Prayas JEE AIR 2025

WEEKLY TEST 01

DURATION : 180 Minutes | **DATE : 14/07/2024** | **M.MARKS : 300**

Topics Covered

Physics:	Mathematical Tools, Motion in a Straight Line, Motion in a Plane, Laws of Motion, Circular Motion, Work, Energy and Power, Centre of Mass & System of Particles, Introduction and Definition, Calculation of COM - Discrete particle systems, Calculation of CPM - Continuous mass systems, Additive System and Negative system, Shifting of COM, Velocity of COM, Acceleration of COM, Conservation of linear momentum, Jumping from cart, The recoil of Gun, Explosion Problems
Chemistry:	Some Basic Concepts of Chemistry, Redox Reaction, Solutions, Thermodynamics , Equilibrium, Chemical Kinetics, Introduction, Instantaneous rate & average rate of reaction, Rate Law Expression, Rate Constant, Characteristics of Rate Constant, Nature and Concentration of the Reactants, Temperature, Presence of Catalyst, Surface Area of Reactants, Order and Molecularity of Reaction, Order of Reaction from Reaction Mechanism, Negative Order of the Reaction, Steady State Approximation and Equilibrium Approximation, Zero Order Reaction, Half Life Period of a Reaction, First Order Reaction, Numericals on Some Important First Order Reactions, Second Order Reaction, nth Order of Reaction, Pseudo First Order Reaction, Hit and Trial Method, Van't Hoff Differential Method, Initial Rate Method, Ostwald Method, Fractional Change Method
Mathematics:	Basic Maths, Quadratic Equations, Sequence and Series, Trigonometric Functions, Trigonometric Equation, determinants, Matrices, Sets, Relations and Functions, Relation, Type of Relations, Functions, Doman and Range of Functions, Type of Functions, Equal Function, Classification of Function

General Instructions:

1. Immediately fill in the particulars on this page of the test booklet.
2. The test is of **3 hours** duration.
3. The test booklet consists of 90 questions. The maximum marks are **300**.
4. There are three Sections in the question paper, Section I, II & III consisting of Section-I **(Physics),** Section-II **(Chemistry),** Section-III **(Mathematics)** and having **30 questions** in each part in which first **20** questions are compulsory and are of Objective Type and Last **10** questions are integers type in which you have to attempt **5** questions only.
5. There is only one correct response for each question.
6. Each correct answer will give **4** marks while **1** Mark will be deducted for a wrong response.
7. No student is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
8. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
9. **Do not fold or make any stray mark on the Answer Sheet (OMR).**

OMR Instructions:

1. Use blue/black dark ballpoint pens.
2. Darken the bubbles completely. Don't put a tick mark or a cross mark where it is specified that you fill the bubbles completely. Half-filled or over-filled bubbles will not be read by the software.
3. Never use pencils to mark your answers.
4. Never use whiteners to rectify filling errors as they may disrupt the scanning and evaluation process.
5. Writing on the OMR Sheet is permitted on the specified area only and even small marks other than the specified area may create problems during the evaluation.
6. Multiple markings will be treated as invalid responses.
7. **Do not fold or make any stray mark on the Answer Sheet (OMR).**

Name of the Student (In CAPITALS) : _____

Roll Number: _____

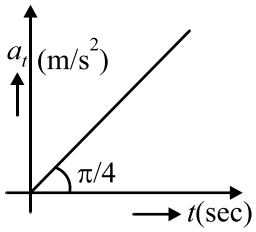
OMR Bar Code Number: _____

Candidate's Signature: _____ **Invigilator's Signature** _____

SECTION-I (PHYSICS)

Single Correct Type Questions

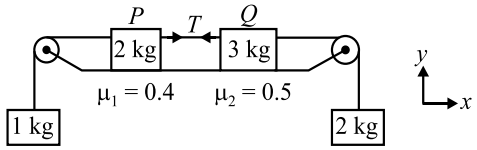
1. Tangential acceleration of a particle starting from rest and moving in a circle of radius 2 m varies with time as shown in the graph. Time after which total acceleration of the particle makes an angle of 45° with the radial acceleration is



(1) 2 sec (2) 4 sec

(3) $\frac{1}{2}$sec (4) $\sqrt{2}$ sec

2. In the mass pulley system in the figure, frictional force on 2 kg block *P* is f_1 and on 3 kg block *Q* is f_2. If *T* is tension in the string connecting the blocks *P* and *Q*, then which of the following options is correct?



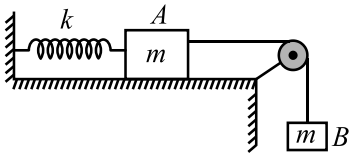
(1) $\vec{f}_1 = -8\ \text{N}\hat{i},\ \vec{f}_2 = -15\ \text{N}\hat{i}, T = 2\,\text{N}$

(2) $\vec{f}_1 = 8\ \text{N}\hat{i},\ \vec{f}_2 = 15\ \text{N}\hat{i}, T = 2\,\text{N}$

(3) $\vec{f}_1 = -5\ \text{N}\hat{i},\ \vec{f}_2 = -15\ \text{N}\hat{i}, T = 5\,\text{N}$

(4) $\vec{f}_1 = 5\ \text{N}\hat{i},\ \vec{f}_2 = -15\ \text{N}\hat{i}, T = 5\,\text{N}$

3. The system is held with the spring at its relaxed length and then released. Find the maximum elongation of spring if coefficient of friction between the block *A* and the horizontal surface is $\frac{1}{4}$. (Take *g* = acceleration due to gravity and *k* = stiffness of spring, $m_A = m_B = m$)
(Assume string and pulley to ideal)



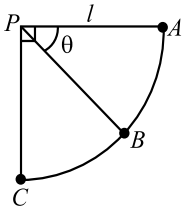
(1) $\frac{3mg}{k}$

(2) $\frac{3mg}{2k}$

(3) $\frac{2mg}{3k}$

(4) $\frac{2mg}{k}$

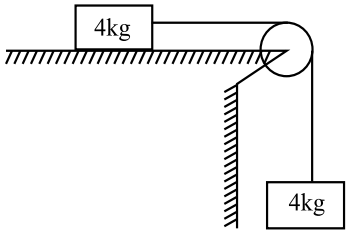
4. One end of a light string is tied to a bob and other end is connected to a fixed point *P*. The ball is released from rest with string horizontal and just taut. The ball moves in a vertical circular path as shown in figure. If velocity of the ball at *B* and *C* are $\vec{V}_B$ and $\vec{V}_C$ related as $2|\vec{V}_B| = |\vec{V}_C|$, then the value of $\frac{1}{\sqrt{\sin\theta}}$ is:



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

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

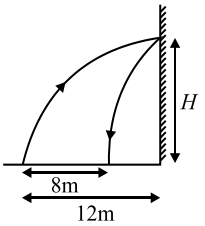
5. The magnitude of acceleration of centre of mass of the system if coefficient of friction between the block and table is 0.2 and mass of each block is 4 kg is (g =10 m/s^2)



(1) $2\sqrt{2}$ m/s^2 (2) 2 m/s^2

(3) $4\sqrt{2}$ m/s^2 (4) 4 m/s^2

6. A ball is projected from ground with some initial speed at an angle 53° with the horizontal. There is a smooth vertical wall at a distance of 12 m from the point of projection. After collision, the ball lands on the ground at a distance 8 m from the point of projection. The horizontal component of speed just before and just after the collision remains same. Find the height *H* at which the ball hits the wall.



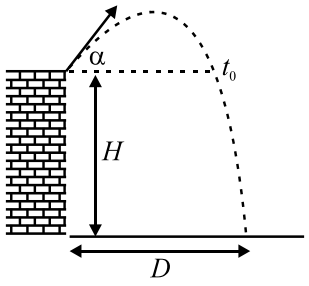
(1) 1.2 m
(2) 2 m
(3) 4 m
(4) 6.6 m

7. One end of an ideal spring is fixed at point *O* and other end is attached to small mass *m*. Mass is given an initial velocity v_0 parallel to its length on a smooth horizontal surface when spring has length $\frac{5\ell_0}{4}$. If the maximum elongation of the spring is $\frac{l_0}{2}$, where l_0 is natural length then find the spring constant.

(1) $\frac{16}{3}\frac{mv_0^2}{l_0^2}$ (2) $144\frac{mv_0^2}{l_0^2}$

(3) $\frac{25}{144}\frac{mv_0^2}{l_0^2}$ (4) $\frac{1}{144}\frac{mv_0^2}{l_0^2}$

8. A projectile is launched at an angle α above the horizontal of a roof of height *H* above the ground. After a time t_0 has elapsed since the launch, the projectile passes the level of roof top moving downward. It eventually lands on the ground at a horizontal distance *D* from its launch site. Value of $\tan\alpha$, in terms of *H*, t_0 and the acceleration due to gravity (*g*) is:



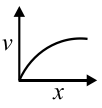
(1) $\tan\alpha = \frac{t_0^2 g\left[1+\sqrt{1+\frac{8H}{gt_0^2}}\right]}{2D}$

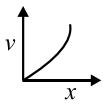
(2) $\tan\alpha = \frac{t_0^2 g\left[1+\sqrt{1+\frac{8H}{gt_0^2}}\right]}{4D}$

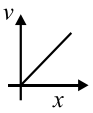
(3) $\tan\alpha = \frac{t_0^2 g\left[1+\sqrt{1+\frac{4H}{gt_0^2}}\right]}{2D}$

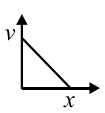
(4) $\tan\alpha = \frac{t_0^2 g\left[1+\sqrt{1+\frac{4H}{gt_0^2}}\right]}{4D}$

9. A particle starts from origin at $t = 0$ according to law $x = A(1 - e^{-\lambda t})$ graph between its velocity and displacement is

(1) 

(2) 

(3) 

(4) 

10. If velocity of the particle is given by $v = \sqrt{x}$, *x* denotes the position of the particle. Initially particle was at $x = 4$ m, then which of the following is **INCORRECT**?

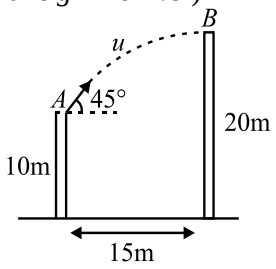
(1) At $t = 2$ sec, the position of the particle is at $x = 9$ m

(2) Particle acceleration at t = 2 sec is 1 m/s^2

(3) Particle acceleration is $\frac{1}{2}$ m/s^2 throughout the motion

(4) Particle will never go in negative direction from its starting position.

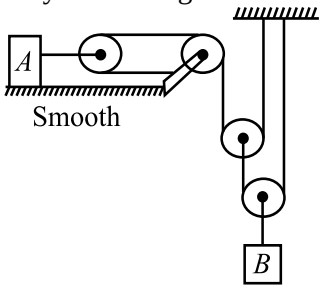
11. Find the value of '*u*' so that the ball reaches at point *B*. (Take $g = 10$ m/s^2)



(1) 20 m/s (2) 40 m/s

(3) $15\sqrt{2}$ m/s (4) 50 m/s

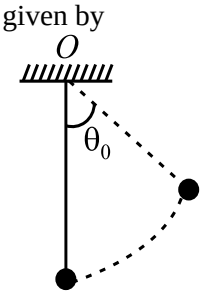
12. In the figure shown if mass of each block is *m*. Find the acceleration of block *A*. (g = 10 m/s^2 and all the pulleys and string are ideal and massless).



(1) 2 m/s^2 (2) 4 m/s^2

(3) 1 m/s^2 (4) None

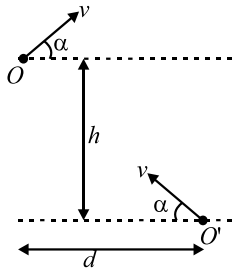
13. A small bob hangs from a support *O* in a vertical plane if the bob is slightly displaced then it oscillate about its mean position as shown in figure. The angular amplitude of the pendulum is θ_0. If the ratio of maximum tension to minimum tension during the motion is 4, then angular amplitude is given by



(1) $\theta_0 = \cos^{-1}\left(\frac{1}{4}\right)$ (2) $\theta_0 = \cos^{-1}\left(\frac{3}{4}\right)$

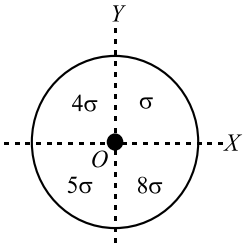
(3) $\theta_0 = \cos^{-1}\left(\frac{1}{2}\right)$ (4) $\theta_0 = \cos^{-1}\left(\frac{3}{5}\right)$

14. Two particles are projected simultaneously from two points, O and O' such that d is the horizontal distance and h is the vertical distance between them. They are projected at the same inclination α to the horizontal with the same speed v. The time after which their separation becomes minimum is-



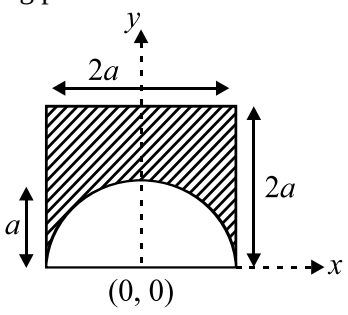
(1) $d\,(v\cos\alpha)$ (2) $2d/(v\cos\alpha)$
(3) $d/(2v\cos\alpha)$ (4) d/v

15. 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:



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

16. A semicircular disc of radius *'a'* is removed from a uniform square plate of side '$2a$' as shown in the figure. The coordinate of centre of mass of the remaining portion are

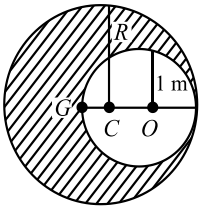


(1) $\left(0,\frac{4a}{3(4-\pi)}\right)$ (2) $\left(\frac{a}{2},\frac{4a}{3(4-\pi)}\right)$
(3) $\left(0,\frac{20a}{3(8-\pi)}\right)$ (4) $\left(0,\frac{8a}{3(4-\pi)}\right)$

17. Two blocks of masses 10 kg and 30 kg are placed on the straight line with coordinates (0, 0) and (x, 0) respectively. The block of 10 kg is moved on the same line through a distance of 6 cm towards the other block. The distance through which the block of 30 kg must be moved to keep the position of centre of mass of the system unchanged is

(1) 4 cm towards the 10 kg block
(2) 2 cm away from the 10 kg block
(3) 2 cm towards the 10 kg block
(4) 4 cm away from the 10 kg block

18. As shown in figure when a spherical cavity (centred at O) of radius 1 m is cut out of a uniform sphere of radius R m (centred at C), the centre of mass of remaining (shaded) part of sphere is at G, i.e. on the surface of the cavity. R can be determined by the equation:

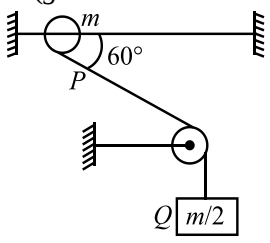


(1) $(R^2 + R + 1)\,(2 - R) = 1$
(2) $(R^2 + R - 1)\,(2 - R) = 1$
(3) $(R^2 + R + 1)\,(2 + R) = 1$
(4) $(R^2 - R + 1)\,(2 + R) = 1$

19. A particle moves along a circle of radius 'R' with speed varies as $v = a_0 t$, where a_0 is a positive constant and t is time. Then the angle between the velocity vector and the acceleration vector of the particle when it has covered one fourth of the circle is

(1) $\tan^{-1}\left(\frac{\pi}{4}\right)$ (2) $\tan^{-1}\left(\frac{\pi}{2}\right)$
(3) $\tan^{-1}(\pi)$ (4) $\tan^{-1}(2\pi)$

20. A smooth ring P of mass m can slide on a fixed horizontal rod. A string tied to the ring passes over a fixed pulley and carries a block Q of mass $(m/2)$ as shown in the figure. At an instant $t = 0$, the string between the ring and the pulley makes an angle 60° with the rod. The initial acceleration of the ring is (g = acceleration due to gravity)

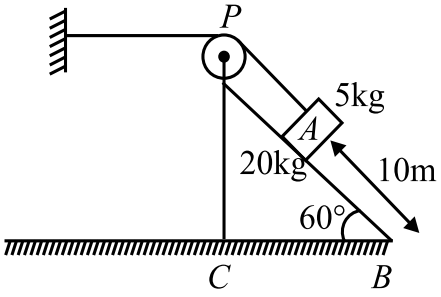


(1) $\frac{2g}{3}$ (2) $\frac{3g}{2}$
(3) $\frac{2g}{9}$ (4) $\frac{9g}{2}$

Integer Type Questions

21. If $y = \sin^{-1} x$, the value of $\frac{dy}{dx}$ at $y = \frac{\pi}{3}$ is

22. The system is released from rest and the wedge slides to the left on a smooth horizontal surface and block *A* moves on the inclined surface as shown in the figure. Find the net displacement (in meter) of the block *A* relative to ground as it reaches the bottom of the inclined surface.

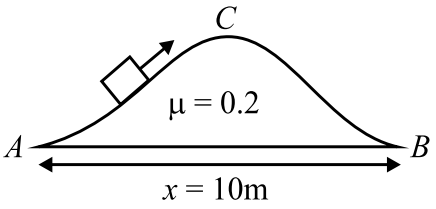


23. A block of mass 1 kg is moving with a constant acceleration 1 m/s^2 on a rough horizontal surface. The coefficient of friction between the block and the plane is $\mu = 0.1$. If initial velocity of the block is zero, then what is the power delivered in watt by the external agent at a time t = 2 second from the beginning? (Take g = 10 m/s^2)

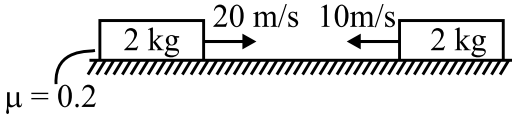
24. A system of two balls of mass *m* and 2*m* attached by a light spring, is released in earth's gravity by compressing the spring by some amount. Acceleration of mass 2*m* at a certain moment during the fall is 2 m/s^2 in vertically upward direction. What is the magnitude of acceleration (in m/s^2) of *m* at that instant? (Take g = 10 m/s^2)

25. A small particle is projected along the inner surface of a smooth vertical fixed spherical shell of radius *R*, its velocity at the lowest point is $\sqrt{\frac{95Rg}{25}}$. It will leave the circle at an angular position measured from the highest point in degrees will be

26. A block of mass 1 kg is slowly pulled along the curved path *ACB* by a tangential force as shown in the figure. If coefficient of friction between the curved path and the block is 0.2, then find the work done (in joule) against the frictional force when the block is moved from *A* to *B*.
(Take g = 10 m/s^2)



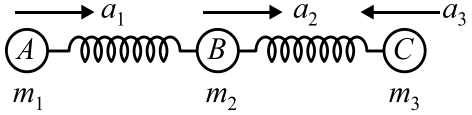
27. Two blocks are initially far apart and are approaching each other with the velocities as shown in the figure. If coefficient of friction for both the blocks is 0.2, then the distance covered by the centre of mass of the system before coming to rest permanently is *x* cm. Find the value of *x*/10. (Take g = 10 m/s^2)



28. If $y = \frac{15}{4(0.75\sin\theta + \cos\theta)}$, the minimum value of *y* is

29. A particle moves along a parabolic path $y = 9x^2$ in such a way that the *x* component of velocity remains constant and has a value 1/3 m/s. The acceleration of the particle is $b\,\hat{j}$ m/s^2. Find the value of *b*.

30. Shown in the figure is a system of three particles connected by two springs. The acceleration of *A*, *B* and *C* at an instant are 1 m/s^2, 2 m/s^2 and (1/2) m/s^2, respectively, directed as shown in the figure. External force (in newton) acting on the system is (m_1 = 1 kg, m_2 = 2 kg and m_3 = 4 kg)



SECTION-II (CHEMISTRY)

Single Correct Type Questions

31. A solution containing 12.8% sodium hydroxide by mass has a density of 1.131 g/mL. What volume of this solution contains 5.00 mol of NaOH:

(1) 0.0240 L (2) 1.67 L
(3) 1.38 L (4) 1.00 L

32. A 10 gram sample of natural gas containing CH_4 and C_2H_4 was burnt in excess of oxygen to give 29.0 grams of CO_2 and some water. How many grams of water are formed:

(1) 9.42 g (2) 18.81 g
(3) 11.42 g (4) 15.31 g

33. Solutions containing 23 g of HCOOH is/are:

(I) 46 g of 70%$\left(\frac{w}{v}\right)$ HCOOH ($d_{solution}$ = 1.40 g/mL)

(II) 50 g of 10 M HCOOH ($d_{solution}$ = 1 g/mL)

(III) 50 g of 25%$\left(\frac{w}{w}\right)$ HCOOH

(IV) 46 g of 5 M HCOOH ($d_{solution}$ = 1 g/mL)

(1) I and II only (2) II, III and IV only

(3) I only (4) I, II, III, and IV

34. The molar ratio of Fe^{2+} to Fe^{3+} in a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ having equal number of sulphate ion in both ferrous and ferric sulphate is:

(1) 1 : 2 (2) 3 : 2

(3) 2 : 3 (4) Can't be determined

35. Match the column-I and column-II

	Column-I		**Column-II**
A	$P_2H_4 \rightarrow PH_3 + P_4H_2$	P	$E = \frac{3M}{4}$
B	$I_2 \rightarrow I^- + IO_3^-$	Q	$E = \frac{3M}{5}$
C	$MnO_4^- + Mn^{2+} + H_2O \rightarrow Mn_3O_4 + H^+$	R	$E = \frac{15M}{26}$
D	$H_3PO_2 \rightarrow PH_3 + H_3PO_3$	S	$E = \frac{5M}{6}$

	A	**B**	**C**	**D**
(1)	S	Q	R	P
(2)	P	Q	R	S
(3)	S	P	Q	R
(4)	Q	S	R	P

36. CN^- is oxidised by NO_3^- in presence of acid:

$aCN^- + b\ NO_3^- + cH^+ \rightarrow (a+b)\ NO + aCO_2 + \frac{c}{2}H_2O$

What are the values of a, b, c in that order:

(1) 3, 7, 7 (2) 3, 10, 7

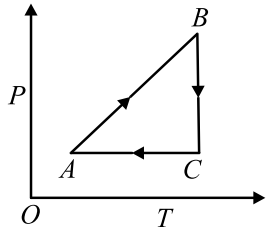
(3) 3, 10, 10 (4) 3, 7, 10

37. A 150 mL solution of I_2 is divided into two unequal parts. I part reacts with hypo solution in acidic medium. 15 mL of 0.4 M hypo was consumed. II part was added with 100 mL of 0.3 M NaOH solution. Residual base required 10 mL of 0.3 M H_2SO_4 solution for complete neutralization. What was the initial concentration of I_2?

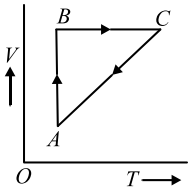
(1) 0.08 M (2) 0.1 M

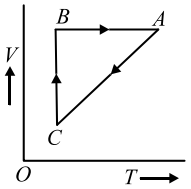
(3) 0.2 M (4) None of these

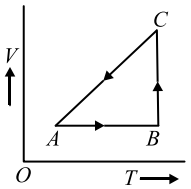
38. A cyclic process is shown in the P–T diagram.

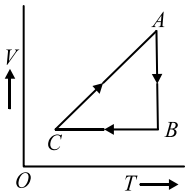


Which one of the following graphs show the same process on V–T diagram?

(1)


(2)


(3)


(4)


39. **Statement-I:** The standard free energy change of all spontaneously occurring reactions is negative.

Statement-II: The standard free energies of the elements in their standard states at 1 bar and 298 K are taken as zero.

(1) Statement-I is true, statement-II is true, statement-II is correct explanation for statement-I.

(2) Statement-I is true, statement-II is true, statement-II is NOT a correct explanation for statement-I.

(3) Statement-I is true, statement-II is false.

(4) Statement-I is false, statement-II is true.

40. Determine $\Delta H°/kJ$ for the following reaction using the listed enthalpies of reaction:

$4CO(g) + 8H_2(g) \rightarrow 3CH_4(g) + CO_2(g) + 2H_2O(1)$

$C\ (graphite) + 1/2O_2(g) \rightarrow CO(g)$ $\Delta H°/kJ = -110.5$

$CO(g) + 1/2O_2(g) \rightarrow CO_2(g)$ $\Delta H°/kJ = -282.9$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(1)$ $\Delta H°/kJ = -285.8$

$C(graphite) + 2\ H_2(g) \rightarrow CH_4(g)$ $\Delta H°/kJ = -74.8$

(1) – 622.4 (2) – 686.2

(3) –747.4 (4) –653.5

41. What is the percentage hydrolysis of NaCN in its N/80 solution when the dissociation constant for HCN is 1.3×10^{-9} and $K_w = 1.0 \times 10^{-14}$?

(1) 2.48 (2) 5.26
(3) 8.2 (4) 9.6

42. Aniline behaves as a weak base. When 0.1 M, 50 mL solution of aniline was mixed with 0.1 M, 25 mL solution of HCl, the pH of resulting solution was 8. The pH of 0.01 M solution of anilinium chloride will be

(1) 6 (2) 6.5
(3) 5 (4) 5.5

43. At 18°C, the solubility of CdS in water is 6.33×10^{-15}M. What is the concentration of Cd^{2+} ion in a solution of pH = 1 saturated with H_2S gas, in which concentration of H_2S = 0.1 M? The product of the first and second ionization constants of H_2S is 1.1×10^{-22} at this temperature

(1) 6.343×10^{-8} M
(2) 4.368×10^{-8} M
(3) 4.368×10^{-9} M
(4) 3.643×10^{-8} M

44. The equilibrium $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$ is attained at 25°C in a closed rigid container. When an inert gas, helium is introduced, which of the following statement is/are correct?

(I) Concentrations of SO_2, Cl_2 and SO_2Cl_2 do not change
(II) More chlorine is formed
(III) Concentration of SO_2 is reduced
(IV) More SO_2Cl_2 is formed

(1) II and III only
(2) IV only
(3) I only
(4) II and IV only

45. Which of the following are the examples of pseudo unimolecular reactions?

(i) Acid catalysed hydrolysis of an ester
(ii) Inversion of cane sugar
(iii) Decomposition of ozone
(iv) Decomposition of N_2O_5

Select the correct answer using the codes given below

(1) i and ii only
(2) i and iii only
(3) ii, iii and iv only
(4) i, ii and iv only

46. The reaction, $2N_2O_5 \rightarrow 4NO_2 + O_2$, is forming NO_2 at the rate of 0.0076 mole / lit / sec at some time:

Which of the following statements will be correct?

(i) The rate of change of $[O_2]$ at this time will be 0.0019 mole/lit/sec
(ii) The rate of change of $[N_2O_5]$ at this time will be 0.0038 mole/lit/sec
(iii) The rate of reaction at this time will be 0.0076 mole/lit/sec

(1) i, ii and iii (2) i and iii only
(3) ii and iii only (4) i and ii only

47. A 1.2% solution (weight/volume) of NaCl is isotonic with 7.2% solution (weight/volume) of glucose. Calculate van't Hoff factor of NaCl. (Molar mass of NaCl and glucose are 58.5 g mol^{-1} and 180 g mol^{-1} respectively)

(1) 1.85 (2) 1.95
(3) 1.25 (4) 1.45

48. Consider the following pairs of completely miscible liquids in order: water-dioxane, acetone-chloroform and ethylene dibromide-propylene dibromide. These will respectively show the following type of deviations from Raoult's law (in the vapour pressure curves)

(1) Negative, Positive, Zero
(2) Positive, Zero, Negative
(3) Positive, Negative, Zero
(4) Zero, Positive, Negative

49. At a particular temperature, the vapour pressures of the two liquids A and B are respectively 120 and 180 mm of mercury. If 2 moles of A and 3 moles of B are mixed to form an ideal solution, then the vapour pressure of solution at the same temperature will be (in mm of mercury)

(1) 46 (2) 156
(3) 146 (4) 106

50. In a solution of an organic solute (mol. wt. = 180) in CCl_4, where the solute is dimerised, 50 g of the solute is present per litre of the solution. The osmotic pressure of the solution is 4.11 atm at 27°C (Assume R = 0.082 lit atm K^{-1} mol^{-1}). The percentage degree of association of the solute in CCl_4 is

(1) 75.5%
(2) 70%
(3) 60 %
(4) 80 %

Integer Type Questions

51. If the molarity of a sulphuric acid solution of specific gravity 1.2 containing 27% H_2SO_4 by weight is M, the value of 10M is _____.
(Nearest Integer)

52. A mixture of ethanol and water contains 54% water by mass. The mole percentage of alcohol in this solution will be____%.

53. $KMnO_4$ oxidizes X^{n+} ion to XO_3^-, itself changing to Mn^{2+} in acidic medium. 2.68×10^{-3} mole of X^{n+} requires 1.61×10^{-3} mole of MnO_4^-. If the weight of 1 g equivalent of XCl_n is 56, then the value of (M + n) will be____. (M is the atomic mass of X)

54. Oxygen is heated from 300 K to 600 K at a constant pressure of 1 bar. What is the increase in its molar entropy? The molar heat capacity in $JK^{-1}\ mol^{-1}$ for O_2 is
$C_P = 25.5 + 13.6 \times 10^{-3}\ T - 42.5 \times 10^{-7}\ T^2$
(Nearest Integer)

55. A sample of a fluorocarbon was allowed to expand reversibly and adiabatically to twice its volume. In the expansion the temperature dropped from 298.15 to 248.44 K. Assume the gas behaves perfectly. Calculate the value of $C_{v,m}$ ($J\ K^{-1}\ mol^{-1}$).
[log (298.15) = 2.47, log (248.44) = 2.39, log (2) = 0.30, R = 8.3 $J\ K^{-1}\ mol^{-1}$] (Nearest Integer)

56. The degree of dissociation of HI at a particular temperature is 0.8. Find the volume (in ml) of 1.5 M sodium thiosulphate solution required to react completely with the iodine present at equilibrium in acidic conditions, when 0.135 mol each of H_2 and I_2 are heated at 440 K in a closed vessel of capacity 2.0 L.

57. A container contains three gases, A, B and C in equilibrium $A \rightleftharpoons 2B + C$. At equilibrium the concentration of A was 3 M, and that of B was 4 M. On doubling the volume of container, the new equilibrium concentration of B was found to be 3 M. Calculate the sum of K_C and initial equilibrium concentration of C (Nearest Integer)

58. The half life time of first order decomposition of nitroamide is 2.1 hour at 15°C

$$NH_2NO_2(aq) \rightarrow N_2O(g) + H_2O(l)$$

If 6.2 g of NH_2NO_2 is allowed to decompose, then calculate the value of (X+Y) where X is the time (in h) taken by NH_2NO_2 to decompose to 99 percent and Y is the volume (in L) of dry N_2O (measured at STP) produced at this point.
(Nearest Integer)

59. The decomposition of a compound 'P' at temperature T, according to the following equation $2P(g) \rightarrow 4Q(g) + R(g) + S(l)$ is a first-order reaction. After 30 minutes, from the start of the decomposition in a closed vessel, the total pressure developed is found to be 445 mm Hg and after a long time, the total pressure is 625 mm Hg. The vapour pressure of S(l) at this temperature is 25 mm Hg. The total pressure (in mm Hg) after 60 minutes is____.

60. X g of a non-electrolyte compound (molar mass = 200) is dissolved in 1.0 litre of 0.05 M NaCl aqueous solution. The osmotic pressure of this solution is found to be 4.92 atm at 27°C Calculate the value of X. Assume complete dissociation of NaCl and ideal behaviour of this solution
($R = 0.082$ litre atm $mol^{-1}\ K^{-1}$)

SECTION-III (MATHEMATICS)

Single Correct Type Questions

61. Domain of definition of the function

$$f(x) = \log(\sqrt{10 \cdot 3^{x-2} - 9^{x-1} - 1}) + \sqrt{\cos^{-1}(1-x)}$$

(1) [0, 1] (2) [1, 2]
(3) (0, 2) (4) (0, 1)

62. The range of the function

$$f(x) = \frac{e^x \ln 5^{(x^2+2)} \cdot (x^2 - 7x + 10)}{2x^2 - 11x + 12} \text{ is}$$

(1) $(-\infty, \infty)$
(2) $[0, \infty)$
(3) $\left(\frac{3}{2}, \infty\right)$ (4) $\left(\frac{3}{2}, 4\right)$

63. Consider the functions $f : X \rightarrow Y$ and $g: Y \rightarrow Z$ then which of the following is incorrect?
(1) If f and g both are injective then gof : $X \rightarrow Z$ is injective
(2) If f and g both are surjective then gof : $X \rightarrow Z$ is surjective
(3) If gof : $X \rightarrow Z$ is bijective then f is injective and g is surjective.
(4) none of these

64. Which of the following statements are incorrect?

I. If $f(x)$ and $g(x)$ are one to one then $f(x) + g(x)$ is also one to one.

II. If $f(x)$ and $g(x)$ are one-one then $f(x) \cdot g(x)$ is also one-one.

III. If $f(x)$ is odd then it is necessarily one to one.

(1) I and II only (2) II and III only

(3) III and I only (4) I, II and III

65. Let $f : A \to B$ and $g : B \to C$ be two functions and gof : $A \to C$ is defined. Then which of the following statement(s) is true?

(1) If gof is onto then f must be onto.

(2) If f is into and g is onto then gof must be onto function.

(3) If gof is one-one then g is not necessarily one-one.

(4) If f is injective and g is surjective then gof must be bijective mapping.

66. Two points A and B in a plane are related if $OA = OB$, where O is a fixed point. This relation is

(1) Reflexive but not symmetric

(2) Symmetric but not transitive

(3) An equivalence relation

(4) Reflexive but not transitive

67. Let R be the set of real numbers.

Statement-1 : $A = \{(x, y) \in R \times R : y - x$ is an integer $\}$ is an equivalence relation on R.

Statement-2 : $B = \{(x, y) \in R \times R : x = \alpha y$ for some rational number $\alpha\}$ is an equivalence relation on R.

(1) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1.

(2) Statement-1 is true, Statement-2 is true and Statement-2 is not the correct explanation of Statement-1

(3) Statement-1 is true, Statement-2 is false.

(4) Statement-1 is false, Statement-2 is true.

68. If A, B and C are three sets such that $A \cap B = A \cap C$ and $A \cup B = A \cup C$, then

(1) $A = B$ (2) $A = C$

(3) $B = C$ (4) $A \cap B = \phi$

69. Let A, B are square matrices of same order satisfying $AB = A$ and $BA = B$ then $(A^{2010} + B^{2010})^{2011}$ equals.

(1) $A + B$

(2) $2010(A + B)$

(3) $2011(A + B)$

(4) $2^{2011}(A + B)$

70. A and B are two non-singular matrices so that $A^6 = I$ and $AB^2 = BA(B \neq I)$. A value of K so that $B^K = I$ is

(1) 31

(2) 32

(3) 63

(4) 64

71. If a, b, c, are in A.P. and p, p' are respectively A.M. and G.M. between a and b while q, q' are respectively A.M. and G.M. between b and c, then

(1) $p^2 + q^2 = p'^2 + q'^2$

(2) $pq = p'q'$

(3) $p^2 - q^2 = p'^2 - q'^2$

(4) $p^2 + p'^2 = q^2 + q'^2$

72. If $\tan\theta$ and $\cot\theta$ are the roots of the equation $x^2 + 2x + 1 = 0$, then the least value of $x^2 + \tan\theta x + \cot\theta$ is

(1) $\frac{3}{4}$ (2) $\frac{5}{4}$

(3) $\frac{-5}{4}$ (4) $\frac{-3}{4}$

73. If x, y, z are real such that $x + y + z = 4$, $x^2 + y^2 + z^2 = 6$, then the range x is

(1) $(-1, 1)$ (2) $[0, 2]$

(3) $[2, 3]$ (4) $[2/3, 2]$

74. If all values of x obtained from the equation $4^x + (k-3)2^x + k = 4$ are non-positive, then the largest integral value of k is

(1) 1 (2) 2

(3) 3 (4) 4

75. Let $m(b)$ be the minimum value of $f(x) = (2 + b + b^2)x^2 - 2\sqrt{2}(2b+1)x + 8$, where $b \in [-3, 10]$. The maximum value of $m(b)$ is

(1) 2 (2) 4

(3) 6 (4) 8

76. The roots of the equation $x^2 + 6x + a = 0$ are real and distinct and they differ by atmost 4, then the range of values of a, is

(1) (5, 9]

(2) [5, 9)

(3) [4, 8)

(4) [3, 9)

77. If α, β, γ are the real roots of a cubical polynomial satisfying, $\begin{vmatrix} \alpha^2 & \beta^2 & \gamma^2 \\ (\alpha+1)^2 & (\beta+1)^2 & (\gamma+1)^2 \\ (\alpha-1)^2 & (\beta-1)^2 & (\gamma-1)^2 \end{vmatrix} = 0$ then

(1) all roots must be distinct
(2) at least two roots are equal
(3) at least one root is non-zero
(4) none of these

78. If $\begin{vmatrix} a & l & m \\ l & b & n \\ m & n & c \end{vmatrix} \begin{vmatrix} bc-n^2 & mn-lc & ln-bm \\ mn-lc & ac-m^2 & lm-an \\ ln-bm & lm-an & ab-l^2 \end{vmatrix} = 64$ then the value of $\begin{vmatrix} 2a+3l & 3l+5m & 5m+4a \\ 2l+3b & 3b+5n & 5n+4l \\ 2m+3n & 3n+5c & 5c+4m \end{vmatrix}$ equals

(1) 120 (2) 240
(3) 360 (4) 480

79. If $a_1, a_2, a_3 \ldots a_9$ are in H.P and $a_4 = 5, a_5 = 4$ then the value of $\begin{vmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{vmatrix}$ is

(1) $\frac{31}{15}$ (2) $\frac{41}{18}$
(3) $\frac{50}{21}$ (4) $\frac{61}{27}$

80. Let

$$A = \begin{pmatrix} 0 & \sin\alpha & \sin\alpha \cdot \sin\beta \\ -\sin\alpha & 0 & \cos\alpha \cdot \cos\beta \\ -\sin\alpha \cdot \sin\beta & -\cos\alpha \cdot \cos\beta & 0 \end{pmatrix},$$

then

(1) $|A|$ is independent of α and β
(2) A^{-1} depends only on α
(3) A^{-1} depends only on β
(4) $|A|$ depends of α and β both

Integer Type Questions

81. Let a and b be real numbers and let $f(x) = a\sin x + b\sqrt[3]{x} + 4, \forall x \in R$. If $f\left(\log_{10}\left(\log_3 10\right)\right) = 5$ then find the value of $f\left(\log_{10}\left(\log_{10} 3\right)\right)$.

82. Let $f(x) = |x^2 - 9| - |x - a|$. Find the number of integers in the range of a so that $f(x) = 0$ has 4 distinct real root.

83. If $f(\theta) = \begin{vmatrix} 1+\sin^2\theta & \cos^2\theta & 4\sin 4\theta \\ \sin^2\theta & 1+\cos^2\theta & 4\sin 4\theta \\ \sin^2\theta & \cos^2\theta & 1+4\sin 4\theta \end{vmatrix}$ then number of solutions of $f(\theta) = 0$ in $\left[0, \frac{\pi}{2}\right]$ is

84. $(\alpha\beta)(\delta\beta) = \gamma\gamma\gamma$ and each of the letters represents uniquely a different non-zero digits then the trace of the matrix $A = \begin{bmatrix} \alpha & 1 & 2 & 0 \\ 0 & \beta & 1 & 1 \\ 0 & 0 & \gamma & 3 \\ 1 & 1 & 0 & \delta \end{bmatrix}$ is equal to ___.

85. Number of positive integral solution of

$$\frac{x^3(2x-3)^2(x-4)^6}{(x-3)^3(3x-8)^4} \le 0$$

86. If $x_i > 0 \quad \forall i = 1, 2, 3$. Then least value of $\left(\sum_{i=1}^{3} x_i\right)\left(\sum_{i=1}^{3} \frac{1}{x_i}\right)$ is _____.

87. The sum

$$\sqrt{1+\frac{1}{1^2}+\frac{1}{2^2}} + \sqrt{1+\frac{1}{2^2}+\frac{1}{3^2}} + \ldots + \sqrt{1+\frac{1}{999^2}+\frac{1}{1000^2}}$$

is equal to $\frac{10^k - 1}{1000}$, where k = _____.

88. If in a triangle ABC, $\tan A + \tan B + \tan C$ has the value 6, then the value of $6 \cot A \cot B \cot C$ is

89. If α, β, γ are acute angles and $\cos\theta = \sin\beta/\sin\alpha$, $\cos\phi = \sin\gamma / \sin\alpha$ and $\cos(\theta - \phi) = \sin\beta\sin\gamma$, then the value of $\tan^2\alpha - \tan^2\beta - \tan^2\gamma$ is equal to

90. Let $x, y \in R$ satisfy the condition such that $\sin x \sin y + 3\cos y + 4\sin y \cos x = \sqrt{26}$. The value of $16 \times 17(\tan^2 x + \cot^2 y)$ is equal to