PHYSICS

Α

- 1. A particle starts moving at t = 0 along positive x axis with initial velocity 4 m/s. It has a constant acceleration of 2 m/s² in negative x-direction. Then find the distance travelled in time 0 to 3 s.
 - (a) 3 m (b) 12 m (c) 5 m (d) 9 m
- 2. A balloon at rest starts rising from the ground with an acceleration of 1.25 m/s^2 . After 8s, a stone is released from the balloon. The stone will:
 - (a) cover a distance of 40 m

(b) have a displacement of 50 m

(c) reach the ground in 4s

- (d) begin to move down after being released
- 3. In the figure, the blocks A, B and C of mass m each have accelerations a_1 , a_2 and a_3 respectively. F_1 and F_2 are external forces of magnitudes 2mg and mg respectively. Assume all the pulleys are massless and smooth as well as all the strings are also massless and inextensible. The correct order of accelerations of the blocks will be:



(a) $a_1 = a_2 = a_3$ (b) $a_1 > a_3 > a_2$ (c) $a_1 = a_2, a_2 > a_3$ (d) $a_1 > a_2, a_2 = a_3$

4. Block A is placed on block B, whose mass is greater than that of A. There is friction between the blocks, while the ground is smooth. A horizontal force *P*, increasing linearly with time, begins to act on A. The accelerations a_1 and a_2 of A and B respectively are plotted against time (*t*). Choose the correct graph.





- 5. A particle is at origin at time t = 0 moving in the *xy* plane with a constant acceleration α in the *y*-direction. Its equation of motion is $y = \beta x^2$ (where β is a positive constant). Its velocity component in the *x*-direction is:
 - (a) variable (b) $\sqrt{\frac{2\alpha}{\beta}}$ (c) $\frac{\alpha}{2\beta}$ (d) $\sqrt{\frac{\alpha}{2\beta}}$
- 6. A point moving along the *x*-direction starts from rest at x = 0 and comes to rest at x = 1 after 1 s. Its acceleration at any point is denoted by α . Which of the following is not correct?
 - (a) α must change sign during the motion.

Α

- (b) $|\alpha| \ge 4$ units at some or all points during the motion.
- (c) It is not possible to specify an upper limit for $|\alpha|$ from the given data.
- (d) $\mid \alpha \mid$ cannot be less than 1/2 during the motion.
- 7. In a simple pendulum, the breaking strength of the string is double the weight of the bob. The bob is released from rest when the string is horizontal. The string breaks when it makes an angle θ with the vertical, then θ is:

(a)
$$\theta = \cos^{-1}(1/3)$$
 (b) $\theta = 60^{\circ}$ (c) $\theta = \cos^{-1}(2/3)$ (d) $\theta = 0$

8. The tube AC forms a quarter circle in a vertical plane. The ball B has an area of cross-section slightly smaller than that of the tube, and can move without friction through it. B is placed at A and displaced slightly. It will



(OC is horizontal and OA is vertical line)

- (a) always be in contact with the inner wall of the tube
- (b) always be in contact with the outer wall of the tube
- (c) initially be in contact with the inner wall and later with the outer wall
- (d) initially be in contact with the outer wall and later with the inner wall
- 9. The horizontal range of a projectile is R and the maximum height attained by it is H. A strong wind now begins to blow in the direction of the motion of the projectile, giving it a constant horizontal acceleration = g/2 (g is the acceleration due to gravity). Under the same conditions of projection, the horizontal range of the projectile will now be:

(a)
$$R + \frac{H}{2}$$
 (b) $R + H$ (c) $R + \frac{3H}{2}$ (d) $R + 2H$

10. A block of mass m is placed on a horizontal surface. The coefficient of friction between them is μ . The block has to be moved by applying a single external force on it. The force may be applied in any direction. The minimum value of this force must be:

(a) mg, applied vertically upward, if $\mu > 1$ (b) μ mg, applied horizontally, if $\mu < 1$

(c) $\frac{\mu mg}{\sqrt{\mu^2 + 1}}$ for all values of μ (d) $\frac{\mu^2 mg}{\mu^2 + 1}$ for all values of μ



11. STATEMENT-1: In an elastic collision in one dimension between two bodies, neither of which was at rest before collision, total momentum remains the same before, during and after the collision.

STATEMENT-2: In an elastic collision in one dimension between two bodies, neither of which was at rest before collision, total kinetic energy remains the same before, during and after the collision.

- (a) Statement-1 is True, Statement-2 is True; Statement-2 is the correct explanation for Statement-1.
- (b) Statement-1 is True, Statement-2 is True; Statement-2 is not the correct explanation for Statement-1.
- (c) Statement-1 is True, Statement-2 is False.

Α

- (d) Statement-1 is False, Statement-2 is True.
- 12. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of the river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be ______°, so that the swimmer reaches the point B (where θ is the angle of velocity of swimmer with respect to water with line AB).



13. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initially at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is :



14. Two identical blocks A and B each of mass m, resting on a smooth horizontal floor, are connected by a light spring of natural length L and spring constant K. A third block C of mass m moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is:

(a)
$$v\sqrt{\frac{m}{2K}}$$
 (b) $\sqrt{\frac{mv}{2K}}$ (c) $v\sqrt{\frac{m}{K}}$ (d) $\sqrt{\frac{m}{2K}}$

- 15. A particle is moving along a circular path with a constant speed of 10 ms^{-1} . What is the magnitude of the change in velocity of the particle, when it moves through an angle of 60° around the centre of the circle?
 - (a) zero (b) 10 m/s (c) $10\sqrt{3}$ m/s (d) $10\sqrt{2}$ m/s



genius 20 🗲

16. Match List-I with List-II

Α



Choose the correct answer from the options given below :

- $(a) (A) \rightarrow (iii), (B) \rightarrow (ii), (C) \rightarrow (iv), (D) \rightarrow (i)$
- (b) (A) \rightarrow (iv), (B) \rightarrow (iii), (C) \rightarrow (i), (D) \rightarrow (ii)
- $(c) (A) \rightarrow (i), (B) \rightarrow (iv), (C) \rightarrow (ii), (D) \rightarrow (iii)$
- $(d) (A) \rightarrow (iv), (B) \rightarrow (i), (C) \rightarrow (iii), (D) \rightarrow (ii)$
- 17. The pitch and the number of divisions, on a circular scale, for a given screw gauge, are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the reference line. The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively. The thickness of this sheet is:

(a) 5.755 m (b) 5.725 mm (c) 5.740 m (d) 5.950 mm

CHEMISTRY

[h= planck's constant = 6.626×10^{-34} J.s. Gas constant R = 8.314 JK⁻¹ mol⁻¹ = 2 Cal K⁻¹ mol⁻¹, 1 cal = 4.18 J, 1atm = 1.01325×10^5 Nm⁻², KE = Kinetic energy, a = vandarwaal's constant for pressure correction, other symbols have their usual meaning]

- **18.** Suppose you want an acidic solution to carry out a chemical reaction with 2 moles of NaOH. Which sample of acid is the best or most affordable choice for you?
 - (a) $1 \text{ M } \text{H}_2\text{SO}_4$ (50 Rs per L) (b) $1 \text{ M } \text{H}_2\text{SO}_4$ (56 Rs per L)
 - (c) 1 M HCl (30 Rs per L) (d) 1 M HCl (27 Rs. Per L)
- **19.** 10 moles of C completely reacts with 6 moles of O_2 . What will be the weight of CO_2 produced after

the reaction. $(C+O_2 \longrightarrow CO_2 + CO)$

- (a) 440 gm (b) 264 (c) 88 gms (d) None of these
- **20.** When the frequency of light incident on a metallic plate is doubled, the KE of the emitted photoelectrons will be:
 - (a) doubled
 - (b) halved
 - (c) increased but more than double of the previous KE
 - (d) increased but less than double of the previous KE



genius 20 =

- **21.** Difference between nth and $(n + 1)^{th}$ Bohr's radius of 'H' atom is equal to it's $(n-1)^{th}$ Bohr's radius. The value of n is:
 - (a) 1 (b) 2 (c) 3 (d) 4
- 22. Which of the following statement is correct in relation to the hydrogen atom?

(a) 3s-orbital is lower in energy than 3p-orbital.

- (b) 3p–orbital is lower in energy than 3d–orbital.
- (c) 3s and 3p–orbitals are of lower energy than 3d–orbitals.
- (d) 3s, 3p and 3d–orbitals, all have the same energy.
- 23. Assertion : The bond angle around PBr_3 is larger than that in PH_3 but the bond angle of NBr_3 is less than that of NH_3 .
 - **Reason :** As Br is more electronegative than Hydrogen, it attracts lone pair towards itself and this reduces the bond angle in NBr₃.
 - (a) Assertion and Reason both are true and reason is the correct explanation of assertion.
 - (b) Assertion is true but reason is false.
 - (c) Assertion and Reason both are true and reason is not the correct explanation of assertion.
 - (d) Assertion is false but reason is true.
- **24.** The dipole moment (in Debye units) of m-dichlorobenzene is 1.72. What is the value of dipole moment for o-dichlorobenzene?

25. Which of the following is/are **NOT** paramagnetic?

(a)
$$O_2^+$$
 (b) KO_2 (c) F_2^{2-} (d) NaH

26. 1 mole of an ideal gas is initially at temperature T and volume V. Its volume increases by ΔV due to an increase in temperature ΔT , (P remains constant). The quantity $\delta \left(\delta = \frac{\Delta V}{V\Delta T}\right)$ varies with temperature as: (X axis represents Temperature in Kelvin)



- 27. When 100 ml ozonised oxygen was passed through turpentine oil, there was a reduction of volume by 20 ml. If 100 ml of such mixture is heated to decompose ozone completely, what will be the increase in volume?
 - (a) 10 ml (b) 20 ml
 - (c) 40 ml
- (d) No change in volume



28. The figure given below a graph of pressure versus density for an ideal gas at two temperatures T_1 and T_2 . Which of the option is correct?



29. When 10 mL of a strong acid is added to 10 mL of an alkali, the temperature rises by 5°C. If 100 mL of the same acid is mixed with 50 mL of the same base, the temperature rise would be :

(a)
$$5^{\circ}$$
C (b) 3.33° C (c) 20° C (d) 8.33° C

30. A gas absorbs 35.8 cal of heat and undergoes an expansion from 1 L to 1.5 L against the external pressure of 1.2 atm. Which of the following is the change in the internal energy of the system?

(a) -210.68 J (b) +210.68 J (c) -89.12 J (d) +88.849 J

31. Find the heat of combustion of
$$CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$$
, If –

(i)
$$C + 2S \rightarrow CS_2$$
; $\Delta_f H = +117.0 \text{ kJ mol}^{-1}$
(ii) $C + O_2 \rightarrow CO_2$; $\Delta_f H = -393 \text{ kJ mol}^{-1}$
(iii) $S + O_2 \rightarrow SO_2$; $\Delta_f H = -297 \text{ kJ mol}^{-1}$
(a) -807 kJ mol^{-1} (b) $-1104 \text{ kJ mol}^{-1}$ (c) $+1104 \text{ kJ mol}^{-1}$ (d) $+807 \text{ kJ mol}^{-1}$

32. Professor I.L. Finar instructed his student to convert the given compound commonly known as Amino acid (X) into a new compound (Y) in which the $-NH_2$ group is replaced by -COOH group. The student was confused in writing the correct IUPAC name of these two compounds. What will be the correct IUPAC names of X and Y, where X is as follows?



- (a) 2-Ethyl-2-amino ethanoic acid, 2-Ethyl-2-carboxyl ethanoic acid
- (b) 2-Aminobutanoic acid, Ethylpropanedioic acid
- (c) 2-Aminobutanoic acid, 2-Carboxybutanoic acid
- (d) 2-Carboxypropan-1-amine, Propane-1, 1-dicarboxylic acid.
- **33.** The first ionisation potential of Na, Mg, Al and Si are in the order of:

 $(a) \ Na < Mg > Al < Si \qquad (b) \ Na > Mg > Al > Si \qquad (c) \ Na < Mg < Al > Si \qquad (d) \ Na > Mg > Al < Si$

34. For the reaction, $2A + 3B + 4C \rightarrow D + 2E$, if the molecular masses of A, B, C, D & E are 20, 30, 15, 40 & 60 respectively & total 18 moles of A, B, & C was taken initially, then what could be the maximum mass of E which can be obtained from the above amount?

```
(a) 240 gm (b) 120 gm (c) 540 gm (d) 380 gm
```



6

Δ

MATHEMATICS

A

35.	Let x, y, z be three positive real numbers such that					
	$x + [y] + {z} = 13.2$					
	$[x]+\{y\}+z=14.3$					
	${x}+y+[z]=15.1$					
	where [a] denotes the greatest integer $\leq a$ and $\{b\}$ denotes the fractional part of b then:					
	(a) $x + y + z = 21.3$	(b) $x + y + z = 43.6$	(c) $x + y + z = 21$	(d) $x + y + z = 42$		
36.	The minimum value of	the minimum value of $f(x) = x-1 + x-2 + x-3 $ is equal to:				
	(a) 1	(b) 2	(c) 3	(d) 0		
37.	The solution of the inequation $ x^2 - 2x - 3 < x^2 - x + 5 $ is:					
	(a) $(-\infty, 5)$		(b) $(-\infty, 2) \cup (3, 8) \cup (8)$	(∞)		
	(c) $(-8,\infty)$		(d) $(3,8)$			
38.	If $\log_3 x - \log_x 3 = 7$ then the value of $(\log_3 x)^2 + (\log_x 3)^2$ is:					
	(a) 49	(b) 51	(c) 47	(d) None of these		
39.	The roots of the quadratic equation $x^2 - 2015x + k = 0$ are prime numbers, then k is equal to:					
	(a) 4022	(b) 4026	(c) 2017	(d) 2016		
40.	In a convex polygon, the degree measures of the interior angles form an arithmetic progression. If smallest angle is 159° and the largest angle is 177°, then the number of sides in the polygon is:					
	(a) 21	(b) 27	(c) 30	(d) 31		
41.	Maximum value of $\cos x (\sin x + \cos x)$ is equal to:					
	(a) $\sqrt{2}$	(b) 2	(c) $\frac{\sqrt{2}+1}{2}$	(d) $\sqrt{2} + 1$		
42.	$\tan 100^\circ + \tan 125^\circ + \tan 100^\circ \tan 125^\circ$ is equal to:					
	(a) 0	(b) $\frac{1}{2}$	(c) -1	(d) 1		
43.	General solution of the equation $\sin x + \cos x = 1$ is:					
	(a) $\frac{n\pi}{2} + \left(-1\right)^n \frac{\pi}{4}$	(b) $2n\pi + (-1)^n \frac{\pi}{4}$	(c) $n\pi + (-1)^n \frac{\pi}{4}$	(d) $n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}$		
	{where $n \in I$, I represents a set of integers}.					
44.	Number of solutions of $\tan 2x = \tan 6x$ in $(0, 3\pi)$ is:					
	(a) 4	(b) 5	(c) 3	(d) None of these		



the

45.	Let $f: \mathbb{R} \to \mathbb{R}$ be defined by:						
	$f(x) = \begin{cases} 2x & , & x > 3 \\ x^2 & , & 1 < x \le 3 \\ 3x & , & x \le 1 \end{cases}$						
	Then $f(-1) + f(2) + f(4)$ is						
	(a) 9	(b) 14	(c) 5	(d) None of these			
46.	If $S_n = an^2 + \frac{n}{4}(n-1)d$ is the sum of first n terms of an A.P. then common difference is equal to:						
	(a) $a + 2d$	(b) $2a + d$	(c) $\frac{a+d}{2}$	(d) $2a + \frac{d}{2}$			
47.	If $2f(x) - 3f\left(\frac{1}{x}\right) = x^2$, x is not equal to zero, then $f(2)$ is equal to:						
	(a) $\frac{-7}{4}$	(b) $\frac{5}{2}$	(c) –1	(d) None of these			
48.	The range of the function $f(x) = e^{-x} + e^{x}$ is:						
	(a) [1,∞)	(b) (−∞,1]	(c) [2,∞)	(d) (−∞,2]			
49.	The value of $1^2 + 3^2 + 5^2 + \dots + 25^2$ is:						
	(a) 1728	(b) 1456	(c) 2925	(d) 1469			
50.	If α,β are roots of the equation $ax^2 - bx - c = 0$ then $\alpha^2 - \alpha\beta + \beta^2$ is equal to:						
	(a) $\frac{b^2 + 3ac}{a^2}$	(b) $\frac{b^2 - 3ac}{a^2}$	(c) $\frac{b^2 + 2ac}{a^2}$	(d) $\frac{b^2 - 2ac}{a^2}$			



A

SOLUTION

PHYSICS

1. (c)

v = u + at0 = 4 - 2t

t = 2s.

At 2s particle will change its direction

For 0 to 2s

$$S_1 = 4 \times 2 - \frac{1}{2} \times 2 \times 2^2 = 4m$$

For 2 to 3s

$$S_2 = 0 + \frac{1}{2} \times 2 \times 1^2 = 1m$$

Total distance travelled = 4 + 1

- = 5m
- 2. (c)

When a particle separates from a moving body, it retains the velocity of the body but not its acceleration.

At the instant of release, the balloon is 40 m above the ground and has an upward velocity of 10 m/s. For the motion of the stone from the balloon to the ground, u = 10 m/s, s = -40 m,

 $a = -10 \text{ m/s}^2(g).$

3. (b)

 $a_1 = g, a_2 = g / 3, a_3 = g / 2.$

4. (c)

The two blocks will move together with the same acceleration as long as the force of friction between them is less than the limiting friction, as the only force on the lower block B is the force of friction. Once limiting friction is reached, the acceleration of B becomes constant $\left(=\frac{F_{\text{lim}}}{\text{mass of B}}\right)$, and the acceleration of A continues to increase at a faster rate.

5. (d)

y =
$$\beta x^2$$
 or $\frac{dy}{dt} = 2\beta \frac{dx}{dt}$
or $\frac{dx}{dt} = \sqrt{\alpha/2\beta}$.
[$\frac{d^2x}{dt^2} = 0$ as it has acceleration only in the y-direction.]



6. (d)

Α

The simplest solution to the motion is shown by the plot OAB. The area under the $v \sim t$ plot must be equal to 1 (displacement).



For this, $\frac{V}{2} = 1$ or V = 2.

The acceleration $\frac{V}{1/2} = 4$ units.

 \therefore slope of OA = 4.

Taking OAB as reference, the condition of the motion can be satisfied by any other curve, e.g., OCB, as long as the area under it is equal to 1. Also, the slope of the curve at any point gives the acceleration α . Points D and E have $\alpha = 4$. Points below D have $\alpha < 4$ and above D have $\alpha > 4$. As the shape of the curve OCB is arbitrary, it is not possible to set upper or lower limits on the acceleration.

7. (c)

$$mg\ell\cos\theta = \frac{1}{2}mv^{2} \qquad \dots (i)$$

$$T - mg\cos\theta = \frac{mv^{2}}{\ell}$$

$$2mg - mg\cos\theta = \frac{mv^{2}}{\ell} \qquad \dots (ii)$$
From i & ii

$$2mg\ell\cos\theta = 2mg\ell - mg\ell\cos\theta$$

$$3\cos\theta = 2$$

$$\cos\theta = \frac{2}{3}$$

$$\theta = \cos^{-1}\left(\frac{2}{3}\right)$$
8. (c)

After releasing at point A particle will loose contact with lower surface at angle $\cos^{-1}\left(\frac{2}{3}\right)$ from vertical.



genius 20 =

A

For the projectile, $R = \frac{u^2 \sin 2\theta}{g}, H = \frac{u^2 \sin^2 \theta}{2g}$. Time of flight = $t = \frac{2u \sin \theta}{g}$. Initial horizontal velocity = u cos θ . When horizontal acceleration g/2 is present, The horizontal range = $(u \cos \theta)t + \frac{1}{2}(\frac{g}{2})t^2$ = $(u \cos \theta)\frac{2u \sin \theta}{g} + \frac{g}{4}(\frac{4u^2 \sin^2 \theta}{g^2})$ = R+ 2H.



$$mg = N + P \sin \theta$$

or
$$N = mg - P\sin\theta$$
.

 $P\cos\theta = F_{lim} = \mu N = \mu mg - \mu P\sin\theta$

or $P[\cos\theta + \mu \sin\theta] = \mu mg$

or $P = \frac{\mu mg}{\cos \theta + \mu \sin \theta}$.

For P to be minimum,
$$\frac{d}{d\theta}(\cos\theta + \mu\sin\theta) = 0$$

or $-\sin\theta + \mu\cos\theta = 0$ or $\tan\theta = \mu$.

$$\therefore P_{\min} = \frac{\mu mg}{\frac{1}{\sqrt{\mu^2 + 1}} + \mu \frac{\mu}{\sqrt{\mu^2 + 1}}} = \frac{\mu mg}{\sqrt{\mu^2 + 1}}$$

11. (c)

In an elastic collision in one dimension between two bodies, neither of which was at rest before collision, then total kinetic energy remains the same before and after the collision but it is not equal to kinetic energy during collision. Momentum is always conserved during collision.



12. (a)

Α

Velocity of mass with respect to ground can be given as $\overline{V}_{M} = \overline{V}_{MR} + \overline{V}_{R}$

Vector addition of the velocities is shown below in which V_M should be along line AB. Given that velocity of man with respect to river and that of river is same so we use



As the velocities of man and that of river are same the resultant velocity of man with respect to ground vectors will be the angle bisector of the two vectors in the diagram shown so we have $\theta = 30^{\circ}$.

13. (c)

Maximum speed is at mean position (equilibrium) where

$$x = \frac{F}{k}$$

Using work energy theorem, we have

$$F(x) - \frac{1}{2}kx^{2} = \frac{1}{2}mv^{2} - 0$$

$$F\left(\frac{F}{k}\right) - \frac{1}{2}k\left(\frac{F}{k}\right)^{2} = \frac{1}{2}mv^{2}$$

$$v_{max} = \frac{F}{\sqrt{mk}}$$

14. (a)

As C collides elsastically, it comes to rest and A moves with speed v. Then spring compression will be maximum when A and B moves with equal speeds i.e. v/2. At this instant maximum compression can be given by conservation of energy, calculated as

$$\frac{1}{2}(2m)\left(\frac{v}{2}\right)^2 = \frac{1}{2}kx^2$$
$$x = \sqrt{\frac{m}{2k}}v$$

15. (b)

For above circular motion, change in velocity is

$$|\Delta \overline{\mathbf{v}}| = \sqrt{\mathbf{v}_1^2 + \mathbf{v}_2^2 + 2\mathbf{v}_1\mathbf{v}_2\cos(\pi - \theta)}$$
$$\Rightarrow |\Delta \overline{\mathbf{v}}| = 2\mathbf{v}\sin\frac{\theta}{2}$$
$$\Rightarrow |\Delta \overline{\mathbf{v}}| = (2 \times 10) \times \sin(30^\circ)$$
$$\Rightarrow |\Delta \overline{\mathbf{v}}| = 10 \text{ m/s}$$

16. (b)

All the option in List-I can be directly related with the vector triangles given in List-II using triangle law of vector addition.



A

17. (b)

Least count of screw gauge is given as

$$LC = \frac{\text{Pitch}}{\text{No.of division}}$$

$$LC = 0.5 \times 10^{-2} \text{ mm}$$
Zero error is given as
$$z = 3 \times 0.5 \times 10^{-2} \text{ mm}(+\text{ve})$$

$$z = 1.5 \times 10^{-2} \text{ mm} = 0.015 \text{ mm}$$
Thickness of sheet measured by screw gauge is
$$t = \text{MSR} + \text{CSR} - \text{ZE}(+\text{ve zero error})$$

$$t = 5.5 \text{ mm} + (48 \times 0.5 \times 10^{-2}) = 0.015$$

t = 5.5 + 0.24 - 0.015 = 5.725 mm

CHEMISTRY

18. (a)

Choice – A: 1 mol H_2SO_4 will be required to react with 2 mol NaOH. To get 1 mol H_2SO_4 , we need to take 1 L, 1 M solution, Hence net cost = 50 Rs

Choice -B: 1 mol H₂SO₄ will be required to react with 2 mol NaOH. To get 1 mol H₂SO₄, we need to take 1 L, 1 M solution, Hence net cost = 56 Rs

Choice - C: 2 mol HCl will be required to react with 2 mol NaOH. To get 2 mol HCl, we need to take 2 L, 1 M solution, Hence net cost = 60 Rs

Choice -C: 2 mol HCl will be required to react with 2 mol NaOH. To get 2 mol HCl, we need to take 2 L, 1 M solution, Hence net cost = 54 Rs

The best choice will be 1M H₂SO₄ (Rs. 50 per L)

19. (c)

Balance the question as per given reaction condition :

$$10C + 6O_2 \longrightarrow 2CO_2 + 8CO_2$$

$$\therefore$$
 mass of CO₂ = 2 mol $\times \frac{44 \text{ g}}{\text{mol}} = 88 \text{ g}$

Alternative method: Apply POAC.

Conserving C-atom :

 $1 \times \text{mole of } C = 1 \times \text{mol of } 10, +1 \times \text{mol of } 10$

 $10 \text{ mole} = \text{mole of } CO_2 + \text{mol of } CO \qquad \dots(i)$

Conserving O-atom

 $2 \times \text{mol of } O_2 = 2 \times \text{mol of } CO_2 + 1 \times \text{mol of } CO$ $12 \text{ mol} = 2 \times \text{mol of } CO_2 + \text{mol of } CO$...(ii) Solving (i) and (ii) Mole of $CO_2 = 2 \text{ mol.}$ $\therefore \text{ mol of } CO = 8 \text{ mol}$ $\therefore \text{ mol of } CO = 2 \text{ mol.}$





20. (c)

Α

Kinetic energy (KE₁) of photoelectrons emitted when light of frequency v falls on a the surface of a metal is given by

 $KE_1 = h\nu - h\nu_0 \Longrightarrow h\nu = KE_1 + h\nu_0 \quad \dots (i)$

where v_0 is the threshold frequency. When frequency of the incident light is doubled the new kinetic energy (KE₂) of photoelectrons is given by

 $KE_2 = 2h\nu - h\nu_0 = 2 \times (KE_1 + h\nu_0) - h\nu_0 \qquad \dots (ii)$

From (i) and (ii) \Rightarrow KE₂ = 2KE₁ + hv₀

21. (d)

 $\mathbf{r}_{\mathrm{n}} \times \mathrm{n}^{2}$

 $r_{n+1}-r_n=\ r_n-1;\ (n+1)^2-n^2=(n-1)^2 \, or \ n=4.$

22. (d)

Energy of single electron system is only depend on the principle quantum number, so that energy of different orbitals of same principle quantum number is same.

23. (b)

Assertion and Reason both are true and reason is not correct explanation of assertion.

24. (d)

$$\mu_{R} = \sqrt{\mu_{1}^{2} + \mu_{2}^{2} + 2\mu_{1}\mu_{2}\cos 120^{\circ}}$$

$$= \sqrt{\mu^{2}} (\mu_{1} = \mu_{2} = \mu)$$

$$\mu = \mu_{R} = 1.72$$

$$\mu_{R} = \sqrt{\mu_{1}^{2} + \mu_{2}^{2} + 2\mu_{1}\mu_{2}\cos 60^{\circ}}$$

$$= \sqrt{2\mu^{2} + 2\mu^{2}\frac{1}{2}} \qquad (\mu_{1} = \mu_{2} = \mu)$$

$$= \sqrt{3} \times \mu$$

$$= \sqrt{3} \times 1.72 = 2.98 \text{ D}.$$

25. (c)

Species with unpaired electrons are paramagnetic

Electronic configurations of O_2^+ , O_2^- and H_2^- are O_2^+ : $\sigma_{1s}^2 \sigma_{2s}^{*2} \sigma_{2s}^2 \sigma_{2p_x}^2 \pi_{2p_y}^2 \pi_{2p_z}^2 \pi_{2p_y}^{*1} - Unpaired electron$ $KO_2 \rightarrow K^+$ and O_2^- : $\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2p_x}^{*2} \pi_{2p_y}^2 \pi_{2p_y}^2 \pi_{2p_y}^{*2} \pi_{2p_z}^{*2} \pi_{2p_z}^{*1} - Unpaired electron$ $NaH_2 \rightarrow Na^+$ and H_2^- : $\sigma_{1s}^2 \sigma_{1s}^{*1} - Unpaired electron$

26. (c)

PV = RT $P\Delta V = R\Delta T \qquad (for one mole)$ $\frac{\Delta V}{\Delta T} = \frac{R}{P} = \frac{RV}{RT} = \frac{V}{T}$ $\delta = \left(\frac{\Delta V}{V\Delta T}\right) = \frac{1}{T}$



27. (a)

Α

Ozone is absorbed by turpentine oil

- \therefore 20 ml O₃ result 30 ml of O₂
- ∴ Final volume is 80+30=110 ml

Increase in volume = 110-100=10 ml.

28. (a)

$$\rho = \frac{PM}{RT}$$
$$\rho \propto P$$
$$\rho \propto \frac{1}{T}$$

Keeping the pressure constant it is visible from the graph.



Since,
$$\rho_1 < \rho_2$$
 and $\rho \propto \frac{1}{T}$ therefore, $T_1 > T_2$

29. (b)

Change in temperature $(\Delta t) \propto \frac{\text{Heat exchanged } (q)}{\text{Mass}(m)}$

$$\Rightarrow \frac{\Delta t_1}{\Delta t_2} = \frac{10^{-2} \times 150}{20 \times 50 \times 10^{-3}} = 1.5$$
$$\Rightarrow \Delta t_2 = \frac{5}{1.5} = 3.33^{\circ}C$$

30. (d)

$$\Delta U = q + W = 35.8 \times 4.18 - 1.2 (1.5 - 1) \times 1.01325 \times 10^5 \times 10^{-3} = 149.644 - 60.795 = 88.849$$

31. (b)

On doing he following operation, we get the enthalpy of combustion of $\ensuremath{CS_2}$

$$-(i) + (ii) + 2(iii)$$
 i.e. $\Delta H = -117 - 393 + 2(-297) = -1104$ KJ mol⁻¹

32. (b)



2-Aminobutanoic acid

Ethylpropanedioic acid



33. (a)

34. (a)

For maximum product the reactant should be taken in stoichiometric ratio.

 $2A + 3B + 4C \longrightarrow D + 2E$ $2x \quad 3x \quad 4x \qquad \text{moles of each are taken}$ $2x + 3x + 4x = 18 \Longrightarrow x = 2$ $\therefore \quad \frac{\text{mol of } A}{2} = \frac{\text{mol of } E}{2} \Longrightarrow \text{mole of } E = 2x = 4 \text{ mol}$ $\therefore \text{ mass of } E = 4 \text{ mol } \times 60 \text{ g/mol} = 240 \text{ g}$

MATHEMATICS

35. (a)

$$x + [y] + \{z\} = 13.2$$
 ...(i)
 $[x] + \{y\} + z = 14.3$...(ii)
 $\{x\} + y + [z] = 15.1$...(iii)
Adding (i), (ii) & (iii):
 $2x + 2y + 2z = 42.6$
 $\Rightarrow x + y + z = 21.3$

$$f(x) = \begin{cases} -(x-1)-(x-2)-(x-3), & x < 1 \\ (x-1)-(x-2)-(x-3), & 1 \le x < 2 \\ (x-1)+(x-2)-(x-3), & 2 \le x < 3 \\ (x-1)+(x-2)+(x-3), & x \ge 3 \end{cases}$$

$$=\begin{cases} -3x+6 , x < 1 \\ -x+4 , 1 \le x < 2 \\ x , 2 \le x < 3 \\ 3x-6 , x \ge 3 \end{cases}$$



$$|x^{2} - 2x - 3| < |x^{2} - x + 5|$$

$$\Rightarrow |x^{2} - 2x - 3| < x^{2} - x + 5 \qquad (\because x^{2} - x + 5 > 0, \forall x \in \mathbb{R})$$

$$x^{2} - 2x - 3 = (x + 1)(x - 3)$$

Case-1: $x < -1$ or $x > 3$

$$\therefore x^{2} - 2x - 3 < x^{2} - x + 5$$

$$\Rightarrow -x < 8 \Rightarrow x > -8$$

$$\Rightarrow x \le (-8, -1) \cup (3, \infty)$$

Case-2: $-1 \le x \le 3$

$$\Rightarrow -(x^{2} - 2x - 3) < x^{2} - x + 5$$

$$\Rightarrow -x^{2} + 2x + 3 < x^{2} - x + 5$$

$$\Rightarrow 0 < 2x^{2} - 3x + 2$$

$$\Rightarrow 2x^{2} - 3x + 2 > 0 \Rightarrow x \in \mathbb{R}$$

$$\therefore x \in (-8, -1) \cup [-1, 3] \cup (3, 0)$$

$$\Rightarrow x \in (-8, \infty)$$

)

38. (b)

 $\log_3 x - \log_x^3 = 7$

Squaring both sides.

$$\left(\log_{3}^{x} - \log_{x}^{3}\right)^{2} = 49$$
$$\Rightarrow \left(\log_{3}=49 x\right)^{2} + \left(\log_{x} 3\right)^{2} - 2\log_{3} x \cdot \log_{x} 3$$
$$\Rightarrow \left(\log_{3}^{x}\right)^{2} + \left(\log_{x}^{3}\right)^{2} = 51$$

39. (b)

 $\alpha + \beta = 2015$

 \because roots are prime and sum of roots is odd

$$\Rightarrow$$
 one root is 2

Let
$$\alpha = 2, \beta = 2013$$

$$\therefore \mathbf{K} = \alpha\beta = 2 \times 2013 = 4026$$

40. (c)

Let the number of sides in the polygon is n then

$$(2n-4)90^\circ = \frac{n}{2} \{159^\circ + 177^\circ\}$$
$$\Rightarrow 180n - 360 = n \ 168$$
$$\Rightarrow 12n = 360^\circ \Rightarrow n = 30$$



41. (c)

A

 $f = \cos x (\sin x + \cos x)$ $= \sin x \cos x + \cos^2 x$

$$= \frac{\sin 2x}{2} + \frac{1 + \cos 2x}{2}$$
$$= \frac{1}{2} + \frac{1}{2} (\sin 2x + \cos 2x)$$
$$f_{max} = \frac{1}{2} + \frac{1}{2} \times \sqrt{2}$$
$$= \frac{\sqrt{2} + 1}{2}$$

42. (d)

$$\tan(100^{\circ} + 125^{\circ}) = \frac{\tan 100^{\circ} + \tan 125^{\circ}}{1 - \tan 100^{\circ} \tan 125^{\circ}}$$
$$\Rightarrow 1 = \frac{\tan 100^{\circ} + \tan 125^{\circ}}{1 - \tan 100^{\circ} \tan 125^{\circ}} \begin{cases} \tan(100^{\circ} + 125^{\circ}) \\ = \tan(225^{\circ}) \\ = \tan(180^{\circ} + 45^{\circ}) \\ = \tan 45^{\circ} = 1 \end{cases}$$

$$\Rightarrow 1 - \tan 100^{\circ} \tan 125^{\circ} = \tan 100^{\circ} + \tan 125^{\circ}$$
$$\Rightarrow \tan 100^{\circ} + \tan 125^{\circ} + \tan 100^{\circ} \tan 125^{\circ} = 1$$

43. (d)

 $\sin x + \cos x = 1$

$$\Rightarrow \cos x \cdot \frac{1}{\sqrt{2}} + \sin x \cdot \frac{1}{\sqrt{2}} = \frac{1}{\sqrt{2}}$$
$$\Rightarrow \sin\left(x + \frac{\pi}{4}\right) = \sin\frac{\pi}{4}$$
$$\Rightarrow x + \frac{\pi}{4} = n\pi + (-1)^n \frac{\pi}{4} \Rightarrow x = n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}$$

44. (b)

$$\tan 2x = \tan 6x$$

$$\Rightarrow 6x = n\pi + 2x \Rightarrow 4x = n\pi \Rightarrow x = \frac{n\pi}{4}$$

Now $0 < \frac{n\pi}{4} < 3\pi \Rightarrow 0 < n\pi < 12\pi \Rightarrow 0 < n < 12$

$$\Rightarrow n = 1, 2, ..., 11$$

also $2x \neq (2p+1)\frac{\pi}{2} * 6x \neq (2q+1)\frac{\pi}{2}$

$$\Rightarrow 2.\frac{n\pi}{4} \neq (2p+1)\frac{\pi}{2} & 6.\frac{n\pi}{4} + (2q+1)\frac{\pi}{2}$$

$$\Rightarrow n \neq (2p+1) & n \neq \frac{2q+1}{3}$$

$$\Rightarrow n \neq 1, 3, 5, 7, 9, 11$$

$$\Rightarrow n = 2, 4, 6, 8, 10$$



45. (a)

$$f(-1)+f(2)+f(4)$$

 $=3\times(-1)+2^2+2\times 4$
 $=-3+4+8=9$

46. (d)

$$S_n = an^2 + \frac{n}{4}(n-1)d$$

$$S_1 = T_1 = a$$

$$S_2 = a \times 4 + \frac{2}{4} \cdot (1) \cdot d = 4a + \frac{d}{2}$$

$$\Rightarrow T_2 = 4a + \frac{d}{2} - a = 3a + \frac{d}{2}$$

 \therefore Common difference = $T_2 - T_1$

$$=2a+\frac{d}{2}$$

47. (a)

$$2f(x) - 3f\left(\frac{1}{x}\right) = x^{2}$$

$$2f\left(\frac{1}{x}\right) - 3f(x) = \frac{1}{x^{2}}$$

$$\Rightarrow 4f(x) - 6f\left(\frac{1}{x}\right) = 2x^{2}$$

$$= 6f\left(\frac{1}{x}\right) - 9f(x) = \frac{3}{x^{2}}$$

$$-5f(x) = 2x^{2} + \frac{3}{x^{2}}$$

$$\Rightarrow f(x) = -\frac{1}{5}\left(2x^{2} + \frac{3}{x^{2}}\right)$$

$$\Rightarrow f(2) = -\frac{1}{5}\left(8 + \frac{3}{4}\right) = -\frac{1}{5}\left(\frac{35}{4}\right)$$

$$\Rightarrow f(2) = -\frac{7}{4}$$

48. (c)

$$\frac{e^{-x} + e^{x}}{2} \ge \sqrt{e^{-x} \cdot e^{x}}$$
$$\Rightarrow \frac{f(x)}{2} \ge 2 \Rightarrow f(x) \ge 2$$



49. (c)

$$1^{2} + 3^{2} + 5^{2} + \dots + 25^{2} ==$$

$$= (1^{2} + 2^{2} + 3^{2} + \dots + 24^{2} + 25^{2}) - (2^{2} + 4^{2} + 6^{2} + \dots + 24^{2})$$

$$= (1^{2} + 2^{2} + \dots + 25^{2}) - 4(1^{2} + 2^{2} + 3^{2} + \dots + 12^{2})$$

$$= \frac{25 \cdot 26 \cdot 51}{6} - 4 \cdot \frac{12 \cdot 13 \cdot 25}{6}$$

$$= 5525 - 2600 = 2925$$
50. (a)

$$\alpha + \beta = \frac{b}{a}, \alpha\beta = -\frac{c}{a}$$

$$\alpha^{2} - \alpha\beta + \beta^{2} = (\alpha + \beta)^{2} - 3\alpha\beta$$

$$= \frac{b^{2}}{a^{2}} + \frac{3c}{a}$$

A

 $=\frac{b^2+3ac}{a^2}$