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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2023

COMPUTER BASED TEST (CBT)

Questions & Solutions

Date: 10 April, 2023 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

31. In a metallic conductor, under the effect of applied electric field, the free electrons of the conductor

(1) move in the straight line path in the same direction

(2) drift from higher potential to lower potential.

(3) move in the curved paths from lower potential to higher potential

(4) move with the uniform velocity throughout from lower potential to higher potential

NTA Ans. (3)

Reso Ans. (3)

Sol. Motion of electron is random as well as drift opposite to field i.e. from low potential to high potential.

32. In an experiment with vernier calipers of least count 0.1 mm, when two jaws are joined together the zero of vernier scale lies right to the zero of the main scale and 6th division of vernier scale coincides with the main scale division. While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks, and 4th division of vernier scale concides with the main scale division. The diameter of bob is measured as

(1) 3.22 (2) 3.25 (3) 3.18 (4) 3.26

NTA Ans. (3)

Reso Ans. (3)

Sol. Zero error = $0 + 0.01 \times 6 = 0.06$ cm

Reading = $3.2 + 0.01 \times 4 = 3.24$ cm

Diameter = $3.24 - 0.06$

$= 3.18$ cm

33. the distance between two plates of a capacitor is d and its capacitance is C_1, when air is the medium between the plates. If a metal sheet of thickness $\frac{2d}{3}$ and of the same area as plate is introduced between the plates, the capacitance of the capacitor becomes C_2. The ratio $\frac{C_2}{C_1}$ is

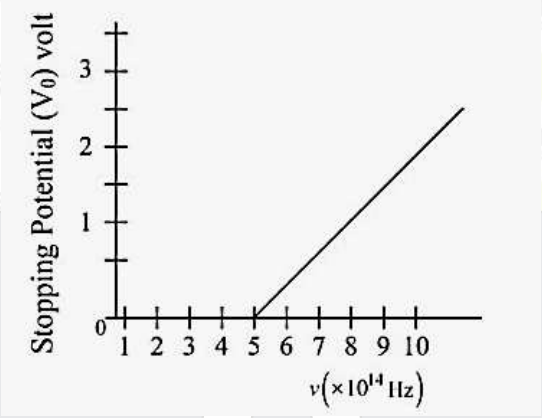
(1) 4:1 (2) 2:1 (3) 3:1 (4) 1:1

NTA Ans. (3)
Reso Ans. (3)

Sol. $C_1 = \frac{A\epsilon_0}{d}$

$$C_2 = \frac{A\epsilon_0}{(d-t)+\frac{t}{K}} = \frac{A\epsilon_0}{\left(d-\frac{2d}{3}\right)+\frac{2d}{3(\infty)}} = \frac{3A\epsilon_0}{d} \quad \therefore \frac{C_2}{C_1} = 3$$

34. The variation of stopping potential (V_0) as a function of frequency (v) of the incident light for a metal is shown in figure. The work function of the surface is



(1) 2.98 eV (2) 1.36 eV (3) 2.07 eV (4) 18.6 eV

NTA Ans. (3)

Reso Ans. (3)

Sol. $W = \frac{6.63\times10^{-34}\times5\times10^{14}}{1.6\times10^{-19}}eV$

$= 2.07$ eV

35. The half life of a radioactive substance is T. The time taken, for disintegrating $\frac{7}{8}$ th part of its original mass will be

(1) T (2) 3T (3) 8T (4) 2T

NTA Ans. (2)

Reso Ans. (2)

Sol. $\frac{1}{8}$ th part will remain so 3 half life i.e. 3T time taken.

36. The amplitude of magnetic field in an electromagnetic wave propagating along y-axis is 6.0×10^{-7} T. The maximum value of electric field in the electromagnetic wave is

(1) 180 Vm^{-1} (2) 2×10^{15} Vm^{-1} (3) 5×10^{14} Vm^{-1} (4) 6.0×10^{-7} Vm^{-1}

NTA Ans. (1)

Reso Ans. (1)

Sol. $E = CB$

$= 3 \times 10^8 \times 6 \times 10^{-7}$

$= 180$ V/m

37. Two projectiles are projected at 30° and 60° with the horizontal with the same speed. The ratio of the maximum height attained by the two projectiles respectively is :

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

NTA Ans. (2)

Reso Ans. (2)

Sol. $$\frac{h_1}{h_2}=\frac{\frac{u^2\sin^2 30^\circ}{2g}}{\frac{u^2\sin^2 60^\circ}{2g}}=\frac{1}{3}$$

38. Young's moduli of the material of wires A and B are in the ratio of 1:4, while its area of cross section are in the ratio of 1:3. If the same amount of load is applied to both the wires, the amount of elongation produced in the wires A and B will in the ratio of

[Assume length of wires A and B are same]

(1) 36: 1 (2) 1: 36 (3) 1:12 (4) 12: 1

NTA Ans. (4)

Reso Ans. (4)

Sol. $$\frac{F}{A}=y\left(\frac{\Delta L}{L}\right)$$

$$\frac{\Delta L_1}{\Delta L_2}=\frac{A_2}{A_1}\times\frac{y_2}{y_1}=\frac{3}{1}\times\frac{4}{1}=12$$

39. Given below are two statements :

Statement I : For diamagnetic substance, $-1 \le \chi < 0$, where χ is the magnetic susceptibility.

Statement II : Diamagnetic substances when placed in an external magnetic field, tend to move from stronger to weaker part of the field.

In the light of the above statements, choose the correct answer from the options given below

(1) Statement I is incorrect but Statement II is true

(2) Statement I is correct but Statement II is false

(3) Both Statement I and Statement II are False

(4) Both Statement I and Statement II are true

NTA Ans. (4)

Reso Ans. (4)

Sol. For diamagnetic substance, susceptibility is small and negative so they tend to move from stronger to weaker part of field when placed in external magnetic field.

40. A person travels x distance with velocity v_1 and then x distance with velocity v_2 in the same direction. The average velocity of the person is v, then the relation between v, v_1 and v_2 will be

(1) $\frac{2}{v}=\frac{1}{v_1}+\frac{1}{v_2}$ (2) $\frac{1}{v}=\frac{1}{v_1}+\frac{1}{v_2}$

(3) $v=v_1+v_2$ (4) $v=\frac{v_1+v_2}{2}$

NTA Ans. (1)

Reso Ans. (1)

Sol. $v_{avg}=\frac{2x}{\frac{x}{v_1}+\frac{x}{v_2}}=\frac{2v_1v_2}{v_1+v_2} \Rightarrow \frac{2}{v_{avg}}=\frac{1}{v_1}+\frac{1}{v_2}$

41. A bar magnet is released from rest along the axis of a very long vertical copper tube. After some time the magnet will

(1) move down with an acceleration equal to g

(2) oscillate inside the tube

(3) move down with almost constant speed

(4) move down with an acceleration greater than g

NTA Ans. (3)

Reso Ans. (3)

Sol. Because of negligible net force, bar magnet will move with almost constant speed as weight will almost balance with large magnetic force due to induction.

42. A gas mixture consists of 2 moles of oxygen and 4 moles of neon at temperature T. Neglecting all vibrational modes, the total internal energy of the system will be,

(1) 11 RT (2) 4RT (3) 8RT (4) 16RT

NTA Ans. (1)

Reso Ans. (1)

Sol. $U=\frac{5}{2}\times 2\times RT+\frac{3}{2}\times 4\times RT = 11RT$

43. The ratio of intensities at two points P and Q on the screen in a Young's double slit experiment where phase difference between two waves of same amplitude are $\frac{\pi}{3}$ and $\frac{\pi}{2}$ respectively are

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

NTA Ans. (3)

Reso Ans. (3)

Sol. We know $I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$I_A = I + I + 2I.\cos60° = 3I$

Similarly $I_B = I + I + 2I\cos90° = 2I$

$\therefore \frac{I_A}{I_B} = \frac{3}{2}$

44. A gas is compressed adiabatically, which one of the follwing statement is NOT true.

(1) The change in the internal energy is equal to the work done on the gas

(2) The temperature of the gas increases

(3) There is no heat supplied to the system

(4) There is no change in the internal energy

NTA Ans. (4)

Reso Ans. (4)

Sol. $\Delta Q = \Delta U + \Delta W$

$\Delta Q = 0$

$\Delta U = -\Delta W$

gas is compressed so ΔW is negative

and ΔU will be positive so ΔT will also be positive

45. Given below are two statement:

statement I : Rotation of the earth shows effect on the value of acceleration due to gravity (g)

statement II : The effect of rotation of the earth on the value of 'g' at the equator is minimum and that at the pole is maximum.

In the light of the above statements , choose the correct answer from the options given below

(1) Both statement I and statement II are false

(2) statement I and true but statement II is false

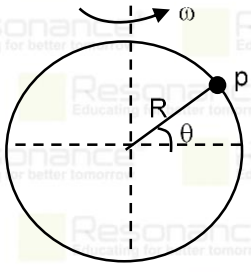
(3) Both statement I and statement II are true

(4) statement I is false but statement II is true

NTA Ans. (2)

Reso Ans. (2)

Sol.



$g_p = g_0[1-\omega^2 R\cos^2\theta]$

46. For a periodic motion represented by the equation

$y = \sin \omega t + \cos \omega t$

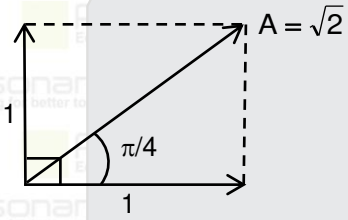
the amplitude of the motion is

(1) $\sqrt{2}$ (2) 1 (3) 2 (4) 0.5

NTA Ans. (1)

Reso Ans. (1)

Sol.



Phasor diagram

$$y = \sin\omega t + \sin\left(\omega t + \frac{\pi}{2}\right) = \sqrt{2}\sin\left[\omega t + \frac{\pi}{4}\right]$$

47. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R

Assertion A : An electric fan continues to rotate for some time after the current is switched off.

Reason R : Fan continues to rotate due to inertia of motion.

In the light of above statements, choose the most appropriate answer from the options given below.

(1) Both A and R are correct but R is NOT the correct explanation of A

(2) A is correct but R is not correct

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

(4) A is not correct but R is correct

NTA Ans. (3)

Reso Ans. (3)

Sol. Fan will retard after current is switched off and stop after some time

48. A message signal of frequency 3kHz is used to modulate a carrier signal of frequency 1.5 MHz. The bandwidth of the amplitude modulated wave is

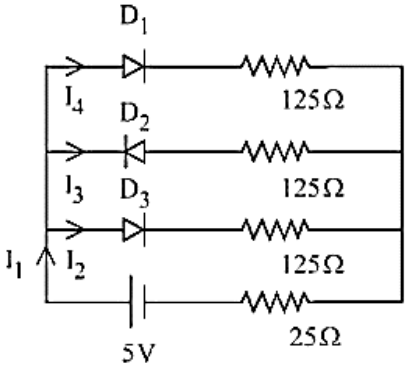
(1) 6 MHz (2) 6 kHz (3) 3 MHz (4) 3 kHz

NTA Ans. (2)

Reso Ans. (2)

Sol. band width = $2 f_m = 2 \times 3 = 6$ kHz

49. If each diode has a forward bias resistance of 25 Ω in the below circuit,



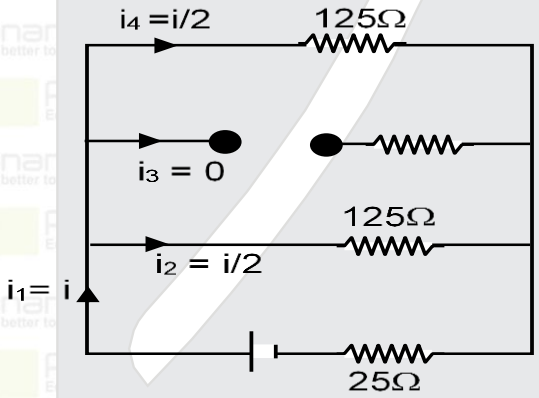
which of the following options is correct:

(1) $\frac{I_2}{I_3}=1$ (2) $\frac{I_1}{I_2}=1$ (3) $\frac{I_3}{I_4}=1$ (4) $\frac{I_1}{I_2}=2$

NTA Ans. (4)

Reso Ans. (4)

Sol.



$i_3 = 0$

$i_1 = i$

$i_2 = i_4 = i/2$

$\therefore \frac{i_1}{i_2}=\frac{i}{\frac{i}{2}}=2$

50. The time period of a satellite revolving above earth's surface at a height equal to R will be (given g= π^2 m/s^2, R= radius of earth)

(1) $\sqrt{4R}$ (2) $\sqrt{2R}$ (3) $\sqrt{8R}$ (4) $\sqrt{32R}$

NTA Ans. (4)

Reso Ans. (4)

Sol. $\therefore V = \sqrt{\frac{GM}{R+h}} = \sqrt{\frac{GM}{R+R}} = \sqrt{\frac{GM}{2R}}$

$$\therefore T = \frac{2\pi[2R]}{V_0} = \frac{4\pi R}{\sqrt{GM}} \times \sqrt{2R} = \left(\frac{4\sqrt{2}\pi}{\sqrt{GM}}\right) \times R^{3/2} = \frac{4\sqrt{2}\pi}{\sqrt{gR^2}} R^{\frac{3}{2}}$$

$T = \sqrt{32\,R}$

51. A square loop of side 2.0 cm is placed inside a long solenoid that has 50 turns per centimetre and carries as sinusoidally varying current of amplitude 2.5A and angular frequency 700 rad s^{-1}. The central axes of the loop and selenoid coincide. The amplitude of the emf induced in the loop is x × 10^{-4} V .The value of x is (Take, $\pi = \frac{22}{7}$)

NTA Ans. 44

Reso Ans. 44

Sol. $\phi = BA = \mu_0 ni\, A = \mu_0 nAi_0 \sin\omega t$

$\varepsilon = \mu_0 ni_0 \omega A \cos\omega t$

$$\varepsilon_0 = \mu_0 ni_0 \omega A = 4 \times \frac{22}{7} \times 10^{-7} \times \frac{50}{10^{-2}} \times 2.5 \times 700 \times 4 \times 10^{-4} = 44 \times 10^{-4}$$

52. A rectangular block of mass 5 kg attached to an horizontal spiral spring executes simple harmonic motion of amplitude 1 m and time period 3.14s. The maximum force exerted by spring on block is _____N.

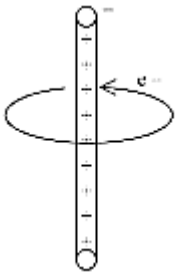
NTA Ans. 20

Reso Ans. 20

Sol. $F_{max} = m\omega^2 A$

$$= 5 \times \frac{4\pi^2}{T^2} \times A = 20\ N$$

53. An electron revolves around an infinite cylindrical wire having uniform linear charge density $2\times10^{-8}Cm^{-1}$ in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is _____ $\times10^{6}ms^{-1}$. Given mass of electron = 9×10^{-31} kg



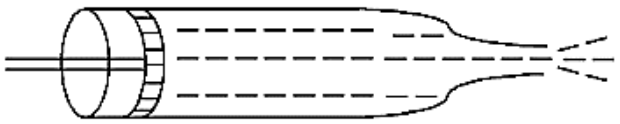
NTA Ans. 8

Reso Ans. 8

Sol. $\frac{mv^2}{r} = e\times\frac{2k\lambda}{r}$

$v = \sqrt{\frac{2ek\lambda}{m}} = 8 \times 10^6$ m/s

54. Figure below shows a liquid being pushed out of the tube by a piston having area of cross section 2.0 cm^2. The area of cross section at the oulet is 10 mm^2. If the piston is pushed at a speed of 4 cm s^{-1}, the speed of outgoing fluid is _____ cm s^{-1}



NTA Ans. 80

Reso Ans. 80

Sol. $A_1V_1 = A_2V_2$

$2 \times 4 = (10\times10^{-2})V_2$

$V_2 = 80$ cm/sec.

55. If the maximum load carried by an elevator is 1400 kg (600 kg - Passengers + 800 kg- elevator), which is moving up with a uniform speed of 3 ms^{-1} and the frictional force acting on it is 2000 N, then the maximum power used by the motor is ____ kW ($g=10$ m/s^2)

NTA Ans. 48

Reso Ans. 48

Sol. F = Mg + f

= 14000 + 2000

= 16000

Power = FV

= 48 KW

56. A force of -P $\hat{k}$ acts on the origin of the coordinate system. The torque about the point (2,–3) is $P\left(a\hat{i}+b\hat{j}\right)$, The ratio of $\frac{a}{b}$ is $\frac{x}{2}$. The value of x is-

NTA Ans. (3)

Reso Ans. (3)

Sol. $\vec{\tau}=\vec{r}\times\vec{F}$

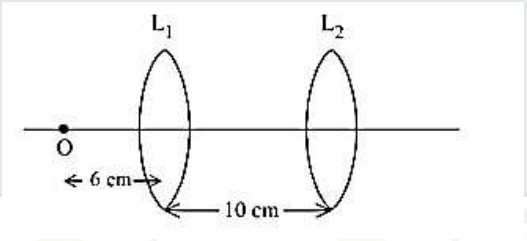
$=(2\hat{i}-3\hat{j})\times[-p\hat{k}] \ =[2\hat{j}+3\hat{i}]\,p$

Comparing with $p[a\hat{i}+b\hat{j}]$

a = 3 & b = 2

$\therefore \frac{a}{b}=\frac{3}{2}=\frac{x}{2}$ $\quad\therefore$ x = 3

57. A point object, 'O' is placed in front of two thin symmetrical coaxial convex lenses L_1 and L_2 with focal length 24 cm and 9 cm respectively. The distance between two lenses is 10 cm and the object is placed 6 cm away from lens L_1 as shown in the figure. The distance between the object and the image formed by the system of two lenses is _____ cm.



NTA Ans. 34

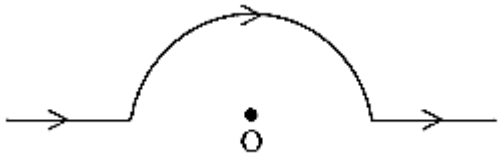
Reso Ans. 34

Sol. $\frac{1}{v_1}-\frac{1}{-6}=\frac{1}{24}\Rightarrow v_1=-8$

$\frac{1}{v_2}-\frac{1}{-18}=\frac{1}{9}\Rightarrow v_2=18$

So distance between object and image is 34.

58. A straight wire carrying of 14 A is bent into a semi-circular arc of radius 2.2 cm as shown in the figure. The magnetic field produced by the current at the centre (O) of the arc is _____ × 10^{-4}T



NTA Ans. 2

Reso Ans. 2

Sol. $B = \frac{\mu_0 i}{4R} = 4 \times \frac{22}{7} \times 10^{-7} \times 14$

$$B = \frac{\mu_0 i}{4R} = \frac{4 \times \frac{22}{7} \times 10^{-7} \times 14}{4 \times 2.2 \times 10^{-2}}$$

$= 2 \times 10^{-4}$ T

59. If 917 Å be the lowest wavelength of Lyman series then the lowest wavelength of Balmer series will be _____ Å

NTA Ans. 3668

Reso Ans. 3668

Sol. $\frac{1}{917} = RZ^2\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$

$$\frac{1}{\lambda} = RZ^2\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]$$

Solving λ = 3668 Å

60. A rectangular parallelopiped is measured as 1 cm × 1 cm × 100 cm. If its specific resistance is 3 × 10^{-7} Ω m then the resistance between its two opposite rectangular faces will be _____ ×10^{-7} Ω

NTA Ans. 3

Reso Ans. 3

Sol. $R = \frac{\rho \ell}{A} = \frac{3 \times 10^{-7} \times 1 \times 10^{-2}}{100 \times 1 \times 10^{-4}}$

$= 3 \times 10^{-7}$