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# JEE (Main)

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

# 2023

# COMPUTER BASED TEST (CBT)

## Questions & Solutions

**Date: 12 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 wire of resistance 160 Ω is melted and drawn in a wire of one-fourth of its length. The new resistance of the wire will be

(1) 10 Ω (2) 16 Ω (3) 640 Ω (4) 40 Ω

**NTA Ans. (1)**

**Reso Ans. (1)**

**Sol.** $R = \frac{\rho\ell}{A} = 160\ \Omega$

$$R^1 = \frac{\rho\frac{\ell}{4}}{4A} = \frac{\rho\ell}{16A} \quad \{v = \ell A = \text{constant}\}$$

$$\Rightarrow\ R' = \frac{R}{16} = \frac{160}{16} = 10\ \Omega$$

**32.** A ball is thrown vertically upward with an initial velocity of 150 m/s. The ratio of velocity after 3 s and 5 s is $\frac{x+1}{x}$. The value of x is {take, g = 10 m/s$^2$}

(1) 6 (2) –5 (3) 5 (4) 10

**NTA Ans. (3)**

**Reso Ans. (3)**

**Sol.** $v = u + at$

$v_1 = 150 - 10 \times 3 = 120$ m/s

$v_2 = 150 - 10 \times 5 = 100$ m/s

$$\frac{v_1}{v_2} = \frac{120}{100} = \frac{12}{10} = \frac{6}{5}$$

**33.** Three forces $F_1$ =10 N, $F_2$ = 8 N, $F_3$ = 6 N are acting on a particle of mass 5 kg. The forces $F_2$ and $F_3$ are applied perpendicularly so that particle remains at rest. If the force $F_1$ is removed, then the acceleration of the particle is:

(1) 7 ms$^{-2}$ (2) 4.8 ms$^{-2}$ (3) 2 ms$^{-2}$ (4) 0.5 ms$^{-2}$

**NTA Ans. (3)**

**Reso Ans. (3)**

**Sol.** Net force after $F_1$ is removed

$$F_{net} = \sqrt{6^2 + 8^2} = 10$$

$$\text{so } a = \frac{10}{5} = 2\text{m/s}^2$$

**34.** A proton and an $\alpha$-particle are accelerated from rest by 2 V and 4 V potentials, respectively. The ratio of their de-Broglie wavelength is:

(1) 4 : 1 (2) 16 : 1 (3) 2 : 1 (4) 8 : 1

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

**Sol.** $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mk}} = \frac{h}{\sqrt{2mqV}}$

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha}{m_p}.\frac{q_\alpha}{q_p}\frac{V_\alpha}{V_p}} = \sqrt{\frac{4}{1}\times\frac{2}{1}\times\frac{4}{2}} = 4$$

**35.** A body cools from 80°C to 60°C in 5 minutes. The temperature of the surrounding is 20°C. The time it takes to cool from 60°C to 40°C is:

(1) 500 s (2) 450 s (3) $\frac{25}{3}$ s (4) 420 s

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

**Sol.** $\frac{dQ_{loss}}{dt} = -ms\frac{dt}{dt} = KA(T - T_0)$

$$ms\frac{(80-60)}{5\,min.} = KA\left(\frac{80+60}{2} - 20\right)$$

$$ms\frac{(60-40)}{\Delta t} = KA\left(\frac{60+40}{2} - 20\right)$$

$$\frac{\Delta t}{5} = \frac{50}{30} \Rightarrow \Delta t = \frac{25}{3} = 8.3 \text{ minutes}$$

**36.** Two satellites A and B move round the earth in the same orbit. The mass of A is twice the mass of B. The quantity which is same for the two satellites will be

(1) Potential energy (2) Kinetic energy (3) Speed (4) Total energy

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

**Sol.** $V = \sqrt{\frac{GM}{r}}$ (Same for both the satellites)

**37.** Given below are two statements:

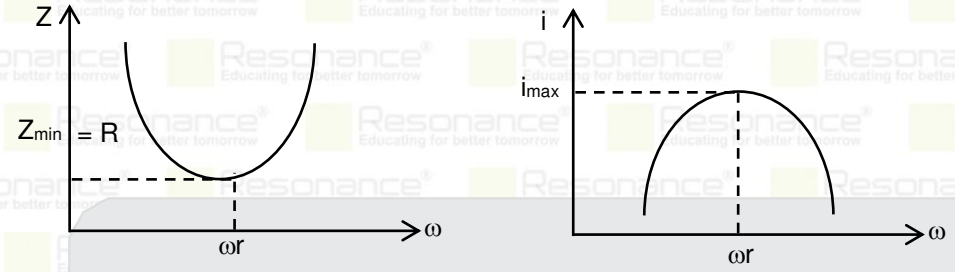
**Statement I:** When the frequency of an a.c source in a series LCR circuit increases, the current in the circuit first increases, attains a maximum value and then decreases.

**Statement II:** In a series LCR circuit, the value of power factor at resonance is one.

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

(1) Both Statement I and Statement II are true.
(2) Statement I is incorrect but Statement II is true.
(3) Both Statement I and Statement II are False.
(4) Statement I is correct but Statement II is false.

**NTA Ans. (2)**
**Reso Ans. (1)**
**Sol.**




At resonance
$Z = Z_{min} = R$

So $\cos\phi = \frac{R}{Z} = 1$

**38.** Given below are two statements:

**Statement I:** A truck and a car moving with same kinetic energy are brought to rest by applying breaks which provide equal retarding forces. Both come to rest in equal distance.

**Statement II:** A car moving towards east takes a turn and moves towards north, the speed remains unchanged. The acceleration of the car is zero.

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

(1) Statement I is incorrect but Statement II is correct.
(2) Both Statement I and Statement II are incorrect.
(3) Both Statement I and Statement II are correct.
(4) Statement I is correct but Statement II is incorrect.

**NTA Ans. (4)**
**Reso Ans. (4)**
**Sol.** Using work power Energy

$w = K_f - K_i$

$\Rightarrow -Fx = 0 - K_i$

$\Rightarrow x = \frac{K_i}{F}$

Both F & $K_i$ are same so x will be same

Velocity of car changes so there will be non zero acceleration.

**39.** An engine operating between the boiling and freezing points of water will have

(A) efficiency more than 27%.
(B) efficiency less than the efficiency of a Carnot engine operating between the same two temperatures.
(C) efficiency equal to 27%
(D) efficiency less than 27%

Choose the correct answer from the options given below:

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

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

**Sol.** Carrot efficiency

$$\eta = 1 - \frac{T_{less}}{T_{more}} = 1 - \frac{273}{373} = 26.8\ \%$$

so for all cycles working between 100ºC and 0ºC

$\eta = \leq 26.8\%$

Both assertion and reason are true and the reason is the correct explainer of the assertion

**40.** The ratio of escape velocity of a planet to the escape velocity of earth will be:
Given: Mass of the planet is 16 times mass of earth and radius of the planet is 4 times the radius of earth.

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

**NTA Ans. (3)**

**Reso Ans. (1)**

**Sol.** $v = \sqrt{\frac{2GM}{R}}$

$$\frac{v_p}{v_e} = \sqrt{\frac{M_p}{M_e}\frac{R_e}{R_p}} = \sqrt{16 \times \frac{1}{4}} = 2$$

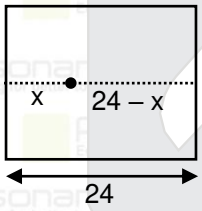
**41.** An ice cube has a bubble inside. When viewed from one side the apparent distance of the bubble is 12 cm. When viewed from the opposite side, the apparent distance of the bubble is observed as 4 cm. If the side of the ice cube is 24 cm, the refractive index of the ice cube is

(1) $\frac{6}{5}$ (2) $\frac{3}{2}$ (3) $\frac{4}{3}$ (4) $\frac{2}{3}$

**NTA Ans. (2)**

**NTA Ans. (2)**

**Sol.**




$$d' = \frac{d}{n_{rad}}$$

$$\Rightarrow 12 = \frac{x}{n} \quad ....(1)$$

$$4 = \frac{24 - x}{n}$$

$$\Rightarrow 4 = \frac{24 - 12n}{n} \Rightarrow 4n = 24 - 12\ n \Rightarrow 16n = 24$$

$$\Rightarrow n = \frac{24}{16} = \frac{6}{4} = \frac{3}{2}$$

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

**Assertion A:** EM waves used for optical communication have longer wavelengths than that of microwave, employed in Radar technology.

**Reason R :** Infrared EM waves are more energetic than microwaves, (used in Radar)

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

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

(2) A is true but R is false

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

(4) A is false but R is true

**NTA Ans. (1)**

**Reso Ans. (1)**

**43.** In an n-p-n common emitter (CE) transistor the collector current changes from 5 mA to 16 mA for the change in base current from 100 µA and 200 µA, respectively. The current gain of transistor is_____.

(1) 9 (2) 210 (3) 110 (4) 0.9

**NTA Ans. (3)**

**Reso Ans. (3)**

**Sol.** $B = \frac{\Delta IC}{\Delta IB} = \frac{(16-5)\times 10^{-3}}{(200-100)\times 10^{-6}} = \frac{11\times 10^{-3}}{100\times 10^{-6}} = 110$

**44.** The amplitude of 15 sin (1000 $\pi$t) is modulated by 10 sin (4 $\pi$t) signal. The amplitude modulated signal contains frequencies of

(A) 500 Hz (B) 2 Hz (C) 250 Hz (D) 498 Hz

(E) 502 Hz

Choose the correct answer from the options given below:

(1) A, D and E only (2) A and D only

(3) A and C only (4) A and B only

**NTA Ans. (1)**

**Reso Ans. (1)**

**Sol.** $C(t) = 10\sin(1000\pi t) \Rightarrow \omega_c = 1000\pi = 2\pi f_c$

$f_c = 500$ Hz

$m(t) = 5\sin(4\pi t) \Rightarrow \omega_m = 4\pi = 2\pi f_m$

$f_m = 2$Hz

The frequencies contained in the resultant amplitude modulated wave:-

$f_c$, $f_c + f_m$, $f_c - f_m$

= 500 Hz, 502 Hz, 498 Hz

**45.** Match List I with List II

| LIST-I | LIST-II |
|---|---|
| (A) Spring constant | (I) $[T^{-1}]$ |
| (B) Angular speed | (II) $[MT^{-2}]$ |
| (C) Angular momentum | (III) $[ML^2]$ |
| (D) Moment of Inertia | (IV) $[ML^2T^{-1}]$ |

Choose the correct answer from the options given below:

(1) A-I, B-III, C-II, D-IV (2) A-II, B-III, C-I, D-IV (3) A-IV, B-I, C-III, D-II (4) A-II, B-I, C-IV, D-III

**NTA Ans. (4)**

**Reso Ans. (4)**

**Sol.** Moment of inertia

$I = mr^2$

$[I] = [M][L^2] = ML^2$

Angular speed $\omega = \frac{d\theta}{dt} = \frac{1}{T} = M^0L^0T^{-1}$

Angular momentum $L = mvr = (M)(L/T)(L) = M^1L^2T^{-1}$

spring constant $K = \frac{F}{x} = \frac{M^1T^1T^{-2}}{L^1} = M^1L^0T^{-2}$

**46.** If the r. m. s speed of chlorine molecule is 490 m/s at 27°C, the r. m. s speed of argon molecules at the same temperature will be (Atomic mass of argon = 39.9 u, molecular mass of chlorine = 70.9 u)

(1) 751.7 m/s (2) 651.7 m/s (3) 451.7 m/s (4) 551.7 m/s

**NTA Ans. (2)**

**Reso Ans. (2)**

**Sol.** $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{rms} \propto \frac{1}{\sqrt{M}}$

$\frac{V_{Ar}}{V_{Cl}} = \sqrt{\frac{M_{Cl}}{M_{Ar}}} \Rightarrow V_{Ar} = V_{Cl}\sqrt{\frac{M_{Cl}}{M_{Ar}}} = 490\sqrt{\frac{70.9}{39.9}} = 651.7 \text{ m/s}$

**47.** Given below are two statements:

**Statement I:** The diamagnetic property depends on temperature.

**Statement II:** The induced magnetic dipole moment in a diamagnetic sample is always opposite to the magnetizing field.

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

(1) Both Statement I and Statement II are true.

(2) Both Statement I and Statement II are False.

(3) Statement I is incorrect but Statement II is true.

(4) Statement I is correct but Statement II is false.

**NTA Ans. (3)**

**Reso Ans. (3)**

**48.** A particle is executing simple harmonic motion (SHM). The ratio of potential energy and kinetic energy of the particle when its displacement is half of its amplitude will be

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

**NTA Ans. (1)**

**Reso Ans. (1)**

**Sol.** $U = \frac{1}{2} mw^2x^2$ & $k = \frac{1}{2} mw^2 (A^2-x^2)$

so $\frac{U}{K} = \frac{x^2}{A^2-x^2} = \frac{(A/2)^2}{A^2-(A/2)^2} = \frac{1/4}{1-1/4} = \frac{1}{4} \times \frac{4}{3} = \frac{1}{3}$

**49.** A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. The number of spectral lines emitted will be:

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

**NTA Ans. (2)**

**Reso Ans. (Bonus)**

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

**Assertion A:** If an electric dipole of dipole moment $30 \times 10^{-5}$ Cm is enclosed by a closed surface, the net flux coming out of the surface will be zero.

**Reason R:** Electric dipole consists of two equal and opposite charges.

In the light of 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 and R is the correct explanation of A

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

(4) A is true but R is false

**NTA Ans. (2)**

**Reso Ans. (2)**

**Sol.** Both the statements are correct.

**51.** To maintain a speed of 80 km/h by a bus of mass 500 kg on a plane rough road for 4 km distance, the work done by the engine of the bus will be_____ KJ. [The coefficient of friction between tyre of bus and road is 0.04.]

**NTA Ans. 784**

**Reso Ans. 784**

**Sol.** The value of rolling friction

$F = \mu mg = 0.04 \times 500 \times 10 = 196N$

So, $W = Fs = 196 \times 4 \times 10^3 = 784 \times 10^3$ J

**52.** A common example of alpha decay is

$${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}_2He^4 + Q$$

Given:

$${}^{238}_{92}U = 238.05060\ u$$

$${}^{234}_{90}Th = 234.04360\ u$$

$${}^{4}_{2}He = 4.00260\ u \text{ and } 1u = 931.5\ \frac{MeV}{c^2}$$

The energy released (Q) during the alpha decay of ${}^{238}_{92}U$ is_____MeV

**NTA Ans. 4**

**Reso Ans. 4**

**Sol.** $\Delta m = 238.05060 - (234.04360 + 4.00260) = 0.0044$

So $Q = \Delta m \times 931.5 = 0.0044 \times 931.5 = 4.0986$ MeV

**53.** A conducting circular loop is placed in a uniform magnetic field of 0.4 T with its plane perpendicular to the field. Somehow, the radius of the loop starts expanding at a constant rate of 1 mm/s. The magnitude of induced emf in the loop at an instant when the radius of the loop is 2 cm will be μV.

**NTA Ans. 50**

**Reso Ans. 50**

**Sol.** $\phi = BA = (0.4)\ \pi r^2$

$$emf = \frac{d\phi}{dt} \times (0.4\pi)\ (2r\ \frac{dr}{dt})$$

$$emf = 0.8\ \pi r \left(\frac{dr}{dt}\right)$$

$$emf = 0.8 \times 3.14 \times (2 \times 10^{-2})\ (1 \times 10^{-3})$$

$$emf = 50\mu \text{ volt}$$

**54.** 64 identical drops each charged upto potential of 10 mV are combined to form a bigger drop. The potential of the bigger drop will be _____mV.

**NTA Ans. 160**

**Reso Ans. 160**

**Sol.**


Charge on the bigger drop = nq

Radius of the bigger drop = $n^{1/3}R$

$$V \propto \frac{q}{R} = \frac{n}{n^{1/3}} = n^{2/3} \text{ time} = (64)^{2/3} = 16 \text{ times}$$

= 16 × 10 m volt = 160 m volt

**55.** A compass needle oscillates 20 times per minute at a place where the dip is 30° and 30 times per minute where the dip is 60°. The ratio of total magnetic field due to the earth at two places respectively is $\frac{4}{\sqrt{x}}$

The value of x is

**NTA Ans. 243**

**Reso Ans. 243**

**Sol.** $T = 2\pi\sqrt{\frac{I}{MB}}$ so $T \propto \frac{I}{\sqrt{B}}$

$T = \frac{1}{20}$ min & $T^1 = \frac{1}{30}$ min.

$$\frac{T}{T'} = \sqrt{\frac{B'\cos 60^\circ}{B\cos 30^\circ}} \Rightarrow \frac{B'}{B} = \sqrt{3}\left(\frac{T}{T'}\right)^2 = \sqrt{3}\left(\frac{3}{2}\right)^2 = \sqrt{3}\frac{9}{4}$$

So $\frac{B}{B'} = \frac{4}{9\sqrt{3}} = \frac{4}{\sqrt{243}}$

**56.** For a rolling spherical shell, the ratio of rotational kinetic energy and total kinetic energy is $\frac{x}{5}$. The value of x is_____.

**NTA Ans. 02**

**Reso Ans. 02**

**Sol.** $$\frac{K_R}{K_T} = \frac{\frac{1}{2}I\omega^2}{\frac{1}{2}I\omega^2 + \frac{1}{2}MV^2} = \frac{\frac{1}{2}\frac{2}{3}MR^2\omega^2}{\frac{1}{2}\frac{2}{3}MR^2\omega^2 + \frac{1}{2}MR^2\omega^2} = \frac{\frac{2}{3}}{\frac{2}{3}+1} = \frac{2}{5}$$

**57.** Glycerin of density $1.25 \times 10^3$ kg $m^{-3}$ is flowing through the conical section of pipe. The area of cross-section of the pipe at its ends are 10 $cm^2$ and 5 $cm^2$ and pressure drop across its length is 3 $Nm^{-2}$. The rate of flow of glycerin through the pipe is $x \times 10^{-5}$ $m^3s^{-1}$. The value of x is_____.

**NTA Ans. 04**

**Reso Ans. 04**

**Sol.**

$A_1V_1 = A_2V_2$

$\Rightarrow 10V_1 = 5V_2 \quad \Rightarrow V_2 = 2V_1$

and $P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$

$\Rightarrow P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$

$\Rightarrow 3 = \frac{1}{2} \times 1.25 \times 10^3 \times 3V_1^2$

$\Rightarrow V_1^2 = \frac{200}{125\times10^3} = \frac{1}{625}$

$\Rightarrow V_1 = \frac{1}{25}$ m/s

So rate of flow $\theta = A_1V_1 = 10 \times 10^{-4} \times \frac{1}{25} = 4 \times 10^{-5}$ m$^3$/s

**58.** For a certain organ pipe, the first three resonance frequencies are in the ratio of 1 : 3 : 5 respectively. If the frequency of fifth harmonic is 405 Hz and the speed of sound in air is 324 ms$^{-1}$ the length of the organ pipe is _____m.

**NTA Ans. 1**

**Reso Ans. 1**

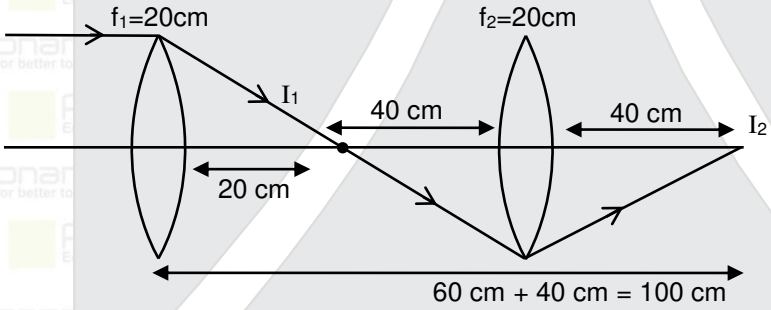
**Sol.** $405 = 5\frac{V}{4\ell} \Rightarrow \ell = \frac{5\times324}{4\times405} = 1$

**59.** Two convex lenses of focal length 20 cm each are placed coaxially with a separation of 60 cm between them. The image of the distant object formed by the combination is at _____cm from the first lens.

**NTA Ans. 100**

**Reso Ans. 100**

**Sol.**




For 2nd lens

$\frac{1}{v} - \frac{1}{4} = \frac{1}{f}$ ; $\frac{1}{v} - \frac{1}{40} = \frac{1}{20}$ ; $\frac{1}{v} = \frac{1}{20} - \frac{1}{40}$ ; v = 40 cm

$\therefore$ Distance of final image from first lens = (60 + 40) cm = 100 cm

**60.** The current flowing through a conductor connected across a source is 2 A and 1.2 A at 0°C and 100°C respectively. The current flowing through the conductor at 50°C will be_____$\times10^2$ mA.

**NTA Ans. 15**

**Reso Ans. 15**

**Sol.** $R_2 = R_1(1 + \alpha\Delta T)$

let resistance of wire at 0°C is R

So, $2R = 1.2\,R(1 + \alpha\,100)$

$\Rightarrow \quad \alpha = 1/150$

and $2R = iR(1 + \alpha 50)$

$\Rightarrow \quad 2 = i(1 + 1/150 \times 50) = i(1 + 1/3)$

$\Rightarrow \quad 2 = \frac{4}{3}i \Rightarrow i = 3/2 = 1.5A$