



JEE-MAIN – JUNE, 2022

(Held On Tuesday 24th June, 2022)

TIME : 9 : 00 AM to 12 : 00 PM

Physics

Test Pattern : JEE-MAIN

Maximum Marks : 120

Topic Covered: FULL SYLLABUS

Important instruction:

1. Use Blue / Black Ball point pen only.
2. There are three sections of equal weightage in the question paper **Physics**, **Chemistry** and **Mathematics** having 30 questions in each subject. Each paper have 2 sections A and B.
3. You are awarded +4 marks for each correct answer and –1 marks for each incorrect answer.
4. Use of calculator and other electronic devices is not allowed during the exam.
5. No extra sheets will be provided for any kind of work.

Name of the Candidate (in Capitals) _____

Father's Name (in Capitals) _____

Form Number : in figures _____

: in words _____

Centre of Examination (in Capitals): _____

Candidate's Signature: _____

Invigilator's Signature : _____

Rough Space

YOUR TARGET IS TO SECURE GOOD RANK IN JEE-MAIN

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FINAL JEE-MAIN EXAMINATION – JUNE, 2022

(Held On Friday 24th June, 2022)

TIME : 9 : 00 AM to 12 : 00 PM

PHYSICS

TEST PAPER WITH SOLUTION

SECTION-A

1. The bulk modulus of a liquid is $3 \times 10^{10} \text{ Nm}^{-2}$. The pressure required to reduce the volume of liquid by 2% is :

- (A) $3 \times 10^8 \text{ Nm}^{-2}$ (B) $9 \times 10^8 \text{ Nm}^{-2}$
(C) $6 \times 10^8 \text{ Nm}^{-2}$ (D) $12 \times 10^8 \text{ Nm}^{-2}$

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $B = 3 \times 10^{10}$

$$-\frac{\Delta V}{V} = 0.02$$

$$B = \frac{\Delta P}{-\frac{\Delta V}{V}} \Rightarrow \Delta P = -B \left(\frac{\Delta V}{V} \right)$$

$$= (3 \times 10^{10})(0.02)$$

$$= 6 \times 10^8 \text{ N / m}^2$$

2. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : In an uniform magnetic field, speed and energy remains the same for a moving charged particle.

Reason (R) : Moving charged particle experiences magnetic force perpendicular to its direction of motion.

- (A) Both (A) and (R) are true and (R) is the correct explanation of (A)
(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)
(C) (A) is true but (R) is false
(D) (A) is false but (R) is true.

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. $\vec{F} = q(\vec{v} \times \vec{B})$

$$\vec{F} \perp \vec{v}$$

$$\text{Work done} = \vec{F} \cdot \vec{S}$$

$$\text{Work done} = 0$$

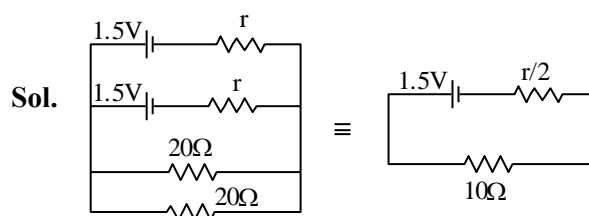
3. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω . A voltmeter connected in the circuit measures 1.2 V.

The internal resistance of each cell is

- (A) 2.5Ω (B) 4Ω
(C) 5Ω (D) 10Ω

Official Ans. by NTA (C)

Allen Ans. (C)



$$V = E - ir/2$$

$$1.2 = 1.5 - i \left(\frac{r}{2} \right)$$

$$i \frac{r}{2} = 0.3$$

$$i = \frac{1.5}{10 + \frac{r}{2}} \Rightarrow 10i + \frac{ir}{2} = 1.5$$

$$10i = 1.5 - 0.3$$

$$i = 0.12 \text{ A}$$

$$\Rightarrow r = \frac{0.6}{0.12} = 5\Omega$$

4. Identify the pair of physical quantities which have different dimensions :

(A) Wave number and Rydberg's constant
 (B) Stress and Coefficient of elasticity
 (C) Coercivity and Magnetisation
 (D) Specific heat capacity and Latent heat

Official Ans. by NTA (D)

Allen Ans. (D)

Sol. $S = \frac{Q}{m\Delta T} = \frac{J}{Kg^\circ C}$

$$L = \frac{Q}{m} = \frac{J}{Kg}$$

5. A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be : [use $g = 10 \text{ m/s}^2$]

(A) $\frac{1}{2} \sin^{-1} \left(\frac{5t^2}{4R} \right)$ (B) $\frac{1}{2} \sin^{-1} \left(\frac{4R}{5t^2} \right)$

(C) $\tan^{-1} \left(\frac{4t^2}{5R} \right)$ (D) $\cot^{-1} \left(\frac{R}{20t^2} \right)$

Official Ans. by NTA (D)

Allen Ans. (D)

Sol. $R = \frac{V^2 (2 \sin \theta \cos \theta)}{g}$

$$t = \frac{V \sin \theta}{g} \Rightarrow V = \frac{gt}{\sin \theta}$$

$$\Rightarrow R = \frac{g^2 t^2}{\sin^2 \theta} \cdot \frac{2 \sin \theta \cos \theta}{g}$$

$$\tan \theta = \frac{2gt^2}{R} = \frac{20t^2}{R}$$

$$\cot \theta = \frac{R}{20t^2}$$

6. A block of mass 10 kg starts sliding on a surface with an initial velocity of 9.8 ms^{-1} . The coefficient of friction between the surface and block is 0.5. The distance covered by the block before coming to rest is : [use $g = 9.8 \text{ ms}^{-2}$]

(A) 4.9 m (B) 9.8 m
 (C) 12.5 m (D) 19.6 m

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $a = -\mu g = -0.5 \times 9.8 = -4.9 \text{ m/s}^2$

$$d = \frac{v^2}{2a} = \frac{9.8 \times 9.8}{2(4.9)}$$

$$= 9.8 \text{ m}$$

7. A boy ties a stone of mass 100 g to the end of a 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi} \text{ rev./min}$. The value of

K is : (Assume the string is massless and unstretchable)

(A) 400 (B) 300
 (C) 600 (D) 800

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $T = M\omega^2 R$

$$T = 80 \text{ N} \quad M = 0.1 \quad \omega = ? \quad R = 2 \text{ m}$$

$$80 = 0.1 \omega^2 (2)$$

$$\omega^2 = 400$$

$$\omega = 20$$

$$2\pi f = 20$$

$$f = \frac{10 \text{ rev}}{\pi \text{ s}}$$

$$= \frac{600 \text{ rev}}{\pi \text{ min}}$$

8. A vertical electric field of magnitude $4.9 \times 10^5 \text{ N/C}$ just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be :

(Given $g = 9.8 \text{ m/s}^2$)

- (A) $1.6 \times 10^{-9} \text{ C}$ (B) $2.0 \times 10^{-9} \text{ C}$
(C) $3.2 \times 10^{-9} \text{ C}$ (D) $0.5 \times 10^{-9} \text{ C}$

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $Mg = qE$

$$(0.1 \times 10^{-3})(9.8) = 4.9 \times 10^5 q$$

$$\frac{2 \times 10^{-4}}{10^5} = q$$

$$q = 2 \times 10^{-9} \text{ C}$$

9. A particle experiences a variable force $\vec{F} = (4x\hat{i} + 3y^2\hat{j})$ in a horizontal x-y plane. Assume distance in meters and force is newton. If the particle moves from point (1, 2) to point (2, 3) in the x-y plane, the Kinetic Energy changes by

- (A) 50.0 J (B) 12.5 J
(C) 25.0 J (D) 0 J

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $F = 4x\hat{i} + 3y^2\hat{j}$

$$W = \Delta KE$$

$$W = \int \vec{F} \cdot (dx\hat{i} + dy\hat{j})$$

$$= \int_1^2 4x dx + \int_2^3 3y^2 dy$$

$$= (2x^2)_1^2 + (y^3)_2^3$$

$$= (8 - 2) + (27 - 8)$$

$$= 6 + 19 = 25 \text{ J}$$

10. The approximate height from the surface of earth at which the weight of the body becomes $\frac{1}{3}$ of its weight on the surface of earth is : [Radius of earth $R = 6400 \text{ km}$ and $\sqrt{3} = 1.732$]

- (A) 3840 km (B) 4685 km
(C) 2133 km (D) 4267 km

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $Mg' = \frac{M}{3}g$

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

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

$$\frac{R}{R+h} = \frac{1}{\sqrt{3}}$$

$$h = (\sqrt{3} - 1)R$$

$$= (1.732 - 1)6400$$

$$h = 4685 \text{ km}$$

11. A resistance of 40Ω is connected to a source of alternating current rated 220 V, 50 Hz. Find the time taken by the current to change from its maximum value to rms value :

- (A) 2.5 ms (B) 1.25 ms
(C) 2.5 s (D) 0.25 s

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. Considering sinusoidal AC.

$$\text{Phase at maximum value} = \frac{\pi}{2}$$

$$\text{Phase at rms value} = \frac{3\pi}{4}$$

$$\text{Thus phase change} = \frac{3\pi}{4} - \frac{\pi}{2} = \frac{\pi}{4}$$

$$\text{Now } \omega = 2\pi f$$

$$= 2\pi \times 50$$

$$= 100\pi$$

$$\text{time taken } t = \frac{\theta}{\omega} = \frac{\pi/4}{100\pi} = \frac{1}{400} \text{ s}$$

$$t = 2.5 \times 10^{-3} = 2.5 \text{ ms}$$

12. The equations of two waves are given by :

$$y_1 = 5 \sin 2\pi(x - vt) \text{ cm}$$

$$y_2 = 3 \sin 2\pi(x - vt + 1.5) \text{ cm}$$

These waves are simultaneously passing through a string. The amplitude of the resulting wave is

- (A) 2 cm (B) 4 cm
(C) 5.8 cm (D) 8 cm

Official Ans. by NTA (A)

Allen Ans. (A)

Sol. $A_1 = 5 \quad A_2 = 3$

$$\Delta\theta = 2\pi(1.5) = 3\pi$$

$$A_{\text{net}} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos(3\pi)}$$

$$= |A_1 - A_2|$$

$$= 2 \text{ cm}$$

13. A plane electromagnetic wave travels in a medium of relative permeability 1.61 and relative permittivity 6.44. If magnitude of magnetic intensity is $4.5 \times 10^{-2} \text{ Am}^{-1}$ at a point, what will be the approximate magnitude of electric field intensity at that point ?

(Given : permeability of free space $\mu_0 = 4\pi \times 10^{-7} \text{ NA}^{-2}$, speed of light in vacuum $c = 3 \times 10^8 \text{ ms}^{-1}$)

- (A) 16.96 Vm^{-1} (B) $2.25 \times 10^{-2} \text{ Vm}^{-1}$
(C) 8.48 Vm^{-1} (D) $6.75 \times 10^6 \text{ Vm}^{-1}$

Official Ans. by NTA (C)

Allen Ans. (BONUS)

Sol. $\mu_r = 1.61 \quad \epsilon_r = 6.44$

$$B = 4.5 \times 10^{-2}$$

$$E = ?$$

$$C = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \quad V = \frac{1}{\sqrt{\mu \epsilon}}$$

$$\frac{C}{V} = \sqrt{\mu_r \epsilon_r} = \sqrt{1.61 \times 6.44}$$

$$\frac{E}{B} = V = \frac{3 \times 10^8}{\sqrt{1.61 \times 6.44}} = 9.32 \times 10^7 \text{ m/s}$$

$$E = 4.5 \times 10^{-2} \times 9.32 \times 10^7 \\ = 4.2 \times 10^6$$

14. Choose the correct option from the following options given below :

- (A) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net-force.
(B) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model
(C) A classical atom based on Rutherford's model is doomed to collapse.
(D) The positively charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model.

Official Ans. by NTA (C)

Allen Ans. (C)

- Sol.** According to Rutherford, e^- revolves around nucleus in circular orbit. Thus e^- is always accelerating (centripetal acceleration). An accelerating charge emits EM radiation and thus e^- should lose energy and finally should collapse in the nucleus.

15. Nucleus A is having mass number 220 and its binding energy per nucleon is 5.6 MeV. It splits in two fragments 'B' and 'C' of mass numbers 105 and 115. The binding energy of nucleons in 'B' and 'C' is 6.4 MeV per nucleon. The energy Q released per fission will be :

- (A) 0.8 MeV (B) 275 MeV
(C) 220 MeV (D) 176 MeV

Official Ans. by NTA (D)

Allen Ans. (D)

Sol. $Q = (B.E)_p - (B.E)_r$
 $= (105 + 115)(6.4) - (220)(5.6)$
 $= 176 \text{ MeV}$

16. A baseband signal of 3.5 MHz frequency is modulated with a carrier signal of 3.5 GHz frequency using amplitude modulation method. What should be the minimum size of antenna required to transmit the modulated signal ?

- (A) 42.8 m (B) 42.8 mm
(C) 21.4 mm (D) 21.4 m

Official Ans. by NTA (C)

Allen Ans. (C)

Sol. $f_c = 3.5\text{GHz}$ $f_m = 3.5\text{MHz}$

Side band frequencies are $f_c - f_m$ & $f_c + f_m$, which are almost f_c

$$\lambda = \frac{c}{f_c}$$

Minimum length of antenna =

$$\frac{c}{f_c 4} = \frac{\lambda}{4} = \frac{3 \times 10^8}{3.5 \times 10^9 \times 4}$$

$$= 21.4 \text{ mm}$$

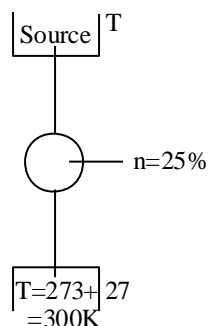
17. A Carnot engine whose heat sinks at 27°C , has an efficiency of 25%. By how many degrees should the temperature of the source be changed to increase the efficiency by 100% of the original efficiency ?

- (A) Increases by 18°C (B) Increase by 200°C
(C) Increase by 120°C (D) Increase by 73°

Official Ans. by NTA (B)

Allen Ans. (B)

Sol.



$$1 - \frac{300}{T} = 0.25$$

$$\frac{300}{T} = 0.75$$

$$T = 400\text{K}$$

If efficiency increased by 100% then new efficiency $\Rightarrow n' = 50\%$

$$1 - \frac{300}{T'} = 0.5$$

$$T' = 600\text{K}$$

$$\begin{aligned} \text{Increase in temp} &= 600 - 400 \\ &= 200 \text{ K or } 200^\circ\text{C} \end{aligned}$$

18. A parallel plate capacitor is formed by two plates each of area $30\pi \text{ cm}^2$ separated by 1 mm. A material of dielectric strength $3.6 \times 10^7 \text{ Vm}^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is $7 \times 10^{-6} \text{ C}$, the value of dielectric constant of the material is :

$$\left\{ \text{Use : } \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{C}^{-2} \right\}$$

- (A) 1.66 (B) 1.75
(C) 2.25 (D) 2.33

Official Ans. by NTA (D)

Allen Ans. (D)

$$\text{Sol. } K = \frac{q}{A \epsilon_0 E} = \frac{7 \times 10^{-6}}{30\pi \times 10^{-4} \times \frac{1}{4\pi \times 9 \times 10^9} \times 3.6 \times 10^7}$$

$$K = \frac{36 \times 7}{30 \times 3.6} = 2.33$$

19. The magnetic field at the centre of a circular coil of radius r , due to current I flowing through it, is B . The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is :

- (A) $B/2$ (B) $2B$
(C) $\left(\frac{2}{\sqrt{5}}\right)^3 B$ (D) $\left(\frac{2}{\sqrt{3}}\right)^3 B$

Official Ans. by NTA (C)

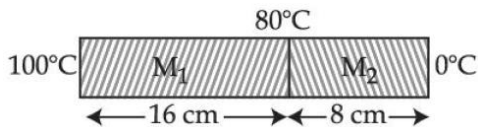
Allen Ans. (C)

$$\text{Sol. } B_c = \frac{\mu_0 I}{2r}, B_a = \frac{\mu_0 I r^2}{2(x^2 + r^2)^{3/2}}$$

$$\text{At } x = \frac{r}{2}$$

$$\begin{aligned} B_a &= \frac{\mu_0 I r^2}{2\left(\frac{r^2}{4} + r^2\right)^{3/2}} \\ &= \frac{\mu_0 I r^2}{2\left(\frac{5}{4}r^2\right)^{3/2}} = \frac{\mu_0 I}{2r} \left(\frac{4}{5}\right)^{3/2} \\ &= \frac{\mu_0 I}{2r} \left(\frac{2}{\sqrt{5}}\right)^3 \end{aligned}$$

20. Two metallic blocks M_1 and M_2 of same area of cross-section are connected to each other (as shown in figure). If the thermal conductivity of M_2 is K then the thermal conductivity of M_1 will be : [Assume steady state heat conduction]



- (A) 10 K (B) 8 K
(C) 12.5 K (D) 2 K

Official Ans. by NTA (B)

Allen Ans. (B)

Sol. $\Delta T \propto R \propto \frac{\ell}{k}$,

$$\frac{\Delta T_1}{\Delta T_2} = \frac{\ell_1}{k_1} \times \frac{k_2}{\ell_2} = \frac{16}{k_1} \times \frac{k}{8}$$

$$\frac{20}{80} = \frac{16}{k_1} \times \frac{k}{8} \rightarrow k_1 = 8k$$

SECTION-B

1. 0.056 kg of Nitrogen is enclosed in a vessel at a temperature of 127°C . The amount of heat required to double the speed of its molecules is _____ k cal. (Take $R = 2 \text{ cal mole}^{-1}\text{K}^{-1}$)

Official Ans. by NTA (12)

Allen Ans. (12)

Sol. $0.056 \text{ kg N}_2 = 56 \text{ gm of N}_2 = 2 \text{ mole of N}_2$

$$T_1 = 400 \text{ K, } v \propto \sqrt{T} \text{ so } T_2 = 4T_1 = 1600 \text{ K}$$

$$Q = \frac{f}{2} n R \Delta T$$

$$f = 5$$

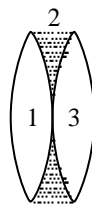
$$Q = 12 \text{ k cal}$$

2. Two identical thin biconvex lenses of focal length 15 cm and refractive index 1.5 are in contact with each other. The space between the lenses is filled with a liquid of refractive index 1.25. The focal length of the combination is _____ cm.

Official Ans. by NTA (10)

Allen Ans. (10)

Sol.



$$\frac{1}{f_1} = \frac{1}{15} = \left(\frac{3}{2} - 1 \right) \left[\frac{2}{R} \right]$$

$$\frac{1}{R} = \frac{1}{15}$$

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

$$= \frac{1}{15} + \left(\frac{5}{4} - 1 \right) \left[\frac{-2}{R} \right] + \frac{1}{15}$$

$$= \frac{1}{15} - \frac{1}{30} + \frac{1}{15}$$

$$= \frac{2-1+2}{30}$$

$$= \frac{3}{30} = \frac{1}{10}$$

$$= 10$$

3. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10 μA and the collector current changes by 1.5 mA. The load resistance is 5 k Ω . The voltage gain of the transistor will be _____.

Official Ans. by NTA (750)

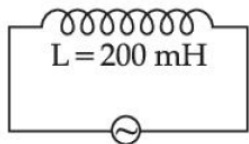
Allen Ans. (750)

Sol. $r_i = \frac{10 \text{ mV}}{10 \mu\text{A}} = 10^3 \Omega$

$$\beta = \frac{1.5 \text{ mA}}{10 \mu\text{A}} = 150$$

$$A_v = \left(\frac{R_o}{r_i} \right) \beta = \left(\frac{5000}{1000} \right) \times 150 = 750$$

4. As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\frac{\sqrt{a}}{\pi}$ A. The value of a is _____.



Official Ans. by NTA (242)

Allen Ans. (242)

Sol. $f = 50\text{ Hz}$
 $X_L = 2\pi fL$
 $= 2\pi(50)(200 \times 10^{-3})$
 $= 20\pi\Omega$
 $i_0 = \frac{V_0}{X_L} \Rightarrow \frac{V_{\text{rms}}\sqrt{2}}{X_L}$
 $= \frac{(220)\sqrt{2}}{20\pi} = \frac{11\sqrt{2}}{\pi}$
 $i_0 = \frac{\sqrt{242}}{\pi}$

5. Sodium light of wavelengths 650 nm and 655 nm is used to study diffraction at a single slit of aperture 0.5 mm. The distance between the slit and the screen is 2.0 m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is _____ $\times 10^{-5}$ m.

Official Ans. by NTA (3)

Allen Ans. (3)

Sol. $a \sin \theta = \frac{3\lambda}{2}$
 $\frac{y}{L} = \theta = \frac{3\lambda}{2a}$ $L = 2\text{ m}$
 $y_1 = \frac{3\lambda_1 L}{2a}$ $\lambda_2 = 655\text{ nm}$
 $y_2 = \frac{3\lambda_2 L}{2a}$ $\lambda_1 = 650\text{ nm}$
 $a = 0.5\text{ mm}$
 $\Delta y = y_2 - y_1 = \frac{3(\lambda_2 - \lambda_1)}{2a} L$
 $= \frac{3(655 - 650)}{2 \times 0.5 \times 10^{-3}} \times 2 \times 10^{-9}$
 $= \frac{3 \times 5 \times 2}{1 \times 10^{-3}} \times 10^{-9}$
 $= 3 \times 10^{-5}$

6. When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted electron is v_1 . When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2 . If $v_2 = x v_1$, the value of x will be _____.

Official Ans. by NTA (2)

Allen Ans. (2)

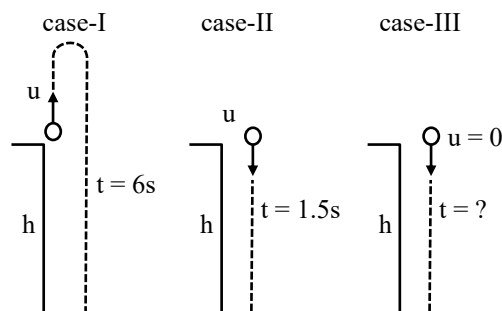
Sol. $h\nu = h\nu_{\text{th}} + \frac{1}{2}mv^2$
 $\nu = 2\nu_{\text{th}}$
 $2h\nu_{\text{th}} = h\nu_{\text{th}} + \frac{1}{2}mv_1^2 \dots (1)$
 $\nu = 5\nu_{\text{th}}$
 $5h\nu_{\text{th}} = h\nu_{\text{th}} + \frac{1}{2}mv_2^2 \dots (2)$
 $\frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \frac{h\nu_{\text{th}}}{4h\nu_{\text{th}}}$
 $\left(\frac{v_1}{v_2}\right)^2 = \frac{1}{4} \Rightarrow v_2 = 2v_1$

7. From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6 s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5 s. A third ball released, from the rest from the same location, will reach the ground in _____ s.

Official Ans. by NTA (3)

Allen Ans. (3)

- Sol.** Let height of tower be h and speed of projection in first two cases be u.



For case-I : 2nd equation $s = ut + \frac{1}{2}at^2$

$$h = -u(6) + \frac{1}{2}g(6)^2$$

$$H = -6u + 18g \dots (i)$$

$$\text{For case-II : } h = u(1.5) + \frac{1}{2}g(1.5)^2$$

$$h = 1.5u + \frac{2.25g}{2} \dots (ii)$$

Multiplying equation (ii) by 4 we get

$$4h = 6u + 4.5g \dots (iii)$$

equation (i) + equation (iii) we get $5h = 22.5g$

$$h = 4.5g \dots (iv)$$

For case-III :

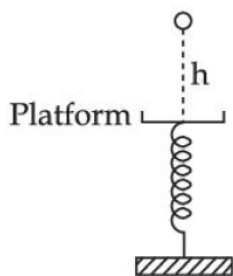
$$h = 0 + \frac{1}{2}gt^2 \dots (v)$$

Using equation (4) & equation (5)

$$4.5g = \frac{1}{2}gt^2$$

$$t^2 = 9 \Rightarrow t = 3s$$

8. A ball of mass 100 g is dropped from a height $h = 10$ cm on a platform fixed at the top of vertical spring (as shown in figure). The ball stays on the platform and the platform is depressed by a distance $\frac{h}{2}$. The spring constant is _____ Nm^{-1} . (Use $g = 10 \text{ ms}^{-2}$)



Official Ans. by NTA (120)

Allen Ans. (120)

Sol. By energy conservation

$$PE = KE$$

$$mg\left(H + \frac{H}{2}\right) = \frac{1}{2}kx^2 \left(x = \frac{H}{2}\right)$$

$$0.100 \times 10 \times \frac{3}{2}(0.10) = \frac{1}{2}k(0.05 \times 0.05)$$

$$k = \frac{3 \times 0.10}{0.05 \times 0.05}$$

$$= \frac{3 \times 1000}{25} = 120 \text{ N/m}$$

9. In a potentiometer arrangement, a cell gives a balancing point at 75 cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emf's of two cells respectively is 3 : 2, the difference in the balancing length of the potentiometer wire in above two cases will be _____ cm.

Official Ans. by NTA (25)

Allen Ans. (25)

$$\text{Sol. } \frac{\varepsilon_1}{\varepsilon_2} = \frac{\ell_1}{\ell_2}$$

$$\frac{3}{2} = \frac{75 \text{ cm}}{\ell_2}$$

$$\ell_2 = 50 \text{ cm}$$

$$\ell_1 - \ell_2 = 75 - 50$$

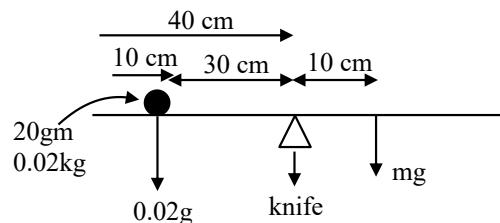
$$= 25 \text{ cm}$$

10. A metre scale is balanced on a knife edge at its centre. When two coins, each of mass 10 g are put one on the top of the other at the 10.0 cm mark the scale is found to be balanced at 40.0 cm mark. The mass of the metre scale is found to be $x \times 10^{-2}$ kg. The value of x is

Official Ans. by NTA (6)

Allen Ans. (6)

Sol. Let mass of meter scale be m .



Balancing torque about knife edge

$$(0.02g) \times (30 \times 10^{-2}) = mg \times (10 \times 10^{-2})$$

$$m = 0.06 \text{ kg} = 6 \times 10^{-2} \text{ kg}$$