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JEE (Main)

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

2023

COMPUTER BASED TEST (CBT)
Questions & Solutions

Date: 08 April, 2023 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

31. A TV transmitting antenna is 98 m high and the receiving antenna is at the ground level. If the radius of the earth is 6400 km, the surface area covered by the transmitting antenna is approximately:

(1) 1240 km^2 (2) 3942 km^2 (3) 4868 km^2 (4) 1549 km^2

NTA Ans. (2)
Reso Ans. (2)

Sol. $d = \sqrt{2Rh}$

$A = \pi d^2 = \pi(2Rh) = 2\pi Rh$

$= 2\pi \times 6400 \times 10^3 \times 98$

$= 2 \times 22/7 \times 64 \times 98 \times 10^5$

$= 39424 \times 10^5 = 3742.4 \times 10^6\ m^2 = 3942\ km^2$

32. The engine of a train moving with speed 10 ms^{-1} towards a platform sounds a whistle at frequency 400 Hz. The frequency heard by a passenger inside the train is: (neglect air speed. Speed of sound in air = 330 ms^{-1})

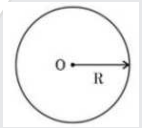
(1) 412 Hz (2) 388 Hz (3) 400 Hz (4) 200 Hz

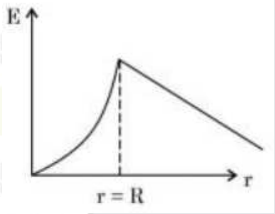
NTA Ans. (3)
Reso Ans. (3)

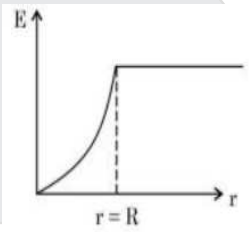
Sol. $f' = \dfrac{(V + V_W)}{(V + V_W) - V_S}.f$

$= \dfrac{330 + 10}{330 + 10 - 120} \times 300 = \dfrac{340}{220} \times 300 = \dfrac{17}{11} \times 300 = \dfrac{5100}{11} = 464\ Hz$

33. Graphical variation of electric field due to a uniformly charged insulating solid sphere of radius R, with distance r from the centre O is represented by:



(1)


(2)


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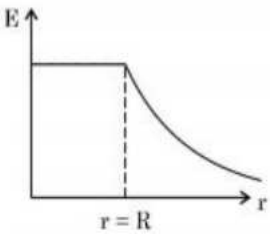

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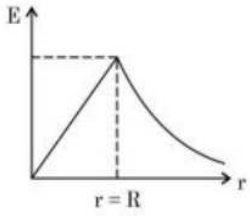
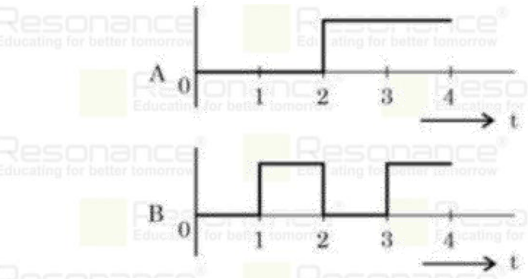


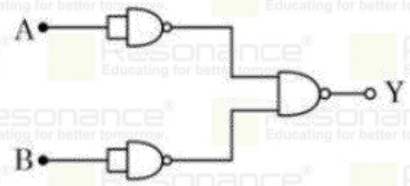
NTA Ans. (4)
Reso Ans. (4)

Sol. $E \propto r \rightarrow$ Inside

$E \propto \dfrac{1}{r^2}$ outside

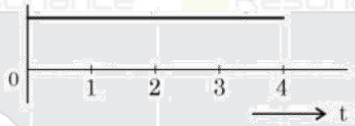
34. For the logic circuit shown, the output waveform at Y is :





(1)

(2)



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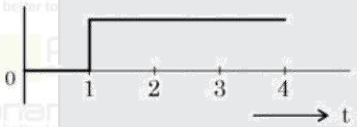
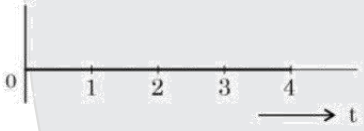
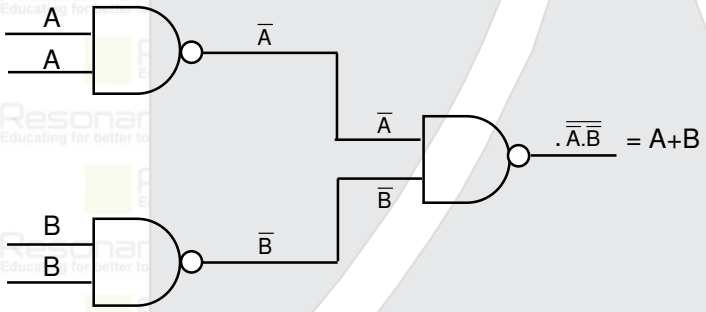


(4)



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



35. At any instant the velocity of a particle of mass 500 g is $(2t\hat{i}+3t^2\hat{j})$ ms^{-1}. If the force acting on the particle at t = 1s is $(\hat{i}+x\hat{j})$N. Then the value of x will be:

(1) 6 (2) 3 (3) 4 (4) 2

NTA Ans. (2)
Reso Ans. (2)

Sol. $\vec{v} = 2t\hat{i} + 3t^2\hat{j}$

Acceleration of the particle it time t

$$\vec{a} = \frac{d\vec{v}}{dt} = 2\hat{i} + 6t\,\hat{j}$$

at time t = 1 sec. $\vec{a} = 2\hat{i} + 6\hat{j}$

So Force on the particle will be

$\vec{F} = m\vec{a}$

$\Rightarrow \vec{F} = 0.5(2\hat{i} + 6\hat{j})$ $\Rightarrow \vec{F} = \frac{1}{2}(2\hat{i} + 6\hat{j})$ $\Rightarrow \vec{F} = \hat{i} + 3\hat{j}$

So value of x is 3.

36. Dimension of $\frac{1}{\mu_0 \in_0}$ should be equal to

(1) T^2/L^2 (2) T/L (3) L/T (4) L^2/T^2

NTA Ans. (4)

Reso Ans. (4)

Sol. Speed = $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

$\Rightarrow \frac{1}{\mu_0 \varepsilon_0} = (\text{Speed})^2$ & $\frac{1}{\mu_0 \varepsilon_0} = [LT^{-1}]^2 = L^2T^{-2}$

37. In a reflecting telescope, a secondary mirror is used to:

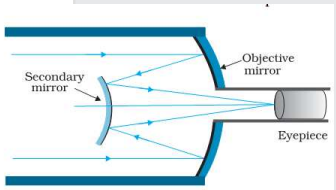
(1) reduce the problem of mechanical support (2) remove spherical aberration

(3) make chromatic aberration zero (4) move the eyepiece outside the telescopic tube

NTA Ans. (4)

Reso Ans. (4)

Sol.



Telescopes with mirror objectives are called reflecting telescopes. They have several advantages. First, there is no chromatic aberration in a mirror. Second, if a parabolic reflecting surface is chosen, pherical aberration is also removed. Mechanical support is much less of a problem since a mirror weighs much less than a lens of equivalent optical quality, and can be supported over its entire back surface, not just over its rim. One obvious problem with a reflecting telescope is that the objective mirror focusses light inside the telescope tube. One must have an eyepiece and the observer right there, obstructing some light (depending on the size of the observer cage). This is what is done in the very large 200 inch (5.08 m) diameters, Mt. Palomar telescope, California. The viewer sits near the focal point of the mirror, in a small cage. Another solution to the problem is to deflect the light being focussed by another mirror. One such arrangement using a convex secondary mirror to focus the incident light, which now passes through a hole in the objective primary mirror, is shown

38. A charge particle moving in magnetic field B, has the components of velocity along B as well as perpendicular to B. The path of the charge particle will be :

(1) Circular path

(2) Helical path with the axis perpendicular to the direction of magnetic field B

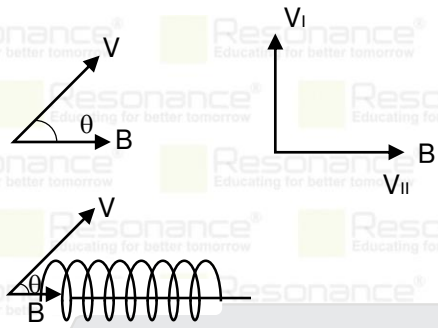
(3) Helical path with the axis along magnetic field B

(4) Straight along the direction of magnetic field R

NTA Ans. (3)

Reso Ans. (3)

Sol.



39. Certain galvanometers have a fixed core made of non-magnetic metallic material. The function of this metallic material is

(1) to bring the coil to rest quickly

(2) to make the magnetic field radial

(3) to produce large deflecting torque on the coil

(4) to oscillate the coil in magnetic field for longer period of time

NTA Ans. (1)

Reso Ans. (1)

Sol. Time varying $\vec{B} \Rightarrow$ Induced $\vec{E} \Rightarrow$ eddy current produced $\Rightarrow$ energy loss $\Rightarrow$ stop

40. A cylindrical wire of mass (0.4 ± 0.01) g has length (8 ± 0.04) cm and radius (6 ± 0.03) mm. The maximum error in its density will be:

(1) 4 % (2) 1 % (3) 3.5% (4) 5%

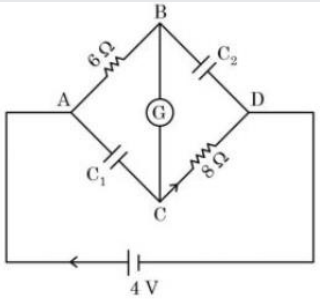
NTA Ans. (1)

Reso Ans. (1)

Sol. $\frac{\Delta\rho}{\rho} = \pm\left[\frac{\Delta m}{m} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell}\right]\times 100$

$= \pm\left[\frac{0.003}{0.3} + 2\frac{(0.005)}{0.5} + \frac{0.006}{0.6}\right]\times 100 = \pm[1 + 2 + 1]\% = 4\%$

41. In this figure the resistance of the coil of galvanometer G is 2 Ω. The emf of the cell is 4 V. The ratio of potential difference across C_1 and C_2 is:



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

NTA Ans. (4)

Reso Ans. (4)

Sol. $V_{C1} = i\,(6 + 2) = 8\,i$

$V_{C2} = i\,(2 + 8) = 10i$

So, $\frac{V_{C_1}}{V_{C_2}} = \frac{8i}{10i} = \frac{8}{10} = \frac{4}{5}$

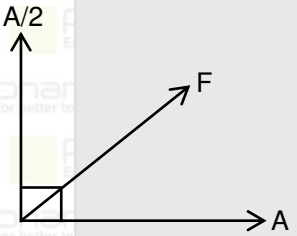
42. Two forces having magnitude A and A/2 are perpendicular to each other. The magnitude of their resultant is:

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

NTA Ans. (3)

Reso Ans. (3)

Sol.



Net force $F = \sqrt{A^2 + \left(\frac{A}{2}\right)^2} = \sqrt{A^2 + \frac{A^2}{4}} = A\sqrt{1 + \frac{1}{4}} = \frac{\sqrt{5}}{2}A$

43. Given below are two statements:

Statement I: If heat is added to a system, its temperature must increase.

Statement II: If positive work is done by a system in a thermodynamic process, its volume must increase.

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

(1) Statement I is false but Statement II is true (2) Both Statement I and Statement II are false

(3) Both Statement I and Statement II are true (4) Statement I is true but Statement II is false

NTA Ans. (1)

Reso Ans. (1)

Sol. Statement -I is false

$W = Pdv$

$\Rightarrow$ w = +ive $\Rightarrow$ So dv = + ive

44. For a nucleus ${}^{A}_{Z}X$ having mass number A and atomic number Z

(A) The surface energy per nucleon (b_S) = $-a_1 A^{2/3}$

(B) The Coulomb contribution to the binding energy $b_c = -a_2 \frac{Z(Z-1)}{A^{4/3}}$

(C) The volume energy $b_v = a_3 A$

(D) Decrease in the binding energy is proportional to surface area.

(E) While estimating the surface energy, it is assumed that each nucleon interacts with 12 nucleons. (a_1, a_2 and a_3 are constants)

Choose the most appropriate answer from the options given below:

(1) C, D only (2) A, B, C, D only (3) B, C only (4) B, C, E only

NTA Ans. (1)

Reso Ans. (1)

Sol. (A) Surface Energy per nucleon $b_s = -a_2 \frac{A^{2/3}}{A} = -a_2 \times A^{-1/3}$

(B) Coulomb contribution in BE $\Rightarrow b_c = -a_3 \frac{z(z-1)}{A^{1/3}}$

(C) Volume energy $\Rightarrow$ $b_v = a_1 A$

(D) Surface energy $b_s = -a_2 A^{2/3}$

$b_s \propto$ surface area

$b_s \propto R^2$

$R = R_0 A^{1/3}$

$b_s \propto A^{2/3}$

(E) In volume energy each nucleus interact with 12 nucleons, but in surface energy it in proportional to area.

45. Proton (P) and electron (e) will have same de-Broglie wavelength when the ratio of their momentum is (assume, $m_p = 1849\ m_e$) :

(1) 43:1 (2) 1 :1849 (3) 1 : 43 (4) 1 : 1

NTA Ans. (4)

Reso Ans. (4)

Sol. $\lambda = \frac{h}{P}$

$\lambda \rightarrow$ same So P will also be same

So $P_P : P_e = 1 : 1$

46. The weight of a body on the earth is 400 N. Then weight of the body when taken to a depth half of the radius of the earth will be:

(1) Zero (2) 200 N (3) 300 N (4) 100 N

NTA Ans. (2)
Reso Ans. (2)

Sol. At a h depth $g^1 = g\left(1-\frac{h}{R}\right) = g\left(1-\frac{R/2}{R}\right) = \frac{g}{2}$

$\Rightarrow mg^1 = \frac{mg}{2} = \frac{400}{2} = 200\ N$

47. An aluminium rod with Young's modulus Y = 7.0 x 10^{10} N/m² undergoes elastic strain of 0.04%. The energy per unit volume stored in the rod in SI unit is:

(1) 5600 (2) 8400 (3) 11200 (4) 2800

NTA Ans. (1)

Reso Ans. (1)

Sol. PE per unit volume = 1/2 stress × strain

= 1/2 y (strain)²

= 1/2 × 1.6 × 10^7 × (.0004)² = 1/2 × 1.6 × 10^7 × 4 × 4 × 10^{-8} = 1.6 × 8 × 10^{-1} = 1.28 J/m³

48. Given below are two statements:

Statement I : If E be the total energy of a satellite moving around the earth, then its potential energy will be E/2

Statement II: The kinetic energy of a satellite revolving in an orbit is equal to the half the magnitude of total energy E.

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

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

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

NTA Ans. (4)

Reso Ans. (4)

Sol. $KE = -(M.E.) = -\frac{P.E.}{2}$

49. Two projectiles A and B are thrown with initial velocities of 40 m/s and 60 m/s at angles 30° and 60° with the horizontal respectively. The ratio of their ranges respectively is (g = 10 m/s²)

(1) $2:\sqrt{3}$ (2) 4 : 9 (3) 1 : 1 (4) $\sqrt{3}:2$

NTA Ans. (2)

Reso Ans. (2)

Sol. For Ist projectile $R_1 = \frac{2u_x u_y}{g}$

$\Rightarrow R_1 = \frac{2\times 20\times 20\sqrt{3}}{10}$

For 2nd projectile

$R_2 = \frac{2\times 30\times 30\sqrt{3}}{10}$

So $\frac{R_1}{R_2} = \frac{4}{9}$

50. An air bubble of volume 1 cm^3 rises from the bottom of a lake 40 m deep to the surface at a temperature of 12°C. The atmospheric pressure is 1×10^5 Pa, the density of water is 1000 kg/m^3 and g = 10 m/s^2. There is no difference of the temperature of water at the depth of 40 m and on the surface. The volume of air bubble when it reaches the surface will be:

(1) 4 cm^3 (2) 3 cm^3 (3) 2 cm^3 (4) 5 cm^3

NTA Ans. (4)

Reso Ans. (4)

Sol. $P_1V_1 = P_2V_2$

$(P_0 + h\rho g) \times V_1 = P_0V_2$

after putting values

$V_2 = 5\ cm^3$

51. An organ pipe 40 cm long is open at both ends. The speed of sound in air is 360 ms^{-1}. The frequency of the second harmonic is ____ Hz.

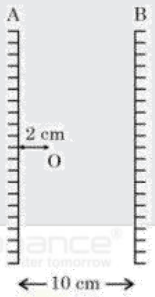
NTA Ans. 900

Reso Ans. 900

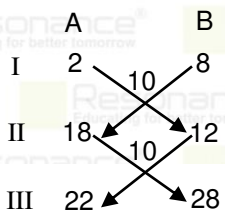
Sol. $$F = \left(\frac{V}{2L}\right)2 = \frac{V}{L} = \frac{360}{40\times10^{-2}}$$

F = 900 Hz

52. Two vertical parallel mirrors A and B are separated by 10 cm. A point object O is placed at a distance of 2 cm from mirror A. The distance of the second nearest image behind mirror A from the mirror A is ____ cm



NTA Ans. 18
Reso Ans. 18
Sol.



53. The magnetic intensity at the center of a long current carrying solenoid is found to be 1.6×10^3 Am^{-1}. If the number of turns is 8 per cm, then the current flowing through the solenoid is _____ A.

NTA Ans. 5

Reso Ans. 5

Sol. $B = \mu_0 nI$

$nI = B/\mu_0 = H$

$I = H/n = \dfrac{4}{8\times10^2} = 5.0\,mA$

54. The momentum of a body is increased by 50%. The percentage increase in the kinetic energy of the body is ____ %

NTA Ans. 125

Reso Ans. 125

Sol. $KE = \dfrac{p^2}{2m}$

$KE' = \dfrac{(1.5p)^2}{2m} = 2.25\ \dfrac{p^2}{2m}$; % change in KE $= \dfrac{2.25-1}{1} \times 100 = 125\%$

55. An oscillating LC circuit consists of a 75 mH inductor and a 1.2 μF capacitor. If the maximum charge to the capacitor is 2.7 μC. The maximum current in the circuit will be _____mA

NTA Ans. 9

Reso Ans. 9

Sol. $I_0 = \dfrac{Q}{\sqrt{LC}} = \dfrac{2.7\times10^{-6}}{\sqrt{75\times10^{-3}\times1.2\times10^{-6}}} = 9\times10^{-3} = 9mA$

56. An electric dipole of dipole moment is 6.0×10^{-6} Cm placed in a uniform electric field of 1.5×10^3 NC^{-1} in such a way that dipole moment is along electric field. The work done in rotating dipole by 180° in this field will be_____mJ.

NTA Ans. 18

Reso Ans. 18

Sol. $\theta_1 = 0°$

$\theta_2 = 180°$

$W = U_f - U_i = (-PE\cos 180°) - (-PE\cos 0°)$

$= 2PE$

$= 2 \times 6 \times 10^{-6} \times 3/2 \times 10^{+3}$

$= 18 \times 10^{-3}\ J = 18\ mJ$

57. A current of 2 A flows through a wire of cross-sectional area 25.0 mm^2. The number of free electrons in a cubic meter are 2.0×10^{28}. The drift velocity of the electrons is _____ $\times 10^{-6}$ ms^{-1} (given, charge on electron = 1.6×10^{-19} C).

NTA Ans. 25

Reso Ans. 25

Sol. $I = neAV_d$

$$V_d = \frac{I}{neA} = \frac{2}{2\times10^{28}\times1.6\times10^{-19}\times25\times10^{-6}}$$

$= 25 \times 10^{-6}$ m/s

58. A nucleus with mass number 242 and binding energy per nucleon as 7.6 MeV breaks into two fragment each with mass number 121. If each fragment nucleus has binding energy per nucleon as 8.1 MeV, the total gain in binding energy is _____ MeV

NTA Ans. 121

Reso Ans. 121

Sol. Gain in binding energy = 242 (8.1 – 7.6) MeV

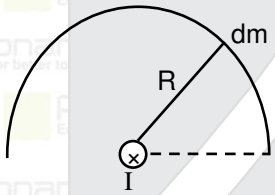
$= 242 \times 0.5 = 121$ MeV

59. The moment of inertia of a semi-circular ring about an axis, passing through the centre and perpendicular to the plane of ring, is $\frac{1}{x}MR^2$, where R is the radius and M is the mass of the semi-circular ring. The value of x will be _____ .

NTA Ans. (1)

Reso Ans. (1)

Sol.



$$I = \int dm R^2 \quad \Rightarrow I = R^2 \int dm \quad \Rightarrow I = mR^2$$

60. An air bubble of diameter 6 mm rises steadily through a solution of density 1750 kg/m^3 at the rate of 0.35 cm/s. The co-efficient of viscosity of the solution (neglect density of air) is _____Pas (given, g = 10 ms^{-2}).

NTA Ans. 10

Reso Ans. 10

Sol. Viscous force = Buoyancy force

$6 \pi \eta rv = \rho V g$

$$\eta = \frac{\rho v g}{6\pi r v}$$

$$\eta = \frac{\rho(4/3\pi r^3)\times g}{6\pi r v}$$

after putting values η =10pas