AIPMT - 2015

Set – E, Physics

Note: Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

Important Instructions:

1. The Answer Sheet is inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars on side – 1 and side – 2 carefully with blue/black ball point pen only.

2. The test is of 3 hours duration and Test Booklet contains 180 questions. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 720.

3. Use Blue/Black Ball Point only for writing particulars on this page/marking responses.

4. Rough work is to be done on the space provided for this purpose in the Test Booklet only.

5. On completion of the test, the candidate must handover the Answer Sheet to the invigilator before leaving Room/Hall. The candidates are allowed to take away this Test Booklet with them.

6. The CODE for this Booklet is E. Make sure that the CODE printed on Side – 2 of the Answer Sheet is the same as that on this Booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.

7. The candidate should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. DO write your roll no. anywhere else except in the specified space in the Test Booklet/ Answer Sheet.

8. Use of white fluid for correction NOT permissible on the Answer Sheet.

9. Each candidate must shown on demand his/her Admission Card to the Invigilator.

10. No candidate, without special permission of the Superintendent or Invigilator, would leave his/her seat.

11. The candidates should not leave the Examination Hall without handling over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet twice. Cases where a candidate has not sign the Attendance Sheet second time will be deemed not be have handed over Answer Sheet and dealt with as an unfair means case.

12. Use of Electronic/Manual Calculator is prohibited.

13. The candidates are governed by all Rules and Regulations of the Board with regard to their conduct in the Examination Hall. All cases or unfair means will be dealt with as per Rules and Regulations of the Board.

14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.

15. The candidates will write the Correct Test Booklet Code is given in the Test Booklet/Answer Sheet in the Attendance Sheet.

Note: Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

Q.1 In energy (E), velocity (V) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be:

(1) $[E V^{-2} T^{-1}]$

(2) $[E V^{-1} T^{-2}]$

(3) $[E V^{-2} T^{-2}]$

(4) $[E^{-2} V^{-1} T^{-3}]$

Q.2 A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1}. The time after which the distance between them becomes shortest, is:

(1) 0 h

(2) 5 h

(3) $5\sqrt{2}$ h

(4) $10\sqrt{2}$ h

Q.3 A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = ßx^{-2n}$ where ß and n are constants and x is the position of the particle. The acceleration of the particle as a function of x, is given by:

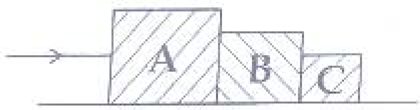
(1) $-2nß^2x^{-2n-1}$

(2) $-2nß^2x^{-4n-1}$

(3) $-2ß^2x^{-2n+1}$

(4) $-2nß^2e^{-4n+1}$

Q.4 Three blocks A, B and C of masses 4kg, 2kg and 1kg respectively, are in contact on a frictionless surface, as shown. If a force of 14 N is applied on the 4kg block, then the contact force between A and B is:



(1) 2 N

(2) 6 N

(3) 8 N

(4) 18 N

Q.5 A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the tableμk. When the block A is sliding on the table, the tension in the string is:

(1) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

(2) $\frac{(m_2-\mu_k m_1)g}{(m_1+m_2)}$

(3) $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$

(4) $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$

Q.6 Two similar springs P and Q have spring constants K_P and K_Q, such that $K_P > K_Q$. They are stretched, first by the same amount (case a), then by the same force (case b). The work done by the springs W_P and W_Q are related as, in case (a) and case (b), respectively:

(1) $W_P = W_Q$; $W_P > W_Q$

(2) $W_P = W_Q$; $W_P = W_Q$

(3) $W_P > W_Q$; $W_Q > W_P$

(4) $W_P < W_Q$; $W_Q < W_P$

Q.7 A block of mass 10 kg, moving in x direction with a constant speed of $10ms^{-1}$, is subjected to a retarding force $F = 0.1xJ/m$ during its travel from x = 20m to 30m. Its final KE will be:

(1) 475J

(2) 450J

(3) 275J

(4) 250J

Q.8 A particle of mass m is driven by a machine that delivers a constant power k watts. If the particle starts from rest the force on the particle at time t is:

(1) $\sqrt{\frac{mk}{2}}t^{-1/2}$

(2) $\sqrt{mk}\,t^{-1/2}$

(3) $\sqrt{2mk}t^{-1/2}$

(4) $\frac{1}{2}\sqrt{mk}\, t^{-1/2}$

Q.9 Two particles of masses m_1, m_2 move with initial velocities u_1 and u_2. On collision, one of the particles get excited to higher level, after absorbing energy ε. If final velocities of particles be v_1 and v_2 then we must have:

(1) $m_1^2u_1 + m_2^2u_2 - \varepsilon = m_1^2v_1 + m_2^2v_2$

(2) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 - \varepsilon$

(3) $\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \varepsilon = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

(4) $\frac{1}{2}m_1^2u_1^2 + \frac{1}{2}m_2^2u_2^2 + \varepsilon = \frac{1}{2}m_1^2v_1^2 + \frac{1}{2}m_2^2v_2^2$

Q.10 A rod of weight W is supported by two parallel knife edges. A and B is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mas of the rod is at distance x from A. The normal reaction on A is.

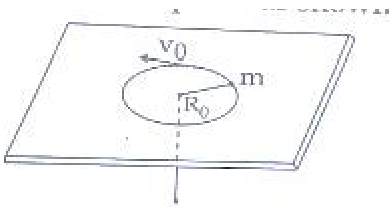
(1) $\frac{Wx}{d}$

(2) $\frac{Wd}{x}$

(3) $\frac{W(d-x)}{x}$

(4) $\frac{W(d-x)}{d}$

Q.11 A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown.



The tension in the string is increases gradually and finally m moves in a circle of radius $\frac{R_0}{2}$. The final value of the kinetic energy is:

(1) mv_0^2

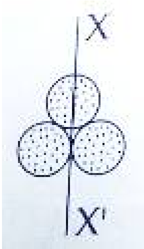
(2) $\frac{1}{4}mv_0^2$

(3) $2mv_0^2$

(4) $\frac{1}{2}mv_0^2$

Q.12 Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell.

Moment of inertia of the system consisting of these three spherical shells about XX' axis is:



(1) $\frac{11}{5}mr^2$

(2) $3mr^2$

(3) $\frac{16}{5}mr^2$

(4) $4mr^2$

Q.13 Kelper's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet

i.e. $T^2 = Kr^3$

here K is constant.

If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is

$F = \frac{GMm}{r^2}$, here G is gravitational constant

The relation between G and K is described as:

(1) $GK = 4\pi^2$

(2) $GMK = 4\pi^2$

(3) $K = G$

(4) $K = \frac{1}{G}$

Q.14 Two spherical bodies of mass M and 5M and radii R and 2R are released in free space with initial separation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is:

(1) 2.5R

(2) 4.5R

(3) 7.5R

(4) 1.5R

Q.15 On observing light from three different stars P, Q and R, it was found that intensity of violet color is maximum in the spectrum of P, the intensity of green color is maximum in the spectrum of R and the intensity of red color is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperatures of P, Q and R, then it can be concluded from the above observations that:

(1) $T_P > T_Q > T_R$

(2) $T_P > T_R > T_Q$

(3) $T_P < T_R < T_Q$

(4) $T_P < T_Q < T_R$

Q.16 The approximate depth of an ocean is 2700m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is $10^3 kg/m^3$. What fractional compression of water will be obtained at the bottom of the ocean?

(1) 0.8×10^{-2}

(2) 1.0×10^{-2}

(3) 1.2×10^{-2}

(4) 1.4×10^{-2}

Q.17 The two ends of a metal rod are maintained at temperature 100°C. The rate of heat flow in the rod is found to be 4.0J/s. If the ends are maintained at temperature 200°C and 210°C, the reate of heat flow will be:

(1) 44.0J/s

(2) 16.8J/s

(3) 8.0J/s

(4) 4.0J/s

Q.18 A wind with speed 40m/s blows parallel to the roof of a house. The area of the root is m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be:

$(P_{air} = 1.2 kg/m^3)$

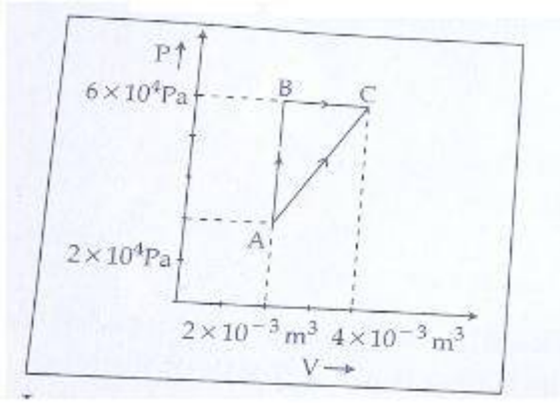
(1) 4.8×10^5 N, downwards

(2) 4.8×10^5 N, upwards

(3) 2.4×10^5 N, upwards

(4) 2.4×10^5 N, downwards

Q.19 Figure below show two paths that may be taken a gas to go from a state A to a state C.



In process AB, 400J of heat is added to the system and in process BC, 100J of heat is added to the system. The heat absorbed by the system in the process AC will be:

(1) 380J

(2) 500J

(3) 460J

(4) 300J

Q.20 A carnot engine, having an efficiency of $\eta = \frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10J, the amount of energy absorbed from the reservoir at lower temperature is:

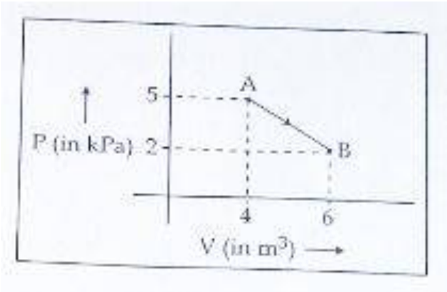
(1) 100J

(2) 99J

(3) 90J

(4) 1J

Q.21 One mole of an ideal diatomic gas undergoes a transition from A to B a transition from A to B along a path AB as shown in the figure,



The change in internal energy of the gas during the transition is:

(1) 20kJ

(2) -20kJ

(3) 20J

(4) -12kJ

Q.22 The ratio of the specific heats $\frac{C_p}{C_v} = \gamma$ in terms of degrees of freedom (n) is given by:

(1) $\left(1 + \frac{1}{n}\right)$

(2) $\left(1 + \frac{n}{3}\right)$

(3) $\left(1 + \frac{2}{n}\right)$

(4) $\left(1 + \frac{n}{2}\right)$

Q.23 When two displacements represented by y_1 a sin (ωt) are superimposed the motion is:

(1) not a simple harmonic

(2) simple harmonic with amplitude $\frac{a}{b}$

(3) simple harmonic with amplitude $\sqrt{a^2 + b^2}$

(4) simple harmonic with amplitude $\frac{(a+b)}{2}$

Q.24 A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position V_1 and V_2, respectively. Its time period is:

(1) $2\pi\sqrt{\frac{x_1^2+x_2^2}{V_1^2+V_2^2}}$

(2) $2\pi\sqrt{\frac{x_2^2-x_1^2}{V_1^2-V_2^2}}$

(3) $2\pi\sqrt{\frac{V_1^2+V_2^2}{x_1^2+x_2^2}}$

(4) $2\pi\sqrt{\frac{V_1^2-V_2^2}{x_1^2-x_2^2}}$

Q.25 The fundamental frequency of a closed organ pipe of length 20 cm equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is:

(1) 80cm

(2) 100cm

(3) 120cm

(4) 140cm

Q.26 A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is **incorrect**?

(1) The potential difference between the plates decreases K times.

(2) The energy stored in the capacitor decreases K times.

(3) The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$.

(4) The charge on the capacitor is not conserved.

Q.27 The electric field in a certain region is acting radially outward and is given by E = Ar. A charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by:

(1) $4\pi\varepsilon_0 Aa^2$

(2) $A\varepsilon_0 a^2$

(3) $4\pi\varepsilon_0 Aa^3$

(4) $\epsilon_0 Aa^3$

Q.28 A potentiometer wire has length 4 m and resistance 8 Ω. The resistance that must be connected in series with the wire and an accumulator of e.m.f. 2V, so as to get a potential gradient 1 mV per cm on the wire is:

(1) 32 Ω

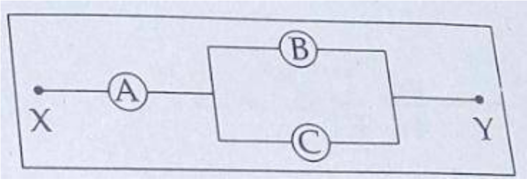
(2) 40 Ω

(3) 44 Ω

(4) 48 Ω

Q.29 A, B and C are voltmeters of resistance R, 1.5r and 3R respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are $V_{A'}$ V_B and V_C respectively.

Then:



(1) $V_A = V_B = V_C$

(2) $V_A \neq V_B = V_C$

(3) $V_A = V_B \neq V_C$

(4) $V_A \neq V_B \neq V_C$

Q.30 Across a metallic conductor of non-uniform cross section a constant potential difference is applied. The quantity which remains constant along the conductor is:

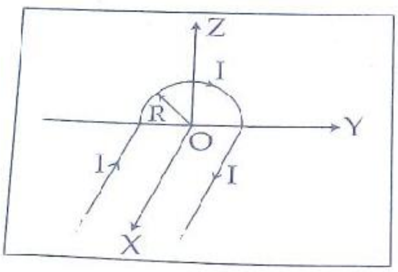
(1) current density

(2) current

(3) drift velocity

(4) electric field

Q.31 A wire carrying current I has the shape as shown in adjoining figure. Linear parts of the wire are very long and parallel to X-axis while semicircular portion of radius R is lying in Y-Z plane. Magnetic field at point O is:



(1) $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\,\hat{\imath} + 2\hat{k}\right)$

(2) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{\imath} - 2\hat{k}\right)$

(3) $\vec{B} = -\frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{\imath} + 2\hat{k}\right)$

(4) $\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(\pi\hat{\imath} - 2\hat{k}\right)$

Q.32 An electron moving in a circular orbit of radius or makes n rotations per second. The magnetic field produced at the centre has magnitude:

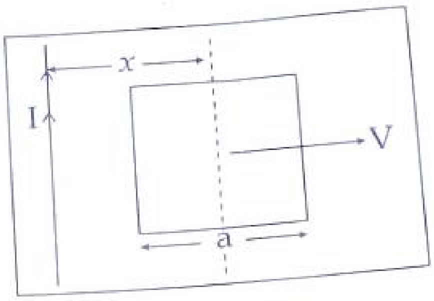
(1) $\frac{\mu_0 ne}{2\pi r}$

(2) Zero

(3) $\frac{\mu_0 n^2 e}{r}$

(4) $\frac{\mu_0 ne}{2r}$

Q.33 A conduction square frame of side 'a' and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity 'V' The emf induced in the frame will be proportional to:



(1) $\frac{1}{x^2}$

(2) $\frac{1}{(2x-a)^2}$

(3) $\frac{1}{(2x-a)^2}$

(4) $\frac{1}{(2x-a)(2x+a)}$

Q.34 A resistance 'R' draws power 'P' when connected to an AC source. If an inductance is now planced in series with the resistance, such that the impedance of the circuit becomes 'Z', the power drawn will be:

(1) $P\left(\frac{R}{Z}\right)^2$

(2) $P\sqrt{\frac{R}{z}}$

(3) $P\left(\frac{R}{Z}\right)$

(4) P

Q.35 A radiation of energy 'E' falls normally on a perfectly reflection surface. The momentum transferred to the surface is (C = Velocity of light):

(1) $\frac{E}{c}$

(2) $\frac{2E}{C}$

(3) $\frac{2E}{c^2}$

(4) $\frac{E}{C^2}$

Q.36 Two identical thin plano – convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surface in contact at the centre. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is:

(1) - 20 cm

(2) – 20 cm

(3) – 50 cm

(4) 50 cm

Q.37 For a parallel beam of monochromatic light of wavelength 'λ', diffraction is produced by a single slit whose width 'a' is of the order of the wavelength of the light. If 'D' is the distance of the screen from the slit, the width of the central maxima will be:

(1) $\frac{2D\lambda}{a}$

(2) $\frac{D\lambda}{\mathrm{a}}$

(3) $\frac{Da}{\lambda}$

(4) $\frac{2Da}{\lambda}$

Q.38 In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A monochromatic light of wavelength 500 nm is used. What will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern?

(1) 0.2 mm

(2) 0.1 mm

(3) 0.5 mm

(4) 0.02 mm

Q.39 The refracting angle of a prism is A, and refractive index of the material of the prism is cot(A/2). The angle of minimum deviation is:

(1) 180° - 3A

(2) 180° - 2A

(3) 90° - A

(4) 180° 2A

Q.40 A certain metallic surface is illuminated with monochromatic light of wavelength, λ. The stopping potential for photo-electric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2 λ, the stopping potential V_0. The threshold wavelength for this surface for photo-electric effect is:

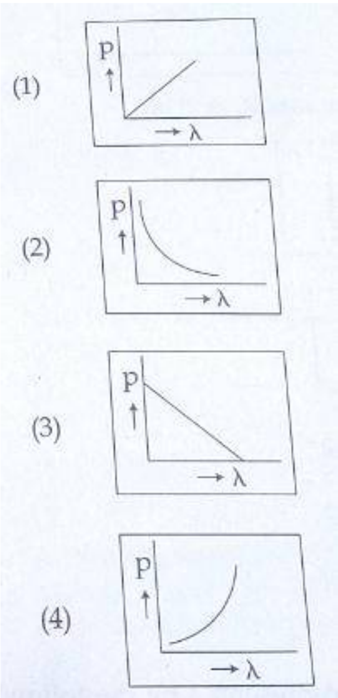
(1) 6 λ

(2) 4 λ

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

(4) $\frac{\lambda}{4}$

Q.41 Which of the following figures represent the variation of particle momentum and the associated de-Broglie wavelength?



(2) is the correct answer

Q.42 Consider 3rd orbit of He^+ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given K = 9 x 10^9 constant, Z = 2 and h (Planck's Constant) = 6.6 x 10^{-34} J s]

(1) 2.92 x 10^6 m/s

(2) 1.46 x 10^6 m/s

(3) 0.73 x 10^6 m/s

(4) 3.0 x 10^8 m/s

Q.43 If radius of the $^{27}_{13}$Al nucleus is taken to be R_{Al} then the radius of $^{123}_{53}$ Te nucleus is nearly:

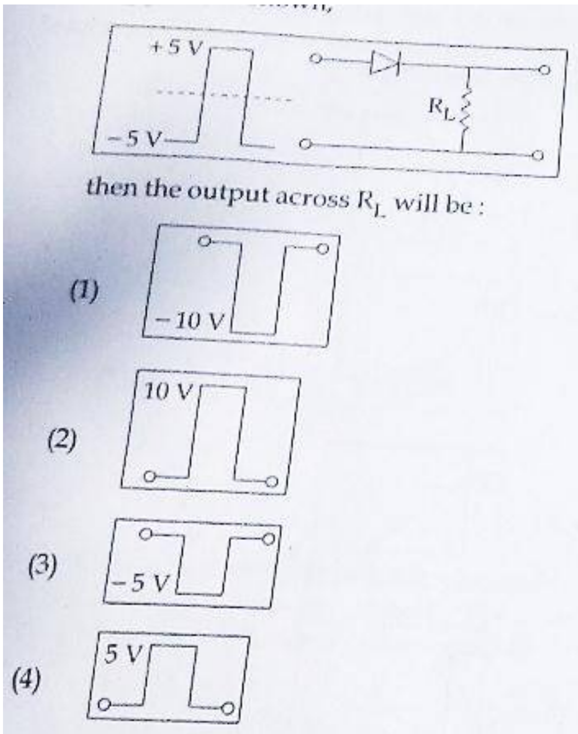
(1) $\left(\frac{53}{13}\right)^{\frac{1}{3}} R_{Al}$

(2) $\frac{5}{3}$ R_{Al}

(3) $\frac{3}{5}$ R_{Al}

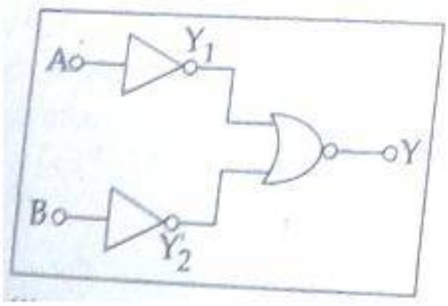
(4) $\left(\frac{13}{53}\right)^{\frac{1}{3}} R_{Al}$

Q.44 If in a p-n junction, a square input signal of 10 V is applied, as shown,



(4) is the correct answer

Q.45 Which logic gate is represented by the following combination of logic gates?



(1) OR

(2) NAND

(3) AND

(4) NOR

Answer Key and Explanations

Sol.1 (3)

energy (E), velocity (V) and time (T)

$E = ML^2T^{-2}$, $V = LT^{-1}$, $T = T$

$E = ML^2\ T^{-2}$, $V = LT^{-1}$, $T = T$

$[S] = [F]/[L] = ML^0T^{-2}$

$ML^0T = [E]^0\ [V]^b\ [T]^c$

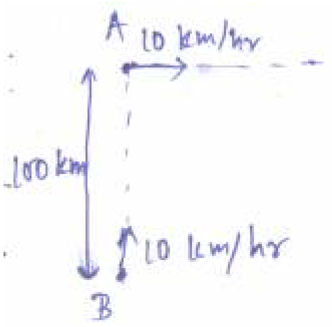
$ML^0\ T^{-2} = M^a\ L^{2a+b}\ T^{-2a-b+c}$

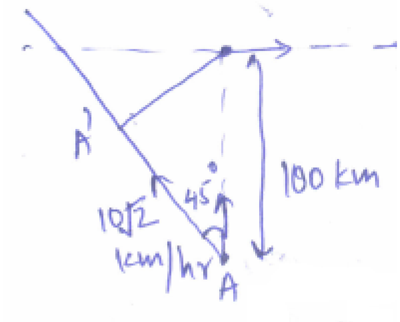
Comparing a, b & c with coefficient in LHS,

a = 1 , b = -2 , c = -2

$[E]\ [V]^{-2}\ [T]^{-2}$

Sol.2 (2)





$\frac{\vec{V_A}}{g} = 10\,\hat{\imath}$; $\frac{\vec{V_B}}{g} = \hat{\jmath}$

$\frac{\vec{V_B}}{A} = -10\hat{\imath} + 10\hat{\jmath}$

$\left|\frac{\vec{V_B}}{a}\right| = 10\sqrt{2}\ km\ /hr$

AA^1 $100 \cos 45° = \frac{100}{\sqrt{2}}$ km

T (time taken) $= \frac{100}{\sqrt{2}\ x\ 10\ x\ \sqrt{2}}\ hr$

T = 5 hrs

Sol.3 (2)

$V(x) = Bx^{-2n}$

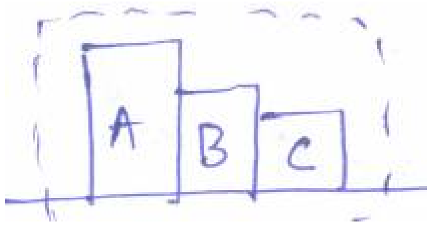
$a = \frac{dv}{dt} \Rightarrow a = \frac{dv}{dt}\frac{dx}{dx} = \frac{dx}{dt}\frac{dv}{dx}$

$\Rightarrow a = v\frac{dv}{dx}$

$\Rightarrow a = (B\ x^{2n})\ (-2n\ B\ x^{-2n-1})$

$A = -2n\ B^2\ x^{-4n-1}$

Sol.4 (2)



$M_A = 4$ kg ,$m_B = 2$kg , $m_C = 1$kg

M_T (total mass) = 4 + 2 + 1 = 7Kg

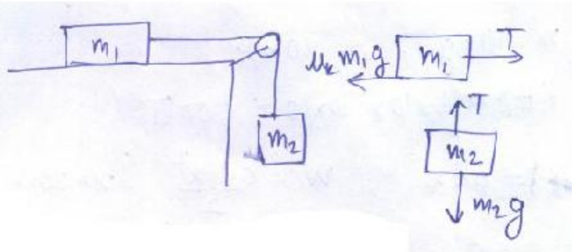
F = 14 N

Q system $= \frac{14}{7} = 2m/s^2$

$14 - F_{AB} = 4 \times 2$

$F_{AB} = 6N$

Sol.5 (3)



$[T - \mu_k m_1 m_2 g = m_1 a] \times m_2$

$[m_2 g - T = m_2 a] \times m_1$

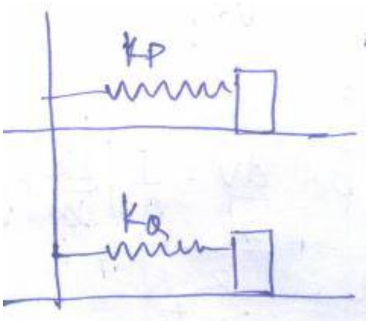
$m_2 T - \mu_k m_1 m_2 g = m_1 m_2 a$

$m_1 m_2 g - m_1 T = m_1 m_2 a$

$\Rightarrow m_2 T - \mu_k m_1 m_2 g = m_1 m_2 g - m_1 T$

$\Rightarrow T = \frac{m_1 m_2 g\,(\mu_K + 1)}{m_1 + m_2}$

Sol.6 (3)



$K_p > k_q$

(a) $W_p = \frac{1}{2} k_p x X^2$

(b) $W_p = F \frac{F}{k_p} = \frac{F^2}{k_p}$

$W_Q = \frac{F^2}{k_q} \Rightarrow W_Q > W_p$

Sol.7 (1)

$M = 10\text{kg}, v = 10\ \text{m/s}$

KE; $= \frac{1}{2} x\ 10\ x\ 10\ x\ 10 = 500$ J

$F = 0.1x$; $W = \frac{0.1\,x^2}{2}$ (x = 20m to x = 30m)

$= \frac{0.1}{2}[900 - 400] = 25$ J

$W_{\text{all forces}} = KE_f - KE_i$

-25 J $= KE_f$ - 500J

$\Rightarrow KE_f = 475$ J

Sol.8 (1)

Power = k

$P = Fv = Mav = m\frac{dv}{dt}\, v$

$K = m\frac{v\,dv}{dt} \Rightarrow \int k\,dt = \int mv\,dv$

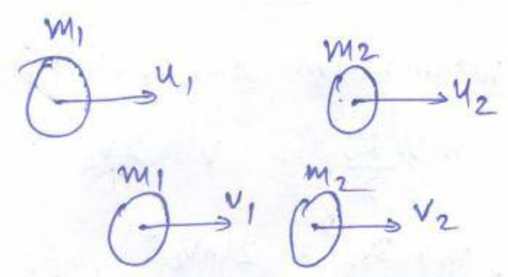
$\Rightarrow kt = \frac{mv^2}{2}$

$\Rightarrow \sqrt{\frac{2kt}{m}} = v \Rightarrow a = \frac{dv}{dt} = \frac{1}{2}\sqrt{\frac{2k}{m}}\cdot\frac{1}{\sqrt{t}}$

$$a = \sqrt{\frac{k}{2mt}}$$

$\Rightarrow F = ma = \sqrt{\frac{mk}{2}}\, t^{-\frac{1}{2}}$

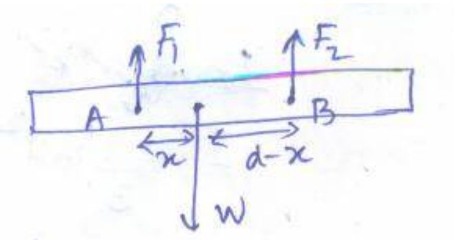
Sol.9 (3)



$TE_i = TE_f$

$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

Sol.10 (4)



$F_1 + F_2 = mg$; (Forces)

$F_1\ x = F_2\ (d - x)$; (Torque)

$\frac{F_1 x}{(d-x)} = F_2$

$\Rightarrow \frac{F_1 x}{(d-x)}\ F_1 = mg \Rightarrow F_1\left(\frac{x}{d-x} + 1\right) = mg$

$$\frac{F_1 d}{(d-x)} = mg$$

$$\Rightarrow F_1 = \frac{W(d-x)}{d}$$

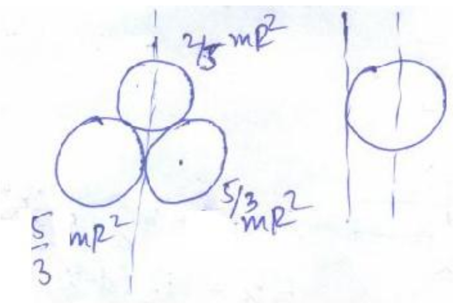
Sol.11 (3)

Angular momentum conservation,

$M\ v_0\ R_0 = mv'.\frac{R_0}{2} \Rightarrow v' = 2v_0$

$KE_f = \frac{1}{2}m\ (2v_0)^2 = 2mv_0^2$

Sol.12 (4)



$I = I_0 + md^2$

$= \frac{2}{3}\ mR^2 + mR^2$

$I = \frac{5}{3}\ mR^2$

$I_T = \left(\frac{5}{3} + \frac{5}{3} + \frac{2}{3}\right)mR^2 = 4\ mR^2$

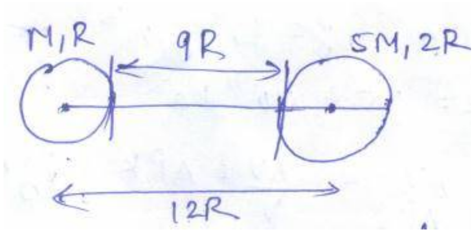
Sol.13 (2)

$\frac{G\ mM_e}{R^2} = \frac{mv^2}{R}\ \&\ \frac{2\pi R}{v} = T\ \Rightarrow v = \frac{2\pi R}{T}$

$\frac{GM_e}{R} = \frac{4\pi^2 R^2}{T^2} \Rightarrow GMeT^2 = 4\pi^2 R^3 \qquad T^2 = \frac{4\pi^2}{GM_e}\ R^3$

$\Rightarrow k = \frac{4\pi^2}{GM} \Rightarrow GMK = 4\pi^2$

Sol.14 (3)



x → distance moved by small sphere

y → distance moved by big sphere

M x = 5M y [No change in centre of mass]

$\frac{x}{5} = y$

$\Rightarrow \frac{x}{5} + x = 9R$ [Available distance for movement]

$\Rightarrow \frac{6x}{5} = 9R$

$\Rightarrow x = \frac{15}{2} R = 7.5 R$

Sol.15 (2)

P	Q	R	
T_p	T_Q	T_R	$E \propto T^4$
Violet	Red	Green	$E \propto \frac{1}{\lambda}$
			$\Rightarrow T^4 \propto \frac{1}{\lambda}$

$\Rightarrow T_p > T_R > T_Q$

Sol.16 (3)

h = 2700 m , $\rho = 10^3$ kg/m^3

k = 45.4×10^{-11} Pa^{-1}

$k = \frac{1}{V}\frac{\Delta V}{\Delta P} \Rightarrow \frac{\Delta V}{V} = \Delta P\, k = \rho g h\, k$

$\Delta P = \rho g h k = 10^3 \times 10 \times 2700 \times 45.4 \times 10^{-11}$

$= 2.7 \times 4.54 \times 10^{-3}$

$= 1.2 \times 10^{-2}$

Sol.17 (4)

100°C  110°C

200°C 210°C

$\Delta T = 10°C$

$\frac{\Delta Q}{\Delta t} = KA\frac{\Delta T}{\Delta x}$

$\frac{\Delta Q}{\Delta t} = \left[\frac{K\,A}{\Delta x}\right]\Delta T \Rightarrow \Delta T = 10°C$

$\frac{\Delta Q}{\Delta t} = 4J/S.$

Sol.18 (3)

$P_A + \rho g h_A + \frac{1}{2}\rho v_A^2 = P_B + \rho g h_B + \frac{1}{2}\rho v_B^2$

$v_B = 0\ ;\ h_A = h_B$

$\Rightarrow P_B - P_A = \frac{1}{2}\rho v_A^2$

$\Rightarrow F = (P_B - P_A)\,A = \frac{1}{2}\rho\ v_A^2\ A$

$\Rightarrow F = \frac{1}{2} x\ 1.2\ x\ 40\ x\ 40\ x\ 250 = 12\ x\ 20\ x\ 1000 = 24\ x\ 10^4\ N = 2.4\ x\ 10^5\ N$

Sol.19 (3)

$Q_{AB} = 400\ J$

$W_{AB} = 0$

$\Rightarrow \Delta U_{AB} = 400J$

$Q_{BC} = 100\ J$

$\therefore W_{BC} = 6 \times 10^4 \times 2 \times 10^{-3}$

$= 120\ J$

$\Delta U_{BC} = -20\ J$

$\Rightarrow \Delta U_{ABC} = 380\ J$

As ΔU is state function, then

$\Delta\ U_{ABC} = \Delta U_{Ac} = 380\ J$

$Q_{Ac} = \Delta U_{Ac} + W_{Ac}$

$= 380 + \frac{(2+6)}{2} \times 10^4 \times 2 \times 10^{-3}$

$Q_{AC} = 460\ J$

Sol.20 (1)

$\eta = 1 - \left(\frac{Q-w}{Q}\right)$

$1 - \eta = \frac{Q-w}{Q} \Rightarrow \frac{9}{10} = \frac{Q-w}{Q}$

$\Rightarrow 9Q = 10\,Q - 10\,W$

$\Rightarrow Q = 10\,W = 10 \times W = 100\,J$

Sol.21 (2)

$\Delta U = n\,C_v \Delta T$

As $nRT = pV$

$\Rightarrow nR\,\Delta T = P_2V_2 - P_1V_1 = nR\,(T_2 - T_1)$

$\Rightarrow \mathbf{nR}\Delta T = 2 \times 10^3 \times 6 - 20 \times 10^3 \times 4 = -8000$

$\Delta U = \frac{5}{2} nR\,\Delta T$ [diatomic]

$\Delta U = \frac{5}{2} \times (-8000) = -20$ KJ

Sol.22 (3)

$\frac{C_p}{C_V} = y$ and $c_p - c_V = R$

$C_V = \frac{fR}{2} = n\frac{R}{2}$

$C_P = \frac{nR}{2} + R$

$\frac{C_p}{C_V} = \frac{n+2}{n} = \left(1 + \frac{2}{n}\right)$

Sol.23 (3)

$y_1, = a \sin \omega t$

$y_2 = b \cos \omega t$

$y_1 + y_2 = a \sin \omega t + b \cos \omega t$

$(y_1 + y_2)_{max} = \sqrt{a^2 + b^2}$

Sol.24 (2)

$x = A \sin \omega t$

V = A cos ωt

$V = \omega\sqrt{A^2 - x^2}$

$V_1 = \omega\sqrt{A^2 - x_1^2}$

$V_2 = \omega\sqrt{A^2 - x_2^2}$

calculating for A

$\Rightarrow v_1^2 + \omega^2 x_1^2 = v_2^2 + \omega^2 x_2^2$

$\Rightarrow v_1^2 - v_2^2 = \omega^2(x_2^2 - x_1^2$

$\Rightarrow \omega = \sqrt{\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}} \Rightarrow T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

Sol.25 (1)

$\frac{V}{4\ell_1} \rightarrow$ Fundamental frequency of closed organ pipe

$\frac{2V}{2\ell_2} \rightarrow$ Second overtone of open organ pipe

$\frac{V}{4\ell_1} = \frac{V}{\ell_2} \Rightarrow 4\ell_1 = \ell_2 = 80$ cm

Sol.26 (4)

Capacitor is charged and is then removed later. Dielectric is introduced between the plants. Charge remains conserved.

Sol.27 (3)

E = A r (electric field of uniformly charged sphere)

Field at surface r = a,

$E = \frac{KQ}{a^2} = A\,a \Rightarrow Q = \frac{Aa^3}{k} = 4\pi E_o Aa^3$

Sol.28 (1)

Let resistance connected is R

So $I = \frac{2V}{(8+R)}$

Potential drop across the wire = $\left(\frac{2}{8+R}\right) \times 8$

Now,

$\left(\frac{2\times 8}{8+R}\right) \times \frac{1}{4} = 1 \times 10^{-3} \times 100$

$\Rightarrow \frac{4}{(8+R)} = 0.1 \Rightarrow 4 = 0.8 + 0.1R$

$\Rightarrow R = 32\Omega$

Sol.29 (1)

$V_A = I \times R = IR$

$V_B = I_1 \times 1.5\ R$

$V_c = (I - I_1) \times 3R$

$V_B = V_c = 1.5\ I_1R + 3I_1R = 3IR \Rightarrow I_1 = \frac{3}{9} \times 2\ I = \frac{2}{3}\ I$

$\Rightarrow V_B = \frac{2}{3} I \times \frac{3}{2} R = IR$ & $V_c = 3R \times \frac{I}{3} = IR$

$\Rightarrow V_B = V_c = V_A$

Sol.30 (2)

∴ Current is constant

Sol.31 (3)

$\vec{B}$due to linear parts $= \left[\frac{\mu_0\, \hat{\imath}}{4\lambda R}(-\hat{k})\right].2$

$\vec{B}$due to semi circular parts$= \frac{\mu_0 \hat{\imath}}{4R}$ (-$\hat{\imath}$)

so, $\vec{B}_{net} = \frac{\mu_0\, I}{2\,\lambda\, R}\hat{k}$ - $\frac{\mu_0\, I}{4R}\hat{\imath}$

$= - \frac{\mu_0\, I}{4\,\lambda\, R}[2\hat{k} + \pi\ \hat{\imath}]$

Sol.32 (4)

$\hat{\imath} = \frac{e}{t} = \frac{e}{1/n} = ne$

$B = \frac{\mu_0\, I}{2\, R} = \frac{\mu_0\, ne}{2\, R}$

Sol.33 (4)

$B\ (y) = \frac{\mu_0\, I}{2\,\lambda\, y}$; $d\phi = \frac{\mu_0\, I}{2\,\lambda} . Q . dy$

$\Rightarrow \phi = \int \frac{\mu_0\, I}{2\,\lambda\, y}\ a . dy = \frac{\mu_0\, I\, a}{2\,\lambda}\ lu\ \left(\frac{x+\frac{a}{2}}{x-\frac{a}{2}}\right)$

East induced $= - \frac{d\phi}{dt} = \frac{\mu_0\, I\, a}{2\,\lambda}\left[\frac{1}{x+\frac{a}{2}} - \frac{1}{x-\frac{a}{2}}\right]\ V$

$= -\frac{\mu_0\, I\, a}{2\,\lambda}\left[\frac{2(\mu-a)-2\,(2x+a)}{(2x+a)(2x-a)}\right] = \left(\frac{\mu_0\, I\, a}{2\,\lambda} . 4a\right) . \frac{1}{(2x+a)(2x-a)}$

Sol.34 (3)

P_{av} = EI cosϕ

Where, cosϕ = R/z

For purle resistive circuit,

Power = EI = P

Where inductance becomes Z,

$$\text{Power} = \text{EI. cos}\phi = \text{EI.}\frac{R}{z}$$

$$= \text{P}\left(\frac{R}{Z}\right)$$

Sol.35 (2)

$$\text{Momentum} = \frac{E}{c}$$

After reflection, ray changer direction,

$$\text{Net momentum transferred} = \frac{E}{C} - \left(-\frac{E}{c}\right)$$

$$= 2E/c$$

Q.36 (3)

The system is combination of plano convex leas, concave leans and again plano convex lens.

Focal length of plano – convex lens,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_1}\right) = (1.5 - 1)\left(\frac{1}{\infty} - \frac{1}{-20}\right) = \frac{1}{40}\ cm$$

F = 40 cm.

Focal length of concave lens farmed by the oil of refractive index 1.7,

$$\frac{1}{f} = (1.7 - 1)\left(\frac{1}{-20} - \frac{1}{20}\right)$$

$$= -\frac{7}{10}\ x\ \frac{1}{10} = -\frac{7}{100}\ cm$$

$$F = -\frac{7}{100}\ cm.$$

Net focal length;

$$\frac{1}{f_{net}} = \frac{1}{40} + \frac{1}{40} - \frac{7}{100} = \frac{50 + 5 - 14}{200}$$

F_{net} = - 50 cm

Sol.37 (2)

width of central maxima $= \frac{2\lambda d}{a}$

$\text{Sin}\theta \approx \tan \approx \frac{\lambda}{a}$

$= 6\text{ Y } = \frac{\lambda D}{a}$

Sol.38 (1)

d = 1mm = $1\text{x}10^{-3}$ m.(distance between the slits)

D = 1m.

a = width of slit.

λ = 500 nm.

for 5 maxima above the central line in double slit diffraction pattern,

$$\text{dsin}\theta = 5\lambda$$

$$\sin\theta = \frac{5\lambda}{d}$$

$$\frac{y}{D} = \frac{5\lambda}{d}$$

$$\text{Y} = \frac{5\lambda D}{d}$$

For first minima of single slit diffraction, I

$$\text{Q}\sin\theta = \lambda$$

$$\text{y}^1 = \frac{\lambda D}{a}$$

so , for $y^1 = y$,

$$\frac{5}{d} = \frac{1}{a}$$

$$\Rightarrow \text{a} = \frac{d}{5} = \frac{1mm}{5} = 0.2\ mm$$

Sol.39 (1)

$$\mu = \frac{\sin(A+\frac{sm}{2})}{Sin\frac{A}{2}}$$

$$\Rightarrow \cot\frac{A}{2} = \frac{\cos\frac{A}{2}}{Sin\frac{A}{2}} = \frac{\sin(A+\frac{sm}{2})}{\sin\frac{A}{2}}$$

$$\Rightarrow \text{Cos}\left(\frac{A}{2}\right) = \sin\left(A + \frac{sm}{2}\right)$$

$\Rightarrow \text{Sin}\left(\frac{\lambda}{2}-\frac{A}{2}\right)=\sin\left(A+\frac{sm}{2}\right)$

$\Rightarrow \frac{\lambda}{2}-\frac{A}{2}=A+\frac{sm}{2}$

$\Rightarrow \lambda - A = 2A + \delta m$

$\Rightarrow \delta m = \lambda - 3A$

Sol.40 (2)

Energy incident $= \frac{h\,c}{\lambda}$

Kinetic energy of electrons = 3 eV_0

Work function $= \frac{hc}{\lambda} - 3eV_0$

Where energy incident $= \frac{h\,c}{2\,\lambda}$

Kinetic energy of electrons = eV_0

$\Rightarrow \frac{h\,c}{2\,\lambda} - ev_0 = \frac{h\,c}{\lambda} - 3eV_0$

$\Rightarrow \frac{h\,c}{3\,\lambda} = 2\,eV_0 \Rightarrow \frac{h\,c}{\lambda} = 4eV_0$

Threshold wavelength occurs when kinetic energy is zero.

I.e.

Threshold energy $= \frac{h\,c}{\lambda} - 3eV_0$

$= \frac{h\,c}{\lambda}$ - 3. X $\frac{h\,c}{4\,\lambda}$

$= \frac{h\,c}{4\,\lambda}$

so, $\lambda' = 4\,\lambda$.

Sol.41 (2)

$P = \frac{h}{\lambda}$

$\Rightarrow p.\,\lambda$ = constant

Sol.42 (2)

Energy in 3rd orbit $= -13.6 \times \left(\frac{z^2}{n^2}\right)$

$= -13.6 \times \frac{4}{9}$

$= -6.04$ eV

Kinetic energy = 6.04 eV = $\frac{1}{2}$ $m_e v^2$

$v^2 = \frac{2\ x\ 6.04\ x\ 1.6\ x\ 10^{-19}}{m_e}$

v = 1.46 x 10^6 m/s

Sol.43 (2)

$R = R_0 A^{\frac{1}{3}}$

so,

$R_{AL} = R_0 \cdot (27)^{\frac{1}{3}}$

For Te,

$R_{Te} = R_0 \cdot (125)^{\frac{1}{3}}$

$\Rightarrow \frac{R_{Te}}{R_{AL}} = \left(\frac{125}{27}\right)^{\frac{1}{3}}$

$\Rightarrow R_{Tc} = \frac{5}{3} R_{Al}$

Sol.44 (4)

Diode will only conduct where Potential is positive in a manner to forward bias it.

Sol.45 (3) AND

1, 1 gives 1.

1 , O gives 0.