05/04/2024
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 block of mass 50 kg is moving with speed of 10 m/s on rough horizontal surface.

(Friction coefficient of 0.3)

Find of the kinetic friction acting on the object.

(1) 500 N (2) 150 N

(3) 167 N (4) 16 N

Answer (2)

Sol. $f = \mu N = 0.3 \times 500 = 150$ N

2. A truck is moving from rest with constant power P. If the displacement of the truck is proportional to t^n, where t is time, find n.

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

(3) $\frac{1}{2}$ (4) $\frac{5}{2}$

Answer (2)

Sol. $Pt = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2Pt}{m}}$

$v = \frac{ds}{dt}$

$\therefore \quad s = \int \sqrt{\frac{2Pt}{m}}dt$

$s \propto t^{3/2}$

3. The van der Waals gas equation is expressed as $\left(P - \frac{a}{V^2}\right)(V - b) = nRT$, where symbols have their usual meaning, then dimension of $\frac{a}{b^2}$ is

(1) $\left[ML^2T^{-2}\right]$ (2) $\left[M^2L^2T^{-2}\right]$

(3) $\left[MLT^{-2}\right]$ (4) $\left[ML^3T^{-2}\right]$

Answer (1)

Sol. $[P] = \left[\frac{a}{V^2}\right]$

$ML^{-1}T^{-2} = \frac{a}{L^6}$

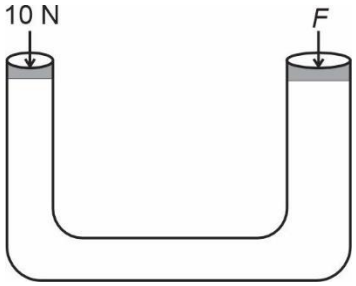
$a = ML^{+5}T^{-2}$

and $[V] = [b] = \left[L^3\right]$

$\left[\frac{a}{b^2}\right] = \frac{ML^5T^{-2}}{L^3}$

$= \left[ML^2T^{-2}\right]$

4. In a hydraulic lift force F is applied to balance 10 N load, diameter of effort arm is 14 cm and load arm is 1.4 cm. The F is equal to



(1) 500 N (2) 100 N

(3) 2000 N (4) 1000 N

Answer (4)

Sol. $P_1 = P_2$

$$\frac{10}{\frac{\pi}{4}(1.4)^2} = \frac{F}{\frac{\pi}{4}(14)^2}$$

$F = 1000$ N

5. A hollow sphere is rolling without slipping. Find ratio of rotational kinetic energy to total kinetic energy of sphere

(1) $\frac{4}{7}$ (2) $\frac{3}{7}$

(3) $\frac{2}{7}$ (4) $\frac{5}{7}$

Answer (3)

Sol. $K_{rot} = \frac{1}{2}\left(\frac{2}{5}MR^2\right)\omega^2$

$$K_{total} = \frac{1}{2}Mv^2 + \frac{1}{2}\left(\frac{2}{5}MR^2\right)\omega^2$$

$v = R\omega$

$$\therefore \quad K_{total} = \frac{1}{2}\left(\frac{7}{5}MR^2\right)\omega^2$$

$$\frac{K_{rot}}{K_{total}} = \frac{2}{7}$$

6. Shortest wavelength in Lyman series has wavelength of 915 Å. Longest wavelength of Balmer series has a value of?

(1) 5296 Å (2) 3647 Å

(3) 6588 Å (4) 7294 Å

Answer (3)

Sol. Lyman : $\frac{1}{915} = RZ^2\left(\frac{1}{1} - \frac{1}{\infty}\right)$

$$RZ^2 = \frac{1}{915}$$

Balmer : Transition from $n = 3$ to $n = 2$

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

$$\frac{1}{\lambda} = \frac{1}{915}\left(\frac{5}{36}\right)$$

$$\boxed{\lambda = 6588\,\text{Å}}$$

7. In sonometer, fundamental frequency changes from 400 Hz to 500 Hz keeping same tension. Find percentage change in length.

(1) 5% (2) 10%

(3) 20% (4) 40%

Answer (3)

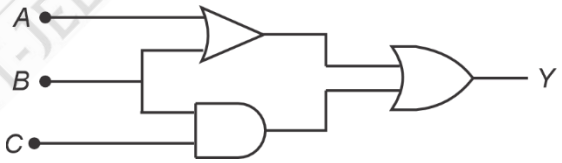
Sol. $f = \frac{v}{2l_1} = 400$

$$\frac{v}{2l_2} = 500$$

$$\frac{l_2 - l_1}{l_1} \times 100 = \frac{\frac{v}{1000} - \frac{v}{800}}{\frac{v}{800}} \times 100 = \left(\frac{8}{10} - 1\right) \times 100$$

$= -20\%$

8. For what boolean values of A, B & C the given logic gate gives output of zero?



(1) $A = 1, B = 0, C = 1$

(2) $A = 0, B = 0, C = 1$

(3) $A = 0, B = 1, C = 1$

(4) $A = 1, B = 1, C = 1$

Answer (2)

Sol. Putting values gives option (2).

9. $20R$ resistance wire is cut into 10 equal parts. Now each part first is connected in series and then in parallel. Find ratio of equivalent resistance in both cases ($R_{series} : R_{parallel}$)

(1) 100 : 1

(2) 50 : 1

(3) 25 : 1

(4) 5 : 1

Answer (1)

Sol. **Series :** $R_{eq} = 20R$

Parallel : $R'_{eq} = \frac{R}{5}$

Ratio : $R_{eq} : R'_{eq} = 20R : \frac{20R}{100} = 1 : \frac{1}{100} = 100 : 1$

10. On vehicles containing inflammable fluid, metallic chains are provided touching of the earth, then correct option is

(1) It is custom

(2) Alert for another vehicle

(3) For discharging the statics charges developed due to friction

(4) It is fashion

Answer (3)

Sol. Because of friction, metallic body gets changed.

11. 400 Ω series resistance is required to convert a galvanometer of 100 Ω to a voltameter of range 10 V. To convert same galvanometer, in ammeter of 10A, what should be the shunt resistance

(1) 4 Ω

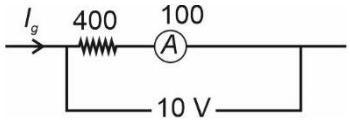
(2) 0.4 Ω

(3) 0.2 Ω

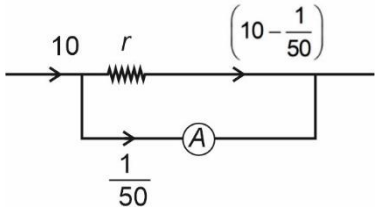
(4) 5 Ω

Answer (3)

Sol.



$I_g = \frac{10}{500} = \frac{1}{50}$ A



$\Rightarrow \quad 10r = \frac{1}{50} \times 100$

$r = 0.2\ \Omega$

12. A particle is moving in circular path of radius 9 m such that it completes 120 rev in 3 minutes. Find centripetal acceleration.

(1) $8\pi^2$ m/s^2 (2) $16\pi^2$ m/s^2

(3) $32\pi^2$ m/s^2 (4) 16π m/s^2

Answer (2)

Sol. $\omega = \frac{\Delta\theta}{\Delta t} = \frac{120 \times 2\pi}{3 \times 60} = \frac{4\pi}{3}$ rad/s

$a_c = \omega^2 r$

$= \left(\frac{16}{9}\pi^2\right) \times 9$

$= 16\pi^2$ m/s^2

13. The current flowing through an inductor vary with time as $i = (3t + 2)A$ and back emf induced in it is 12 V at an instant. Find inductance

(1) 1 H

(2) 2 H

(3) 4 H

(4) 5 H

Answer (3)

Sol. $\varepsilon = \left| L\frac{di}{dt} \right|$

$12 = L(3)$

$L = 4$ H

14. In thermodynamics adiabatic process, pressure is directly proportional to cube of absolute temperature. Find $\frac{C_p}{C_v}$ for the gas

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

(2) $\frac{7}{5}$

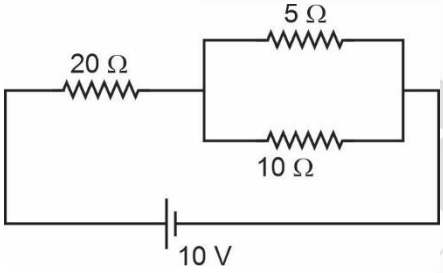
(3) $\frac{3}{2}$

(4) $\frac{8}{7}$

Answer (3)

Sol. $P \propto T^3 \Rightarrow \frac{P^3V^3}{P} \propto P^2V^3 \propto PV^{3/2} = PV^{\gamma}$

15. Find the ratio of power dissipated in 5 Ω and 10 Ω resistor.



(1) 1 : 2

(2) 1 : 4

(3) 2 : 1

(4) 4 : 1

Answer (3)

Sol. $P = i^2R = \frac{V^2}{R}$

$\therefore$ Voltage across 5 Ω and 10 Ω is same

$P \propto \frac{1}{R}$

$\frac{P_1}{P_2} = \frac{R_2}{R_1} \Rightarrow P_1 : P_2 = 10 : 5$

$\boxed{P_1 : P_2 = 2 : 1}$

16. Angular momentum of revolving electron of hydrogen atom in a given orbit is dependent on radius r as

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

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

Answer (4)

Sol. $L = \frac{nh}{2\pi}$ (i) $r = \frac{n^2}{2} r_0$ (ii)

$\Rightarrow L \propto \sqrt{r}$.

17. In a photoelectric effect, stopping potential of photoelectrons does not depend on

(1) Intensity of radiation

(2) Frequency of radiation

(3) Material or metal

(4) Kinetic energy of electrons

Answer (1)

Sol. $eV_S = h\nu - \phi_0$

eV_S = KE

18. If F_1 is electrostatic force, F_2 is magnetic force on a charge particle of charge q, where E is electric field, B is magnetic field and v is velocity of particle. Mark correct option.

(1) $\vec{F}_1 = q(\vec{v} \times \vec{E})$

(2) $\vec{F}_2 = q\vec{B}$

(3) $\vec{F}_1 = \vec{q}(\vec{E} \times \vec{v})$

(4) $\vec{F}_2 = q(\vec{v} \times \vec{B})$

Answer (4)

Sol. $\vec{F}_1 = q\vec{E}$

$\vec{F}_2 = q(\vec{v} \times \vec{B})$

19.

(A)	X-Ray	(P)	$\lambda > 700$ nm
(B)	UV Ray	(Q)	100 nm $< \lambda <$ 400 nm
(C)	γ-Ray	(R)	$\lambda < 0.3$ nm
(D)	Infrared	(S)	0.3 nm $< \lambda <$ 10 nm

(1) (A) $\rightarrow$ (S), (B) $\rightarrow$ (Q), (C) $\rightarrow$ (P), (D) $\rightarrow$ (R)

(2) (A) $\rightarrow$ (S), (B) $\rightarrow$ (Q), (C) $\rightarrow$ (R), (D) $\rightarrow$ (P)

(3) (A) $\rightarrow$ (P), (B) $\rightarrow$ (Q), (C) $\rightarrow$ (R), (D) $\rightarrow$ (S)

(4) (A) $\rightarrow$ (P), (B) $\rightarrow$ (R), (C) $\rightarrow$ (Q), (D) $\rightarrow$ (S)

Answer (2)

Sol. Most energetic gamma rays and less energetic are Infrared.

20. A conducting sphere is given a charge Q on it. The ratio of potential at points at a distance $\frac{R}{2}$ and $\frac{3R}{2}$ from the centre of the sphere is

(1) 1 : 3

(2) 3 : 2

(3) 3 : 1

(4) 2 : 3

Answer (2)

Sol. $V_1 = \frac{KQ}{R}$

$V_2 = \frac{2KQ}{3R}$

$\therefore \quad \frac{V_1}{V_2} = \frac{3}{2}$

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. A particle is projected with some speed and it is observed that it achieves a maximum height of 64 m. If the same particle is projected with initial speed half to the first value, then new maximum height achieved by particle will be _____ m.

Answer (16)

Sol. $H_{max} = \frac{u^2}{2g} = 64$ m

$H'_{max} = \frac{u^2}{4(2g)} = \frac{64}{4} = 16$ m

22. If a body is moving with a momentum. $\vec{P} = \sin kt\,\hat{i} - \cos kt\,\hat{j}$, then angle between $\vec{F}$ and $\vec{P}$ is _____ degrees.

Answer (90)

Sol. We know that $\vec{F} = \frac{d\vec{P}}{dt}$

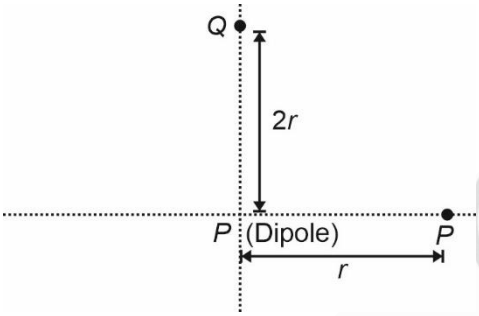
$$\vec{F} = (\cos kt \times k)\hat{i} - (-\sin kt \times k)\hat{j}$$

$$\vec{F} = (k\cos kt)\hat{i} + (k\sin kt)\hat{j}$$

$$\therefore \quad \cos\theta = \frac{\vec{F}\cdot\vec{P}}{|\vec{F}||\vec{P}|} = 0$$

$$\theta = 90°$$

23. Electric field due to the dipole at *P* is *E* and at point *Q* is $\frac{E}{K}$, find *K*.



Answer (16)

Sol. $E_P = \frac{2K_P}{r^3}$

$$E_Q = \frac{K_P}{(2r)^3}$$

$$\therefore \quad E_Q = \frac{1}{16}E_P$$

24. The least count of a vernier calliper is 0.1 mm and 20 vernier scale division coincides with 19 main scale division, then one main scale division is _____ mm.

Answer (2)

Sol. 20 VSD = 19 MSD

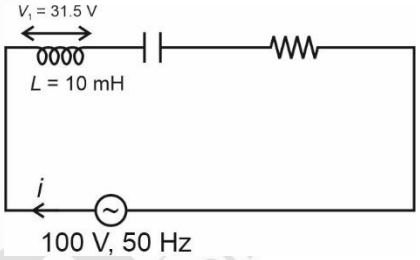
$$\text{VSD} = \frac{19}{20}\text{MSD}$$

$$\text{LC} = \text{MSD} - \frac{19}{20}\text{MSD}$$

$$0.1\,\text{mm} = \frac{\text{MSD}}{20}$$

MSD = 2 mm

25. Find the current *i* (upto nearest integer), in the circuit.



Answer (10)

Sol. $V_L = i\,X_L$

$$31.5 = (i)\times(\omega L)$$

$$31.5 = i \times 2\pi FL$$

$$i = \frac{31.5}{2\pi \times 50 \times 10^{-2}} = \frac{31.5}{3.14}$$

$$\boxed{i \approx 10\ \text{A}}$$

26.

27.

28.

29.

30.