Sol. $d\tan 60° = 2\sqrt{3}$

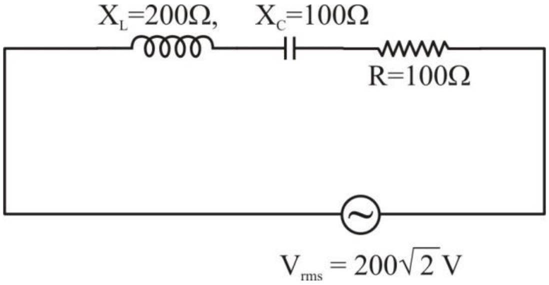
$d = 2$ cm

$B = 3 \times \frac{\mu_0 i}{2\pi d}\sin 60°$

$= 3 \times \frac{2\times10^{-7}\times 2}{2\times10^{-2}} \times \frac{\sqrt{3}}{2}$

$= 3\sqrt{3}\times10^{-5}$

10. In the given circuit, rms value of current (I_{rms}) through the resistor R is :



(1) 2A

(2) $\frac{1}{2}$A

(3) 20 A

(4) $2\sqrt{2}$A

Official Ans. by NTA (1)

Ans. (1)

Sol. $z = \sqrt{100^2 + (200-100)^2}$

$= 100\sqrt{2}\,\Omega$

$i_{rms} = \frac{V_{rms}}{z} = \frac{200\sqrt{2}}{100\sqrt{2}}$

$= 2A$

11. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m s^{-1} each. The recoil velocity of the gun is :

(1) 0.02 m/s

(2) 2.5 m/s

(3) 1.5 m/s

(4) 0.6 m/s

Official Ans. by NTA (4)

Ans. (4)

Sol. $20\times10^{-3}\times\frac{180}{60}\times100 = 10\,V$

$\Rightarrow\ v = 0.6$ m/s

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

Assertion A : Efficiency of a reversible heat engine will be highest at –273°C temperature of cold reservoir.

Reason R : The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1-\frac{T_2}{T_1}\right)$.

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

(1) **A** is true but **R** is false

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

(3) **A** is false but **R** is true

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

Official Ans. by NTA (4)

Ans. (4)

Sol. Both A and R are true and R is the correct explanation of A

13. Match List I with List II.

	List I		List II
A	Torque	I.	kg m^{-1} s^{-2}
B	Energy density	II.	kg ms^{-1}
C	Pressure gradient	III.	kg m^{-2} s^{-2}
D	Impulse	IV.	kg m^2 s^{-2}

Choose the **correct** answer from the options given below :

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

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

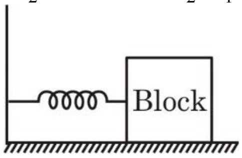
(3) A-IV, B-I, C-II, D-III

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

Official Ans. by NTA (4)

Ans. (4)

14. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio ω_2/ω_1 is :



(1) $\sqrt{2}$

(2) $\frac{1}{\sqrt{2}}$

(3) 2

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

Official Ans. by NTA (2)

Ans. (2)

Sol. $\omega = \sqrt{\frac{k}{m}}$

$\frac{\omega_2}{\omega_1} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{2}}$

15. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to :

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

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

Official Ans. by NTA (2)

Ans. (2)

Sol. $KE = \frac{P^2}{2m}$, $P = \frac{h}{\lambda}$

$eV_1 = \frac{\left(\frac{h}{\lambda}\right)^2}{2m}$

$eV_2 = \frac{\left(\frac{h}{1.5\lambda}\right)^2}{2m}$

$\frac{V_1}{V_2} = (1.5)^2 = \frac{9}{4}$

16. Match List I with List II :

	List I		List II
A.	Attenuation	I	Combination of a receiver and transmitter.
B.	Transducer	II	Process of retrieval of information from the carrier wave at received
C.	Demodulation	III	Converts one form of energy into another
D.	Repeater	IV	Loss of strength of a signal while propagating through a medium

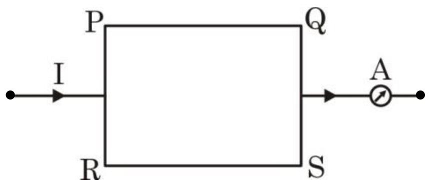
Choose the correct answer from the options given below :

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

Official Ans. by NTA (4)

Ans. (4)

17. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $f_{PQ}^{I} : f_{PQ}^{2I}$ is :



(1) 1 : 2 (2) 1 : 4
(3) 1 : 5 (4) 1 : 3

Official Ans. by NTA (2)

Ans. (2)

Sol. $F \propto I_1 I_2$

$F_I : F_{2I} = 1 : 4$

18. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire 'B' will be (wires having uniform circular cross sections)

(1) 6.06×10^{-2} mm
(2) 2.77×10^{-2} mm
(3) 3.0×10^{-2} mm
(4) 6.9×10^{-2} mm

Official Ans. by NTA (4)

Ans. (4)

Sol. $Y = \frac{F/A}{\frac{\Delta\ell}{\ell}}$

$\Rightarrow F = \frac{YA}{\ell}\Delta\ell$

$\left(\frac{A\Delta\ell}{\ell}\right)_1 = \left(\frac{A\Delta\ell}{\ell}\right)_2$

$\Rightarrow \frac{\Delta\ell_2}{\Delta\ell_1} = \frac{A_1}{A_2} \times \frac{\ell_2}{\ell_1}$

$\Rightarrow \frac{\Delta\ell_2}{0.2} = \frac{1}{2.4 \times 2.4} \times \frac{2}{1}$

$\Rightarrow \Delta\ell_2 = 6.9 \times 10^{-2}$ mm

19. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be :

(1) $2\sqrt{gR}$ (2) $\sqrt{gR}$

(3) $\sqrt{\frac{gR}{2}}$ (4) $\sqrt{2gR}$

Official Ans. by NTA (2)

Ans. (2)

Sol. Loss in PE = Gain in KE

$$\left(-\frac{GMm}{2R}\right)-\left(-\frac{GMm}{R}\right)=\frac{1}{2}mv^2$$

$$\Rightarrow v^2=\frac{GM}{R}=gR$$

$$\Rightarrow v=\sqrt{gR}$$

20. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is :

(1) $\frac{1}{2\pi}\frac{W}{m^2}$ (2) $\frac{1}{40\pi}\frac{W}{m^2}$

(3) $\frac{1}{10\pi}\frac{W}{m^2}$ (4) $\frac{1}{20\pi}\frac{W}{m^2}$

Official Ans. by NTA (2)

Ans. (2)

Sol. $I_{EF}=\frac{1}{2}\times\frac{5}{4\pi\times5^2}$

$$=\frac{1}{40\pi}W/m^2$$

SECTION-B

21. A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temperature on absolute scale will be.......... K when the faulty thermometer reads 41°C.

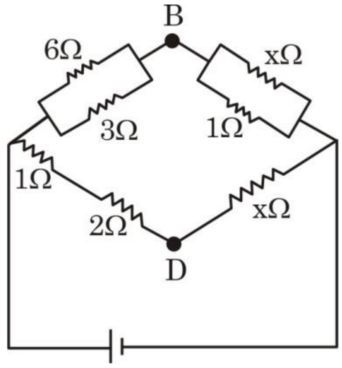
Official Ans. by NTA (313)

Ans. (313)

Sol. $\frac{41°-5°}{95°-5°}=\frac{C-0°}{100°-0°}$

$$\Rightarrow C=\frac{36}{90}\times100=40°C=313\,K$$

22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is ....



Official Ans. by NTA (2)

Ans. (2)

Sol. $\frac{2}{3}=\frac{\frac{x}{x+1}}{x}$

$$\Rightarrow \frac{2}{3}=\frac{1}{x+1}$$

$$\Rightarrow x=0.5=\frac{1}{2}$$

n = 2

23. The velocity of a particle executing SHM varies with displacement (x) as $4v^2=50-x^2$. The time period of oscillations is $\frac{x}{7}$s. The value of x is .... $\left(\text{Take } \pi=\frac{22}{7}\right)$

Official Ans. by NTA (88)

Ans. (88)

Sol. $4v^2=50-x^2$

$$\Rightarrow v=\frac{1}{2}\sqrt{50-x^2}$$

$$\omega=\frac{1}{2}$$

$$T=\frac{2\pi}{\omega}=4\pi=\frac{88}{7}$$

x = 88

24. In a Young's double slit experiment, the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits, then $\frac{I_1+I_2}{I_0}=$.......

Official Ans. by NTA (3)

Ans. (3)

Sol. $I = 4I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$

$I_1 = 4I_0 \cos^2\left(\frac{\pi}{4}\right) = 2I_0$

$I_2 = 4I_0 \cos^2\left(\frac{2\pi}{3}\right) = I_0$

$\Rightarrow \frac{I_1 + I_2}{I_0} = 3$

25. A radioactive nucleus decays by two different process. The half life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is _______.

Official Ans. by NTA (300)

Ans. (300)

Sol. $\frac{dN_1}{dt} = -\lambda_1 N \qquad \frac{dN_2}{dt} = -\lambda_2 N$

$\frac{dN}{dt} = -(\lambda_1 + \lambda_2)N$

$\Rightarrow \lambda_{eq} = \lambda_1 + \lambda_2$

$\Rightarrow \frac{1}{t_{1/2}} = \frac{1}{300} + \frac{1}{30} = \frac{11}{300}$

$\Rightarrow t_{1/2} = \frac{300}{11}$

26. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4s is $\frac{1}{3}\alpha^2\sqrt{P}$ m. The value of α will be ……

Official Ans. by NTA (4)

Ans. (4)

Sol. $\frac{1}{2}mV^2 = Pt$

$V = \sqrt{\frac{2Pt}{m}}$

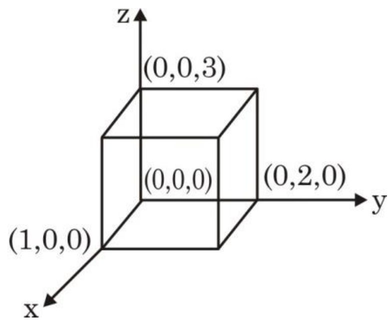
$\frac{dx}{dt} = \sqrt{\frac{2Pt}{m}}$

$x = \sqrt{\frac{2P}{m}}\frac{2}{3}\left[t^{3/2}\right]_0^4$

$x = \frac{16\sqrt{P}}{3} = \frac{1}{3} \times 16\sqrt{P}$

$\alpha = 4$

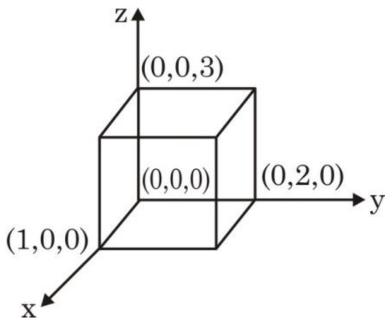
27. As shown in figure, a cuboid lies in a region with electric field $E = 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$ N/C. The magnitude of charge within the cuboid is $n \in_0 C$. The value of n is _______ (if dimension of cuboid is $1 \times 2 \times 3$ m^3)



Official Ans. by NTA (12)

Ans. (12)

Sol. $\vec{E} = 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$



$\phi_{net} = -8 \times 3 + 2 \times 6 = -12$

$-12 = \frac{q}{\in_0}$

$|q| = 12\in_0$

28. In an ac generator, a rectangular coil of 100 turns each having area 14×10^{-2} m^2 is rotated at 360 rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be _______ V. $\left(\text{Take } \pi = \frac{22}{7}\right)$

Official Ans. by NTA (1584)

Ans. (1584)

Sol. $\xi_{max} = NAB\omega$

$= 100 \times 14 \times 10^{-2} \times 3 \times \frac{360 \times 2\pi}{60}$

$= 1584V$

29. A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x}ms^{-2}$. The value of x ________.

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Official Ans. by NTA (125)

Ans. (125)

Sol. $a = \omega^2 R = \left(\frac{28 \times 2\pi}{60}\right)^2 \times 1.8$

$= \left(\frac{56}{60} \times \frac{22}{7}\right)^2 \times 1.8$

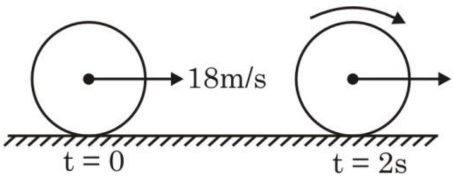
$= \frac{(44)^2}{225} \times 1.8$

$= \frac{1936 \times 1.8}{225}$

x = 125

30. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m/s at t = 0 s on a rough horizontal surface. It starts off with a purely sliding motion at t = 0 s. After 2s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2s will be ________ J

(given, coefficient of friction is 0.3 and $g = 10 \text{ m/s}^2$).



Official Ans. by NTA (54)

Ans. (54)

Sol. $a = -\mu_k g = -3$

$V = 18 - 3 \times 2$

$V = 12$ m/s

$KE = \frac{1}{2}mv^2 + \frac{1}{2}\frac{mr^2}{2}\frac{v^2}{r^2}$

$KE = \frac{3}{4}mv^2$

KE = 3 × 18 = 54 J