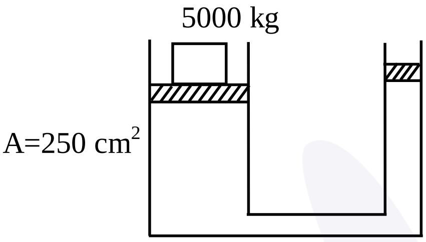
# FINAL JEE–MAIN EXAMINATION – APRIL, 2023
Held On Saturday 08th April, 2023
TIME : 03:00 PM to 06:00 PM

## SECTION - A

**31.** A hydraulic automobile lift is designed to lift vehicles of mass 5000 kg. The area of cross section of the cylinder carrying the load is 250 $cm^2$. The maximum pressure the smaller piston would have to bear is [Assume g = 10 $m/s^2$] :

(1) $2 \times 10^{+5}$ Pa (2) $20 \times 10^{+6}$ Pa (3) $200 \times 10^{+6}$ Pa (4) $2 \times 10^{+6}$ Pa

**Sol.** **(4)**




From pascal law same $\Delta P$ transmitted through out liquid

$$\Delta P = \frac{F}{A} = \frac{5000 \times 10}{250 \times 10^{-4}}$$

$= 2 \times 10^6$ Pa

**32.** The orbital angular momentum of a satellite is L, when it is revolving in a circular orbit at height h from earth surface. If the distance of satellite from the earth center is increased by eight times to its initial value, then the new angular momentum will be-

(1) 8L (2) 3L (3) 4L (4) 9L

**Sol.** **(2)**

$$L = mv_0r \left(v_0 = \sqrt{\frac{GM}{h}}\right)$$

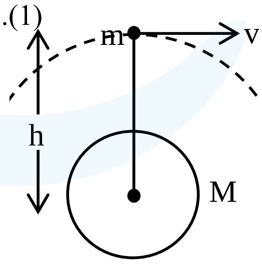
$L = m\sqrt{GMh}$ …….(1)

h' → h + 8h = 9h

$L' = m\sqrt{GM9h}$ ……..(2)

$\frac{L'}{L} = 3$

L' = 3L




**33.** The waves emitted when a metal target is bombarded with high energy electrons are

(1) Microwaves (2) X-rays (3) Radio Waves (4) Infrared rays

**Sol.** **(2)**

By theory

**34.** Match List I with List II

| LIST – I | | LIST – II | |
|---|---|---|---|
| A. | Torque | I. | $ML^{-2}T^{-2}$ |
| B. | Stress | II. | $ML^2T^{-2}$ |
| C. | Pressure gradient | III. | $ML^{-1}t^{-1}$ |
| D. | Coefficient of viscosity | IV | $ML^{-1}T^{-2}$ |

Choose the correct answer from the options given below:

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

**Sol.** **(4)**

[Torque] = F.L

$MLT^{-2}.L = ML^2T^{-2}$

[Stress] = $\frac{F}{A}$

$\frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

[Pressure gradient] = $\frac{\Delta P}{\Delta L} = \frac{F}{A^2.L}$

$= \frac{MLT^{-2}}{L^3}$

$= ML^{-2}T^{-2}$

$F = nA\frac{dv}{dy}$

$\eta = ML^{-1}T^{-1}$

**35.** Give below are two statements

**Statement I :** Area under velocity- time graph gives the distance travelled by the body in a given time.

**Statement II :** Area under acceleration- time graph is equal to the change in velocity- in the given time.

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

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

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

(3) Both Statement I and and Statement II are false.

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

**Sol.** **(Official Ans. (1))**

**(Motion Ans. (4))**

$\vec{v} = \frac{d\vec{s}}{dt} \Rightarrow \int d\vec{s} = \int \vec{v}\,dt$

Area of $\vec{v}$ vs time gives displacement

$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \int d\vec{v} = \int \vec{a}\,dt$

Area of $\vec{a}$ vs t graph gives change in velocity

**36.** The power radiated from a linear antenna of length $l$ is proportional to (Given, $\lambda$ = Wavelength of wave):

(1) $\frac{l}{\lambda}$ (2) $\frac{l^2}{\lambda}$ (3) $\frac{l}{\lambda^2}$ (4) $\left(\frac{l}{\lambda}\right)^2$

**Sol.** **(4)**

**37.** Electric potential at a point 'P' due to a point charge of $5 \times 10^{-9}$C is 50 V. The distance of 'P' from the point charge is:

(Assume, $\frac{1}{4\pi\varepsilon_0}$ = $9 \times 10^{+9}$ Nm$^2$C$^{-2}$)

(1) 3 cm (2) 9 cm (3) 0.9 cm (4) 90 cm

**Sol.** **(4)**

$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

$\Rightarrow r = \frac{9\times10^9\times5\times10^{-9}}{50}$

$\Rightarrow r = \frac{9}{10}\times100\,\text{cm}$

r = 90 cm

**38.** The acceleration due to gravity at height h above the earth if h<<R (Radius of earth) is given by

(1) $g' = g\left(1-\frac{h^2}{2R^2}\right)$ (2) $g' = g\left(1-\frac{h}{2R}\right)$ (3) $g' = g\left(1-\frac{2h^2}{R^2}\right)$ (4) $g' = g\left(1-\frac{2h}{R}\right)$

**Sol.** **(4)**

$g' = \frac{GM}{(R+h)^2}$

$g' = \frac{GM}{R^2\left(1+\frac{h}{R}\right)^2}$

using binomial expansion & neglect higher order term

$\Rightarrow g' = g\left(1-\frac{2h}{R}\right)$

**39.** An emf of 0.08 V is induced in a metal rod of length 10 cm held normal to a uniform magnetic field of 0.4 T, when moves with a velocity of:

(1) 2 $ms^{-1}$ (2) 20 $ms^{-1}$ (3) 3.2 $ms^{-1}$ (4) 0.5 $ms^{-1}$

**Sol.** **(1)**

$\varepsilon = Blv$

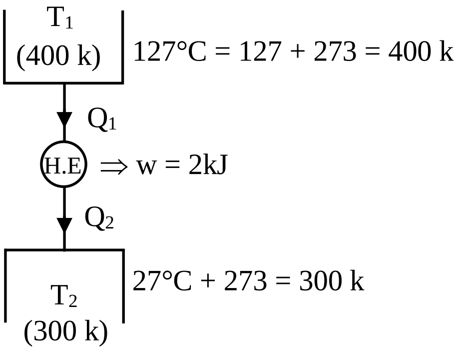
$\Rightarrow 0.08 = v\times0.4\times\frac{10}{100}$

$\Rightarrow v = 2$ m/s

**40.** Work done by a Carnot engine operating between temperatures 127°C and 27°C is 2 kJ. The amount of heat transferred to the engine by the reservoir is:

(1) 2 kJ (2) 4 kJ (3) 2.67 kJ (4) 8 kJ

**Sol.** **(4)**




$n = 1 - \frac{300}{400} = \frac{1}{4}$

$n = \frac{w}{Q_1} = \frac{1}{4} \Rightarrow Q_1 = 8kJ$

**41.** The width of fringe is 2 mm on the screen in a double slits experiment for the light of wavelength of 400 nm. The width of the fringe for the light of wavelength 600 nm will be:
(1) 1.33 mm (2) 3 mm (3) 2 mm (4) 4 mm

**Sol.** **(2)**

$\beta = \frac{D\lambda}{d}$

$\Rightarrow \beta \propto \lambda$

$\frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2} \Rightarrow \frac{2}{\beta} = \frac{400}{600}$

$\beta = 3$ mm

**42.** The temperature at which the kinetic energy of oxygen molecules becomes double than its value at 27°C is
(1) 1227°C (2) 627°C (3) 327°C (4) 927°C

**Sol.** **(3)**

KE of $O_2$ molecules = $5 \times \left(\frac{1}{2}KT\right)$

$(KE)_{27°C} = 5 \times \frac{1}{2}k(27+273) = \frac{5}{2}k \times 300$

$(KE)_T = 2\left(\frac{5}{2}k\right) \times 300 = \frac{5}{2}k(600)$

i.e. T = 600 K

= 600 – 273

T = 327°C

**43.** Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**
**Assertion A :** Electromagnets are made of soft iron.
**Reason R :** Soft iron has high permeability and low retentivity.
In the light of above, statements, chose the **most appropriate** answer from the options given below.
(1) **A** is correct but **R** is not correct

(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(3) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**
(4) **A** is not correct but **R** is correct

**Sol.** **(2)**

**44.** The trajectory of projectile, projected from the ground is given by $y = x - \frac{x^2}{20}$ . Where x and y are measured in meter. The maximum height attained by the projectile will be.

(1) 10 m (2) 200 m (3) $10\sqrt{2}$ m (4) 5 m

**Sol.** **(4)**

$$y = x - \frac{x^2}{20}$$

$$\left(\frac{dy}{dx}\right) = 1 - \frac{x}{10} \quad \text{for } y_{max}\,;\ \frac{dy}{dx} = 0$$

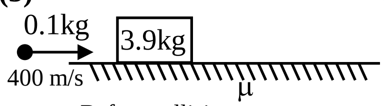
$$x = 10$$

$$y_{max} = 10 - \frac{100}{20} = 5m$$

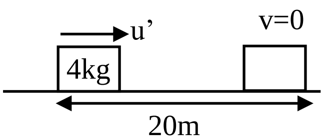
**45.** A bullet of mass 0.1 kg moving horizontally with speed 400 $ms^{-1}$ hits a wooden block of mass 3.9 kg kept on a horizontal rough surface. The bullet gets embedded into the block and moves 20 m before coming to rest. The coefficient of friction between the block and the surface is _______.
(Given g = 10 $m/s^2$)

(1) 0.90 (2) 0.65 (3) 0.25 (4) 0.50

**Sol.** **(3)**



Before collision



After collision

Apply momentum conservation just before and just after the collision

$$0.1 \times 400 = (3.9 + .1)\,u'$$

$$\Rightarrow u = 10 \text{ m/s}$$

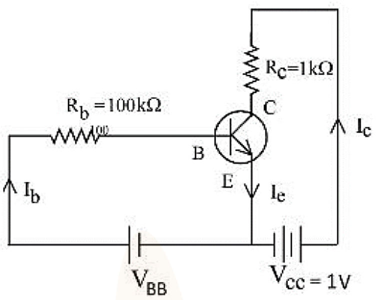
$$\Delta KE = W_{\text{all FORCE}}$$

$$\because f = \mu mg \text{ (kinetic friction)}$$

$$\Rightarrow 0 - \frac{1}{2}(4)(10)^2 = -\mu(4)g \times 20$$

$$\Rightarrow \mu = 0.25$$

**46.** For a given transistor amplifier circuit in CE configuration $V_{CC}$ = 1 V, $R_C$ = 1 kΩ, $R_b$ = 100 kΩ and β = 100. Value of base current $I_b$ is




(1) $I_b = 100\ \mu A$ (2) $I_b = 10\ \mu A$ (3) $I_b = 0.1\ \mu A$ (4) $I_b = 1.0\ \mu A$

**Sol.** **(2)**

$V_{cc} = 1\text{ V}$

$R_c I_c = 1$

$I_c = \frac{1}{10^3}\text{A} = 1\text{ mA}$

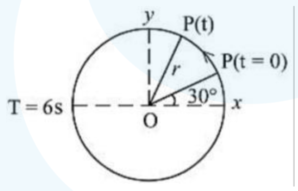
$\beta = \frac{I_c}{I_\beta}$

$I_\beta = \frac{I_C}{\beta}$

$= 1 \times 10^{-5}\text{ A}$

$= 10\ \mu A$

**47.** For particle P revolving round the centre O with radius of circular path r and angular velocity ω, as shown in below figure, the projection of OP on the x-axis at time t is

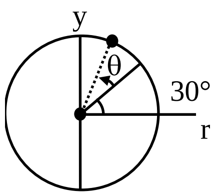



(1) $x(t) = r\cos\left(\omega t + \frac{\pi}{6}\right)$ (2) $x(t) = r\cos\left(\omega t - \frac{\pi}{6}\omega\right)$

(3) $x(t) = r\cos(\omega t)$ (4) $x(t) = r\sin\left(\omega t + \frac{\pi}{6}\right)$

**Sol.** **(1)**

$\theta = \omega t$




Angle from x axis $= \omega t + \frac{\pi}{6}$

Projection of OP on x axis $= r\cos\left(\omega t + \frac{\pi}{6}\right)$

**48.** A radio active material is reduced to 1/8 of its original amount in 3 days. If $8 \times 10^{-3}$ kg of the material is left after 5 days the initial amount of the material is

(1) 64 g (2) 40 g (3) 32 g (4) 256 g

**Sol.** **(4)**

$m = m_0 e^{-\lambda t}$

$\frac{m_0}{8} = m_0 e^{-\lambda t}$

$-\ln 8 = -\lambda t$

$= \lambda = \frac{\ln 8}{3}$ per day

$m = m_0 e^{-\lambda t}$

$8 = m_0 \ e^{-\frac{\ln 8}{3}\times 5}$

$\Rightarrow 8 = m_0 \ e^{-\frac{3\ln 2}{3}\times 5}$

$8 = m_0 \ e^{\ln 2^{-5}}$

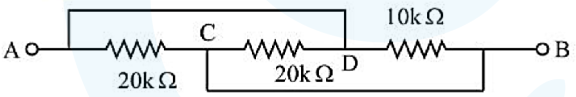
$= 8 \ m_0 \left(\frac{1}{2^5}\right)$

$m_0 = 8 \times 2^5$

$= 8 \times 32$

$m_0 = 256$ gm

**49.** The equivalent resistance between A and B as shown in figure is:




(1) 20 kΩ (2) 30 kΩ (3) 5 kΩ (4) 10 kΩ

**Sol.** **(3)**

Potential different across all resistor is same

So they are in parallel

$\frac{1}{R} = \frac{1}{20} + + \frac{1}{20} + \frac{1}{10}$

$R_{eq} = 5k\Omega$

**50.** In photo electric effect

A. The photocurrent is proportional to the intensity of the incident radiation.

B. Maximum Kinetic energy with which photoelectrons are emitted depends on the intensity of incident light.

C. Max K.E with which photoelectrons are emitted depends on the frequency of incident light.

D. The emission of photoelectrons require a minimum threshold intensity of incident radiation.

E. Max. K.E of the photoelectrons is independent of the frequency of the incident light.

Choose the correct answer from the options given below:

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

**Sol.** **(2)**

$h\nu = \phi + (KE)_{max}$

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

## SECTION - B

**51.** A 600 pF capacitor is charged by 200 V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. Electrostatic energy lost in the process is _________ μJ

**Sol.** **(6)**

loss of strength = $\frac{1}{2}\frac{c\times c}{c+c}(v_1-v_2)^2$

$= \frac{1}{2}\times\left[\frac{600\times10^{-12}}{2}\right]\times(200)^2$

= 600 × $10^{-12}\times10^4 = 6\times10^{-6} = 6\mu J$

**52.** A series combination of resistor of resistance 100 Ω, inductor of inductance 1 H and capacitor of capacitance 6.25 μF is connected to an ac source. The quality factor of the circuit will be __________

**Sol.** **(4)**

$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

$= \frac{1}{100}\sqrt{\frac{1}{6.25\times10^{-6}}}$

= 4

**53.** The number density of free electrons in copper is nearly 8 × $10^{28}$ $m^{-3}$. A copper wire has its area of cross section = 2 × $10^{-6}$ $m^2$ and is carrying a current of 3.2 A. The drift speed of the electrons is ________ $\times10^{-6}$ $ms^{-1}$

**Sol.** **(125)**

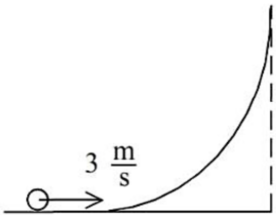
I = neAvd

$\Rightarrow 3.2 = 8\times10^{28}\times1.6\times10^{-19}\times2\times10^{-6}(v_d)$

$\Rightarrow v_d = \frac{1}{8\times10^{-6}\times10^{9}}$

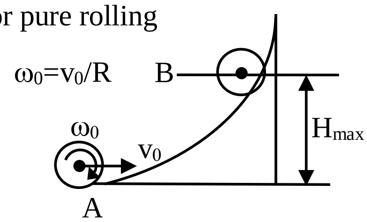
$\Rightarrow v_d = 125\times10^{-6}$ m/s

**54.** A hollow spherical ball of uniform density rolls up a curved surface with an initial velocity 3 m/s (as shown in figure). Maximum height with respect to the initial position covered by it will be _________ cm (take, g = 10 m/$s^2$)




**Sol.** **(75)**

For pure rolling




$(M.E)_A = (M.E)_B$

$$\Rightarrow \frac{1}{2}mv_0^2 + \frac{1}{2}\times\left(\frac{2}{3}mR^2\right)\left(\frac{v_0}{R}\right)^2 = mgH_{max}$$

$$\Rightarrow H_{max} = \frac{5}{6}\frac{v_0^2}{g} = \frac{5}{6}\times\frac{3^2}{10} = 0.75m$$

$$\Rightarrow H_{max} = 75cm$$

**55.** A steel rod of length 1 m and cross sectional area $10^{-4}$ m$^2$ is heated from 0°C to 200°C without being allowed to extend or bend. The compressive tension produced in the rod is __________ × $10^4$N. (Given Young's modulus of steel = $2 \times 10^{11}$ Nm$^{-2}$, coefficient of linear expansion = $10^{-5}$K$^{-1}$)

**Sol.** **(4)**

Thermal stress = Y α ΔT

F = Y A α ΔT

$= 2 \times 10^{11} \times 10^{-4} \times 10^{-5} \times 200$

$= 4 \times 10^4$

x = 4

**56.** The ratio of magnetic field at the centre of a current carrying coil of radius r to the magnetic field at distance r from the centre of coil on its axis is $\sqrt{x}:1$. The value of x is ________

**Sol.** **(8)**

$$B_{axis} = \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$$

$$\frac{(B_{axis})x=R}{(B_{axis})x=0} = \frac{\dfrac{\mu_0 i R^2}{2(R^2+R^2)^{3/2}}}{\dfrac{\mu_0 i R^2}{2(R^2)^{3/2}}} = \frac{R^3}{2^{3/2}R^3} = \frac{1}{\sqrt{8}}$$

$$\frac{(B)_{At_{centrs}}}{(B)_{At}\, x=R} = \frac{\sqrt{8}}{1}$$

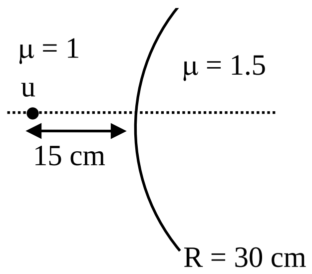
x = 8

**57.** The ratio of wavelength of spectral lines $H_\alpha$ and $H_\beta$ in the Balmer series is $\frac{x}{20}$. The value of x is _______

**Sol.** **(27)**

**58.** Two transparent media having refractive indices 1.0 and 1.5 are separated by a spherical refracting surface of radius of curvature 30 cm. The centre of curvature of surface is towards denser medium and a point object is placed on the principle axis in rarer medium at a distance of 15 cm from the pole of the surface. The distance of image from the pole of the surface is __________ cm.

**Sol.** **(30)**




$$\frac{1.5}{v} - \frac{1}{(-15)} = \frac{1.5-1}{30}$$

$$\Rightarrow \frac{1.5}{v} - \frac{1}{60} - \frac{1}{15} = \frac{1-4}{60}$$

V = – 30 cm

= 30 cm

**59.** A guitar string of length 90 cm vibrates with a fundamental frequency of 120 Hz. The length of the string producing a fundamental frequency of 180 Hz will be __________ cm.

**Sol.** **(60)**

$\mathbf{f} = \frac{v}{2L}$ (Fundamental Frequency)

$120 = \frac{v}{2L}$ …….(1)

$180 = \frac{v}{2L'}$ …….(2)

$$\frac{L'}{L} = \frac{120}{180}$$

$$L' = \frac{2}{3} \times 90$$

L’ = 60 cm

**60.** A body of mass 5 kg is moving with a momentum of 10 kg ms$^{-1}$. Now a force of 2 N acts on the body in the direction of its motion for 5 s. The increase in the Kinetic energy of the body is _________ J.

**Sol.** **(30)**

$$\textbf{(KE)} = \frac{P^2}{2M}$$

$$\Rightarrow \frac{1}{2}mu^2 = \frac{(10)^2}{2\times 5}$$

$$= \frac{1}{2} \times 5 \times u^2 = \frac{100}{10}$$

Initial speed u = 2 m/s

$\Delta KE = w_{\text{all forces}}$

$= \vec{F}.\vec{S} \quad (\theta = 0°)$

$$= F\left(ut + \frac{1}{2}at^2\right)$$

$$= 2.\left[2\times 5+\frac{1}{2}\times\frac{2}{5}\times 5^2\right]$$

= 30 J