

**JEE Main January 2026**  
**Question Paper With Text Solution**  
**21 January | Shift-2**

**PHYSICS**



**JEE Main & Advanced | XI-XII Foundation | VI-X Pre-Foundation**

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**JEE MAIN JANUARY 2026 | 21 JANUARY SHIFT-2**
**SECTION - A**

Question ID : 860654853

26. A river of width 200 m is flowing from west to east with a speed of 18 km/h. A boat, moving with speed of 36 km/h in still water, is made to travel one-round trip (bank to bank of the river). Minimum time taken by the boat for this journey and also the displacement along the river bank are \_\_\_ and \_\_\_ respectively.

- (1) 40 s and 200 m    (2) 40 s and 100 m    (3) 40 s and 0 m    (4) 20 s and 100 m

चौड़ाई 200 m की एक नदी पश्चिम से पूर्व 18 km/h की चाल के साथ प्रवाहित हो रही है। स्थिर जल में 36 km/h की चाल से गतिमान एक नौका को एक चक्कर (नदी के किनारे से किनारे तक) लगवाया जाता है। नौका द्वारा इस यात्रा के लिए लिया गया न्यूनतम समय तथा नदी के किनारे के अनुदिश विस्थापन क्रमशः \_\_\_\_\_ और \_\_\_\_\_ हैं।

- (1) 40 s और 200 m    (2) 40 s और 100 m    (3) 40 s और 0 m    (4) 20 s और 100 m

**Ans.** Official answer NTA (1)

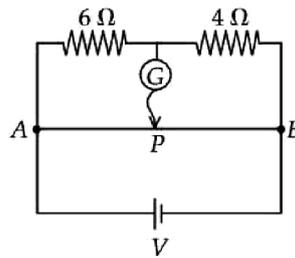
**Sol.** Minimum time taken =  $\frac{2d}{v} = \frac{2 \times 200}{36} = 40s$

Displacement along river =  $ut = 200$  m

Question ID : 860654863

27. The total length of potentiometer wire AB is 50 cm in the arrangement as shown in figure. If P is the point where the galvanometer shows zero reading then the length AP is \_\_\_\_\_ cm.

चित्र में दर्शाए गए व्यवस्थापन में विभवमापी के तार AB की कुल लम्बाई 50 cm है। यदि P वह बिन्दु है जहाँ गैल्वेनोमापी शून्य पाठ्यांक दिखाता है तो लम्बाई AP \_\_\_\_\_ cm है।



- (1) 30                      (2) 20                      (3) 15                      (4) 25

**Ans.** Official answer NTA (1)

**Sol.** For zero reading  $\frac{l_{AP}}{l_{PB}} = \frac{6}{4}$

$\Rightarrow l_{AP} = 30$  cm

Question ID : 860654860

28. The kinetic energy of a simple harmonic oscillator is oscillating with angular frequency of 176 rad/s.

 The frequency of this simple harmonic oscillator is \_\_\_\_\_ Hz.  $\left[ \text{take } \pi = \frac{22}{7} \right]$ 

एक सरल आवर्ती दोलक की गतिज ऊर्जा 176 rad/s की कोणीय आवृत्ति के साथ दोलन कर रही है। इस सरल आवर्ती दोलक की

 आवृत्ति \_\_\_\_\_ Hz है।  $\left[ \pi = \frac{22}{7} \text{ लें} \right]$ 

(1) 14

(2) 28

(3) 88

(4) 176

**Ans.** Official answer NTA (1)

**Sol.** Oscillation frequency of K.E = 2 × Freq. of oscillation

$$\therefore \omega(\text{oscillation}) = 176/2 = 88 \text{ rad/s}$$

$$\therefore \text{frequency} = 88/2\pi = 14$$

Question ID : 860654861

 29. A capacitor C is first charged fully with potential difference of  $V_0$  and disconnected from the battery. The charged capacitor is connected across an inductor having inductance L. In  $t$  s 25% of the initial energy in the capacitor is transferred to the inductor. The value of  $t$  is \_\_\_\_\_ s.

 एक संधारित्र C को पहले विभवान्तर  $V_0$  के साथ पूर्ण आवेशित किया जाता है और फिर बैटरी से वियोजित कर दिया जाता है। आवेशित संधारित्र प्रेरकत्व L वाले एक प्रेरक पर संयोजित है।  $t$  s में संधारित्र की प्रारम्भिक ऊर्जा का 25% प्रेरक में स्थानान्तरित हो जाता है।  $t$  का मान \_\_\_\_\_ s है।

(1)  $\frac{\pi\sqrt{LC}}{3}$

(2)  $\frac{\pi\sqrt{LC}}{2}$

(3)  $\pi\sqrt{\frac{LC}{2}}$

(4)  $\frac{\pi\sqrt{LC}}{6}$

**Ans.** Official answer NTA (4)

**Sol.** After  $t$  second electric energy remaining is 75% of original

$$\Rightarrow \frac{q^2}{2C} = \frac{3}{4} \left( \frac{q_0^2}{2C} \right)$$

$$\Rightarrow q = \frac{\sqrt{3}}{2} q_0$$

$$\therefore q = q_0 \cos(\omega t)$$

$$\Rightarrow \cos(\omega t) = \frac{\sqrt{3}}{2}$$

$$\Rightarrow \omega t = \frac{\pi}{6}$$



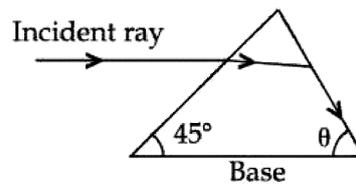
$$\Rightarrow \frac{1}{\sqrt{LC}} t = \frac{\pi}{6}$$

$$\Rightarrow t = \frac{\pi}{6} \sqrt{LC}$$

Question ID : 860654868

30. As shown in the diagram, when the incident ray is parallel to base of the prism, the emergent ray grazes along the second surface.

चित्र में दर्शाए गए अनुसार, जब आपतित किरण प्रिज़म के आधार के समान्तर है, तो निर्गत किरण द्वितीय पृष्ठ के अनुदिश संस्पर्शी है।



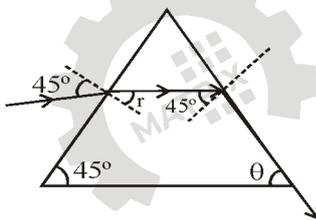
If refractive index of the material of prism is  $\sqrt{2}$ , the angle  $\theta$  of prism is.

यदि प्रिज़म के पदार्थ का अपवर्तनांक  $\sqrt{2}$  है, तो प्रिज़म का कोण  $\theta$  है।

- (1)  $45^\circ$                       (2)  $60^\circ$                       (3)  $75^\circ$                       (4)  $90^\circ$

**Ans.** Official answer NTA (2)

**Sol.**  $\because \mu = \sqrt{2} \Rightarrow$  critical angle  $\theta_c = 45^\circ$



Applying snells law for 1st refraction

$$\sin 45^\circ = \sqrt{2} \sin r \Rightarrow r = 30^\circ$$

$\because$  Sum of all angles of a quadrilateral is  $360^\circ$

$$\therefore \theta = 60^\circ$$

Question ID : 860654852

31. A spherical body of radius  $r$  and density  $\sigma$  falls freely through a viscous liquid having density  $\rho$  and viscosity  $\eta$  and attains a terminal velocity  $v_0$ . Estimated maximum error in the quantity  $\eta$  is :

(Ignore errors associated with  $\sigma, \rho$  and  $g$ , gravitational acceleration)

त्रिज्या  $r$  और घनत्व  $\sigma$  का एक गोलीय पिण्ड घनत्व  $\rho$  और श्यानता  $\eta$  के एक द्रव से होकर मुक्त रूप से गिरता है और एक सीमान्त चाल  $v_0$  प्राप्त कर लेता है। राशि  $\eta$  में आकलित महत्तम त्रुटि है :

( $\sigma, \rho$  और गुरुत्वीय त्वरण  $g$  से सम्बद्ध त्रुटियों की उपेक्षा)

(1)  $\frac{2\Delta r}{r} + \frac{\Delta v_0}{v_0}$       (2)  $2\left[\frac{\Delta r}{r} + \frac{\Delta v_0}{v_0}\right]$       (3)  $2\frac{\Delta r}{r} - \frac{\Delta v_0}{v_0}$       (4)  $2\left[\frac{\Delta r}{r} - \frac{\Delta v_0}{v_0}\right]$

**Ans.** Official answer NTA (1)

**Sol.**  $\therefore$  Terminal velocity  $V_0 = \frac{2gr^2}{9\eta}(\sigma - \rho)$

$\Rightarrow \eta \propto \frac{V_0}{r^2}$

$\therefore \frac{\Delta \eta}{\eta} = \frac{\Delta V_0}{V_0} + \frac{2\Delta r}{r}$

Question ID : 860654866

32. A battery with EMF  $E$  and internal resistance  $r$  is connected across a resistance  $R$ . The power consumption in  $R$  will be maximum when :

EMF  $E$  और आंतरिक प्रतिरोध  $r$  के साथ एक बैटरी एक प्रतिरोध  $R$  पर संयोजित है।  $R$  में शक्ति उपभोग (खपत) अधिकतम होगा तब :

(1)  $R = r/2$       (2)  $R = \sqrt{2}r$       (3)  $R = r$       (4)  $R = 2r$

**Ans.** Official answer NTA (3)

**Sol.** Power consumption is maximum (in external circuit)

When  $R = r$

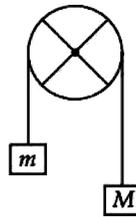
Question ID : 860654854

33. The pulley shown in figure is made using a thin rim and two rods of length equal to diameter of the rim. The rim and each rod have a mass of  $M$ . Two blocks of mass of  $M$  and  $m$  are attached to two ends of a light string passing over the pulley, which is hinged to rotate freely in vertical plane about its center. The magnitudes of the acceleration experienced by the blocks is \_\_\_\_\_.

(assume no slipping of string on pulley).

चित्र में दिखाई गई घिरनी एक पतले नेमि (रिम) और नेमि के व्यास के बराबर लम्बाई की दो छड़ों के प्रयोग से बनाई जाती है। नेमि और प्रत्येक छड़ के द्रव्यमान  $M$  हैं। द्रव्यमान  $M$  और  $m$  के दो गुटके घिरनी के ऊपर से गुजरती हुई एक हल्की डोरी के सिरों से जुड़े हुए हैं जो कि ऊर्ध्वाधर तल में अपने केन्द्र के सापेक्ष स्वतंत्र रूप से घूर्णन करने के लिए कब्जायुक्त है। गुटकों द्वारा अनुभूत त्वरण का परिमाण \_\_\_\_\_ है।

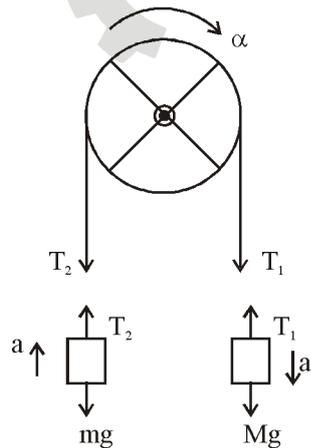
(घिरनी पर डोरी की कोई फिसलन ना मानें)



- (1)  $\left[ \left( \frac{13}{6} \right) M + m \right]$       (2)  $\frac{(M - m)g}{2M + m}$       (3)  $\frac{(M - m)g}{M + m}$       (4)  $\left[ \left( \frac{8}{3} \right) M + m \right]$

Ans. Official answer NTA (4)

Sol.



For the blocks

$$Mg - T_1 = Ma \quad \dots\dots\dots(i)$$

$$T_2 - mg = ma \quad \dots\dots\dots(ii)$$



For pulley

$$(T_1 - T_2)l/2 = \left[ \left( \frac{Ml^2}{12} \times 2 \right) + \frac{Ml^2}{4} \right] \alpha$$

$$(T_1 - T_2) = \left[ \frac{M}{3} + \frac{M}{2} \right] \alpha l \dots\dots\dots \text{(iii)}$$

For no slipping

$$a = \frac{l}{2} \alpha \dots\dots\dots \text{(iv)}$$

From (i),(ii),(iii) & (iv)

$$\frac{(M - m)g}{\left[ \left( \frac{8}{3} \right) M + m \right]}$$

Question ID : 860654851

34. Keeping the significant figures in view, the sum of the physical quantities 52.01 m, 153.2 m and 0.123 m is :

सार्थक संख्याओं को दृष्टिगत रखते हुए, भौतिक राशियों 52.01 m, 153.2 m और 0.123 m का योग है :

- (1) 205 m                      (2) 205.333 m                      (3) 205.33 m                      (4) 205.3 m

**Ans.** Official answer NTA (4)

**Sol.** 52.01 + 153.2 + 0.123  
= 205.333  
= 205.3 (SF rule for addition)

Question ID : 860654867

35. Given below are two statements :

**Statement I :** In a Young's double slit experiment, the angular separation of fringes will increase as the screen is moved away from the plane of the slits

**Statement II :** In a Young's double slit experiment, the angular separation of fringes will increase when monochromatic source is replaced by another monochromatic source of higher wavelength

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

Options :

- (1) Both Statement I and Statement II are false  
(2) Statement I is false but Statement II is true  
(3) Statement I is true but Statement II is false  
(4) Both Statement I and Statement II are true

नीचे दो कथन दिए गए हैं :

**कथन I :** यंग के एक द्विझिरी प्रयोग में, फ्रिंजों का कोणीय पार्थक्य, परदे को झिरियों के तल से दूर किए जाने पर बढ़ेगा।

**कथन II :** यंग के एक द्विझिरी प्रयोग में, फ्रिंजों का कोणीय पार्थक्य, एकवर्णी स्रोत को उच्चतर तरंगदैर्घ्य के एक अन्य स्रोत से प्रतिस्थापित किए जाने पर, बढ़ेगा।

उपर्युक्त कथनों के आलोक में, नीचे दिए गए विकल्पों में से **सही उत्तर** चुनें :

विकल्प :

- (1) कथन I और कथन II दोनों असत्य हैं
- (2) कथन I असत्य है, परन्तु कथन II सत्य है
- (3) कथन I सत्य है, परन्तु कथन II असत्य है
- (4) कथन I और कथन II दोनों सत्य हैं

**Ans.** Official answer NTA (2)

**Sol.** Angular separation  $\theta = \frac{\lambda}{d}$  is independent of D

Statement I is false

Statement II is true

Question ID : 860654859

36. The r.m.s. speed of oxygen molecules at  $47^\circ\text{C}$  is equal to that of the hydrogen molecules kept at \_\_\_\_\_  $^\circ\text{C}$ .  
(Mass of oxygen molecule/ mass of hydrogen molecule = 32/2)

$47^\circ\text{C}$  पर ऑक्सीजन अणुओं की r.m.s. चाल \_\_\_\_\_  $^\circ\text{C}$  पर रखे हाइड्रोजन अणुओं की r.m.s. चाल के बराबर है। (ऑक्सीजन अणु का द्रव्यमान/हाइड्रोजन अणु का द्रव्यमान = 32/2)

- (1)  $-100$       (2)  $-235$       (3)  $-253$       (4)  $-20$

**Ans.** Official answer NTA (3)

**Sol.**  $V_{\text{rms}} \propto \sqrt{\frac{T}{M}}$

$$\therefore (V_{\text{O}_2})_{\text{rms}} = (V_{\text{H}_2})_{\text{rms}}$$

$$\therefore \frac{T_{\text{O}_2}}{M_{\text{O}_2}} = \frac{T_{\text{H}_2}}{M_{\text{H}_2}} \Rightarrow \frac{320}{32} = \frac{T_{\text{H}_2}}{2} \Rightarrow T_{\text{H}_2} = 20\text{K}$$

$$\therefore T_{\text{H}_2} = -253^\circ\text{C}$$

Question ID : 860654869

37. The energy of an electron in an orbit of the Bohr's atom is  $-0.04 E_0 \text{ eV}$  where  $E_0$  is the ground state energy. If  $L$  is the angular momentum of the electron in this orbit and  $h$  is the Planck's constant, then

$\frac{2\pi L}{h}$  is \_\_\_\_\_ :

बोर परमाणु की एक कक्षा में एक इलेक्ट्रॉन की ऊर्जा  $-0.04E_0 \text{ eV}$  है जहाँ  $E_0$  निम्नतम अवस्था की ऊर्जा है। यदि  $L$  इस कक्षा में

इलेक्ट्रॉन का कोणीय संवेग है और  $h$  प्लैंक नियतांक है, तो  $\frac{2\pi L}{h}$  \_\_\_\_\_ है।

- (1) 6                      (2) 2                      (3) 4                      (4) 5

**Ans.** Official answer NTA (4)

**Sol.**  $E_n = \frac{-E_0}{n^2} = -0.04E_0$

$\Rightarrow n = 5$

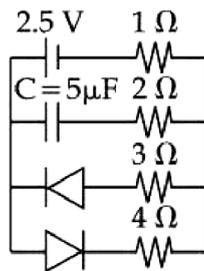
$\therefore mvr = L = \frac{nh}{2\pi}$

$\Rightarrow \frac{2\pi L}{h} = n = 5$

Question ID : 860654870

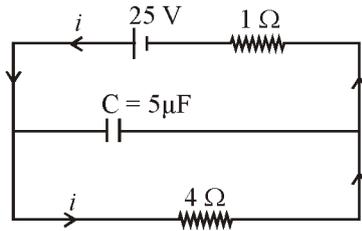
38. The charge stored by the capacitor  $C$  in the given circuit in the steady state is \_\_\_\_\_  $\mu\text{C}$ .

स्थायी दशा में प्रदत्त परिपथ में संधारित्र  $C$  द्वारा संचित किया गया आवेश \_\_\_\_\_  $\mu\text{C}$  है।



- (1) 12.5                      (2) 10                      (3) 5                      (4) 7.5

**Ans.** Official answer NTA (2)

**Sol.** At steady state

$$i = \frac{2.5}{4+1} = 0.5\text{A}$$

$$\begin{aligned} \therefore \text{Charge on capacitor} &= C(\Delta V) \\ &= (5 \times 10^{-6})(4 \times 0.5) \\ &= 10^{-5} \text{ C} \\ &= 10 \mu\text{C} \end{aligned}$$

Question ID : 860654855

39. Two cars A and B each of mass  $10^3 \text{ kg}$  are moving on parallel tracks separated by a distance of 10 m, in same direction with speeds 72 km/h and 36 km/h. The magnitude of angular momentum of car A with respect to car B is \_\_\_\_\_ J.s.

दो कारें A और B, जिनमें प्रत्येक का द्रव्यमान  $10^3 \text{ kg}$  है, समान दिशा में 72 km/h और 36 km/h की चालों के साथ 10 m की दूरी द्वारा पृथक magnitude of angular momentum of car A with respect to car B is \_\_\_\_\_ J.s.

- (1)  $3 \times 15^5$       (2)  $2 \times 10^5$       (3)  $3.6 \times 10^5$       (4)  $10^5$

**Ans.** Official answer NTA (4)**Sol.** w.r.t. to B

$$\begin{aligned} L_{AB} &= m(\mathbf{V}_{AB})_{\perp} r = 10^3 \left[ (72 - 36) \frac{5}{18} \right] \times 10 \\ &= 10^3 [10] 10 = 10^5 \end{aligned}$$

Question ID : 860654858

40. Surface tension of two liquids (having same densities),  $T_1$  and  $T_2$ , are measured using capillary rise method utilizing two tubes with inner radii of  $r_1$  and  $r_2$  where  $r_1 > r_2$ . The measured liquid heights in these tubes are  $h_1$  and  $h_2$  respectively. [Ignore the weight of the liquid about the lowest point of meniscus]. The heights  $h_1$  and  $h_2$  and surfaces tensions  $T_1$  and  $T_2$  satisfy the relation :

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- (1)  $h_1 > h_2$  and  $T_1 = T_2$       (2)  $h_1 < h_2$  and  $T_1 = T_2$   
 (3)  $h_1 > h_2$  and  $T_1 < T_2$       (4)  $h_1 = h_2$  and  $T_1 = T_2$



**Ans.** Official answer NTA (2)

**Sol.** We know that,  $h \propto \frac{T}{r}$

$$\Rightarrow \frac{h_1}{h_2} = \frac{T_1}{T_2} \left( \frac{r_2}{r_1} \right) \dots\dots(1)$$

$$\text{and } r_1 > r_2 \Rightarrow \frac{r_2}{r_1} < 1 \dots\dots(2)$$

From (1) and (2) only suitable option is  $h_1 < h_2$  and  $T_1 = T_2$

Question ID : 860654857

41. A large drum having radius  $R$  is spinning around its axis with angular velocity  $\omega$ , as shown in figure. The minimum value of  $\omega$  so that a body of mass  $M$  remains stuck to the inner wall of the drum, taking the coefficient of friction between the drum surface and mass  $M$  as  $\mu$ , is :

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(1)  $\sqrt{\frac{\mu g}{R}}$

(2)  $\sqrt{\frac{g}{2\mu R}}$

(3)  $\sqrt{\frac{2g}{\mu R}}$

(4)  $\sqrt{\frac{g}{\mu R}}$

**Ans.** Official answer NTA (4)

**Sol.**  $N = M\omega^2 R$  and  $Mg = \mu N$



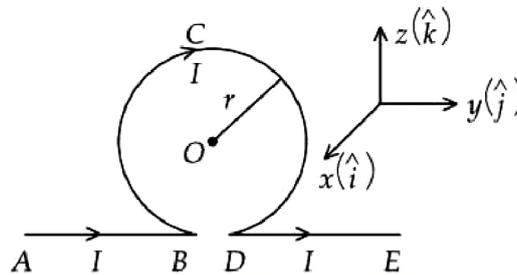
$$\therefore Mg = \mu M \omega^2 R$$

$$\Rightarrow \omega = \sqrt{\frac{g}{\mu R}}$$

Question ID : 860654864

42. An infinitely long straight wire carrying current  $I$  is bent in a planer shape as shown in the diagram. The radius of the circular part is  $r$ . The magnetic field at the centre  $O$  of the circular loop is :

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- (1)  $-\frac{\mu_0 I}{2\pi r}(\pi + 1)\hat{i}$     (2)  $\frac{\mu_0 I}{2\pi r}(\pi + 1)\hat{i}$     (3)  $\frac{\mu_0 I}{2\pi r}(\pi - 1)\hat{i}$     (4)  $-\frac{\mu_0 I}{2\pi r}(\pi - 1)\hat{i}$

**Ans.** Official answer NTA (4)

**Sol.**  $\vec{B}_0 = \frac{\mu_0 I}{4\pi r}\hat{i} + \frac{\mu_0 I}{2r}(-\hat{i}) + \frac{\mu_0 I}{4\pi r}\hat{i}$

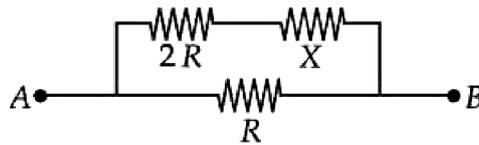
$$\Rightarrow \vec{B}_0 = \frac{\mu_0 I}{2r} \left[ \frac{1}{\pi} - 1 \right] \hat{i}$$

$$\Rightarrow \vec{B}_0 = -\frac{\mu_0 i}{2\pi r} [\pi - 1] \hat{i}$$

Question ID : 860654862

43. Two known resistances of  $R\Omega$  and  $2R\Omega$  and one unknown resistance  $X\Omega$  are connected in a circuit as shown in the figure. If the equivalent resistance between points A and B in the circuit is  $X\Omega$ , then the value of X is \_\_\_\_\_  $\Omega$ .

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- (1)  $R$                       (2)  $(\sqrt{3} + 1)R$                       (3)  $2(\sqrt{3} - 1)R$                       (4)  $(\sqrt{3} - 1)R$

**Ans.** Official answer NTA (4)

**Sol.**  $X = R_{eq} = \frac{(2R + X)R}{2R + X + R}$

$$\Rightarrow X(3R + X) = (2R + X)R$$

$$\Rightarrow 3RX + X^2 = 2R^2 + XR$$

$$\Rightarrow X^2 + 2RX - 2R^2 = 0$$

$$X = \frac{-2R + \sqrt{4R^2 + 4(2R^2)}}{2(1)} = \frac{-2R + \sqrt{12R^2}}{2}$$

$$\Rightarrow X = -R + \sqrt{3}R$$

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

Question ID : 860654865

44. Consider two identical metallic spheres of radius  $R$  each having charge  $Q$  and mass  $m$ . Their centers have an initial separation of  $4R$ . Both the spheres are given an initial speed of  $u$  towards each other. The minimum value of  $u$ , so that they can just touch each other is :

(Take  $k = \frac{1}{4\pi\epsilon_0}$  and assume  $kQ^2 > Gm^2$  where  $G$  is the Gravitational constant)

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$$(1) \sqrt{\frac{kQ^2}{4mR} \left(1 - \frac{Gm^2}{kQ^2}\right)}$$

$$(2) \sqrt{\frac{kQ^2}{2mR} \left(1 - \frac{Gm^2}{kQ^2}\right)}$$

$$(3) \sqrt{\frac{kQ^2}{4mR} \left(1 + \frac{Gm^2}{kQ^2}\right)}$$

$$(4) \sqrt{\frac{kQ^2}{2mR} \left(1 - \frac{Gm^2}{2kQ^2}\right)}$$

**Ans.** Official answer NTA (1)

**Sol.** From mechanical energy conservation:

$$k_i + v_i = k_f + u_f$$

$$\Rightarrow 2 \left[ \frac{1}{2} m u^2 \right] + \frac{kQ^2}{4R} - \frac{Gm^2}{4R} = 0 + \frac{kQ^2}{2R} - \frac{GM^2}{2R}$$

$$\Rightarrow m u^2 = \frac{kQ^2}{2R} - \frac{Gm^2}{2R}$$

$$\Rightarrow u = \sqrt{\frac{kQ^2}{4mR} \left(1 - \frac{Gm^2}{kQ^2}\right)}$$

Question ID : 860654856

45. A body of mass 2 kg is moving along x-direction such that its displacement as function of time is given by  $x(t) = \alpha t^2 + \beta t + \gamma$  m, where  $\alpha = 1 \text{ m/s}^2$ ,  $\beta = 1 \text{ m/s}$ ,  $\gamma = 1 \text{ m}$ . The work done on the body during the time interval  $t = 2 \text{ s}$  to  $t = 3 \text{ s}$ , is \_\_\_\_\_ J.

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(1) 24

(2) 49

(3) 42

(4) 12

**Ans.** Official answer NTA (1)

**Sol.**  $x = t^2 + t + 1$

$$v = 2t + 1$$

$$\text{At } t = 2 \text{ sec. } \Rightarrow v = 5 \frac{\text{m}}{\text{sec}}$$

$$\text{At } t = 3 \text{ sec. } \Rightarrow v = 7 \frac{\text{m}}{\text{sec}}$$



$$\therefore \omega_{\text{net}} = k_f - k_i = \frac{2}{2} [7^2 - 5^2] = 49 - 25 = 24 \text{ Joule}$$

Question ID : 860654873

46. An electromagnetic wave of frequency 100 MHz propagates through a medium of conductivity,  $\sigma = 10 \text{ mho / m}$ . The ratio of maximum conduction current density to maximum displacement current density is \_\_\_\_\_ .

$$\left[ \text{Take } \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 / \text{C}^2 \right]$$

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**Ans.** Official answer NTA (1800)

**Sol.** Conduction current density,  $J_c = \frac{i_c}{A} = \frac{V}{AR} = \frac{E(l)}{A \left[ \frac{l}{\sigma A} \right]} = \sigma E$

$$\therefore (J_c)_{\text{max}} = \sigma E_0$$

Where  $E_0$  amplitude of electric field.

and displacement current density,  $J_d = \frac{i_d}{A} = \frac{1}{A} \epsilon_0 \frac{d\phi}{dt}$

$$J_d = \epsilon_0 \frac{dE}{dt} \text{ where } E = \epsilon_0 \sin(\omega t + \phi)$$

$$(J_d)_{\text{max}} = \epsilon_0 E_0 \omega$$

$$\therefore \frac{(J_c)_{\text{max}}}{(J_d)_{\text{max}}} = \frac{\sigma E_0}{\epsilon_0 E_0 \omega} = \frac{\sigma}{\epsilon_0 \omega} = \frac{10 \times 9 \times 10^9 \times 4\pi}{2\pi \times 100 \times 10^6} = 1800$$

Question ID : 860654874

47. In a Young's double slit experiment set up, the two slits are kept 0.4 mm apart and screen is placed at 1 m from slits. If a thin transparent sheet of thickness  $20 \mu\text{m}$  is introduced in front of one of the slits then



center bright fringe shifts by 20 mm on the screen. The refractive index of transparent sheet is given by

$$\frac{\alpha}{10}, \text{ where } \alpha \text{ is } \underline{\hspace{2cm}}.$$

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**Ans.** Official answer NTA (14)

**Sol.** Path difference for central maxima =  $\frac{yd}{D} = (\mu - 1)t$

$$\Rightarrow (\mu - 1) = \frac{yd}{Dt}$$

$$\Rightarrow (\mu - 1) = \frac{20 \times 10^{-3} \times 0.4 \times 10^{-3}}{1 \times 20 \times 10^{-6}} = 0.4$$

$$\Rightarrow \mu = 1.4 = \frac{14}{10}$$

$$\therefore \alpha = 14$$

Question ID : 860654875

48. A particle having electric charge  $3 \times 10^{-19} \text{ C}$  and mass  $6 \times 10^{-27} \text{ kg}$  is accelerated by applying an electric potential of 1.21 V. Wavelength of the matter wave associated with the particle is  $\alpha \times 10^{-12} \text{ m}$ . The value of  $\alpha$  is  $\underline{\hspace{2cm}}$ . (Take Planck's constant =  $6.6 \times 10^{-34} \text{ J.s}$ )

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**Ans.** Official answer NTA (10)

**Sol.** 
$$\lambda = \frac{h}{\sqrt{2MqV}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 6 \times 10^{-27} \times 3 \times 10^{-19} \times 1.21}} = \frac{6.6 \times 10^{-34}}{6.6 \times 10^{-23}} = 10^{-11} \text{ m}$$

$$\Rightarrow \lambda = 10 \times 10^{-12} \text{ m}$$

Question ID : 860654872

49. A diatomic gas ( $\gamma = 1.4$ ) does 100 J of work when it is expanded isobarically. Then the heat given to the gas  $\underline{\hspace{2cm}}$  J.

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**Ans.** Official answer NTA (350)

**Sol.** 
$$\gamma = 1 + \frac{2}{f} = 1.4$$



$$\Rightarrow f = 5$$

From 1<sup>st</sup> Law:

$$Q = \frac{5}{2}nR\Delta T + nR\Delta T \text{ and } \omega = nR\Delta T = 100 \text{ Joule}$$

$$\Rightarrow Q = \left(\frac{5}{2} + 1\right)100 = 350 \text{ Joule}$$

Question ID : 860654871

50. The terminal velocity of a metallic ball of radius 6 mm in a viscous fluid is 20 cm/s. The terminal velocity of another ball of same material and having radius 3 mm in the same fluid will be \_\_\_\_\_ cm/s.

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**Ans.** Official answer NTA (5)

**Sol.** 
$$V_T = \frac{2gr^2}{9\eta}(\sigma - \rho)$$

$$V_T \propto r^2$$

$$\therefore \frac{V_2}{V_1} = \frac{r_2^2}{r_1^2}$$

$$\Rightarrow \frac{V_2}{20} = \left(\frac{3}{6}\right)^2 = \frac{1}{4}$$

$$\Rightarrow V_2 = 5 \text{ cm/sec}$$