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JEE (Main)

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

2023

COMPUTER BASED TEST (CBT)

Questions & Solutions

Date: 13 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. To radiate EM signal of wavelength λ with high efficiency, the antennas should have minimum size equal to

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

NTA Ans. (1)
Reso Ans. (1)

32. In an electromagnetic wave, at an instant and at a particular position, the electric field is along the negative z-axis and magnetic field is along the positive x-axis. Then the direction of propagation of electromagnetic wave is :

(1) positive z-axis
(2) positive y-axis
(3) negative y-axis
(4) at 45º angle from positive y-axis

NTA Ans. (1)
Reso Ans. (1)

Sol. Direction of propagation of EM wave will be in the direction of $\vec{E}\times\vec{B}$.

33. The distance travelled by an object in time t is given by $s = (2.5)t^2$. The instantaneous speed of the object at t = 5 s will be :

(1) 12.5 ms^{-1} (2) 5 ms^{-1} (3) 62.5 ms^{-1} (4) 25 ms^{-1}

NTA Ans. (4)
Reso Ans. (4)
Sol. V = 5t = 25 m/s

34. A particle executes SHM of amplitude A. The distance from the mean position when its's kinetic energy becomes equal to its potential energy is

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

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

Sol. K.E. = P.E.

$$\frac{1}{2}m\omega^2\left(A^2-x^2\right)=\frac{1}{2}m\omega^2x^2 \Rightarrow x=\pm\frac{A}{\sqrt{2}}$$

35. In the equation $\left[X+\frac{a}{Y^2}\right][Y-b] = RT$, X is pressure, Y is volume, R is universal gas constant and T is temperature. The physical quantity equivalent to the ratio $\frac{a}{b}$ is :

(1) Energy
(2) Pressure gradient
(3) Coefficient of viscosity
(4) Impulse

NTA Ans. (1)
Reso Ans. (1)

Sol. X and a/Y^2 have same dimensions
Y and b have same dimensions
$\therefore$ $[a] = [ML^5T^{-2}]$; $[b] = [L^3]$
$[a]/[b] = [ML^2T^{-2}]$ which is dimensions of energy.

36. The mean free path of molecules of a certain gas at STP is 1500 d, where d is the diameter of the gas molecules. While maintaining the standard pressure, the mean free path of the molecules at 373 K is approximately.
(1) 1098 d (2) 1500 d (3) 2049 d (4) 750d

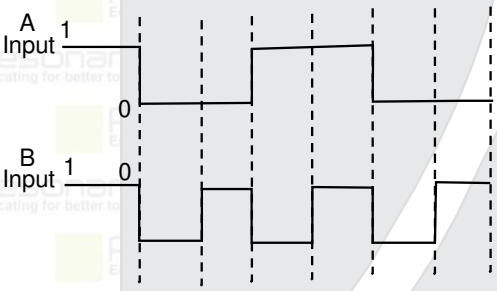
NTA Ans. (3)
Reso Ans. (3)

Sol. formula of mean free path is $\lambda = \dfrac{RT}{\sqrt{2}\pi d^2 N_A P}$

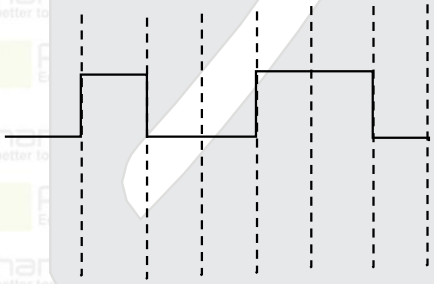
$\lambda \propto T$

$$\frac{1500\,d}{\lambda} = \frac{273}{373} \Rightarrow \lambda = 2049\,d$$

37.



(1)



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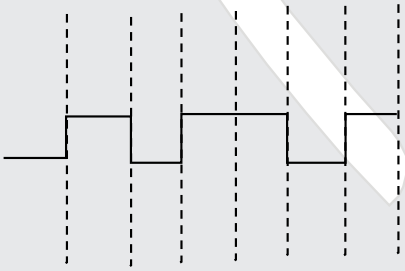

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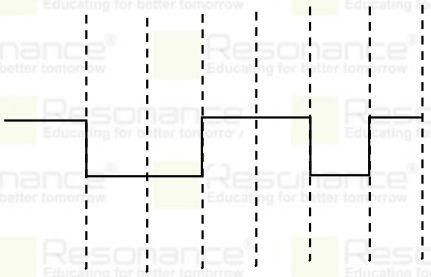

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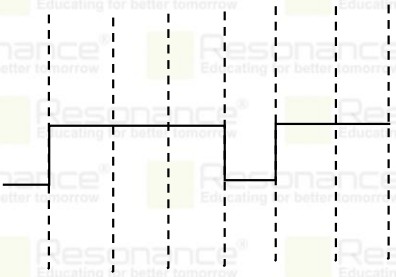


NTA Ans. (1)
Reso Ans. (1)

Sol. Truth table for NAND gate is

A	B	$Y = \overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

On the basis of given input A and B the truth table is

A	B	Y
1	1	0
0	0	1
0	1	1
1	0	1
1	1	0
0	0	1
0	1	1

correct answer is (1).

38. Given below are two statements :

Statement I : An AC circuit undergoes electrical resonance if it contains either a capacitor or an inductor.

Statement II : An AC circuit containing a pure capacitor or a pure inductor consumes high power due to its non-zero power factor.

In the light of above statements, choose the correct answer from the options given below :
(1) Both Statement I and Statement II are false
(2) Both Statement I and Statement II are true
(3) Statement I is true but Statement II is false
(4) Statement I is false but statement II is true

NTA Ans. (1)
Reso Ans. (1)

Sol. At resonance power factor is = 0, therefore net reactance should be zero, therefore inductor & capacitor must be present. Also power factor is zero for pure inductor or pure capacitor hence both the component consume zero average power.

39. A 10μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are :

(1) 5μC, 5μC (2) 9μC, 1μC (3) 8μC, 2μC (4) 7μC, 3μC

NTA Ans. (1)
Reso Ans. (1)

Sol. $F = \frac{Kq(Q-q)}{r^2}$

F is max at q = Q/2 = 10/2 = 5μC

40. Two planets A and B of radii R and 1.5 R have densities ρ and $\rho/2$ respectively. The ratio of acceleration due to gravity at the surface of B to A is :

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

NTA Ans. (3)
Reso Ans. (3)
Sol. acceleration due to gravity

$$g = \frac{GM}{R^2} = \frac{4}{3}\pi G\rho R$$

$$\therefore \quad \frac{g_2}{g_1} = \frac{\rho_2}{\rho_1} \times \frac{R_2}{R_1} = \frac{1}{2} \times 1.5 = \frac{3}{4}$$

41. Given below are two statements :

Statement I : For a planet, if the ratio of mass of the planet to its radius increases. the escape velocity from the planet also increase

Statement II : Escape velocity is independent of the radius of the planet.

In the light of above statement choose the most appropriate answer form the options given below

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

(2) Both Statement I and Statement II are correct

(3) Statement I is correct but statement II is incorrect

(4) Both Statement I and Statement II are incorrect

NTA Ans. (3)
Reso Ans. (3)
Sol. Statement 1 is correct & Statement 2 is incorrect

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

Assertion A : The binding energy per nucleon is practically indepedent of the atomic number for nuclei of mass number in the range 30 to 170.

Reason R : Nuclear force is short ranged.

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

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

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

(3) A is false but R is true

(4) A is true but R is false

NTA Ans. (2)
Reso Ans. (2)
Sol. Binding energy per nucleon is nearly same for nuclei of mass number ranging 30 to 170.

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

Assertion A : A spherical body of radius (5±0.1) mm having a particular density is falling through a liquid of constant density. The percentage error in the calculation of its terminal velocity 4%

Reason R : The terminal velocity of the spherical body falling through the liquid is inversely proportional to its radius.

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

(1) A is false but R is true

(2) Both A and R are true bot R is NOT the correct explanation of A

(3) A is true but R is false

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

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

Sol. Terminal velocity of a sphere

$\Rightarrow \quad V_t \propto r^2$

$\Rightarrow \quad \frac{\Delta V_t}{V_t} = 2 \cdot \frac{\Delta r}{r}$

$\Rightarrow \quad \frac{\Delta V_t}{V_t} \times 100\% = 2\frac{(0.1)}{5} \times 100 = 4\%$

Also $V_t \propto r^2$

Reason R is false Option (3) is correct.

44. An electron is moving along the positive x-axis. If the uniform magnetic field is applied parallel to the negative z-axis, then

(A) The electron will experience magnetic force along positive y-axis

(B) The electron will experience magnetic force along negative y-axis

(C) The electron will continue to move along the positive x-axis

(D) The electron will move along circular path in magnetic field

Choose the correct answer from the options given below :

(1) C and D only (2) B and E only

(3) B and D only (4) A and E only

NTA Ans. (2)

Reso Ans. (2)

Sol. Magnetic force $\vec{F} = -e(\vec{v} \times \vec{B})$

Force will be along negative y-axis.

Magnetic force & velocity are perpendicular therefore path of electron is circle.

45. The initial pressure and volume of an ideal gas are P_0 and V_0 . The final pressure of the gas when the gas is suddenly compressed to volume $\frac{V_0}{4}$ will be :

(Given) γ = ratio of specific heats at constant pressure and at constant volume

(1) P_0 (4) $P_0(4)^{\frac{1}{\gamma}}$ (2) $P_0(4)^{\gamma}$ (3) $4P_0$ (4) P_0

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

Sol. When gas is suddenly compressed, then processes is adiabatic.
Equation of gas for adiabatic process is PV^{γ} = constant.

$$\Rightarrow \quad P_1V_1^{\gamma} = P_2V_2^{\gamma} \quad \Rightarrow \quad P_0V_0^{\gamma} = P_2\left(\frac{V_0}{4}\right)^{\gamma} \quad \Rightarrow \quad P_2 = P_0(4)^{\gamma}$$

Option (2) is correct

46. Given below are two statement:

Statement I : Out of microwaves, infrared rays and ultraviolet rays, ultraviolet rays are the most effective for the emission of electrons from a metallic surface.

Statement : II Above the threshold frequency, the maximum kinetic energy of photoelectrons is inversely proportional to the frequency of the incident light.

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

(1) Statement I is true but statement II is false

(2) Both statement I and statement II are true

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

(4) Both Statement I and Statement II are false

NTA Ans. (1)

Reso Ans. (1)

Sol. Frequency of UV rays is greater than frequencies of microwave & infrared rays therefore it is more effective for emission of electrons from a metallic surface.

$(K)_{max.} = h\nu - \phi$

47. A passenger sitting in a train A moving at 90 km/h observes another train B moving in the opposite direction for 8 s. If the velocity of the train B is 54 km/h then length of train B is.

(1) 200 m (2) 120 m (3) 320 m (4) 80 m

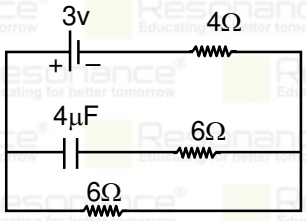
NTA Ans. (3)

Reso Ans. (3)

Sol. $(90 + 54)\ \frac{5}{18} \times 8 = \ell$

$\ell = 320$ m

48. In the network shown below, the charge accumulated in the capacitor in steady state will be



(1) 7.2μC (2) 10.3 μC (3) 1.8 μC (4)12 μC

NTA Ans. (1)

Reso Ans. (1)

Sol. $i = \frac{3}{10}$

$q = 4 \times 6 \times \frac{3}{10} = \frac{36}{5} = 7.2\ \mu C$

49. A vehicle of mass 200 kg is moving along a levelled curved road of radius 70 m with angular velocity of 0.2 rad/s. The centripetal force acting on the vehicle is :

(1) 2240 N (2) 2800 N (3) 174 N (4) 560 N

NTA Ans. (4)
Reso Ans. (4)
Sol. Centripetal force $F = m\omega^2 r = 200 \times (0.2)^2 \times 70 = 560N$

50. In a Young's double slits experiment, the ratio of amplitude of light coming from slits is 2 : 1. The ratio of the maximum to minimum intensity in the interference pattern is :

(1) 9 : 4 (2) 9 : 1 (3) 2 : 1 (4) 25 : 9

NTA Ans. (2)

Reso Ans. (2)

Sol. Given that $\frac{A_1}{A_2} = 2$

$\frac{I_{max.}}{I_{min.}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2 = 9$

51. An insulated copper wire of 100 terms is wrapped around a wooden cylindrical core of the cross-sectional area 24 cm^2. The two ends of the wire are connected to a resistor. The total resistance in the circuit is 12Ω. If an extremely applied uniform magnetic field in the core along its axis changes from 1.5 T in one direction to 1.5 T in the opposite direction, the charge flowing through a point in the circuit during the change of magnetic field will be —— μC.

NTA Ans. 60
Reso Ans. 60

Sol. Charge flows $q = \left(\frac{\phi_1 - \phi_2}{R}\right) = \frac{2NBA}{R} = 60\ mC$

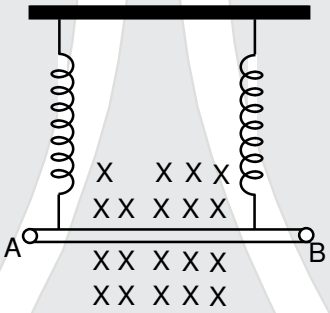
52. A light rope is wound around a hollow cylinder of mass 5 kg and radius 70 cm. The rope ios pulled with a force of 52.5 N. The angular acceleration of the cylinder will be ——— rad s^{-2}

NTA Ans. 15
Reso Ans. 15
Sol. Torque

$\Rightarrow \quad FR = mR^2\alpha$

$$\alpha = \frac{F}{mR} = \frac{52.5}{5\times 0.7} = 15\,\text{rad./m}^2$$

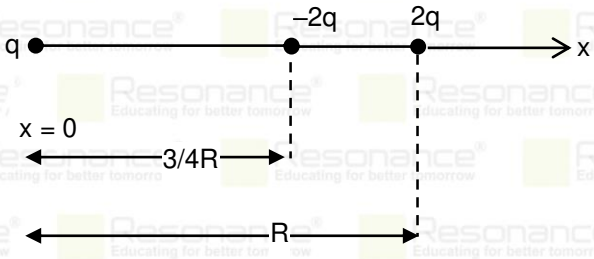
53. A straight wire AB of mass 40 g and length 50 cm is suspended by a pair of flexible leads in uniform magnetic field of magnitude 0.40 T as shown in the figure. The magnitude of the current required in the wire to remove the tension in the supporting leads is ——— A. (Take g = 10 ms^{-2})



NTA Ans. 2
Reso Ans. 2
Sol. $Bi\ell = mg$

$$i = \frac{mg}{B\ell} = \frac{\frac{40}{1000}\times 10}{0.4\times 0.5} = 2$$

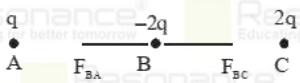
54. Three point charges q, – 2q and 2q are placed on x- axis at a distance x = 0, x = $\frac{3}{4}$ R and x = R respectively from origin as shown. If q = 2 × 10^{-6} C and R = 2 cm, the magnitude of net force experienced by the charge – 2 q is ———N.



NTA Ans. 5440

Reso Ans. 5440

Sol.



$$F_{BA} = \frac{Kq(2q)}{\left(\frac{3}{4}R\right)^2} \text{ \& } F_{BC} = \frac{K(2q)(2q)}{\left(\frac{R}{4}\right)^2}$$

$$F_B = F_{BC} - F_{BA} = \frac{544Kq^2}{9R^2} = 5440$$

55. A bi convex lens of focal length 10 cm is cut in two identical parts along a plane perpendicular to the principal axis. The power of each lens after cut is ——— D.

NTA Ans. 5
Reso Ans. 5

Sol. $P = \frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$

$$P' = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R}\right)$$

$$\frac{P'}{P} = \frac{1}{2} = P' = \frac{1}{2} \times \frac{1}{0.1} = 5D$$

56. A car accelerates from rest to u m/s. The energy spent in this process is E J. The energy required to accelerate the car from um m/s to 2u m/s is nE J. The value of n is

NTA Ans. 3
Reso Ans. 3

Sol. $E_1 = \frac{1}{2}mu^2 - 0 = \frac{1}{2}mu^2 = E$

$$E_2 = \frac{1}{2}m(2u)^2 - \frac{1}{2}mu^2 = \frac{3}{2}mu^2 = 3E$$

57. In an experiment with tonometer when a mass of 180 g is attached to the string, it vibrates with fundamental frequency of 30 Hz . When a mass m is attached, the string vibrates with fundamental frequency of 50 Hz. The value of m is ————g.

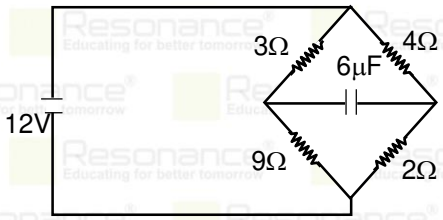
NTA Ans. 500
Reso Ans. 500

Sol. Fundamental frequency $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

$$\frac{f_2}{f_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\left(\frac{50}{30}\right)^2 = \frac{mg}{180g} \Rightarrow m = 500 \text{ g}$$

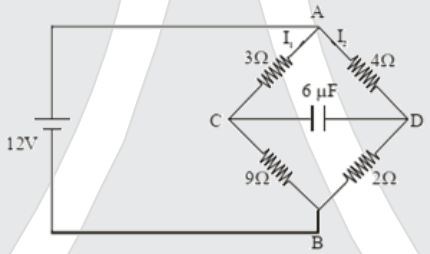
58. In the circuit shown, the energy stored in the capacitor is n μJ. The value of n is



NTA Ans. 75
Reso Ans. 75

Sol. $I_1 = \frac{12}{3+9} = 1A$

$I_2 = \frac{12}{4+2} = 2A$

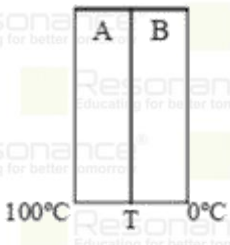


$V_A - V_C = 3I_1 = 3V$ .....(1)
$V_A - V_D = 2 \times 4 = 8V$ .....(2)
Subtracting equation (1) from equation (2)
$V_C - V_D = 5V \Rightarrow V = 5V$

$U = \frac{1}{2}CV^2 = \frac{1}{2} \times 6 \times 5^2 = 75\mu J$

59. Two plates A and B have thermal conductivities 84 $Wm^{-1}K^{-1}$ and 126 $Wm^{-1}K^{-1}$ respectively. They have same surface area nd same thickness. They are placed in contact along their surfaces. If the temperatures of the outer surface of A and B are kept at 100 ºC and 0 ºC respectively, then the temperature of the surface of contact in steady state is ——— ºC.

NTA Ans. 40
Reso Ans. 40
Sol.



Let the temperature of contact surface is T, then

$H_A = H_B$

$$\frac{K_A A(T_A - T)}{L} = \frac{K_B A(T - T_B)}{L}$$

$84(100 - T) = 126\,(T - 0)$

$2(100 - T) = 3T$

$200 - 2T = 3T$

$T = 40°C$

60. An atom absorbs a photon of wavelength 500 nm and emits another photon of wavelength 600 nm. The net energy absorbed by the atom in this process in $n \times 10^{-4}$ eV. The value of n is ——

(Take $h = 6.6 \times 10^{-34}$Js) and $c = 3 \times 10^8$ m/s

NTA Ans. 4125
Reso Ans. 4125

Sol. $E = E_1 - E_2 = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2} = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

$= 6.6 \times 10^{-34} \times 3 \times 10^8 \left(\frac{1}{500\times10^{-9}} - \frac{1}{600\times10^{-9}}\right)$

$= 6.6 \times 10^{-20}$ J

$= \frac{6.6\times10^{-20}}{1.6\times10^{-19}}$eV $= 4.125 \times 10^{-1}$ eV $= 4125 \times 10^{-4}$ eV