ALL INDIA TEST SERIES

PART TEST – I

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

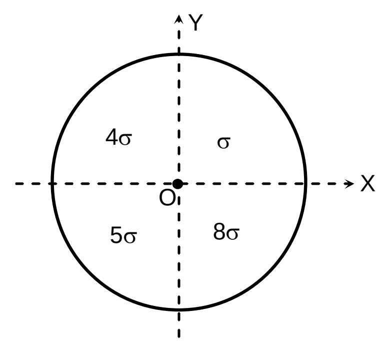
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A man is moving on a circular path of radius R on horizontal ground with constant angular velocity ω. Rain is falling with constant velocity 4 ms^{-1} making an angle 45° with vertical, in the plane containing north-south direction. The magnitude of average velocity of rain with respect to man in one full rotation is

   (A) 4 ms^{-1}
   (B) $\sqrt{4^2+\omega^2R^2+\sqrt{2}\omega R}$
   (C) $\sqrt{4^2+\omega^2R^2-\sqrt{2}\omega R}$
   (D) $(4+\omega R)$

2. Mass per unit area of the disc in first quadrant is σ, in the second quadrant is 4σ, in the third quadrant is 5σ and in the fourth quadrant is 8σ. The coordinates of centre of mass of this system are:



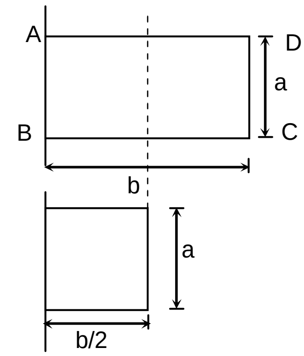
   (A) $\left(0, \frac{-16R}{27\pi}\right)$
   (B) $\left(0, \frac{-2R}{3\pi}\right)$
   (C) $\left(0, \frac{-16R}{65}\right)$
   (D) $\left(0, \frac{-4R}{3\pi}\right)$

3. A particle of mass 1 kg, moving with velocity $\vec{u}=\hat{i}+\hat{j}$ in gravity free space strikes a smooth plane and final velocity of particle after collision becomes $\vec{v}=b\hat{j}$. Which of the following vectors **CANNOT** represent a vector perpendicular to plane (b, m and n are real numbers other than zero)?

   (A) $\left(m\hat{i}+n\hat{k}\right)$
   (B) $\left(\hat{i}+m\hat{j}\right)$
   (C) $\left(m\hat{i}+\hat{j}\right)$
   (D) $\hat{i}$

Space for Rough work

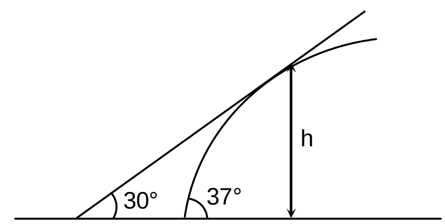
4. Moment of inertia of a rectangular plate about one of its side AB is I_0. What is the value of moment of inertia about same side if rectangular sheet is folded as shown in figure.



(A) $\frac{I_0}{2}$ (B) $2I_0$

(C) $I_0 + \frac{mb^2}{4}$ (D) $\frac{I_0}{4}$

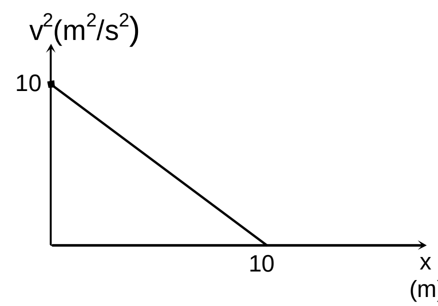
5. A particle is projected with speed 50 ms^{-1} at an angle 37° with the horizontal and it touches an inclined plane of inclination 30° as shown in figure. Height of the point from the ground where particle touches the incline is ($g = 10\ m/s^{-2}$)



(A) $\frac{55}{3}$m (B) 55 m

(C) 40 m (D) 18 m

6. Graph of square of velocity v^2 versus displacement x for the particle moving in straight line is shown in figure. Magnitude of acceleration of particle when displacement of particle is 5m is



(A) 0.5 ms^{-2}
(B) 0
(C) 2 ms^{-2}
(D) $\sqrt{5}$ ms^{-2}

7. Two cars 1 and 2 of mass m_1 and m_2 ($m_1 > m_2$) are moving in a straight line towards each other on a smooth horizontal road. They collide and both come to rest. If E_1 and E_2 are energies of 1 and 2 respectively, V_1 and V_2 be the speeds of 1 and 2 respectively before collision then choose correct option

(A) $E_1 < E_2$, $V_2 < V_1$ (B) $E_1 < E_2$, $V_1 < V_2$

(C) $E_2 < E_1$, $V_2 < V_1$ (D) $E_2 < E_1$, $V_1 < V_2$

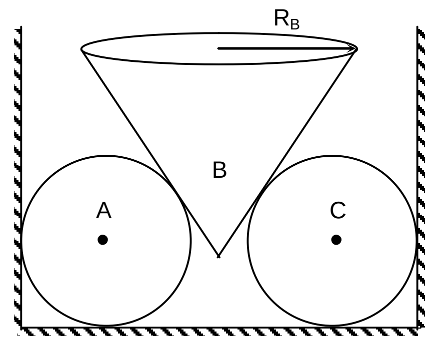
Space for Rough work

8. Moment of inertia of an n sided regular polygon frame made up of n uniform rods each of length a and mass m, about axis perpendicular to plane of polygon and passing through one of its end is I. The change in moment of inertia of frame about the same axis, if length of each side is increased by small amount Δa ($\Delta a << a$) without changing mass is:

(A) $\left(\frac{I\Delta a}{a}\right)$ (B) $\frac{4I\Delta a}{a}$

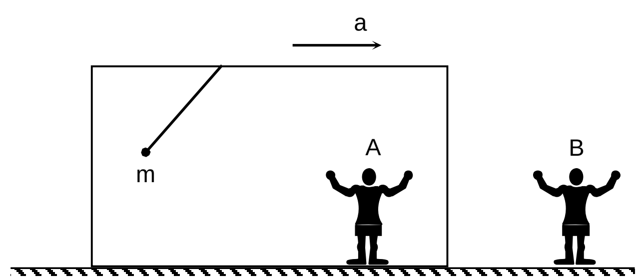
(C) $\frac{3I\Delta a}{a}$ (D) $\frac{2I\Delta a}{a}$

9. If three bodies are in equilibrium as shown in figure then ratio of normal reaction on A from wall to normal reaction on C from the wall is independent of:
(m_B is mass of cone, R_A is radius of sphere A, R_B is radius of cone and ground is smooth.)



(A) m_B (B) R_A
(C) R_B (D) All

10. A pendulum of mass m is connected to the ceiling of a car which in turns moving with constant acceleration $\vec{a}$ on horizontal ground. Pendulum is at rest with respect to car. There are two observers, A sitting in car and B is on ground at rest. Based on above information choose correct option. (where $\vec{T}$ is tension force on mass by the string).



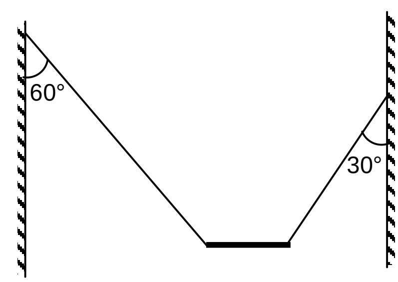
(A) Net force on mass as seen by A is $m\vec{g}+\vec{T}+m\vec{a}$
(B) Net force on mass as seen by B is $m\vec{g}+\vec{T}+m\vec{a}$
(C) Net force on mass as seen by B is $m\vec{g}+\vec{T}$
(D) Net force on mass as seen by A is $m\vec{g}+\vec{T}$

Space for Rough work

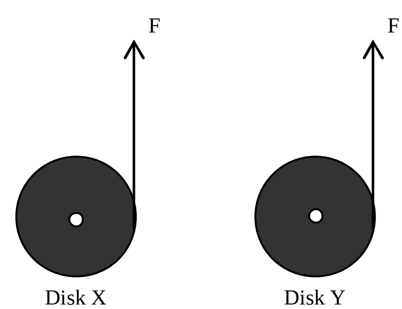
11. An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 50,000 kg is moving with a speed of 36 km h^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0 m. If 90% of energy of the wagon is lost due to friction, the spring constant of spring is
(A) 5×10^4 N/m (B) 5×10^3 N/m
(C) 2.5×10^6 N/m (D) 2.5×10^4 N/m

12. A particle of mass m is projected with initial velocity u making an angle θ with horizontal. Angular momentum of particle when radius of curvature of the trajectory is maximum, about point of projection is (where T is time of flight). Consider only the part of projectile for which the final point is at the same horizontal level as point of projection.
(A) $mg\frac{uT^2}{2}$ (B) $mguT^2$
(C) $\frac{2mu^3\sin^2\theta\cos\theta}{g}$ (D) $\frac{mu^2\cos^2\theta\sin\theta}{g}$

13. A rod of mass 5 kg is suspended with the help of two strings as shown in figure and remains in equilibrium. Linear mass density of rod is given by $\mu = \lambda x^n$ where x is distance from left end of the rod. The value of n is
(A) 3 (B) 2
(C) 5 (D) 4



14. Two uniform disks, X and Y, have masses $m_x < m_y$, equal radii, and equal initial non-zero kinetic energies. Each disk rotates in counter-clockwise sense in the plane of the page about a fixed frictionless axis through its center. As shown in the figure, a force F is applied along tangent to each disk at its right edge for the same amount of time. After the forces are applied, let L represent the magnitude of the angular momentum about the centre of a disk and K represent the kinetic energy of a disk.



Which one of the following choices correctly compares these quantities for disk X and disk Y?
(A) $L_X > L_Y$; $K_X < K_Y$ (B) $L_X > L_Y$; $K_X > K_Y$
(C) $L_X = L_Y$; $K_X = K_Y$ (D) $L_X < L_Y$; $K_X > K_Y$

Space for Rough work

15. Consider three systems, each with three masses, m_1, m_2, m_3 ($m_1 > m_2 > m_3$) with centre of mass at point A, as shown in the figure-1, figure-2 and figure-3 respectively. The same force $\vec{F}$ is applied on the each system separately to just one of the three masses as shown. Which of the following statements is true.

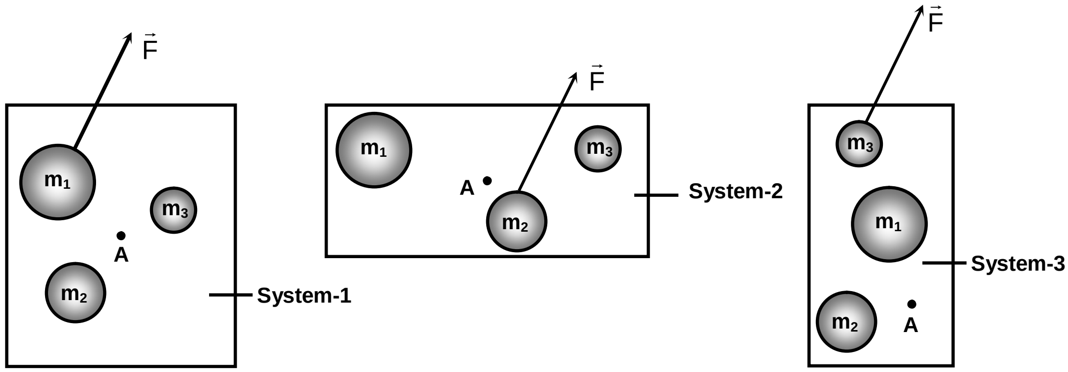
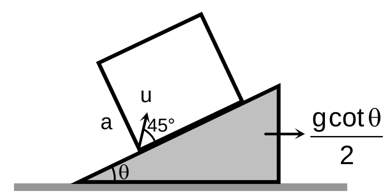


Figure-1 Figure-2 Figure-3

(A) The magnitude of acceleration of centre of mass of the system is largest in figure-1.
(B) The magnitude of acceleration of centre of mass of the system is largest in figure-2.
(C) The magnitude of acceleration of centre of mass of the system is largest in figure-3.
(D) In all cases, the centre of mass of system has same acceleration.

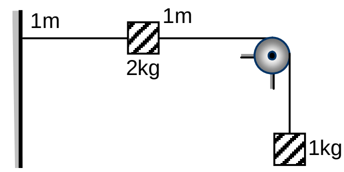
16. The smooth wedge is accelerated at $\frac{g\cot\theta}{2}$ to the right. A cubical box of side a is moving on it. Inside the box a particle is projected with speed u relative to the box at an angle of 45° as shown. Find the time after which the particle will hit the box. [Assuming a is large, so that particle does not collide with top]



(A) $\frac{u}{\sqrt{2}g\sin\theta}$
(B) $\frac{2\sqrt{2}u}{g\cos\theta}$
(C) $\frac{u}{g\sin\theta}$
(D) $\frac{u}{\sqrt{2}g\cos\theta}$

Space for Rough work

17. The system is released from rest in the position shown. Find the velocity with which the block (negligible in dimension) will hit the wall. The pulley is fixed.
[Use $\sqrt{5} = 2.24$ and g = 10 m/s^2]

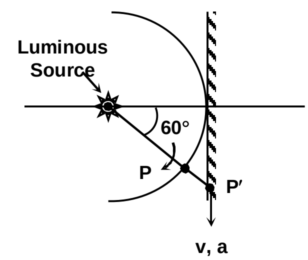


(A) 4m/s
(B) 3.2m/s
(C) 2.3m/s
(D) 1.6m/s

18. A bird can fly in still air at 15 km/hr. Wind is blowing at 5 km/hr due east. What is the time it takes to reach a point 5 km due North east of its starting point.

(A) $t = \left(\frac{\sqrt{34}+\sqrt{2}}{16}\right)$hrs.
(B) $t = \left(\frac{\sqrt{34}-\sqrt{2}}{16}\right)$hrs.
(C) $t = \left(\frac{\sqrt{17}+\sqrt{2}}{16}\right)$hrs.
(D) $t = \left(\frac{\sqrt{17}-\sqrt{2}}{16}\right)$hrs.

19. A particle moves in a circular track of radius R (in meter) with uniform ω = 2 rad/s as shown. The velocity and acceleration of its shadow P′ on a horizontal wall when $\theta = 60°$ is



(A) v = 8R, a = $32\sqrt{3}$ R
(B) v = 8R, a = 0
(C) v = 2R, a = $3\sqrt{3}$ R
(D) v = 2R, a = 0

20. A frog of mass m sits at one end of a plank of mass 3m. The length of the plank is ℓ meter and it is kept on a frictionless surface. The frog wants to jump to the opposite end of the board in one jump. Find the minimum speed of the frog with respect to ground that enables it to perform the feat.

(A) $\sqrt{\frac{3}{2}g\ell}$
(B) $\sqrt{\frac{3}{4}g\ell}$
(C) $\sqrt{\frac{1}{2}g\ell}$
(D) $\sqrt{g\ell}$

Space for Rough work

21. A particle is moving with velocity $\vec{v}_i = 2\hat{i} - 3\hat{j} + 4\hat{k}$ m/s collides elastically with a wall whose outward normal is along the direction of $\vec{p} = 3\hat{i} - 6\hat{j} + 2\hat{k}$. Find the unit vector along the direction of final velocity of the particle just after collision.

(A) $\dfrac{-94\hat{i} + 237\hat{j} + 68\hat{k}}{49\sqrt{29}}$
(B) $\dfrac{3\hat{i} + 6\hat{j} - 2\hat{k}}{7}$
(C) $\dfrac{-94\hat{i} + 68\hat{j} - 237\hat{k}}{49\sqrt{29}}$
(D) $\dfrac{3\hat{i} - 6\hat{j} + 2\hat{k}}{7}$

22. A disc of radius 50 cm is projected from the ground with its plane vertical, such that the velocities of the topmost point (A) and lowest point (B) are :

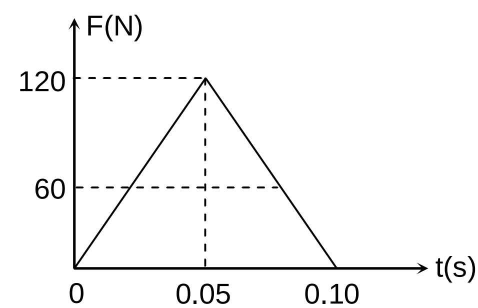
$\vec{v}_A = 20\hat{i} + 10\hat{j}$ m / s

$\vec{v}_B = 10\hat{i} + 10\hat{j}$ m / s

at the instant of projection. Here, $\hat{i}$ and $\hat{j}$ are unit vectors in the plane of the disc, along the horizontal and vertically upward directions respectively. The range of the disc is :

(A) 10 m
(B) 20 m
(C) 30 m
(D) 40 m

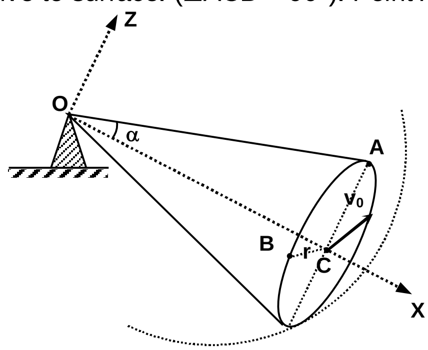
23. When a football is kicked in air, the force by the foot of football player changes with time as shown in the figure.
Assuming that the force is always directed vertically up and mass of ball is 400 gm, determine the maximum height (lifting) of ball (Neglect the air resistance and g = 10 m/s^2)

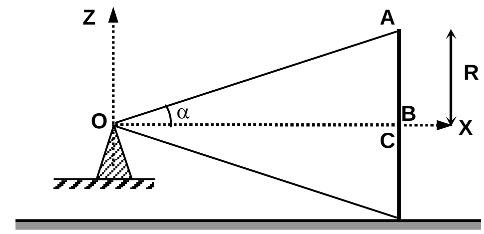


(A) 9.8 m
(B) 19.6 m
(C) 15 m
(D) 8 m

Space for Rough work

24. A cone rolls without slipping on the horizontal surface so that its apex remains fixed and the axis of cone is horizontal. The radius of base of cone is r and the semi-vertex angle is α. The centre of base of cone is C and it moves with constant speed v_0. Find the speed of point A and point B relative to surface. ($\angle ACB = 90°$). Point A and B lies on circumference of the base of cone.





Front View

(A) $2v_0$, $v_0\sqrt{2+\tan^2\alpha}$
(B) v_0, $v_0\sqrt{2+\tan^2\alpha}$
(C) $2v_0$, $v_0\sqrt{1+\tan^2\alpha}$
(D) v_0, $v_0\sqrt{1+\tan^2\alpha}$

25. Two identical particles (say particle-1 and particle-2) each of mass m starts moving from rest from origin along x-axis under the action of time dependent forces $F_1 = F_0\sin\omega t$ and $F_2 = F_0\cos\omega t$ (where F_0 and ω are positive constants) respectively. Choose the correct option.

(A) The magnitude of average velocity of particle-1 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is $\frac{F_0}{m\omega}$

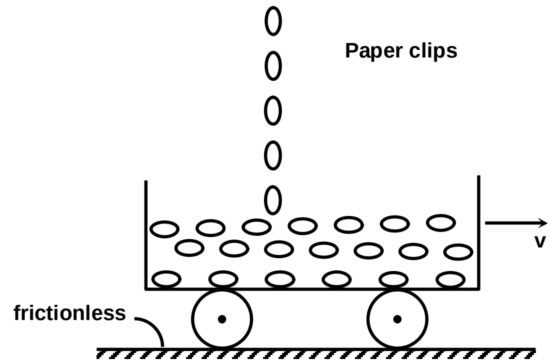
(B) The magnitude of average velocity of particle-2 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is $\frac{F_0}{m\omega}$

(C) The magnitude of average velocity of particle-1 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is zero

(D) The magnitude of average velocity of particle-2 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is non-zero

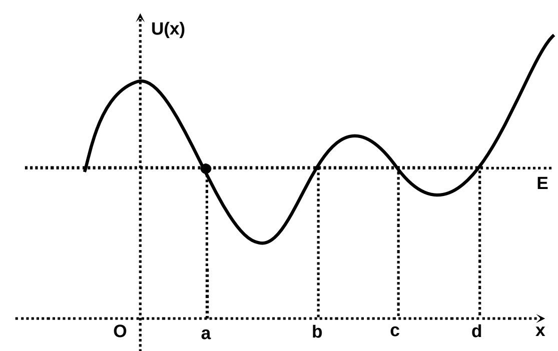
Space for Rough work

26. Suppose you drop paper clips vertically down into an open cart, moving along a straight horizontal road with no friction. Before any paper clips, fell into the cart, the cart is moving with speed v_i and has mass m_i. After all papers clips have fallen into the cart, the cart has mass m_F and speed v_F. The initial horizontal momentum of cart without any paper clips, has magnitude p_i and the initial kinetic energy of the cart without any paper clips is k_i. Component of momentum of the cart with paper clips has momentum p_F and final kinetic energy of the cart with paper clips is k_f. Which of the following statements is true?



(A) $p_f < p_i$, $k_f < k_i$
(B) $p_f = p_i$, $k_f > k_i$
(C) $p_f = p_i$, $k_f < k_i$
(D) $p_f > p_i$, $k_f > k_i$

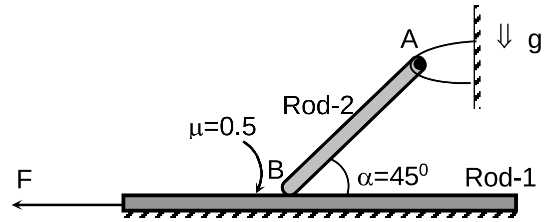
27. The potential energy U(x) for a particle, is shown by solid curve and total mechanical energy E is shown by dotted line in the given figure. If the particle is at x = a, which of the following statements is true about the subsequent motion of the particle?



(A) The kinetic energy k(x) is maximum somewhere in the region a < x < b.
(B) The kinetic energy k(x) is maximum somewhere in the region b < x < c.
(C) The kinetic energy k(x) is maximum somewhere in the region c < x < d.
(D) The kinetic energy is constant for all b < x < c.

Space for Rough work

28. Rod-1 of mass M = 3 kg and length L= 2m respectively, is kept on a smooth horizontal surface as shown in the figure. Rod-2 (AB) of mass m = 3kg and length $\ell = 1m$ is hinged at point A and just touches the Rod-2 as shown in the figure.

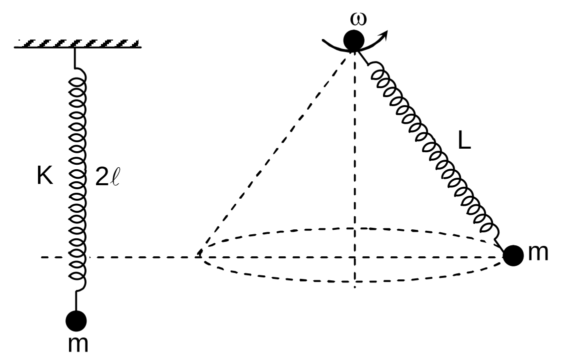


Find the minimum magnitude of force F, required to move the rod-1.

(A) 20N (B) 15N

(C) 10 N (D) 5N

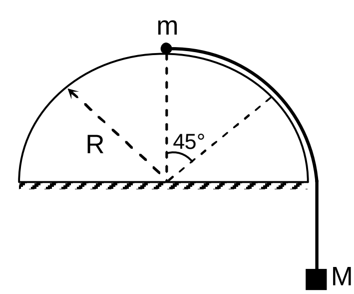
29. When a particle of mass m is suspended from a massless spring of natural length ℓ, the length of the spring becomes 2ℓ. When the same mass moves in conical pendulum as shown in figure, the length of the spring becomes L. The radius of the circle of conical pendulum is :



(A) $\frac{L}{L-\ell}\sqrt{L(L-\ell)}$ (B) $\frac{L}{L-\ell}\sqrt{L(L-2\ell)}$

(C) $\sqrt{L(L-\ell)}$ (D) $\sqrt{L^2-2\ell^2}$

30. A small body of mass m is placed to the top of a fixed hemisphere, and is tied by means of a rope to another body of mass M, which hangs vertically. The system is released, the small body of mass m slides along the hemisphere without friction. At which mass ratio m/M will the small body of mass m leave the surface of the hemisphere exactly at the angle of 45° with vertical $\left(\sqrt{2} = 1.4 \text{ and } \frac{\pi}{\sqrt{2}} = 2.3\right)$



(A) 8 (B) 7.5

(C) 6.5 (D) 6

Space for Rough work

Chemistry

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Which of the following molecule having perfect tetrahedral shape, according to VSEPR theory:
(A) SO_2F_2
(B) SO_4^{2-}
(C) SO_3
(D) SF_4

32. In which of the following process energy is required:
(A) $S \rightarrow S^-$
(B) $Na \rightarrow Na^-$
(C) $N \rightarrow N^-$
(D) $P \rightarrow P^-$

33. The lowest unoccupied molecular orbital (LUMO) of O_2 molecule according to MOT is a
(A) σ -bonding molecular orbital
(B) σ^* – antibonding molecular orbital
(C) π – bonding molecular orbital
(D) π^* - antibonding molecular orbital

34. Which of the following pair of elements will have least electronegativity difference?
(A) Cs, I
(B) Li, I
(C) Na, Cl
(D) Cs, F

35. For given reaction, at constant temperature
$S_8(g) \rightleftharpoons 4S_2(g)$
at equilibrium, vapour density of mixture is found to be 96. The percentage decomposition of S_8 will be.
(A) 88.89%
(B) 11.11%
(C) 44.44%
(D) 34.32%

36. Interstitial hydride is formed by
(A) K
(B) Si
(C) Hf
(D) Co

37. Which of the following is incorrect
(A) $PH_3 < AsH_3 < NH_3 < SbH_3$ (Boiling point)
(B) $HCl < HBr < HI < H_2O$ (Melting point)
(C) $PH_3 < AsH_3 < SbH_3 < NH_3$ (heat of vaporization)
(D) $H_2Te < H_2Se < H_2S < H_2O$ (Boiling point)

Space for Rough work

38. Which of the following statement is incorrect about sodium peroxide?
(A) It decomposes on heating
(B) It is paramagnetic in nature
(C) It can be used in air purification in confined space
(D) It can be used as oxidizing agent

39. Which of the following statement is wrong?
(A) Boron oxides are exclusively acidic
(B) Indium and Thalium oxides are exclusively basic
(C) Boron oxides are exclusively basic
(D) Aluminium and gallium oxides are amphoteric

40. Choose the correct statement about Borazine ($B_3N_3H_6$).
(I) Borazine is iso-electronic with benzene
(II) Chemical properties of borazine and benzene are quite different
(III) Borazine readily undergo addition reaction with polar molecule like HCl
(IV) Borazine is less reactive than benzene.
(A) I & II only
(B) I, II, III & IV
(C) I, II & IV
(D) I, II & III

41. In the following reaction
$Na_2SO_3 + Na_2CrO_4 \longrightarrow Na_2SO_4 + Cr(OH)_3$
What will be the equivalent weight of oxidizing agent among reactants (Mol. Mass of oxidizing agent = M)
(A) M/2
(B) M/3
(C) M
(D) M/6

42. The equilibrium constant for the reaction
$2CH_4(g) + 4H_2O(g) \rightleftharpoons 2CO_2(g) + 8H_2(g)$ and $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ are K_1 and K_2 respectively. The equilibrium constant for the reaction
$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ will be
(A) $\frac{\sqrt{K_1}}{K_2}$
(B) $\frac{K_1}{K_2}$
(C) $\left(\frac{K_1}{K_2}\right)^{1/2}$
(D) $\frac{K_1 - 2K_2}{2}$

43. Which of the following set of quantum numbers is not possible for 3d orbital?
(A) n = 3, $\ell = 2$, m = + 2, s = +1/2
(B) n = 3, $\ell = 2$, m = 0, s = -1/2
(C) n = 3, $\ell = 1$, m = +1, s = -1/2
(D) n = 3, $\ell = 2$, m = -2, s = +1/2

Space for Rough work

44. Pauling suggested an equation to predict the acidic strength of oxy acid
$pK_a \simeq 9 - 7n$ at 25^oC
Where 'n' is the number of non-hydrogenated oxygen atom per molecule. According to Pauling equation which of the following is incorrect?
(A) $pK_a(H_3PO_4) \simeq 2$
(B) $pK_a(HClO_4) \simeq -12$
(C) $pK_a(HOCl) \simeq 9$
(D) $pK_a(H_2SO_3) \simeq -5$

45. If x = total number of neutron and y = total number of proton in $D-{}^{18}O-H$ molecule. The value of x – y will be?
(A) 0
(B) 1
(C) 2
(D) 3

46. For the reaction,
$MnO_4^- + M^{2+} \longrightarrow MO_3^- + Mn^{2+}$
Number of moles of MnO_4^- required for complete oxidization of 2 mole of M^{2+} ion will be
(A) 2 mole
(B) 1.2 mole
(C) 2.4 mole
(D) 2.1 mole

47. The pH of resulting solution, made by mixing of 400 mL, 0.05 M sodium acetate and 100 ml, 0.20 M HCl will be $\left(pK_{a(CH_3COOH)} = 4.75, \log 25 = 1.4\right)$
(A) 1.68
(B) 10.93
(C) 3.08
(D) 12.33

48. An object having mass 50 g is moving with velocity 200 ms^{-1}. If the percentage error in velocity measurement is 0.2%, the uncertainty in its position will be?
($h = 6.4 \times 10^{-34}$ Js. and $\pi = 3.2$)
(A) 1.25×10^{-36}
(B) 2.5×10^{-36}
(C) 2.5×10^{-33}
(D) 1.25×10^{-33}

49. The rate constant of a reaction $A \longrightarrow Product$ is $4.606 \times 10^{-5}\ s^{-1}$. What will be the fraction of 'A' decomposed after 4 hr. ($Antilog_{10}$ (0.288) = 1.94)
(A) 0.52
(B) 0.48
(C) 0.24
(D) 0.26

50. A closed vessel containing NH_4SH solid is in equilibrium according to following equaiton
$NH_4SH(s) \rightleftharpoons NH_3(g) + H_2S(g)$
$H_2S(g)$ is added, such that its new partial pressure is equal to 3/2 times of original total pressure. The ratio of partial pressure of $NH_3(g)$ now to its original value is
(A) 3 : 1
(B) 1 : 3
(C) 2 : 3
(D) 3 : 2

Space for Rough work

51. Calculate the pH of resulting mixture prepared by dissolving 2.12 g of Na_2CO_3 in 100 ml of an aqueous solution and 20 ml of 0.5 M HCl. $\left(pK_a\left(HCO_3^-\right)=10.25\right)$

(A) 10.55 (B) 3.75
(C) 10.25 (D) 3.45

52. A saturated solution of $CaSO_4$ is prepared at 25°C. When 200 ml of this solution is allowed to complete evaporation of water, 0.34 g of residue was obtained. The K_{sp} of $CaSO_4$ at 25°C will be

(A) 1.56×10^{-4} (B) 1.25×10^{-4}
(C) 1.56×10^{-2} (D) 1.25×10^{-2}

53. The time gap between $1/3^{rd}$ to $2/3^{rd}$ completion of a first order reaction is 100 min. What is the time required for completion of 75% of the same reaction.

(A) 50 min (B) 100 min
(C) 400 min (D) 200 min

54. The spin only magnetic moment of Cr^{x+} and Mn^{y+} are identical and equal to 3.87 BM. The value of x – y will be?

(A) +1 (B) +2
(C) - 1 (D) - 2

55. A gas phase chemical reaction
$2A(g) \longrightarrow 2B(g) + 4C(g)$ in a closed vessel. The concentration of 'A' is decreased by 4×10^{-2} mol L^{-1} in 40 seconds. What will be the rate of appearance of 'C'

(A) 4×10^{-2} mol L^{-1} s^{-1} (B) 8×10^{-2} mol L^{-1} s^{-1}
(C) 8×10^{-3} mol L^{-1} s^{-1} (D) 2×10^{-3} mol L^{-1} s^{-1}

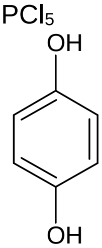
56. For a gas phase reaction:
$A(g) + 2B(g) \rightleftharpoons C(g) + D(g)$
The backward reaction is favoured
(i) By introducing inert gas at constant volume
(ii) By introducing inert gas at constant pressure
(iii) By adding 'A(g)' at constant volume
(iv) By adding 'D(g)' at constant volume
The correct statements is/are

(A) (i), (ii) & (iv) (B) (ii) & (iv)
(C) (i) & (iii) (D) (iv) only

Space for Rough work

57. Molecule with non-zero dipole moments is/are

(i) PCl_5 (ii) PCl_3F_2

(iii)  (iv) PF_3Cl_2

(A) (ii) & (iii) (B) (i) & (iii)
(C) (ii), (iii) & (iv) (D) (iii) & (iv)

58. What will be the binding energy per nucleon of ${}^{2}_{1}H$ atom, which has actual mass of 2.0064 amu mass of neutron = 1.0086 and the mass of ${}^{1}_{1}H$ atom is 1.0078 amu.
Given 1 amu $\equiv$ 931.5 Mev.

(A) 18.63 Mev (B) 0.9315 Mev
(C) 9.315 Mev (D) 93.15 Mev

59. Choose the correct statement
(A) Graphite has greater electrical resistivity than diamond.
(B) Density of graphite is greater than diamond.
(C) Standard molar entropy of diamond is greater than graphite.
(D) Graphite is thermodynamically more stable than diamond at room temperature.

60. Which of the following has least $X{-}O{-}X$ bond angle (X = halogens).

(A) COF_2 (B) $COCl_2$
(C) SOF_2 (D) $SOBr_2$

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let A = {f |f: R $\to$ R} and 'B' be a relation defined on set A such that

$$B = \left\{(f, g) \mid \lim_{x\to 2019} \frac{f(x)}{g(x)} \in R;\ f, g \in A\right\}$$, then relation B is

(A) reflexive, symmetric and transitive
(B) reflexive, transitive but not symmetric
(C) reflexive, symmetric but not transitive
(D) reflexive but neither symmetric nor transitive

62. If the enclosed figure formed by the lines |x| = 3 and |y| = 3 is revolved about y-axis, then the volume of the solid so formed is equal to

(A) 9π (B) 36π
(C) 54π (D) 81π

63. The negation of compound statement $(p \wedge q) \Leftrightarrow (r \wedge q)$ is equivalent to

(A) $[(p \wedge q) \vee (q \wedge r)] \wedge [\sim(p \wedge q \wedge r)]$ (B) $(p \wedge q \wedge r) \vee [(p \wedge q) \vee (q \wedge r)]$
(C) $\sim(p \wedge q \wedge r) \vee [(p \wedge q) \vee (q \wedge r)]$ (D) none of these

64. If f: R $\to$ R be a function satisfying $f(x + y^2) + 1 + 2x = f(x) + f(y^2) + 2x\, f(y)\ \forall\ x, y \in R$, then which of the following statements is true?

(A) 'f' is odd function (B) 'f' is even function
(C) 'f' is neither even nor odd (D) 'f' is both odd and even

65. If $\int \frac{x^{18}-1}{\left(x^{54}+3x^{42}+2x^{36}\right)^{\frac{1}{6}}}dx$ can be expressed as $\frac{\left[P(x)\right]^n}{10x^5}+c$ where P(x) is polynomial in 'x' of lowest possible degree, then number of distinct real solution(s) of P(x) = 0 is

(A) 0 (B) 1
(C) 2 (D) 4

Space for rough work

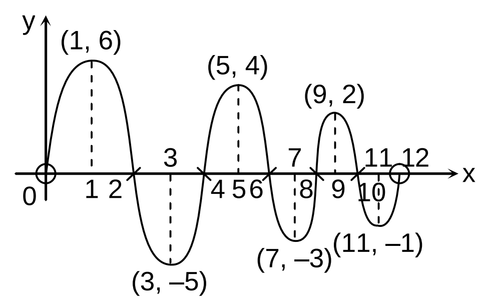
66. If f(x) be a differentiable function which satisfies the functional equation $f(x + y) = f(x)e^y + f(y)e^x + 2xye^xe^y$ $\forall$ x, y $\in$ R and $f'(0) = 0$, then the number of solution(s) of the equation f(x) = 0 is

(A) 0
(B) 1
(C) 2
(D) none of these

67. If f(x) be a differentiable function such that $\frac{d^n}{dx^n}f(x)$ exists $\forall$ x $\in$ R, n $\in$ N; and $f'(\alpha) = f'(\beta) = 0$, $f''(\alpha)\, f''(\beta) < 0$, then which of the following statements can be true

(A) points $(\alpha, f(\alpha))$, $(\beta, f(\beta))$ are local maxima
(B) points $(\alpha, f(\alpha))$, $(\beta, f(\beta))$ are local minima
(C) $(\alpha, f(\alpha))$, $(\beta, f(\beta))$ are points of inflection
(D) none of these

68. Given graph of $y = f'(x)$, for a function f: (0, 12) $\rightarrow$ R, then determine which of the following statements is false



(A) number of points where f(x) has local maxima are 3
(B) number of points where f(x) has local minima are 3
(C) number of points of inflection of f(x) are 6
(D) none of these

69. Given that $f(x) = \tan x - x^{1000}$, $x \geq 0$ has positive roots $x_1, x_2, x_3, x_4, \ldots$ such that $x_i < x_j$ if $i < j$ $\forall$ i, j $\in$ N, then area of region enclosed by f(x) with x-axis between lines x = 0 and x = $\pi/2$, is

(A) $\ln|\sec x_1| - \frac{x_1^{1001}}{1001}$
(B) $\frac{x_1^{1001}}{1001} - \ln|\sec x_1|$
(C) $\frac{x_2^{1001}}{1001} - \frac{2x_1^{1001}}{1001} + 2\ln\left|\frac{\sec x_1}{\sqrt{\sec x_2}}\right|$
(D) $\frac{x_2^{1001}}{1001} - \frac{x_1^{1001}}{1001} + \ln\left|\frac{\sec x_1}{\sqrt{\sec x_2}}\right|$

70. A triangle is formed by lines 2x + y – 4 = 0, 2y – x – 8 = 0 and x-axis. A circle is drawn with the side of the triangle along x-axis as diameter. The area of the region lying inside the circle but outside the triangle is

(A) $25\pi - 20$
(B) $5\pi - 4$
(C) $25\pi - 10\sqrt{2}$
(D) $5\pi - 2\sqrt{2}$

Space for rough work

71. If the n^{th} term of the sequence 0, 1, 1, 2, 3, 5, 8, 13, 21, ... be given by a_n and $\lim\limits_{n\to\infty}\frac{a_{n+1}}{a_n}=m$, then value of [2m] is (where [.] denotes the greatest integer function)
(A) 0
(B) 1
(C) 2
(D) 3

72. If $f(x)=\max\left\{mx,\frac{x}{m}\right\}$, $g(x)=\min\left\{mx,\frac{x}{m}\right\}$; ($m \neq 0$) and $h(x)=(\underbrace{fofofo.....f}_{2018\text{ times}}\,o\,\underbrace{gogog.....og}_{2018\text{ times}})(x)$, then which of the following is **INCORRECT**?
(A) $h'(1) = 1$
(B) $h''(0) = 0$
(C) $h'''(3) = 3$
(D) none of these

73. Solution f(x, y) = 0 of the differential equation $(6x^6y - 2y^4)dx = (2xy^3 + 3x^7)dy$; $(x, y \neq 0)$ which satisfies the condition f(1, 1) = 0 is
(A) $\frac{x^6}{y^2}-\ln(exy)=0$
(B) $\frac{x^6}{y^3}-\ln(exy)=0$
(C) $\frac{x^6}{y^3}-2\ln\left(\sqrt{e}xy\right)=0$
(D) $\frac{x^6}{y^2}-2\ln\left(\sqrt{e}xy\right)=0$

74. If f(x) = sin x and $g(x)=\underbrace{f(f(f.....(f}_{2018\text{ times}}(x))))$, then value of $g'(0) + g''(0) + g'''(0)$ equals
(A) 0
(B) –2017
(C) –2018
(D) $1 - (2018)^2$

75. If $f(a - x) = f(a + x)\ \forall\ a \in R$, then which of the following statements must be correct?
(A) f(x) is an odd function
(B) $f'(x) = 1$ for some $x \in R$
(C) $\int_{\alpha}^{\beta} f(x)dx = 0$, $\forall\ \alpha, \beta \in R$
(D) Fundamental period of f(x) doesn't exist

76. If $x\cos\alpha + y\sin\alpha = p$ is tangent to the curve $y=-\sqrt{x}$, then range of α is
(A) $\bigcup\limits_{n\in N}\left(2n\pi,(2n+1)\pi\right)$
(B) $\bigcup\limits_{n\in N}\left(n\pi,\left(n+\frac{1}{2}\right)\pi\right)$
(C) $\bigcup\limits_{n\in N}\left(\frac{n\pi}{2},(n+1)\frac{\pi}{2}\right)$
(D) $(-\infty, \infty)$

Space for rough work

77. Area of the triangle formed by tangent and normal to a curve f(x, y) = 0 at any point P on the curve, along with x-axis equals square of ordinate of P, then f(x, y) represents
(A) circle (B) parabola
(C) hyperbola (D) pair of lines

78. Let $y = f(x) = (x + a)^2 + (x + b)^2 + c(x + d) + e$ where a, b, c, d, e are arbitrary constants. Let order and degree of differential equation formed from y = f(x), be m, n respectively, then m + n equals
(A) 3 (B) 4
(C) 6 (D) 7

79. Solution of the differential equation $\dfrac{x - y\dfrac{dy}{dx}}{x\dfrac{dy}{dx} - y} = \dfrac{1}{2}\cos\left(\dfrac{y}{x}\right)\left(1 - \dfrac{y^2}{x^2}\right)$ is
(A) $\ln\left|\dfrac{c}{x^2 - y^2}\right| + \sin\left(\dfrac{y}{x}\right) = 0$ (B) $\ln\left|c\left(x^2 - y^2\right)\right| + \cos\left(\dfrac{y}{x}\right) = 0$
(C) $\ln\left|c\left(x^2 - y^2\right)\right| + \sin\left(\dfrac{y}{x}\right) = 0$ (D) $\ln\left|\dfrac{c}{x^2 - y^2}\right| + \cos\left(\dfrac{y}{x}\right) = 0$

80. Let $f(x) = \dfrac{\sin x}{x}$, then value of $\left[\lim\limits_{m\to\infty}\sum\limits_{n=1}^{m}\left(\int\limits_{\pi/6}^{\pi/2}\left(f(x)\right)^n + \int\limits_{(3/\pi)^n}^{(2/\pi)^n}\left(f^{-1}(x)\right)^{1/n}\right)dx\right]$ is (where [.] denotes the greatest integer function)
(A) 8 (B) –8
(C) 9 (D) –9

81. Let f(x) be a periodic differentiable function, $g(x) = \int f(x)dx$; $h(x) = \int\limits_a^b f(x)dx$, where a, b are constants. Consider the statements
(i) g(x) may be a periodic function (ii) h(x) may be a periodic function
(iii) g(x) may not be a periodic function (iv) h(x) may not be a periodic function
Then number of statements(s) which is/are true is
(A) 1 (B) 2
(C) 3 (D) 4

Space for rough work

82. If $\lim\limits_{x\to 0}\left(\frac{a\sin 2x - x^{x+1}}{\ln(2x+1)}\right)^{\frac{2x}{x^2+x}} = \frac{9}{4}$, a $\in$ R, then sum of all possible values of 'a' is

(A) –1 (B) 1
(C) 2 (D) 3

83. Let $\int e^{x^2+x}\left(4x^3+4x^2+5x+1\right)dx = e^{x^2+x}P(x)+c$ where P(x) is polynomial in x, then P(1) is equal to

(A) 2 (B) 3
(C) 4 (D) none of these

84. If f(x) be a differentiable function such that $\lim\limits_{x\to\infty} f(x)$ exists and is equal to a finite number 'ℓ', then which of the following will always be true

(A) $\lim\limits_{x\to\infty}\int_0^x f(t)dt = 0$ (B) $\lim\limits_{x\to\infty} f'(x) = 0$
(C) $\lim\limits_{x\to\infty} x f'(x) = 0$ (D) none of these

85. The limit $\lim\limits_{x\to\infty}\frac{\sum\limits_{r=1}^{2018}(x+r)^{2019}}{\prod\limits_{r=1}^{2019}(x+r)}$

(A) does not exist (B) exists and equal to 0
(C) exists and is non-zero finite number (D) none of these

86. The number of points where the function,
$f(x) = \cos|2018\pi - x| + \sin|2020\pi - x| + (x - \pi)|x^2 - 3\pi x + 2\pi^2|$ is non-differentiable is/are

(A) 0 (B) 1
(C) 2 (D) 3

87. If Rolle's theorem can be applied to f(x) = xlnx, x > 0 in interval $\left[\frac{1}{a},\frac{1}{b}\right]$ where a, b $\in$ I^+, then b equals

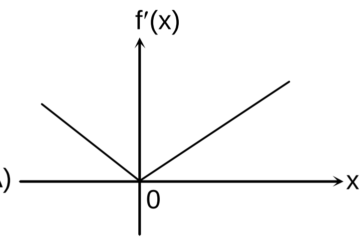
(A) 1 (B) 2
(C) 3 (D) infinite possible values exist

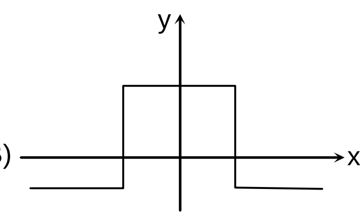
Space for rough work

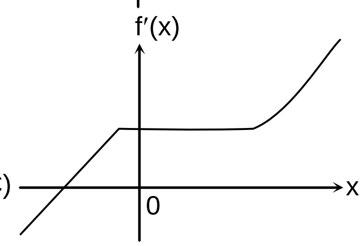
88. The value of the integral $\int_0^{\infty} \frac{\tan^{-1} x}{x^2 + 1 + 2x} dx$ is

(A) $\frac{\pi}{2}$
(B) $\frac{\pi}{4}$
(C) $\frac{\pi}{8}$
(D) none of these

89. If f: R $\to$ R be a differentiable function, then which of the following cannot be graph of $f'(x)$?

(A)


(B)


(C)


(D) none of these

90. In a class of 100 students, 60 like Mathematics, 72 like Physics, 68 like Chemistry and no student likes all three subjects. Then number of students who don't like Mathematics and Chemistry is
(A) 0
(B) 4
(C) 8
(D) cannot be solved with given information

Space for rough work