| NEET(UG) |
|---|
| 04/05/2025 |

# MATRIX

| Paper Code |
|---|
| 47 |

## Question Paper with Solutions & Answer Keys

*for*

Time : 3 hrs. M.M. : 720

# NEET (UG)-2025

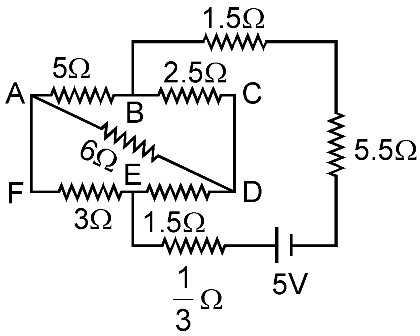
**Read carefully the Instructions on the Cover of this Test Booklet.**

***Important Instructions :***

1. The test is of 3 hours duration and the Test Booklet contains 180 multiple choice questions (Four options with a single correct answer) from **Physics**, **Chemistry** and **Biology** (**Botany** and **Zoology**).
2. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For every wrong response 1 mark shall be deducted from the total scores. The maximum marks are 720.
3. Use Blue / Black Ball point Pen only for writing particulars on this page / marking responses on Answer Sheet.
4. Rough work is to be done in the space provided for this purpose in the Test Booklet only.
5. On completion of the test, the candidate must handover the Answer Sheet to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.
6. The CODE for this Booklet is 47.
7. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Roll No. anywhere else except in the specified space in the Test Booklet/Answer Sheet. Use of white fluid for correction is NOT permissible on the Answer Sheet.
8. Each candidate must show on-demand his/her Admission Card to the Invigilator.
9. No candidate, without special permission of the Centre Superintendent or Invigilator, would leave his/her seat.
10. Use of Electronic/Manual Calculator is prohibited.
11. The candidates are governed by all Rules and Regulations of the examination with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of this examination.
12. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
13. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.

SUBJECT : PHYSICS

1. The current passing through the battery in the given circuit. is :




(1) 1.5 A (2) 2.0 A (3) 0.5 A (4) 2.5 A

**Ans. (3)**

**Sol.** It is a balanced wheatstone bridge between E and B.

$$R_{eq} = \frac{1}{3} + \frac{8 \times 4}{8+4} + 1.5 + 5.5 = \frac{1}{3} + \frac{8}{3} + 7 = 10\Omega$$

Current in circuit $I = \frac{V}{R} = \frac{5}{10} = 0.5$ A

2. The electric field in a plane electromagnetic wave is given by

$E_z = 60\cos(5x + 1.5 \times 10^9 t)$V/m.

Then expression for the corresponding magnetic field is (here subscripts denote the direction of the field) :

(1) $B_y = 60\sin(5x + 1.5 \times 10^9 t)$T (2) $B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t)$T

(3) $B_x = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t)$T (4) $B_z = 60\cos(5x + 1.5 \times 10^9 t)$T

**Ans. (2)**

**Sol.** $B_0 = \frac{E_0}{c} = \frac{60}{3 \times 10^8} = 2 \times 10^{-7}$ T

$\vec{E}, \vec{B}$ and direction of propagation of wave are perpendicular to each other

Hence, magnetic field $B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t)$T

3. A pipe open at both ends has a fundamental frequency *f* in air. The pipe is now dipped vertically in a water drum to half of its length. The fundamental frequency of the air column is now equal to :

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

**Ans. (3)**

**Sol.** $f_{open} = \frac{v}{2l} = f$

$$f_{closed} = \frac{v}{4\left(\frac{l}{2}\right)} = \frac{v}{2l} = f$$

4. An electron (mass $9 \times 10^{-31}$ kg and charge $1.6 \times 10^{-19}$C) moving with speed c/100 (c = speed of light) is injected into a magnetic field $\vec{B}$ of magnitude $9 \times 10^{-4}$ T perpendicular to its direction of motion. We wish to apply an uniform electric field $\vec{E}$ together with the magnetic field so that the electron does not deflect from its path. Then (speed of light $c = 3 \times 10^8$ ms$^{-1}$)

(1) $\vec{E}$ is parallel to $\vec{B}$ and its magnitude is $27 \times 10^4$ V m$^{-1}$

(2) $\vec{E}$ is perpendicular to $\vec{B}$ and its magnitude is $27 \times 10^4$ V m$^{-1}$

(3) $\vec{E}$ is perpendicular to $\vec{B}$ and its magnitude is $27 \times 10^2$ V m$^{-1}$

(4) $\vec{E}$ is parallel to $\vec{B}$ and its magnitude is $27 \times 10^2$ V m$^{-1}$

**Ans. (3)**

**Sol.** Given $v = \frac{c}{100} = \frac{3 \times 10^8}{100} = 3 \times 10^6$ m/s

$E = vB$

$E = 3 \times 10^6 \times 9 \times 10^{-4}$

$= 27 \times 10^2$ V/m

$\vec{E}$ is perpendicular to $\vec{B}$ and its magnitude is $27 \times 10^2$ V/m

5. In a certain camera, a combination of four similar thin convex lenses are arranged axially in contact. Then the power of the combination and the total magnification in comparison to the power (p) and magnification (m) for each lens will be, respectively -

(1) $p^4$ and $m^4$ (2) 4p and 4m (3) $p^4$ and 4m (4) 4p and $m^4$

**Ans. (4)**

**Sol.** In series combination of lenses power adds and magnificaiton multiplies.

$p_{net} = 4p$

$m_{net} = m^4$

6. A 2 amp current is flowing through two different small circular copper coils having radii ratio 1 : 2. The ratio of their respective magnetic moments will be

(1) 4 : 1 (2) 1 : 4 (3) 1 : 2 (4) 2 : 1

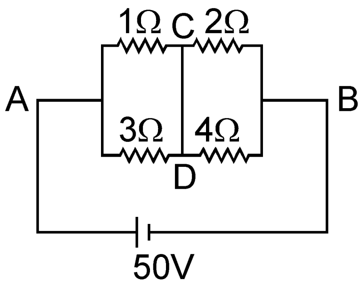
**Ans. (2)**

**Sol.** $M = IA = I\pi r^2$

I = constant, Hence $M \propto r^2$

$$\frac{M_1}{M_2} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

7. A constant voltage of 50 V is maintained between the points A and B of the circuit shown in the figure. The current through the branch CD of the circuit is :

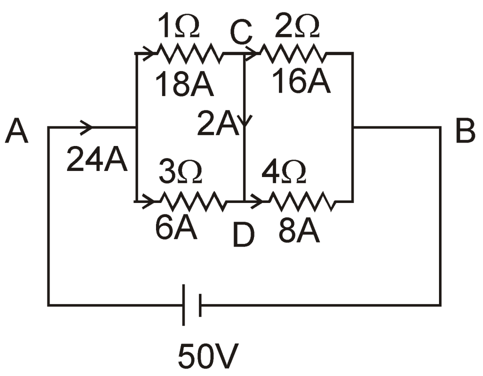



(1) 3.0 A (2) 1.5 A (3) 2.0 A (4) 2.5 A

**Ans. (3)**

**Sol.** $R_{eq} = \frac{3\times1}{3+1}+\frac{4\times2}{4+2}=\frac{3}{4}+\frac{4}{3}=\frac{25}{12}\Omega$

$I = \frac{V}{R_{eq}}=\frac{50}{\frac{25}{12}}=\frac{50\times12}{25}=24A$




Current in branch CD is 2A.

8. Two gases A and B are filled at the same pressure in separate cylinders with movable pistons of radius $r_A$ and $r_B$, respectively. On supplying an equal amount of heat to both the systems reversibly under constant pressure, the pistons of gas A and B are displaced by 16 cm and 9 cm, respectively. If the change in their internal energy is the same, then the ratio $\frac{r_A}{r_B}$ is equal to

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

**Ans.** **(3)**

**Sol.** $\Delta Q \rightarrow$ same; $\Delta V \rightarrow$ same

Then W will be same

$W = P\Delta V$

$P\Delta V_1 = P\Delta V_2$

$A_1L_1 = A_2L_2$

$\frac{r_1}{r_2}=\sqrt{\frac{L_2}{L_1}}=\frac{3}{4}$

9. A container has two chambers of volumes $V_1$ = 2 litres and $V_2$ = 3 litres separated by a partition made of a thermal insulator. The chambers contains $n_1$ = 5 and $n_2$ = 4 moles of ideal gas at pressures $p_1$ = 1 atm and $p_2$ = 2 atm, respectively. When the partition is removed, the mixture attains an equilibrium pressure of :

(1) 1.8 atm (2) 1.3 atm (3) 1.6 atm (4) 1.4 atm

**Ans. (3)**

**Sol.** $P_{mix} V_{mix} = n_{mix} RT_{mix} = P_1V_1 + P_2V_2$

$$P_{mix} = \frac{P_1V_1 + P_2V_2}{V_1 + V_2} = 1.6 \text{ atm}$$

10. The radius of Martian orbit around the Sun is about 4 times the radius of the orbit of Mercury. The Martian year is 687 Earth days. Then which of the following is the length of 1 year on Mercury ?

(1) 124 earth days (2) 88 earth days (3) 225 earth days (4) 172 earth days

**Ans. (2)**

**Sol.** $T^2 \propto r^3$

$T \propto r^{3/2}$

$$\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}$$

$$\frac{687}{T_2} = \left(\frac{4r}{r}\right)^{3/2} = 8$$

$$T_2 = \frac{687}{8} = 85.875 \text{ earth days}$$

11. To an ac power supply of 220 V at 50 Hz, a resistor of 20Ω, a capacitor of reactance 25Ω and an inductor of reactance 45Ω are connected in series. The corresponding current in the circuit and the phase angle between the current and the voltage is, respectively -

(1) 15.6 A and 45° (2) 7.8 A and 30° (3) 7.8 A and 45° (4) 15.6 A and 30°

**Ans. (3)**

**Sol.** $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{(20)^2 + (45-25)^2} = \sqrt{400+400} = 20\sqrt{2}\,\Omega$

$I_{rms} = \frac{V_{rms}}{Z} = \frac{220}{20\sqrt{2}} = \frac{11}{\sqrt{2}} = 11 \times 0.707$

$I_{rms} = 7.8$ A

$\tan\phi = \frac{X_L - X_C}{R} = \frac{20}{20} = 1$

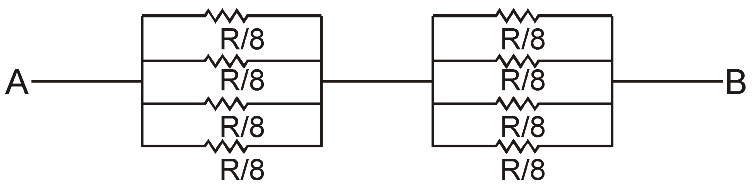
$\phi = 45°$

12. A wire of resistance R is cut into 8 equal pieces. From these pieces two equivalent resistances are made by adding four of these together in paralle. Then these two sets are added in series. The net effective resistance of the combination is :

(1) $\frac{R}{8}$ (2) $\frac{R}{64}$ (3) $\frac{R}{32}$ (4) $\frac{R}{16}$

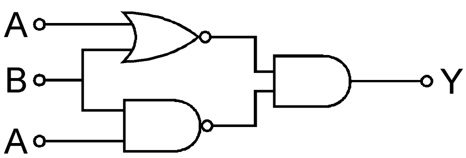
**Ans.** **(4)**

**Sol.** Each piece has resistance $\frac{R}{8}$




$R_{eq} = \frac{R/8}{4} + \frac{R/8}{4} = \frac{R}{32} \times 2 = \frac{R}{16}$

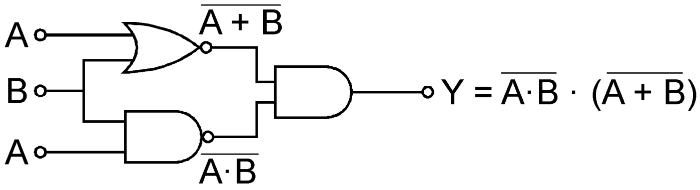
13. The output (Y) of the given logic implementation is similar to the output of an/a _______ gate.




(1) NOR (2) AND (3) NAND (4) OR

**Ans.** **(1)**

**Sol.**




$$y = \left(\overline{A+B}\right)\cdot\left(\overline{A \cdot B}\right)$$

$$= \left(\bar{A}\cdot\bar{B}\right)\cdot\left(\bar{A}+\bar{B}\right)$$

$$= \bar{A}\cdot\bar{A}\cdot\bar{B} + \bar{A}\cdot\bar{B}\cdot\bar{B}$$

$$= \bar{A}\cdot\bar{B} + \bar{A}\cdot\bar{B}$$

$$= \bar{A}\cdot\bar{B} = \overline{A+B}$$

14. Two identical charged conducting spheres A and B have their centres separated by a certain distance. Charge on each sphere is q and the force of repulsion between them is F. A third identical uncharged conducting sphere is brought in contact with sphere A first and then with B and finally removed from both. New force of repulsion between spheres A and B (Radii of A and B are negligible compared to the distance of separation so that for calculating force between them they can be considered as point charges) is best given as -

(1) $\frac{3F}{8}$ (2) $\frac{3F}{5}$ (3) $\frac{2F}{3}$ (4) $\frac{F}{2}$

**Ans. (1)**

**Sol.** q (A) q (B)

$$F = \frac{kq^2}{r^2}$$

q/2 (A) 3q/4 (B)

$$F' = \frac{k\frac{q}{2}\frac{3q}{4}}{r^2} = \frac{3}{8}F$$

15. Consider the diameter of a spherical object being measured with the help of a Vernier callipers. Suppose its 10 Vernier Scale Divisions (V.S.D.) are equal to its 9 Main Scale Divisions (M.S.D.). The least division in the M.S. is 0.1 cm and the zero of V.S. is at x = 0.1 cm when the jaws of Vernier callipers are closed.

If the main scale reading for the diameter is M = 5 cm and the number of coinciding vernier division is 8, the measured diameter after zero error correction, is -

(1) 5.00 cm (2) 5.18 cm (3) 5.08 cm (4) 4.98 cm

**Ans.** **(4)**

**Sol.** 1 MSD = 1mm = 0.1 cm

LC = 0.1mm = 0.01 cm

zero error = 0.1 cm

reading = 5 cm + 8 × (0.01 cm) = 5.08 cm

actual value = 5.08 – 0.1 = 4.98 cm

16. In some appropriate units, time (t) and position (x) relation of a moving particle is given by $t = x^2 + x$. The acceleration of the particle is -

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

(2) $-\frac{2}{(x+2)^3}$

(3) $-\frac{2}{(2x+1)^3}$

(4) $+\frac{2}{(x+1)^3}$

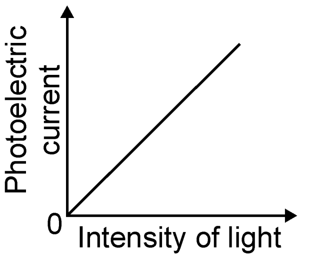
**Ans.** **(3)**

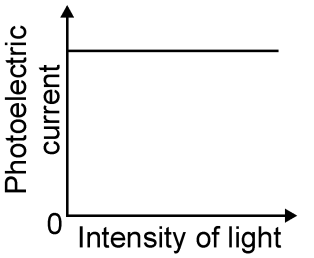
**Sol.** $\frac{dt}{dx} = 2x + 1 = \frac{1}{v}$

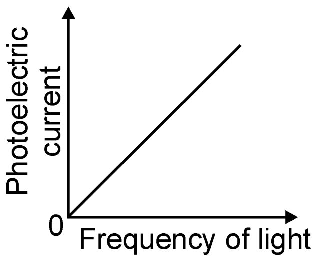
$\Rightarrow v = (2x + 1)^{-1}$

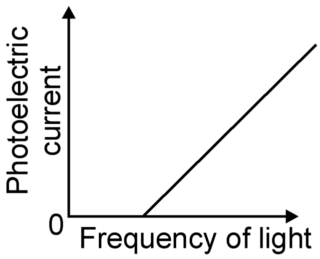
$a = v\frac{dv}{dx} = (2x + 1)^{-1} \times (-1)(2x + 1)^{-2} \times 2 = -\frac{2}{(2x+1)^3}$

17. Which of the following options represent the variation of photoelectric current with property of light shown on the x-axis -

A.



B.



C.



D.



(1) B and D (2) A only

(3) A and C (4) A and D

**Ans. (2)**

**Sol.** Current is directly proportional to intensity of incident light.

18. A particle of mass m is moving around the origin with a constant force F pulling it towards the origin. If Bohr model is used to describe its motion, the radius r of the $n^{th}$ orbit and the particle's speed v in the orbit depend on n as -

(1) $r \propto n^{4/3}$; $v \propto n^{-1/3}$ (2) $r \propto n^{1/3}$; $v \propto n^{1/3}$ (3) $r \propto n^{1/3}$; $v \propto n^{2/3}$ (4) $r \propto n^{2/3}$; $v \propto n^{1/3}$

**Ans. (4)**

**Sol.** $\frac{mv^2}{r} = F$ .....(1)

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

$\Rightarrow r = \frac{nh}{2\pi mv}$ .....(2)

By (1) & (2)

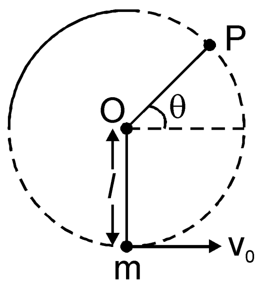
$\Rightarrow \frac{v^3}{n} = \text{constant}$ .....(3)

By (2) & (3)

$r \propto \frac{n}{n^{1/3}}$

$r \propto n^{2/3}$

19. A bob of heavy mass m is suspended by a light string of length $l$. The bob is given horizontal velocity $v_0$ as shown in figure. If the string gets slack at some point P making an angle $\theta$ from the horizontal, the ratio of the speed v of the bob at point P to its initial speed $v_0$ is -




(1) $\left(\frac{\sin\theta}{2+3\sin\theta}\right)^{1/2}$ (2) $(\sin\theta)^{1/2}$ (3) $\left(\frac{1}{2+3\sin\theta}\right)^{1/2}$ (4) $\left(\frac{\cos\theta}{2+3\sin\theta}\right)^{1/2}$

**Ans.** **(1)**

**Sol.** String slack at point P which means tension becomes zero at point P.

At point P

$$mg\sin\theta = \frac{mv^2}{l} \qquad .....(1)$$

Apply energy conservation between lower point and point P

$$\frac{1}{2}mv_0^2 = \frac{1}{2}mv^2 + mgl(1 + \sin\theta)$$

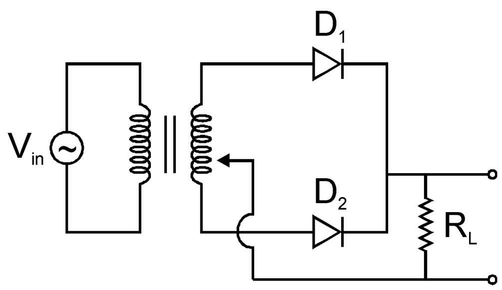
$$v_0^2 = v^2 + \frac{2v^2}{\sin\theta}(1 + \sin\theta)$$

$$v_0^2 = v^2\left(3 + \frac{2}{\sin\theta}\right)$$

$$v_0^2 = v^2\left(\frac{3\sin\theta + 2}{\sin\theta}\right)$$

$$\frac{v}{v_0} = \sqrt{\frac{\sin\theta}{2 + 3\sin\theta}}$$

20. A fully wave rectifier circuit with diodes ($D_1$) and ($D_2$) is shown in the figure. If input supply voltage $V_{in}$ = 220sin(100πt) volt, then at t = 15 msec -




(1) $D_1$ and $D_2$ both are reverse biased

(2) $D_1$ is forward biased, $D_2$ is reverse biased

(3) $D_1$ is reverse biased, $D_2$ is forward biased

(4) $D_1$ and $D_2$ both are forward biased

**Ans.** **(2)**

**Sol.** $V_{primary} = 220\sin(100\pi t)$

transformer will invert the waveform hence

$V_{secondary} = -220\sin(100\pi t)$

at t = 15 ms

$V_{secondary} = -220\sin(100\pi \times 15 \times 10^{-3})$

$V_{secondary} = +220$ V

hence,

$\Rightarrow D_1 \rightarrow$ forward biased

$\Rightarrow D_2 \rightarrow$ reversed biased

21. A balloon is made of a material of surface tension S and its inflation outlet (From where gas is filled in it) has small area A. It is filled with a gas of density $\rho$ and takes a spherical shape of radius R. When the gas is allowed to flow freely out of it, its radius r changes from R to 0 (zero) in time T. If the speed v(r) of gas coming out of the balloon depends on r as $r^a$ and $T \propto S^{\alpha}A^{\beta}\rho^{\gamma}R^{\delta}$ then -

(1) $a = \frac{1}{2}, \alpha = \frac{1}{2}, \beta = -\frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{7}{2}$

(2) $a = \frac{1}{2}, \alpha = \frac{1}{2}, \beta = -1, \gamma = +1, \delta = \frac{3}{2}$

(3) $a = -\frac{1}{2}, \alpha = -\frac{1}{2}, \beta = -1, \gamma = -\frac{1}{2}, \delta = \frac{5}{2}$

(4) $a = -\frac{1}{2}, \alpha = -\frac{1}{2}, \beta = -1, \gamma = \frac{1}{2}, \delta = \frac{7}{2}$

**Ans.** **(4)**

**Sol.** $[T^1] = [M^1T^{-2}]^{\alpha}\ [L^2]^{\beta}\ [M^1L^{-3}]^{\gamma}\ [L^1]^{\delta}$

$\alpha + \gamma = 0$ .....(i)

$-2\alpha = 1$ ......(ii)

$2\beta - 3\gamma + \delta = 0$ .....(iii)

$\alpha = -\frac{1}{2}, \gamma = \frac{1}{2}$

22. A microscope has an objective of focal length 2cm, eyepiece of focal length 4 cm and the tube length of 40 cm. If the distance of distinct vision of eye is 25 cm, the magnification in the microscope is -

(1) 250 (2) 100

(3) 125 (4) 150

**Ans. (3)**

**Sol.** $f_0 = 2$ cm ; $f_e = 4$ cm

$L = 40$ cm ; $D = 25$ cm

In normal adjustment of microscope magnification = $\frac{L}{f_0}\frac{D}{f_e}$

$= \frac{40}{2} \times \frac{25}{4} = 125$

23. Two identical point masses P and Q. suspended from two separate massless springs of spring constant $k_1$ and $k_2$. respectively, oscillate vertically. If their maximum speeds are the same, the ratio $\left(A_Q / A_P\right)$ of the amplitude $A_Q$ of mass Q to the amplitude $A_P$ of mass P is-

(1) $\sqrt{\frac{k_1}{k_2}}$ (2) $\frac{k_2}{k_1}$

(3) $\frac{k_1}{k_2}$ (4) $\sqrt{\frac{k_2}{k_1}}$

**Ans. (1)**

**Sol.** $v_P = v_Q$

$A_P\omega_P = A_Q\omega_Q$

$A_P\sqrt{\frac{k_1}{m}} = A_Q\sqrt{\frac{k_2}{m}}$

$\frac{A_Q}{A_P} = \sqrt{\frac{k_1}{k_2}}$

24. A parallel plate capacitor made of circular plates is being charged such that the surface charge density on its plates is increasing at a constant rate with time. The magnetic field arising due to displacement current is -

(1) Zero between the plates and non-zero outside

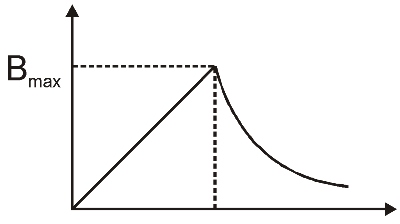
(2) Zero at all places

(3) Constant between the plates and zero outside the plates

(4) non-zero everywhere with maximum at the imaginary cylindrical surface connecting peripheries of the plates.

**Ans. (4)**

**Sol.** Charge density is increasing with constant rate so displacement current is constant, space between plates will act as solid current carrying cylinder.




25. An electric dipole with dipole moment $5 \times 10^{-6}$ Cm is aligned with the direction of a uniform electric field of magnitude $4 \times 10^{5}$ N/C. The dipole is then rotated through an angle of 60° with respect to the electric field. The change in the potential energy of the dipole is -

(1) 1.5 J (2) 0.8 J

(3) 1.0 J (4) 1.2 J

**Ans. (3)**

**Sol.** $\Delta U = pE(\cos\theta_1 - \cos\theta_2)$

$\Delta U = 5 \times 10^{-6} \times 4 \times 10^{5}(\cos 0° - \cos 60°)$

$= 2\left(1 - \frac{1}{2}\right) = 1.0 \text{ J}$

26. There are two inclined surfaces of equal length (L) and same angle of inclination 45° with the horizontal. One of them is rough and the other is perfectly smooth. A given body take 2 times as much time to slide down on rough surface than on the smooth surface. The coefficient of kinetic friction ($\mu_k$) between the object and rough surface is close to -

(1) 0.75 (2) 0.25 (3) 0.40 (4) 0.5

**Ans. (1)**

**Sol.** $\mu_k = \tan\theta(1 - \frac{1}{n^2}) = \tan 45°(1 - \frac{1}{(2)^2}) = (1)(1 - \frac{1}{4}) = 0.75$

27. De-Broglie wavelength of an electron orbiting in the n = 2 state of hydrogen atom is close to (Given Bohr radius = 0.052 nm)

(1) 2.67 nm (2) 0.067 nm (3) 0.67 nm (4) 1.67 nm

**Ans. (3)**

**Sol.** $\lambda = \frac{h}{mv}$; $v = 2.18 \times 10^6 \frac{z}{n} = 2.18 \times 10^6 \left(\frac{1}{2}\right) = 1.09 \times 10^6$ m/s

$$\lambda = \frac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 1.09 \times 10^6} = 0.67 \text{ nm}$$

28. The sun rotates around its centre once in 27 days. What will be the period of revolution if the sun were to expand to twice its present radius without any external influence? Assume the Sun to be a sphere of uniform denisty -

(1) 108 days (2) 100 days (3) 105 days (4) 115 days

**Ans. (1)**

**Sol.** $L = I\omega$

$I_f\omega_f = I_i\omega_i$ $\because I = \frac{2}{5}mr^2$

$$\frac{2}{5}m(2r)^2\frac{2\pi}{T_f} = \frac{2}{5}mr^2\frac{2\pi}{27}$$

$$\frac{4}{T_f} = \frac{1}{27}$$

$T_f = 108$ days

29. A physical quantitiy P is related to four observations a, b, c and d as follows :

$P = a^3b^2/\ c\sqrt{d}$

The percentage errors of measurement in a, b, c and d are 1%, 3%, 2% and 4% respectively. The percentage error in the quantity P is -

(1) 15% (2) 10% (3) 2% (4) 13%

**Ans. (4)**

**Sol.** Error $= 3 \times 1 + 2 \times 3 + 1 \times 2 + \frac{1}{2} \times 4$

$= 3 + 6 + 2 + 2$

$= 13\%$

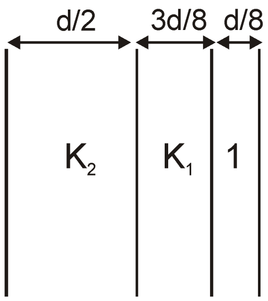
30. The plates of a parallel plate capacitor are separated by d. Two slabs of different dielectric constant $K_1$ and $K_2$ with thickness $\frac{3}{8}$ d and $\frac{d}{2}$ , respectively are inserted in the capacitor. Due to this, the capacitance becomes two times larger than when there is nothing between the plates.

If $K_1 = 1.25\ K_2$, the value of $K_1$ is -

(1) 1.33 (2) 2.66 (3) 2.33 (4) 1.60

**Ans. (2)**

**Sol.**




$$C = \frac{\varepsilon_0 A}{\frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3}}$$

$$2\frac{\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{\frac{d \times 1.25}{2K_1} + \frac{3d}{8K_1} + \frac{d}{8}}$$

$$2 = \frac{1}{\frac{1.25}{2K_1} + \frac{3}{8K_1} + \frac{1}{8}}$$

$$1 = \frac{3}{4K_1} + \frac{5}{4K_1} + \frac{1}{4}$$

$$\frac{8}{4K_1} = \frac{3}{4}$$

$$K_1 = \frac{8}{3} = 2.66$$

31. A ball of mass 0.5 kg is dropped from a height of 40 m. The ball hits the ground and rises to a height of 10m. The impulse imparted to the ball during its collision with the ground is (Take $g = 9.8\ m/s^2$)

(1) 84 NS
(2) 21 NS
(3) 7 NS
(4) 0

**Ans. (2)**

**Sol.** $v_i = \sqrt{2gh_i}$ , $v_f = \sqrt{2gh_f}$

$$I = \Delta P = m\left(\sqrt{2gh_i} + \sqrt{2gh_f}\right)$$

$$= 0.5\left(\sqrt{2 \times 10 \times 40} + \sqrt{2 \times 10 \times 10}\right)$$

$$= 0.5\left(10\left(2\sqrt{2} + \sqrt{2}\right)\right)$$

$$= 5 \times 3\sqrt{2} = 5 \times 3 \times 1.4 = 21\ NS$$

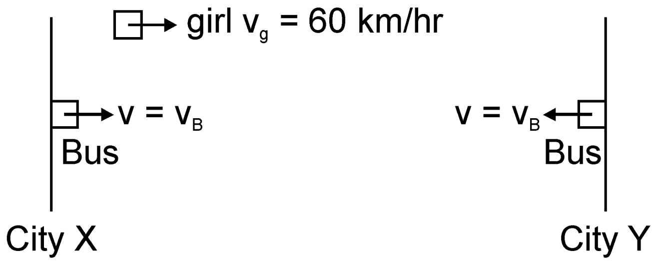
32. Two cities X and Y are connected by a regular bus sevice with a bus leaving in either direction every T min. A girl is driving scooty with a speed of 60 km/h in the direction X to Y notices that a bus goes past her every 30 minutes in direction of her motion, and every 10 minutes in the opposite direction. Choose the correct option for the period T of the bus service and the speed (assumed constant) of the buses.

(1) 15 min, 120 km/h  (2) 9 min, 40 km/h

(3) 25 min, 100 km/h  (4) 10 min, 90 km/h

**Ans. (1)**

**Sol.**




$$\frac{d}{v_B - v_g} = 30 \; ; \qquad \frac{d}{v_B + v_g} = 10$$

$$\Rightarrow \frac{v_B + v_g}{v_B - v_g} = \frac{3}{1}$$

$$\Rightarrow \frac{v_B}{v_g} = 2 \qquad \Rightarrow v_B = 2v_g = 120 \text{ km/h}$$

$$T = \frac{d}{v_B} = 15 \text{ min}$$

33. An oxygen cylinder of volume 30 litre has 18.20 moles of oxygen. After some oxygen is withdrawn from the cylinder, its gauge pressure drops to 11 atmospheric pressure at temperature 27ºC. The mass of the oxygen withdrawn from the cylinder is nearly equal to -

(Given, $R = \frac{100}{12}$ J mol$^{-1}$K$^{-1}$ and molecular mass of $O_2$ = 32,

1 atm pressure = $1.01 \times 10^5$ N/m)

(1) 0.156 kg  (2) 0.125 kg  (3) 0.144 kg  (4) 0.116 kg

**Ans.** **(4)**

**Sol.** $P_2V_2 = n_2RT_2$

$P_2 = 12 \text{ atm} = 12 \times 1.01 \times 10^5 \text{ Pa}$

$V_2 = 30 \times 10^{-3} \text{ m}^3$

$R = \frac{100}{12}$

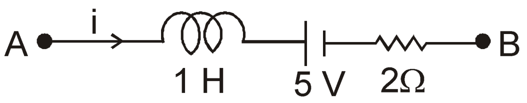
$T_2 = 300$

Then, $n_2 = 14.5$

$\Delta n = n_1 - n_2 = 3.65$

$m = 3.65 \times 32 = 0.116 \text{ kg}$

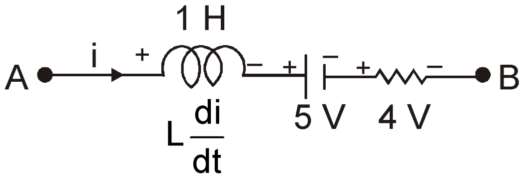
34. AB is part of an electrical circuit (see figure). The potential difference "$V_A - V_B$" , at the instant when current i = 2 A and is increasing at a rate of 1 amp / second is :




(1) 10 volt (2) 5 volt (3) 6 volt (4) 9 volt

**Ans.** **(1)**

**Sol.**



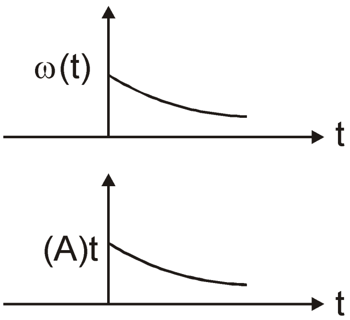

$V_L = L\frac{di}{dt} = 1\times1 = 1 \text{ V}$

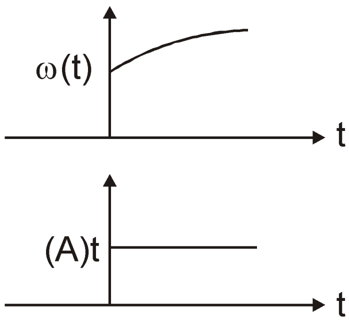
Applying KVL

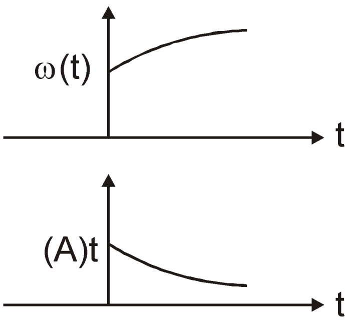
$V_A - 1 - 5 - 4 = V_B$

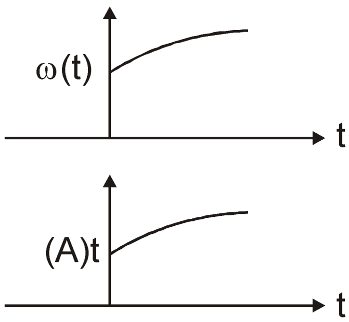
$V_A - V_B = 10 \text{ V}$

35. In an oscillating spring mass system, a spring is connected to a box filled with sand. As the box oscillates, sand leaks slowly out of the box vertically so that the average frequency $\omega(t)$ and average amplitude A(t) of the system change with time t. Which one of teh following options schematically depicts these changes correctly?

(1) 


(2) 


(3) 


(4) 


**Ans. (3)**

**Sol.** As ejecting mass is ejected with some speed so it will carrry some energy so energy of system will decrease due to which amplitude will decrease.

As TE = $\frac{1}{2}kA^2$

36. A model for quantized motion of an electron in a uniform magnetic field B states that the flux passing through the orbit of the electron is n(h/e) where n is an integer, h is Planck's constant and e is the magnitude of electron's charge. According to the model, the magnetic moment of an electron in its lowest energy state will be (m is the mass of the electron) -

(1) $\frac{heB}{2\pi m}$ (2) $\frac{he}{\pi m}$ (3) $\frac{he}{2\pi m}$ (4) $\frac{heB}{\pi m}$

**Ans. (3)**

**Sol.** $\phi = BA = \frac{nh}{e}$

$A = \frac{nh}{eB}$

$\Rightarrow M = iA$

$= \frac{e}{T} \times \frac{nh}{eB}$

$= \frac{e}{2\pi m} \times eB \times \frac{nh}{eB}$

$n = 1$

$M = \frac{he}{2\pi m}$

37. A body weighs 48 N on the surface of the Earth. The gravitational force experienced by the body due to the earth at a height equal to one-third the radius of the earth from its surface is :

(1) 36 N
(2) 16 N
(3) 27 N
(4) 32 N

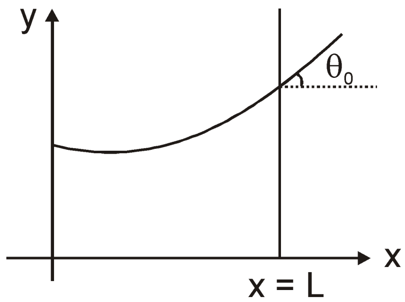
**Ans. (3)**

**Sol.** $g = \frac{GM}{(R+h)^2}$

$g = \frac{GM}{\left(R+\frac{R}{3}\right)^2} = \frac{9}{16} g_0$

$w' = \frac{9}{16} w = \frac{9}{16} \times 48 = 27 \text{ N}$

38. Consider a water tank shown in the figure. It has one wall at x = L and can be taken to be very wide in the z direction. When filled with a liquid of surface tension S and density $\rho$, the liquid surface makes angle $\theta_0(\theta_0<<1)$ with the x-axis at x = L. If y(x) is the height of the surface then the equation for y(x) is :




(take $\theta(x) = \sin\theta(x) = \tan\theta(x) = \frac{dy}{dx}$, g is the acceleration due to gravity)

(1) $\frac{dy}{dx} = \sqrt{\frac{\rho g}{S}}x$

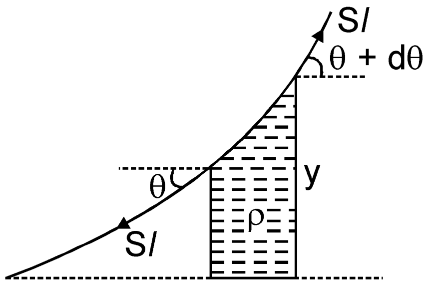
(2) $\frac{d^2y}{dx^2} = \frac{\rho g}{S}x$

(3) $\frac{d^2y}{dx^2} = \frac{\rho g}{S}y$

(4) $\frac{d^2y}{dx^2} = \sqrt{\frac{\rho g}{S}}$

**Ans. (3)**

**Sol.**




$Sl(\theta + d\theta) = Sl\theta + dmg$

$Sld\theta = \rho ydxlg$

$$\frac{d\theta}{dx} = \frac{\rho gy}{S}$$

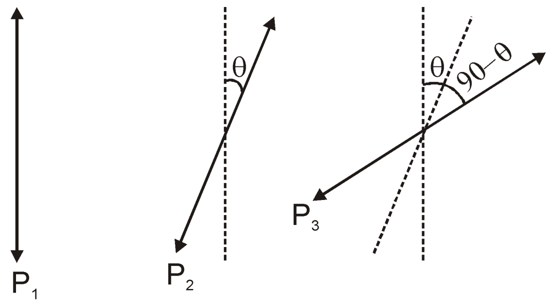
$$\frac{d^2y}{dx^2} = \frac{\rho gy}{S}$$

39. The intensity of transmitted light when a polaroid sheet, placed between two crossed polaroids at 22.5° from the polarization axis of one of the polaroid, is ($I_0$ is the intensity of polarised light after passing through the first polaroid):

(1) $\frac{I_0}{16}$ (2) $\frac{I_0}{2}$ (3) $\frac{I_0}{4}$ (4) $\frac{I_0}{8}$

**Ans. (4)**

**Sol.**




Instensity after polaroid $P_1 = I_0$ (given)

Intensity after polaroid $P_2 = I_0\cos^2(\theta/2)$ where $\theta = 45°$

Intensity after polaroid $P_3 = I_0\cos^2(\theta/2)\sin^2(\theta/2)$

$$= \frac{I_0}{4} \times 4\cos^2(\theta/2)\sin^2(\theta/2)$$

$$= \frac{I_0}{4} \times \sin^2(\theta) = \frac{I_0}{4} \times \sin^2(45°) = \frac{I_0}{8}$$

40. A photon and an electron (mass m) have the same energy E. The ratio ($\lambda_{photon}/\lambda_{electron}$) of their de Broglie wavelength is : (c is the speed of light)

(1) $\frac{1}{c}\sqrt{\frac{E}{2m}}$ (2) $\sqrt{\frac{E}{2m}}$ (3) $c\sqrt{2mE}$ (4) $c\sqrt{\frac{2m}{E}}$

**Ans. (4)**

**Sol.** $\lambda_P = \frac{hc}{E}$ ; $\lambda_e = \frac{h}{\sqrt{2mE}}$

$$\frac{\lambda_P}{\lambda_e} = c\sqrt{\frac{2m}{E}}$$

41. An unpolarized light beam travelling in air is incident on a medium of refractive index 1.73 at Brewster's angle. Then -

(1) Transmitted light is completely polarized with angle of refraction close to 30°

(2) Reflected light is completely polarized and the angle of reflection is close to 60°

(3) Reflected light is partially polarized and the angle of reflection is close to 30°

(4) Both reflected and transmitted light are perfectly polarized with angles of reflection and refraction close to 60° and 30°, respectively

**Ans.** **(2)**

**Sol.** According to Brewster's law

$\mu = \tan(i_p) \Rightarrow \sqrt{3} = \tan(i_p)$

$i_p = 60°$

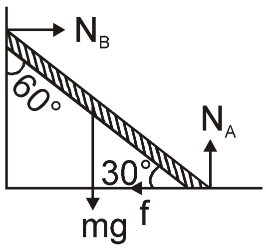
42. A uniform rod of mass 20 kg and length 5 m leans against a smooth vertical wall making an angle of 60º with it. The other end rests on a rough horizontal floor. The friction force that the floor exerts on the rod is (take g = 10 m/s$^2$)

(1) $200\sqrt{3}$ N (2) 100 N

(3) $100\sqrt{3}$ N (4) 200 N

**Ans.** **(3)**

**Sol.**



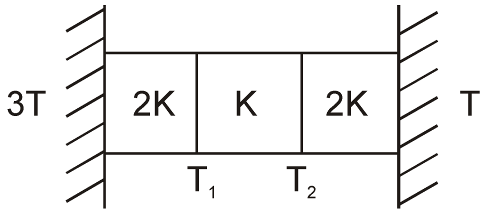

$N_A = mg = 200$ N

$N_B l \sin 30° = mg\frac{l}{2}\sin 60°$

$N_B l\left(\frac{1}{2}\right) = 200\frac{l}{2}\frac{\sqrt{3}}{2}$

$N_B = 100\sqrt{3}$ N

43. Three identical heat conducting rods are connected in series as shown in the figure. The rods on the sides have thermal conductivity 2K while that in the middle has thermal conductivity K. The left end of the combination is maintained at temperature 3T and the right end at T. The rods are thermally insulated from outside. In steady state. temperature at the left junction is $T_1$ and that at the right junction is $T_2$. The ratio $T_1/T_2$ is -




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

**Ans. (4)**

**Sol.** $K_1 : K_2 : K_3 = 2 : 1 : 2$

$\Delta T_1 : \Delta T_2 : \Delta T_3 = 1 : 2 : 1$

$\Delta T_1 = \frac{1}{4} \times 2T = \frac{T}{2}$

$3T - T_1 = \frac{T}{2}$ Hence, $T_1 = \frac{5T}{2}$

$\Delta T_3 = \frac{1}{4} \times 2T = \frac{T}{2}$

$T_2 - T = \frac{T}{2}$ Hence $T_2 = \frac{3T}{2}$

$\frac{T_1}{T_2} = \frac{5}{3}$

44. The kinetic energies of two similar cars A and B are 100 J and 225 J respectively. On applying breaks, car A stops after 1000 m and car B stops after 1500 m. If $F_A$ and $F_B$ are the forces applied by the breaks on cars A and B, respectively, then the ratio $F_A / F_B$ is -

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

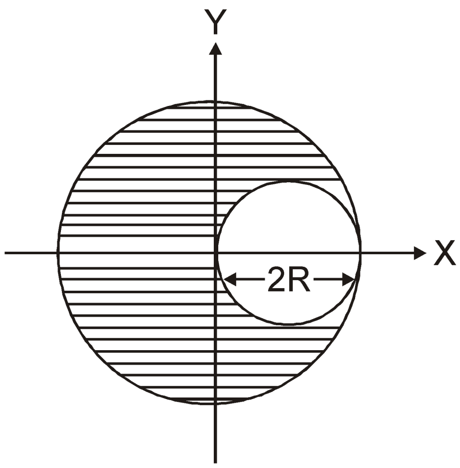
**Ans.** **(3)**

**Sol.** Work done by friction = $\Delta K$

$-F \cdot S = 0 - K \Rightarrow F \cdot S = K$

$$\frac{F_A \cdot S_A}{F_B \cdot S_B} = \frac{K_A}{K_B} \Rightarrow \frac{F_A \cdot 1000}{F_B \cdot 1500} = \frac{100}{225} \Rightarrow \frac{F_A}{F_B} = \frac{2}{3}$$

45. A sphere of radius R is cut from a larger solid sphere of radius 2R as shown in the figure. The ratio of the moment of inertia of the smaller sphere to that of the rest part of the sphere about the Y-axis is -




(1) $\frac{7}{64}$ (2) $\frac{7}{8}$ (3) $\frac{7}{40}$ (4) $\frac{7}{57}$

**Ans.** **(4)**

**Sol.** $I = \frac{2}{5}M(2R)^2 = 4(\frac{2}{5}MR^2)$

$$I_{cut} = \frac{2}{5}mR^2 + mR^2$$

$$= \frac{7}{5}\frac{M}{8}R^2$$

$$I_{remaining} = \frac{8}{5}MR^2 - \frac{7}{40}MR^2 = \frac{57}{40}MR^2$$

$$\frac{I_{cut}}{I_{remaining}} = \frac{7}{57}$$