l}{g}}$

3. A solid sphere is rolling purely with speed v on horizontal surface. It rolls up on inclined surface and stops at height h. Then height h is (g is acceleration due to gravity)

(1) $\frac{3}{10}\frac{v^2}{g}$

(2) $\frac{7}{10}\frac{v^2}{g}$

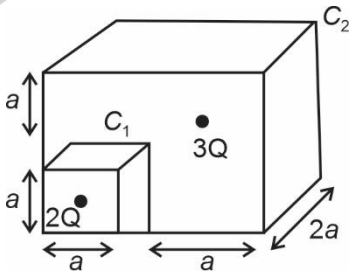
(3) $\frac{5}{7}\frac{v^2}{g}$

(4) $\frac{7}{5}\frac{v^2}{g}$

Answer (2)

Sol. $\frac{1}{2}\left(\frac{2}{5}+1\right)mv^2 = mgh$

4. There are two cubical gaussian surface carrying charges as shown. Find ratio of fluxes through surface C_1 and C_2.



(1) 1 : 1

(2) 2 : 5

(3) 5 : 2

(4) 2 : 3

Answer (2)

Sol. $\phi_{C_1} = \frac{2Q}{\varepsilon_0}$

$\phi_{C_2} = \frac{5Q}{\varepsilon_0}$

5. If the power of a light source is P & frequency of photons emitted is f. Find number of photons emitted in time t

(1) $\frac{Pt}{2hf}$

(2) $\frac{Pt}{hf}$

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

(4) $\frac{Pf}{ht}$

Answer (2)

Sol. $Pt = nhf$

$n = \frac{Pt}{hf}$

6. A photodiode operates at wavelength of 620 nm. Find forbidden energy gap (E_g) for the diode.

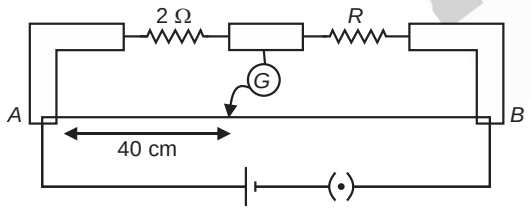
(1) $E_g >> 2$ eV (2) $E_g \geq 2$ eV

(3) $E_g < 2$ eV (4) $E_g = 1$ eV

Answer (2)

Sol. $E_g = \frac{12400}{6200} = 2$ eV

7. In the meter bridge shown below the null point is at 40 cm from A, if R is shunted 2 Ω, find the distance of new balance point from A.



(1) 22.7 cm

(2) 60 cm

(3) 62.5 cm

(4) 60.5 cm

Answer (3)

Sol. $\frac{2}{40} = \frac{R}{60}$

$R = 3\ \Omega$

If R is shunted by 2 Ω

$R' = \frac{6}{5}\ \Omega$

$\frac{2}{\ell} = \frac{6}{5(100-\ell)}$

$5(100 - \ell) = 3\ell$

$500 = 8\ell$

$\ell = \frac{500}{8} = 62.5$ cm

8. A particle is moving in circular path of radius r with speed v such that speed is proportional to radius as $v \propto r^{-3/2}$. Then how does time period of revolution depends on r *i.e.* $T \propto r^n$ then n is

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

(2) $\frac{5}{2}$

(3) $\frac{-5}{2}$

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

Answer (2)

Sol. $T = \frac{2\pi r}{v} \propto \frac{r}{r^{-3/2}} = r^{5/2}$

9. If the *rms* velocity of hydrogen gas molecules is v_0, find the *rms* velocity of oxygen molecules at same temperature.

(1) v_0

(2) $\frac{v_0}{2}$

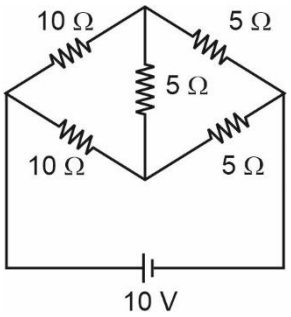
(3) $\frac{v_0}{4}$

(4) $\frac{v_0}{3}$

Answer (3)

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

10. In the given circuit, find electric current drawn from battery.



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

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

(3) $\frac{4}{5}$ A

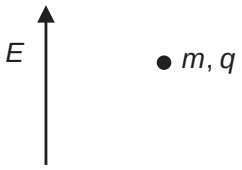
(4) $\frac{5}{4}$ A

Answer (2)

Sol. It is condition of Wheatstone bridge

$$i = \frac{10}{\left(\frac{15}{2}\right)} = \frac{4}{3}\text{A}$$

11. A charged particle (m, q) stays in equilibrium in an electric field as shown



Then, value of q is

(1) $\frac{mg}{2E}$

(2) $\frac{mg}{E}$

(3) $\frac{2mg}{E}$

(4) $\frac{mg}{4E}$

Answer (2)

Sol. $F_{Net} = 0$

$\Rightarrow qE = mg$

$\Rightarrow q = \frac{mg}{E}$

12. In Young's double slit experiment, slits separation is 4 cm and separation between slit and screen is 1.5 m. A wave of wavelength 2 cm is incident of slits then find angular width of fringe.

(1) 0.75 rad

(2) 0.65 rad

(3) 0.80 rad

(4) 0.5 rad

Answer (4)

Sol. Angular fringes width (β) = $\frac{\lambda}{d}$

$$= \frac{2\times10^{-2}}{4\times10^{-2}} = 0.5 \text{ rad}$$

13. In transition from $n = 2$ to $n = 1$ in hydrogen atom, frequency emitted is f_0. The frequency emitted for the transition $n = 3$ to $n = 1$ is

(1) $\frac{27}{32}f_0$

(2) $\frac{25}{18}f_0$

(3) $\frac{32}{27}f_0$

(4) $\frac{18}{25}f_0$

Answer (3)

Sol. $hf_0 = 13.6\left[1-\frac{1}{4}\right]$ ...(i)

$hf = 13.6\left[1-\frac{1}{9}\right]$ ...(ii)

$\Rightarrow \frac{f_0}{f} = \frac{3}{4}\times\frac{9}{8} = \frac{27}{32}$

$\Rightarrow f = \frac{32}{27}f_0$

14. In an isobaric process work done by the gas is 200 J. If the adiabatic constant of the gas is 1.4, the heat supplied to the gas during the process is

(1) 600 J

(2) 700 J

(3) 500 J

(4) 900 J

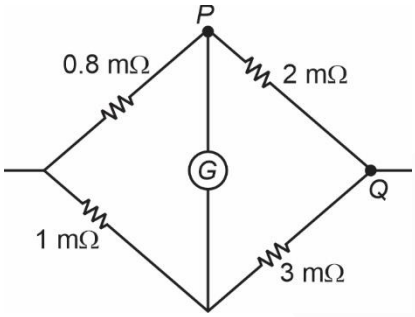
Answer (2)

Sol. $W = 200\ J = nR\Delta T$

$$Q = nC_P\Delta T = \left(\frac{\gamma}{\gamma-1}\right)nR\Delta T$$

$$= \frac{1.4}{0.4}\times 200$$

$= 700\ J$

15. 

A Wheatstone bridge in which resistance PQ is temperature dependent. If temperature is increased from 0° to 25°C then deflection in galvanometer becomes zero. What is temperature coefficient of resistivity?

(1) 0.008/°C (2) 0.08/°C

(3) 0.004/°C (4) 0.04/°C

Answer (1)

Sol. $2.4 = (1 + \alpha\Delta T)$

$1.2 - 1 = 0.2 = \alpha 25$

0.008

16. Two vectors each of magnitude A are inclined at angle θ with each other, then magnitude of resultant vector is

(1) $A\cos^2\frac{\theta}{2}$ (2) $2A\cos\frac{\theta}{2}$

(3) $2A\cos\theta$ (4) $A\cos\frac{\theta}{2}$

Answer (2)

Sol. The magnitude of resultant vector

$$(R) = \sqrt{a^2 + b^2 + 2ab\cos\theta}$$

here, $a = b = A$

then, $R = \sqrt{A^2 + A^2 + 2A^2\cos\theta}$

$$= A\sqrt{2}\ \sqrt{1+\cos\theta}$$

$$= \sqrt{2}A\sqrt{2\cos^2\frac{\theta}{2}}$$

$$= 2A\cos\left(\frac{\theta}{2}\right)$$

17. Two trains are moving along parallel tracks along north-south. If train A has velocity 20 m/s towards north and train B has velocity 30 m/s towards south. Find velocity of train B with respect to A.

(1) 50 m/s towards north

(2) 50 m/s towards south

(3) 10 m/s towards north

(4) 10 m/s towards south

Answer (2)

Sol. $\vec{v}_{B/A} = \vec{v}_B - \vec{v}_A$

$= 50$ m/s towards south

18. 1000 drops of water (of radius r each) combine to form a single drop. Find energy released if surface tension is S.

(1) $1800\pi Sr^2$

(2) $3600\pi Sr^2$

(3) $7200\pi Sr^2$

(4) $900\pi Sr^2$

Answer (2)

Sol. $\frac{4}{3}\pi r^3 \times 1000 = \frac{4}{3}\pi R^3$

$\Rightarrow R = 10r$

$\Rightarrow$ Energy released $= [1000 \times 4\pi r^2 - 4\pi R^2] \times S$

$= 4\pi \times 900r^2 \times S$

$= 3600\pi Sr^2$

19. Which of the following is correct for nuclear force?

(1) It is long ranged force and is independent of charge

(2) It is short ranged force and is dependent of charge

(3) It is short ranged force and is independent of charge

(4) Nuclear force between two neutron is different that between two protons

Answer (3)

Sol. Theoretical

20. A body of mass 4 kg experiences two forces $\vec{F}_1 = 5\hat{i} + 8\hat{j} + 7\hat{k}$ and $\vec{F}_2 = 3\hat{i} - 4\hat{j} - 3\hat{k}$. Find the acceleration 6 the body

(1) 3 m/s^2

(2) 2 m/s^2

(3) $\sqrt{6}$ m/s^2

(4) $\sqrt{5}$ m/s^2

Answer (3)

Sol. $\vec{a} = \frac{\vec{F}_{net}}{M} = \frac{8\hat{i} + 4\hat{j} + 4\hat{k}}{4}$

$= 2\hat{i} + \hat{j} + \hat{k}$

$a = \sqrt{4+1+1}$

$= \sqrt{6}$ m/s^2

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. Find the number of significant digits in the value 10.05.

Answer (4)

Sol. All digits are significant

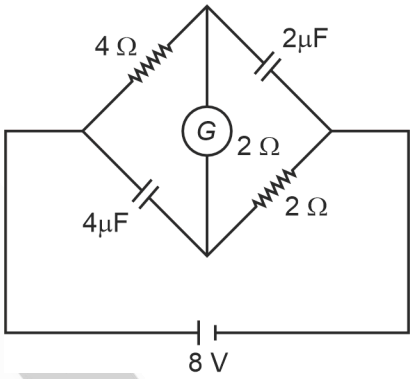
$\Rightarrow$ 4

22. A ball of mass 120 g moving with initial velocity 25 m/s is stopped by an external force F in 0.15 sec. Find the value of F in newton.

Answer (20)

Sol. $F = \frac{\Delta P}{t} = \frac{25 \times \frac{120}{1000}}{0.15} = 20$ N

23. In the given circuit, find the ratio of charge on $4\mu F$ to that on $2\mu F$ in steady state.



Answer (3)

Sol. In steady state, capacitors behave as open circuits.

$\Rightarrow i = \frac{V}{R}$

$= \frac{8}{4+2+2}$ A

= 1 A

$\Rightarrow \Delta V_{4\mu F} = (4 + 2)i = 6$ V

And $\Delta V_{2\mu F} = (2 + 2)i = 4$ V

$\Rightarrow$ Ratio $= \frac{C_2V_2}{C_1V_1} = \frac{24}{8} = 3$

24.

25.

26.

27.

28.

29.

30.