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JEE (Main)

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

2023

COMPUTER BASED TEST (CBT)

Questions & Solutions

Date: 25 January, 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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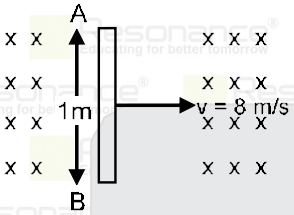
PART : PHYSICS

1. A wire of length 1 m moving with velocity 8 m/s at right angles to a magnetic field of 2T. The magnitude of induced emf, between the ends of wire will be _____

(1) 20 V (2) 16 V (3) 8 V (4) 12 V

Ans. **(2)**

Sol.



$\varepsilon = Bv\ell$

$= 2 \times 8 \times 1 = 16$ v

2. The distance travelled by a particle is related to time t as $x = 4x^2$. The velocity of the particle at t = 5s

(1) 8 ms^{-1} (2) 20 ms^{-1} (3) 25 ms^{-1} (4) 40 ms^{-1}

Ans. **(4)**

Sol. $V = dx/dt = 8t$

$V(5) = 8 \times 5 = 40$ m/s

3. According to law of equipartition of energy the molar specific heat of a diatomic gas at constant volume where the molecule has one additional vibrational mode is :-

(1) $\frac{3}{2}R$ (2) $\frac{7}{2}R$ (3) $\frac{9}{2}R$ (4) $\frac{5}{2}R$

Ans. **(2)**

Sol. $C_v = \frac{fR}{2}$

here $f = 3 + 2 + 2 = 7$

$C_v = \frac{7R}{2}$

4. A particle executes simple harmonic between x = –A and x = +A. If time taken by particle to go from x = 0 to $\frac{A}{2}$ is 2 s; then time taken by particle in going from $x = \frac{A}{2}$ to A is

(1) 1.5 s (2) 3 s (3) 4 s (4) 2 s

Ans. **(3)**

Sol. Time taken by particle to reach half of amplitude from mean position is equal to $\frac{T}{12}$

$\frac{T}{12} = 2 \Rightarrow T = 24$ sec

Time taken from half amplitude to extreme position

$\frac{T}{6} = \frac{24}{6} = 4\,\text{Sec}$

5. The resistance of a wire is 5Ω. It's new resistance in ohm if stretched to 5 times of it's original length will be :

(1) 125 (2) 5 (3) 25 (4) 625

Ans. **(1)**

Sol. $R_1 = \frac{\rho\ell}{A} = \frac{\rho\ell^2}{V}$

$R \propto \ell^2$

$\frac{R_2}{R_1} = \left(\frac{5\ell}{\ell}\right)^2 = 25$

$R_2 = 25 \times 5 = 125$

6. For moving coil galvanometer, the deflection in the coil is 0.05 rad when a current of 10 mA is passed through it. If the torsional constant of suspension wire is 4.0×10^{-5} Nm rad^{-1}, the magnetic field is 0.01T and the number of turns in the coil is 200, the area of each turn (in cm^2) is :

(1) 2.0 (2) 1.0 (3) 1.5 (4) 0.5

Ans. **(2)**

Sol. $\tau_{spring} = \tau_{magnetic\ field}$

$K\theta = MB \sin 90°$

$K\theta = NiAB$

$A = \frac{K\theta}{NiB}$

$A = \frac{4\times10^{-5}\times0.05}{200\times10\times10^{-3}\times0.01} = 1\text{cm}^2$

7. **Statement I :** When a Si sample is doped with Boron, it becomes P type and when doped by Arsenic it becomes N-type semi conductor such that P-type has excess holes and N-type has excess electrons.

Statement II : When such P-type and N-type semi-conductors, are fused to make junction, a current will automatically flow which can be detected with an externally connected ammeter.

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

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

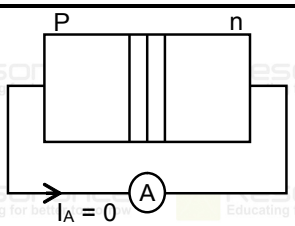
(2) Both Statement **I** and Statement **II** are incorrect

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

(4) Both Statement **I** and statement **II** are correct

Ans. **(1)**

Sol.



No current flows as battery is not connected

8. Two objects are projected with same velocity 'u' however at different angles α and β with the horizontal. If $\alpha + \beta = 90^\circ$, the ratio of horizontal range of the first object to the 2nd object will be :

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

Ans. **(4)**

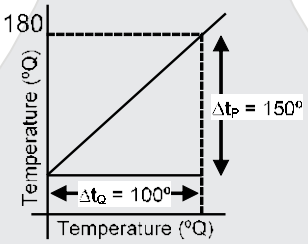
Sol. Range = $\frac{u^2 \sin 2\theta}{g}$

$\theta_1 = \alpha$

$\theta_2 = \beta = 90^\circ - \alpha$

$$\frac{R_1}{R_2} = \frac{\sin 2\theta_1}{\sin 2\theta_2} = \frac{\sin 2\alpha}{\sin(180^\circ - 2\alpha)} = \frac{1}{1}$$

9. The graph between two temperature scales P and Q is shown in the figure. Between upper fixed point and lower fixed point there are 150 equal divisions of scale P and 100 divisions on scale Q. The relationship for conversion between two scales is given by :-



(1) $\frac{t_P}{100} = \frac{t_Q - 180}{150}$ (2) $\frac{t_Q}{150} = \frac{t_P - 180}{100}$ (3) $\frac{t_P}{180} = \frac{t_Q - 40}{100}$ (4) $\frac{t_Q}{100} = \frac{t_P - 30}{150}$

Ans. **(4)**

Sol. $\frac{t_p - MP_p}{BP_p - MP_p} = \frac{t_Q - MP_Q}{BP_Q - MP_Q}$

$\frac{t_Q}{100} = \frac{t_p - 30}{150}$

10. Every planet revolves around the sun in an elliptical orbit :-

A. The force acting on a planet is inversely proportional to square of distance from sun.

B. Force acting on planet in inversely proportional to product of the masses of the planet and the sun.

C. The Centripetal force acting on the planet is directed away from the sun.

D. The square of time period of revolution of planet around sun is directly proportional to cube of semi-major axis of elliptical orbit.

(1) A and D only (2) B and C only (3) A and C only (4) C and D only

Ans. **(1)**

Sol. **(A)** $F = \frac{GM_sm_p}{R^2}$

(D) By Kepler's 3rd law

$T^2 \propto a^3$

11. Given below are two statements :

Statement I : Stopping potential in photoelectric effect does not depend on the power of the light source.

Statement II : For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.

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

(1) Both Statement **I** and Statement **II** are incorrect

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

(3) Both Statement **I** and statement **II** are correct

(4) Statement **I** is incorrect but statement **II** is correct

Ans. **(3)**

12. Match List I with List II

	List I		List II
A.	Troposphere	I.	Approximate 65-75 km over Earth's surface
B.	E-Part of Stratosphere	II.	Approximate 300 km over Earth's surface
C.	F_2-Part of Thermosphere	III.	Approximate 10 km over Earth's surface
D.	D-Part of Stratosphere	IV.	Approximate 100 km over Earth's surface

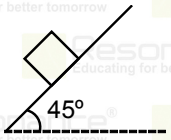
Choose the correct answer from the options given below :

(1) A-III, B-IV, C-II, D-I (2) A-I, B-II, C-IV, D-III

(3) A-III, B-II, C-I, D-IV (4) A-I, B-IV, C-III, D-II

Ans. **(1)**

13. Consider a block kept on an inclined plane (inclined at 45°) as shown in the figure. If the force required to just push it up the incline is 2 times the force required to just prevent if from sliding down, the coefficient of friction between the block and inclined plane(μ) is equal to :



(1) 0.50 (2) 0.33 (3) 0.25 (4) 0.60

Ans. **(2)**

Sol. $mg\sin\theta + \mu mg\cos\theta = 2(mg\sin\theta - \mu mg\cos\theta)$

$mg\sin\theta = 3\mu mg\cos\theta$

$\tan\theta = 3\mu$

$\mu = \frac{1}{3}$

14. The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are :-

A. Real

B. Erect

C. Smaller in size then object

D. Laterally inverted

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

Ans. **(3)**

Sol. Properties of image formation by plane mirror

15. A body of mass is taken from earth surface to the height h equal to twice the radius of earth (R_e), the increase in potential energy will be :

(g = acceleration due to gravity on the surface of Earth)

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

Ans. **(3)**

Sol. $U_i = \frac{-GM_em}{R_e}$

$U_F = \frac{-GM_em}{3R_e}$

$\Delta U = U_F - U_i = \frac{2GM_em}{3R_e}$

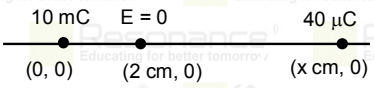
$= \frac{2GM_em}{3R_e} \times \frac{R_e}{R_e} = \frac{2}{3}\ mgR_e$

16. A point charge of 10 μC is placed at the origin. At what location on the X-axis should a point charge of 40 μC be placed so that the net electric field is zero at x = 2 cm on the X-axis?

(1) x = –4 cm (2) x - 4 cm (3) x = 8 cm (4) x = 6 cm

Ans. **(4)**

Sol.



At x = 2 ; $E_1 + E_2 = 0$

$\frac{k(10\mu C)}{(2\times10^{-2})^2} = \frac{k\times40}{((x-2)\times10^{-2})^2}$

x = 6

17. Match List I with List II

	List I		List II
A.	Young's Modulus (Y)	I.	$[ML^{-1}T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[ML^{2}T^{-1}]$
C.	Planck's Constant (h)	III.	$[ML^{-1}T^{-2}]$
D.	Work Function (φ)	IV.	$[ML^{2}T^{-2}]$

Choose the correct answer from the options given below :

(1) A-I, B-III, C-IV, D-II

(2) A-I, B-II, C-III, D-IV

(3) A-II, B-III, C-IV, D-I

(4) A-III, B-I, C-II, D-IV

Ans. **(4)**

Sol. (A) $Y = \frac{F}{A}\frac{L_o}{\Delta L}$

(B) $\eta = \frac{Fd}{Av}$

(C) $h = \frac{E\lambda}{C}$

(D) $\phi = hv - eV_0$

18. Match List I with List II

	List I		List II
A.	Isothermal Process	I.	Work done by the gas decreases internal energy
B.	Adiabatic Process	II.	No change in internal energy
C.	Isochoric Process	III.	The heat absorbed goes partly to increase internal energy and partly to do work
D.	Isobaric Process	IV.	No work is done on or by the gas

Choose the correct answer from the options given below :

(1) A-I, B-II, C-IV, D-III

(2) A-II, B-I, C-IV, D-III

(3) A-I, B-II, C-III, D-IV

(4) A-II, B-I, C-III, D-IV

Ans. **(2)**

Sol.

Isothermal Process	Temperature constant
Adiabatic Process	No heat transfer $\Delta Q = 0$
Isochoric Process	Volume constant $\Delta V = 0$
Isobaric Process	Pressure constant $\Delta P = 0$

19. Match List I with List II

List I		List II	
A.	Gauss's Law in Electrostatics	I.	$\oint \vec{E}.\vec{dl} = -\frac{d\phi_B}{dt}$
B.	Faraday's law	II.	$\oint \vec{B}.\vec{dA} = 0$
C.	Gauss's Law in Magnetism	III.	$\oint \vec{B}.\vec{dl} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$
D.	Ampere-Maxwell Law	IV.	$\oint \vec{E}.\vec{ds} = \frac{q}{\epsilon_0}$

Choose the correct answer from the options given below :

(1) A-I, B-II, C-III, D-IV

(2) A-IV, B-I, C-II, D-III

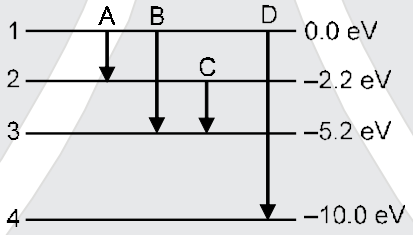
(3) A-III, B-IV, C-I, D-II

(4) A-II, B-III, C-IV, D-I

Ans. **(2)**

Sol. Slandered Equations

20. The energy levels of an atom is shown in figure.



Which one of these transitions will result in the emission of a photon of wavelength 124.1 mm ?

Given ($h = 6.62 \times 10^{-34}$ Js)

(1) D (2) B (3) A (4) C

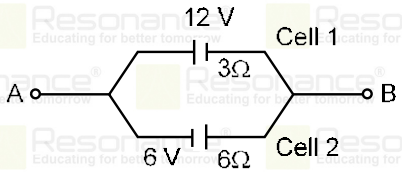
Ans. **(1)**

Sol. $E = \frac{1241}{\lambda(nm)}$ eV

$E = \frac{1241}{124.1}$

E= 10 ev

21. Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3Ω. Cell 2 has emf of 6 V and internal resistance of 6Ω. An external resistor R of 4Ω is connected across A and B. The current flowing through R will be _____ A.

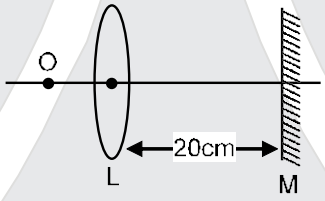


Ans. **(1)**

Sol. $E_{eq} = \dfrac{\frac{12}{3}+\frac{6}{6}}{\frac{1}{3}+\frac{1}{6}} = 10V \qquad r_{eq} = 2\Omega$

$I_{4\Omega} = \dfrac{10}{2+4} = \dfrac{5}{3}\text{Amp.} = 1.67\text{Amp.}$

22. An object is placed on the principal axis of convex of focal length 10cm as shown. A plane mirror is placed on the other side of lens at a distance of 20cm. The image produced by the plane mirror is 5cm inside the mirror. The distance of the object from the lens is _____ cm.



Ans. **(30)**

Sol. Final image is 5 cm behind mirror means image formed by lens is 5 cm infront of mirror.

$\therefore$ v = 15 cm for lens

$\dfrac{1}{v}-\dfrac{1}{u}=\dfrac{1}{f}$

$\dfrac{1}{15}-\dfrac{1}{u}=\dfrac{1}{10}$; $\dfrac{1}{u}=\dfrac{1}{15}-\dfrac{1}{10}$

u = –30 cm

23. A body of mass 1 kg collides heat on elastically with a stationary body of mass 3kg. After collision, the smaller body reverses its direction of motion and moves with a speed of 2 m/s. The initial speed of the smaller body before collision is _____ms^{-1}.

Ans. **(4)**

Sol. Before collision

After collision

$m_1u_1 = m_1 \times (-2) + 3 \times v_2$

$u_1 = -2 + 3v_2$ ...(1)

$e = \dfrac{v_2 - (-2)}{u_1 - 0}$ (e = 1)

$u_1 = v_2 + 2$ ...(2)

by equation 1 and 2

$u_1 = 4$ m/s

$v_2 = 2$

24. A train blowing a whistle of frequency 320 Hz approaches an observer standing on the platform at a speed of 66 m/s. The frequency observed by the observer will be (given speed of sound = 330 ms^{-1}) _____ Hz.

Ans. **(400)**

Sol. $f = f_0\left[\dfrac{V}{V - V_{source}}\right]$

given $V = 330$ m/s

$V_{source} = 66$ m/s

$f_0 = 320$ Hz

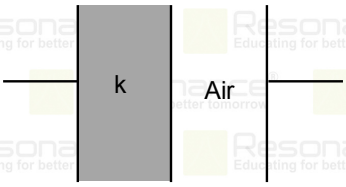
$= 320\left[\dfrac{330}{330 - 66}\right]$

$= 400$

25. A capacitor has capacitance 5μF when it's parallel plates are separated by air medium of thickness d. A slab of material of dielectric constant 1.5 having area equal to that of plates but thickness $\dfrac{d}{2}$ is inserted between the plates. Capacitance of the capacitor in the presence of slab will be _____ μF.

Ans. **(6)**

Sol.



$\left(\frac{d}{2}\right)$ $C_1 = \frac{2\varepsilon_0 A k_1}{d}$ $\left(\frac{d}{2}\right)$ $C_2 = \frac{2\varepsilon_0 A k_2}{d}$

C_1 and C_2 are in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{d}{2\varepsilon_0 A k_1} + \frac{d}{2\varepsilon_0 A k_2}$$

$$= \frac{d}{2\varepsilon_0 A}\left[\frac{1}{k_1} + \frac{1}{k_2}\right]$$

$$\frac{1}{C} = \frac{d}{2\varepsilon_0 A}\left[\frac{k_1 + k_2}{k_1 k_2}\right]$$

$$C_{eq} = \frac{\varepsilon_0 A}{d}\left(\frac{2kk_1}{k_1 + k_2}\right)$$

$$C_{eq} = C\left(\frac{2k_1 k_2}{k_1 + k_2}\right)$$

$k_1 = k$

$k_2 = 1$

$$C_{eq} = C\left(\frac{2k}{k+1}\right)$$

$$= \frac{2ck}{k+1}$$

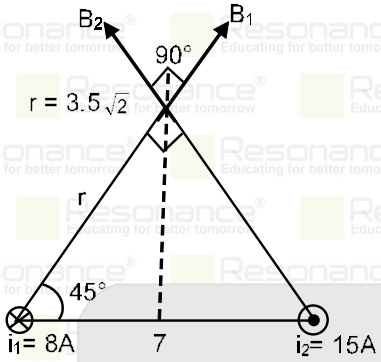
$$C_{eq} = \frac{2 \times 5 \times 1.5}{1.5 + 1}$$

$C_{eq} = 6\ \mu F$

26. Two long parallel wires carrying current 8A and 15A in opposite directions are placed at a distance of 7cm from each other. A point P is at equidistant from both the wires such that the lines joining the point P to the wires are perpendicular to each other. The magnitude of magnetic field at P is _____ 10^{-6}T.
(Given : $\sqrt{2} = 1.4$)

Ans. **(68)**

Sol.



$$B = \frac{\mu_0}{2\pi r} i$$

$$B_1 = \frac{\mu_0}{2\pi} \times \frac{8}{3.5\sqrt{2}}$$

$$B_2 = \frac{\mu_0}{2\pi} \times \frac{15}{3.5\sqrt{2}}$$

$$B_{net} = \sqrt{B_1^2 + B_2^2}$$

$$B_{net} = \frac{\mu_0}{2\pi} \times \frac{1}{3.5\sqrt{2}} \sqrt{8^2 + 15^2}$$

$$B_{net} = \frac{\mu_0}{2\pi} \times \frac{1}{3.5\sqrt{2}} \times 17$$

$$B_{net} = 68 \times 10^{-6}\ T$$

27. If a solid sphere of mass 5kg and a disc of mass 4kg have the same radius. Then the ratio of moment of inertia of the disc about a tangent in its plane to the moment of inertia of the sphere about its tangent will be $\frac{x}{7}$. Then the value of x is _____.

Ans. **(5)**

Sol. $I_1 = \frac{2}{5}MR^2 + MR^2$ $\qquad$ $I_2 = \frac{mR^2}{4} + mR^2$

$= \frac{7}{5}MR^2 = \frac{7}{5} \times 5R^2 = 7R^2$ $\qquad$ $= \frac{5}{4}mR^2 = \frac{5}{4} \times 4R^2 = 5R^2$

$$\frac{I_1}{I_2} = \frac{7R^2}{5R^2}$$

$$\frac{I_1}{I_2} = \frac{7}{5}$$

28. A spherical drop of liquid splits into 1000 identical spherical drops. If u_i is the surface energy of the original drop and μ_f is the total surface energy of the resulting drops, the (ignoring evaporation), $\frac{\mu_f}{\mu_i} = \left(\frac{10}{x}\right)$. The value of x is _____ :

Ans. **(1)**

Sol.

$n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$1000 \times r^3 = R^3$

$r = R/10$

$\mu_i = T \times 4\pi R^2$

$\mu_f = n \times T \times 4\pi \times r^2$

$\frac{\mu_i}{\mu_f} = \frac{R^2}{r^2 n} = \frac{R^2 \times 100}{R^2 \times 1000} = \frac{1}{10}$

29. A nucleus disintegrates into two smaller parts, which have their velocities in the ratio 3 : 2. The ratio of their nuclear sizes will be $\left(\frac{x}{3}\right)^{\frac{1}{3}}$. The value of 'x' is :

Ans. **(2)**

Sol. By Liner momentum conservation

$m_1 v_1 = m_2 v_2$

$\frac{m_1}{m_2} = \frac{2}{3}$

$\frac{m_1}{m_2} = \frac{\rho V_1}{\rho V_2} = \frac{2}{3}$

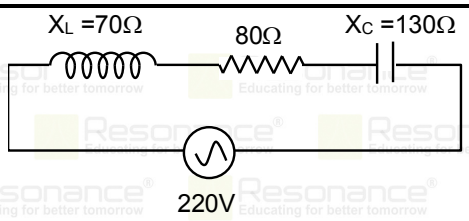
$\frac{R_1}{R_2} = \left[\frac{2}{3}\right]^{1/3}$

by comparing x = 2

30. A series LCR circuit is connected to an AC source of 220V, 50 Hz. The circuit contains a resistance R = 80Ω, an inductor of inductive reactance X_L = 70Ω, and a capacitor of capacitive reactance X_C = 130Ω. The power factor of circuit is $\frac{x}{10}$. The value of x is :

Ans. **(8)**

Sol.



Power factor; $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

$= \frac{80}{\sqrt{80^2 + (130 - 70)^2}} = \frac{80}{100} = \frac{8}{10}$

$= x = 8$

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JEE (ADVANCED) 2022 RESULT

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AIR-1 GEN-EWS

KARTHIKEYA POLISETTY
Roll No.: 21925115

AIR 8

DHEERAJ KURUKUNDA
Roll No.: 21925114

Students in TOP-100 All India Ranks (AIRs)

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DEEVYANSHU MALU
Roll No.: 21219044

AIR-15
ABHIJEET ANAND
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for Class XII Passed Student
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MODE: OFFLINE / ONLINE
CLASS STARTS 10th & 17th April

TARGET: JEE (Main) 2024
for Class XII Passed Student
ABHYAAS COURSE
MODE: OFFLINE / ONLINE
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SCHOLARSHIP ON THE BASIS OF JEE (MAIN) 2023 %ILE / AIR

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