## PAPER WITH SOLUTION

**PART - 1**
**One- Mark Question**
**MATHEMATICS**

**1.** Let ABC be an equilateral triangle with side length a. Let R and r denote the radii of the circumcircle and the incircle of triangle ABC respectively. Then, as a function of a, the ratio $\frac{R}{r}$

(A) strictly increases
(B) strictly decreases
(C) remains constant
(D) strictly increases for a < 1 and strictly decreases for a > 1

**Ans. (C)**

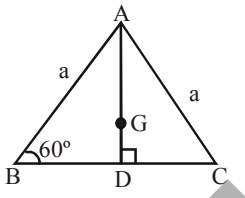
**Sol.** In equilateral triangle centroid(G) and circumcentre are coincide

r = 2

r = GD, R = AG

AG : GD = 2 : 1

$\frac{R}{r} = 2$




**2.** Let b be a non-zero real number. Suppose the quadratic equation $2x^2 + bx + \frac{1}{b} = 0$ has two distinct real roots. Then

(A) $b + \frac{1}{b} > \frac{5}{2}$ (B) $b + \frac{1}{b} < \frac{5}{2}$

(C) $b^2 - 3b > -2$ (D) $b^2 + \frac{1}{b^2} < 4$

**Ans. (C)**

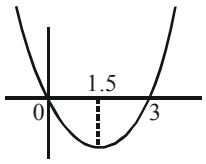
**Sol.** D > 0

$$\Rightarrow b^2 - 4\times 2\times\frac{1}{b} > 0 \Rightarrow \frac{b^3-8}{b} > 0$$

$$\Rightarrow b \in (-\infty, 0)\cup(2,\infty)$$

clearly options A and B are wrong

Let $f(b) = b^2 - 3b$




range of $f(b)$ when $b \in (-\infty,0) \cup (2,\infty)$
$= (f(2), \infty) = (-2,\infty)$
$\Rightarrow b^2 - 3b > -2$ is correct

Also D is wrong as $b^2 + \frac{1}{b^2} \in (0,\infty)$

**3.** Let $p(x) = x^2 + ax + b$ have two distinct real roots, where a, b are real numbers. Define $g(x) = p(x^3)$ for all real numbers x. Then which of the following statements are true ?

I. g has exactly two distinct real roots

II. g can have more than two distinct real roots

III. There exists a real number $\alpha$ such that $g(x) \geq \alpha$ for all real x

(A) Only I (B) Only I and III
(C) Only II (D) Only II and III

**Ans. (B)**

**Sol.** $P(x) = (x - \alpha)(x - \beta)$

$g(x) = (x^3 - \alpha)(x^3 - \beta)$

Let $\alpha = a_1^3$ $\beta = b_1^3$

$g(x) = (x^3 - a_1^3)(x^3 - b_1^3)$

$g(x) = (x - a_1)(x - b_1)\underbrace{(x^2 + a_1x + a_1^2)}_{D<0}\underbrace{(x^2 + b_1x + b_1^2)}_{D<0}$

for exactly two values of x, g(x) = 0

$\because g(x) = x^6 + ax^3 + b$

even degree polynomial so $g(x) \geq \alpha \ \forall \ x \in R$

**4.** Let $a_n$, $n \geq 1$, be an arithmetic progression with first term 2 and common difference 4. Let $M_n$ be the average of the first n terms. Then the sum $\sum_{n=1}^{10} M_n$ is

(A) 110 (B) 335
(C) 770 (D) 1100

**Ans. (A)**

**Sol.** $a_1 = 2$ $d = 4$

$$M_n = \frac{\frac{n}{2}\left[2a_1 + (n-1)d\right]}{n} = 2n$$

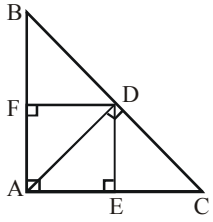
$$\sum_{n=1}^{10} M_n = 2\sum_{n=1}^{10} n = 110$$

**5.** In a triangle ABC, $\angle BAC = 90°$; AD is the altitude from A on to BC. Draw DE perpendicular to AC and DF perpendicular to AB. Suppose AB = 15 and BC = 25. Then the length of EF is

(A) 12 (B) 10
(C) $5\sqrt{3}$ (D) $5\sqrt{5}$

**Ans. (A)**

**Sol.**




AB = 15  BC = 25

$AC = \sqrt{BC^2 - AB^2} = 20$

$\text{Area} = \frac{1}{2}BC.AD = \frac{1}{2}AB.AC \Rightarrow AD = 12$

$\because$ AEDF is Rectangle then AD = EF = 12

**6.** The sides a, b, c of a triangle satisfy the relations $c^2 = 2ab$ and $a^2 + c^2 = 3b^2$. Then the measure of $\angle BAC$, in degrees, is

(A) 30  (B) 45

(C) 60  (D) 90

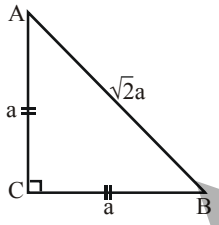
**Ans. (B)**

**Sol.** $c^2 = 2ab$ ...(i)

$a^2 + c^2 = 3b^2$ ...(ii)

$(a + b)^2 = 4b^2$

$\Rightarrow a = b,\ c = \sqrt{2}a$




$\angle A = 45° = \angle B$

$\angle C = 90°$

**7.** Let N be the least positive integer such that whenever a non-zero digit c is written after the last digit of N, the resulting number is divisible by c. The sum of the digits of N is

(A) 9  (B) 18

(C) 27  (D) 36

**Ans. (A)**

**Sol.** Sum of digits of N should be divisible by 9. In this case, the resulting number will always be divisible if c = 1,2,3,5,6 and 9.

To make the resulting number divisible by 4,7 and 8 as well N should be a multiple of LCM of (4,7,8) i.e. 56.

Smallest +ve integer which is multiple of 56 and whose sum of digits is a multiple of 9 is 504.

$\therefore$ N will be 504.

$\therefore$ Sum of digits = 9.

**8.** Let $x_1, x_2, \ldots\ldots, x_{11}$ be 11 distinct positive integers. If we replace the largest of these integers by the median of the other 10 integers, then

(A) The median remains the same

(B) The mean increases

(C) The median decreases

(D) The mean remains the same

**Ans. (C)**

**Sol.** $x_1,x_2,x_3,x_4,x_5,x_6,x_7,x_8,x_9,x_{10},x_{11}$

Median is $x_6$

now replace $x_{11}$ by $\frac{x_5 + x_6}{2}$

so $x_1,x_2,x_3,x_4,x_5,\frac{x_5 + x_6}{2},x_6,x_7,x_8,x_9,x_{10}$

now median is $\frac{x_5 + x_6}{2}$

**9.** The number of cubic polynomials P(x) satisfying P(1) = 2, P(2) = 4, P(3) = 6, P(4) = 8 is

(A) 0

(B) 1

(C) more than one but finitely many

(D) infinitely many

**Ans. (A)**

**Sol.** Let $P(x) - 2x = a(x - \alpha)(x - \beta)(x - \gamma)$

where $\alpha,\beta,\gamma \in \{1,2,3,4\}$ and $\alpha,\beta,\gamma$ are distinct then for any combination of

$\alpha,\beta,\gamma$, a = 0 so P(x) = 2x

$\Rightarrow$ no cubic polynomial possible.

**10.** A two-digit number $\overline{ab}$ is called almost prime if one obtains a two-digit prime number by changing at most one of its digits a and b. (For example, 18 is an almost prime number because 13 is a prime number). Then the number of almost prime two-digit numbers is

(A) 56  (B) 75

(C) 87  (D) 90

**Ans. (D)**

**Sol.** Total numbers of two digit number = 90

In each row from 11 to 19,

20 to 29, 30 to 39,....90 to 99

has atleast one prime number so each number can be reduce in to prime number by changing atmost one digit

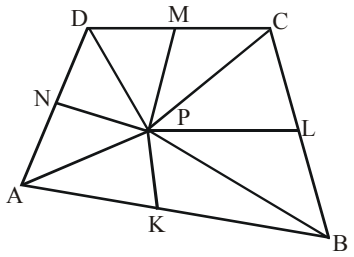
**11.** Let P be an interior point of a convex quadrilateral ABCD and K, L, M, N be the midpoints of AB, BC, CD, DA respectively. If Area(PKAN) = 25, Area(PLBK) = 36, and Area(PMDN) = 41, then Area(PLCM) is

(A) 20 (B) 29

(C) 52 (D) 54

**Ans. (C)**

**Sol.**




$\Delta_1$ = Area of $\Delta PAK$ = area of $\Delta PBK$ [$\because$ AK = BK]

similarly $Ar\Delta PBL = Ar\Delta PCL = \Delta_2$

$Ar\Delta PMC = Ar\Delta PMD = \Delta_3$

$Ar\Delta PMN = Ar\Delta PNA = \Delta_4$

Given $\Delta_1 + \Delta_4 = 25$ ...(i)

$\Delta_1 + \Delta_2 = 36$ ...(ii)

$\Delta_4 + \Delta_3 = 41$ ...(iii)

(ii) + (iii) – (i) $\Rightarrow \Delta_2 + \Delta_3 = 52$ = area PLCM

**12.** The number of non-negative integer solutions of the equations 6x + 4y + z = 200 and x + y + z = 100 is

(A) 3 (B) 5

(C) 7 (D) Infinite

**Ans. (C)**

**Sol.** x + y + z = 100 and 6x + 4y + z = 200

$\Rightarrow$ 5x + 3y = 100 ...(iii)

No. of ordered pair (x,y) satisfying (iii) are (2,30),(5,25), (8,20), (11,15) (14,10), (17,5), (20,0)

$\therefore$ (x,y,z) $\in$ {(2,30,68), (5,25,70), (80,20,72) (11,15,74), (14,10,76), (17,5,78)(20,20,80)}

$\therefore$ No. of non negative integral soluiton = 7

**13.** Let $N_1 = 2^{55} + 1$ and $N_2 = 165$. Then

(A) $N_1$ and $N_2$ are coprime

(B) The HCF (Highest Common Factor) of $N_1$ and $N_2$ is 55

(C) The HCF of $N_1$ and $N_2$ is 11

(D) The HCF of $N_1$ and $N_2$ is 33

**Ans. (D)**

**Sol.** $N_1 = 2^{55} + 1$, $N_2 = 165 = 5 \times 3 \times 11$

$$N_1 = \left(2^5\right)^{11} + 1 = (32)^{11} + 1 = (33-1)^{11} + 1$$

$$= {}^{11}C_0 (33)^{11} - {}^{11}C_1 (33)^{32} + ... + {}^{11}C_{10} 33$$

$\Rightarrow N_1$ is divisible by 33

Also $\because$ Units digit of $N_1$ is 9 $\Rightarrow N_1$ is not divisible by 5.

$\therefore$ HCF of $N_1$ and $N_2$ = 33

**14.** Let $l > 0$ be a real number, C denote a circle with circumference $l$, and T denote a triangle with perimeter $l$. Then

(A) given any positive real number $\alpha$, we can choose C and T as above such that the ratio $\frac{\text{Area}(C)}{\text{Area}(T)}$ is greater than $\alpha$.

(B) given any positive real number $\alpha$, we can choose C and T as above such that the ratio $\frac{\text{Area}(C)}{\text{Area}(T)}$ is less than $\alpha$.

(C) given any C and T as above, the ratio $\frac{\text{Area}(C)}{\text{Area}(T)}$ is independent of C and T

(D) there exist real numbers a and b such that for any circle C and triangle T as above, we must have $a < \frac{\text{Area}(C)}{\text{Area}(T)} < b$.

**Ans. (A)**

**Sol.** Let radius of circle = r and sides of $\Delta$ be a,b,c

$$2\pi r = \ell = a + b + c \Rightarrow r = \frac{\ell}{2\pi}$$

$$\therefore \text{ Area of circle } = \pi r^2 = \frac{\ell^2}{4\pi}$$

$$\text{area of } \Delta = \sqrt{s(s-a)(s-b)(s-c)}.$$

Where $2s = a + b + c = \ell$.

$\because$

$$\frac{(s-a)+(s-b)+(s-c)}{3} \geq \left((s-a)(s-b)(s-c)\right)^{\frac{1}{3}}$$

$$\Rightarrow (s-a)(s-b)(s-c) \leq \left(\frac{s}{3}\right)^3$$

$$\Rightarrow \sqrt{s(s-a)(s-b)(s-c)} \le \frac{s^2}{3\sqrt{3}} = \frac{\ell^2}{12\sqrt{3}}$$

$$\therefore \frac{\text{Area of (c)}}{\text{Area (T)}} \ge \frac{\frac{\ell^2}{4\pi}}{\frac{\ell^2}{12\sqrt{3}}}$$

$$\Rightarrow \frac{\text{Area of (c)}}{\text{Area (T)}} \ge \frac{3\sqrt{3}}{\pi}$$

Hence for given +ve real number $\alpha$ we can choose c and T. such that the ratio of greater than $\alpha$.

**15.** The number of three digit numbers $\overline{abc}$ such that the arithmetic mean of b and c and the square of their geometric mean are equal is

(A) 9 (B) 18

(C) 36 (D) 54

**Ans. (B)**

**Sol.** $\frac{b+c}{2} = bc \Rightarrow \left(b-\frac{1}{2}\right)\left(c-\frac{1}{2}\right) = \frac{1}{4}$

$\Rightarrow (2b-1)(2c-1) = 1$

$\Rightarrow 2b - 1 = 1$ and $2c - 1 = 1$ or $2b - 1 = -1$ and $2c - 1 = -1$.

$\Rightarrow b = 1$ and $c = 1$ or $b = 0$ and $c = 0$

$\therefore$ Nos. can be of form a11 or a00

where a = 1,2,3....,9

$\therefore$ No. of Nos. = 18

## PHYSICS

**16.** Various optical processes are involved in the formation of a rainbow. Which of the following provides the correct order in time in which these processes occur ?

(A) Refraction, total internal reflection, refraction

(B) Total internal reflection, refraction, total internal reflection

(C) Total internal reflection, refraction, refraction

(D) Refraction, total internal reflection, total internal reflection.

**Ans. (A)**

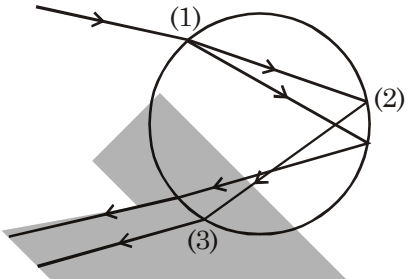
**Sol.** Rainbow is formed due to total internal reflection of incident light by liquid drops.

Hence the process is :

(1) Refraction of incident ray.

(2) TIR

(3) Again refraction when rays come out of liquid drops




**17.** A specially designed Vernier calliper has the main scale least count of 1 mm. On the Vernier scale there are 10 equal divisions and they match with 11 main scale divisions. Then, the least count of the Vernier calliper is

(A) 0.1 mm (B) 0.909 mm

(C) 1.1 mm (D) 0.09 mm

**Ans. (A)**

**Sol.** In this special case, the least count of vernier callipers is :

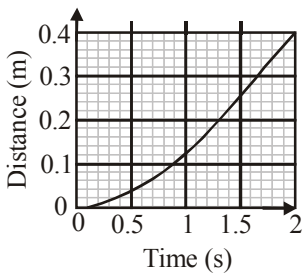
L.C. = 1 VSD – 1 MSD

Here 1 VSD = 1.1 mm

1 MSD = 1mm

$\therefore$ LC = 1.1 mm – 1mm = 0.1 mm

**18.** A steel ball is dropped in a viscous liquid. The distance of the steel ball from the top of the liquid is shown below. The terminal velocity of the ball is closest to :




(A) 0.26 m/s (B) 0.33 m/s

(C) 0.45 m/s (D) 0.21 m/s

**Ans. (B)**

**Sol.** If we calculate the slope of given distance time graph between 0.3m and 0.4 m then slope has approx constant value, as the steel ball acquires constant terminal speed in liquid some time after falling into it.

Hence terminal speed = $\left(\frac{0.4-0.3}{0.3}\right)$m/sec =

$\frac{1}{3}$ = 0.33 m/sec

**19.** A student in a town in India, where the price per unit (1 unit = 1 kW-hr) of electricity is Rs.5.00, purchases a 1 kVA UPS (uninterrupted power supply) battery. A day before the exam, 10 friends arrive to the student's home with their laptops and all connect their laptops to the UPS. Assume that each laptop has a constant power requirement of 90 W. Consider the following statements

I. All the 10 laptops can be powered by the UPS if connected directly.

II. All the 10 laptops can be powered if connected using an extension box with a 3A fuse.

III. If all the 10 friends use the laptop for 5 hours, then the cost of the consumed electricity is about Rs. 22.50.

Select the correct option with the true statements.

(A) I only (B) I and II only

(C) I and III only (D) II and III only

**Ans. (C)**

**Sol.** (1) Power provided by the battery is 1kVA i.e. 1000 V.A = 1000W

Now since all the laptops connected directly have a total power requirement of

90 × 10 = 900W, So battery (UPS) can provide power to all laptops.

(2) If all laptops are used for 5 hours, then cost of consumed electricity is

$\Rightarrow \frac{900\times5\times3600}{3.6\times10^6}\times5$ Rs = 22.5 Rs

So, answer is (C)

**20.** Frosted glass is widely used for translucent windows. The region where a transparent adhesive tape is stuck over the frosted glass becomes transparent. The most reasonable explanation for this is

(A) diffusion of adhesive glue into glass

(B) chemical reaction at adhesive tape-glass interface

(C) refractive index of adhesive glue is close to that of glass

(D) adhesive tape is more transparent than glass

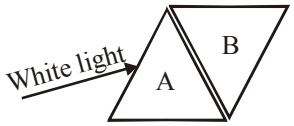
**Ans. (C)**

**Sol.** Frosted glass has different refractive index on its surface as frosted glass is produced by coating on the surface.

Now, as a transparent adhesive tape is stuck on the glass surface, the refractive index of the upper coating is adjusted to be same as that of glass, so it becomes transparent now.

So, answer is (C)

**21.** Consider two equivalent, triangular hollow prisms A and B made of thin glass plates and arranged with negligible spacing as shown in the figure. A beam of white light is incident on prism A from the left. Given that the refractive index of water is inversely related to temperature, the beam to the right of prism B would NOT appear white if




(A) both prisms are filled with hot water (70ºC)

(B) both prisms are filled with cold water (7ºC)

(C) both prisms are empty

(D) prism A is filled with hot water (70ºC) and prism B with cold water (7ºC)

**Ans. (D)**

**Sol.** White light will appear as white light if refractive index of both prism parts are same, since the effects of dispersion are cancelled out. Since R.I. of both parts will not be same when parts are filled with water at different temperatures, hence white light will not come out as white light.

So, answer is (D)

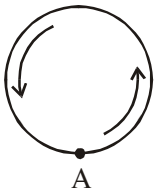
**22.** A ball is moving uniformly in a circular path of radius 1m with a time period of 1.5s. If the ball is suddenly stopped at t = 8.3 s, the magnitude of the displacement of the ball with respect to its position at t = 0 s is closest to

(A) 1 m (B) 33 m

(C) 3 m (D) 2 m

**Ans. (D)**

**Sol.** $\frac{2\pi}{\omega}=1.5 \Rightarrow \omega=\frac{2\pi}{1.5}$ rad/sec




Since time period is 1.5 sec, So ball takes 5 full circles in 7.5 seconds.

Now, since total time is 8.3 seconds so final remaining time is 8.3 –7.5 = 0.8 seconds

$$\Delta\theta=\omega\Delta t=\frac{2\pi}{1.5}\times 0.8$$

$=\frac{16\pi}{15}$ rad. = angle moved in last 0.8 sec

$\Delta\theta \approx \pi$, So displacement $\approx 2R = 2m$

So, answer is (D)

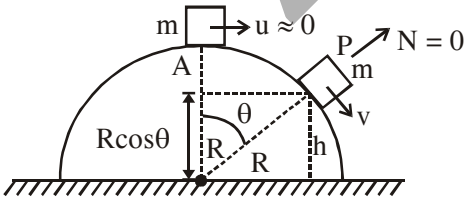
**23.** A particle slides from the top of a smooth hemispherical surface of radius R which is fixed on a horizontal surface. If it separates from the hemisphere at a height h from the horizontal surface then the speed of the particle is

(A) $\sqrt{(2g(R-h))}$ (B) $\sqrt{(2g(R+h))}$

(C) $\sqrt{2gR}$ (D) $\sqrt{2gh}$

**Ans. (A)**

**Sol.**




Block leaves contact at point P.

By W.E. theorem (A to P)

$$mg(R-h)=\frac{1}{2}mv^2$$

$$\therefore \quad v=\sqrt{2g(R-h)}$$

So, answer is (A)

**24.** The nuclear radius is given by $R = r_0A^{1/3}$, where $r_0$ is constant and A is the atomic mass number. Then,

(A) The nuclear mass density of $U^{238}$ is twice that of $Sn^{119}$

(B) The nuclear mass density of $U^{238}$ is thrice that of $Sn^{119}$

(C) The nuclear mass density of $U^{238}$ is the same as that of $Sn^{119}$

(D) The nuclear mass density of $U^{238}$ is half that of $Sn^{119}$

**Ans. (C)**

**Sol.** Since the mass density of all nuclei comes out to be constant,

So answer is (C)

Density of nucleus (approx)

$$=\frac{M}{V}=\frac{Am_p}{\frac{4}{3}\pi R^3}=\frac{Am_P}{\frac{4}{3}\pi r_0^3 A}$$

$=\frac{3m_P}{4\pi r_0^3}$ = constant (independent of mass no. A)

**25.** The electrostatic energy of a nucleus of charge Ze is equal to $kZ^2e^2/R$, where k is a constant and R is the nuclear radius. The nucleus divides into two daughter nuclei of charges Ze/2 and equal radii. The change in electrostatic energy in the process when they are far apart is

(A) $0.375kZ^2e^2/R$ (B) $0.125kZ^2e^2/R$

(C) $kZ^2e^2/R$ (D) $0.5kZ^2e^2/R$

**Ans. (A)**

**Sol.** Electrostatic energy of nucleus = $E_i=\frac{kZ^2e^2}{R}$

initially.

Now it breaks into two nuclei with radii $R_0$ each where by volume conservation.

$$\frac{4}{3}\pi R^3=2\times\frac{4}{3}\pi R_0^3 \qquad \text{i.e. } R_0=\frac{R}{(2)^{1/3}}$$

Both nuclei separate to large distance,

So total energy now as

$$E_f=\frac{2\times K\left(\frac{Ze}{2}\right)^2}{R_0}=\frac{2kZ^2e^2}{4R}2^{1/3}$$

$$= \frac{kZ^2e^2}{R} \times \frac{1}{2^{2/3}} \approx 0.63\frac{kZ^2e^2}{R}$$

Hence change in electrostatic energy

$$= E_i - E_f = \frac{kZ^2e^2}{R}[1 - 0.63] = 0.37\ \frac{kZ^2e^2}{R}$$

Hence, answer is (A)

**26.** Two masses $M_1$ and $M_2$ carry positive charges $Q_1$ and $Q_2$, respectively. They are dropped to the floor in a laboratory setup from the same height where there is a constant electric field vertically upwards. $M_1$ hits the floor before $M_2$. Then,

(A) $Q_1 > Q_2$ (B) $Q_1 < Q_2$

(C) $M_1Q_1 > M_2Q_2$ (D) $M_1Q_2 > M_2Q_1$

**Ans. (D)**

**Sol.** $M_1$ hits the floor before $M_2$ if $a_{M_1} > a_{M_2}$

ie. $$\frac{M_1g - Q_1E}{M_1} > \frac{M_2g - Q_2E}{M_2}$$

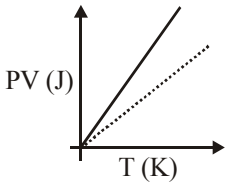
$$g - \frac{Q_1E}{M_1} > g - \frac{Q_2E}{M_2}$$

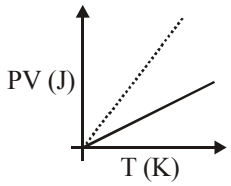
$$\frac{Q_2E}{M_2} > \frac{Q_1E}{M_1}$$

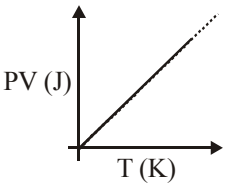
$M_1Q_2 > M_2Q_1$

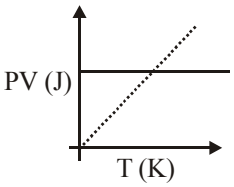
So, answer is (D)

**27.** Which one of the following schematic graphs best represents the variation of PV (in Joules) versus T (in Kelvin) of one mole of an ideal gas? (The dotted line represents PV = T).

(A)



(B)



(C)



(D)



**Ans. (A)**

For ideal gas PV = nRT

n = 1 PV = RT

Slope of PV Vs T graph is R

PV = 8.314 T

So with respect to PV = T

PV = 8.314 T is having more slope So answer (A) is correct.

**28.** Mumbai needs $1.4 \times 10^{12}$ litres of water annually. Its effective surface area is 600 $km^2$ and it receives an average rainfall of 2.4 m annually. If 10% of this rain water is conserved it will meet approximately

(A) 1% of Mumbai's water needs

(B) 10% of Mumbai's water needs

(C) 50% of Mumbai's water needs

(D) 100% of Mumbai's water needs

**Ans. (B)**

Volume of water received annually is

$$V = A \times h \times \frac{10}{100}$$

$A = 600\ km^2$

$= 600 \times 10^6\ m^2$

$h = 2.4\ m$

$$V = 600 \times 10^6 \times 2.4 \times \frac{10}{100}$$

$V = 1440 \times 10^5\ m^3$

$V = 1.4 \times 10^8\ m^3$

Needed water annually $= 1.4 \times 10^{12}$ litres

$= 1.4 \times 10^9\ m^3$

$$\%\ \text{of water received} = \frac{1.4 \times 10^8}{1.4 \times 10^9} \times 100 = 10\%$$

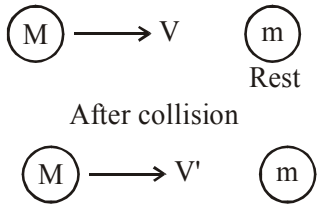
Correct answer is (B)

**29.** A mass M moving with a certain speed V collides elastically with another stationary mass m. After the collision the masses M and m move with speeds V' and v respectively. All motion is in one dimension. Then

(A) V = V' + v (B) V' = V + v

(C) V' = (V + v)/2 (D) v = V + V'

**Ans. (D)**




For elastic collision velocities after collision are given by

$$V_1 = \frac{(m_1 - m_2)}{(m_1 + m_2)}u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$$

$$V_2 = \frac{(m_2 - m_1)}{(m_1 + m_2)}u_2 + \left(\frac{2m_1}{m_1 + m_2}\right)u_1$$

Using this :

$u_1 = V$

$u_2 = 0$

$V_1 = V'$

$V_2 = v$

$m_1 = M$

$m_2 = m$

$$V' = \frac{(M - m)}{(M + m)}V \quad \text{.... (i)}$$

$$v = \frac{2M}{(M + m)}V \quad \text{... (ii)}$$

Subtracting (i) - (ii)

$$V' - v = \frac{\left[(M - m) - 2M\right]V}{(M + m)}$$

$$V' - v = \frac{-M - m}{M + m}V$$

$V' - v = -V$

$V' + V = v$

Correct answer (D)

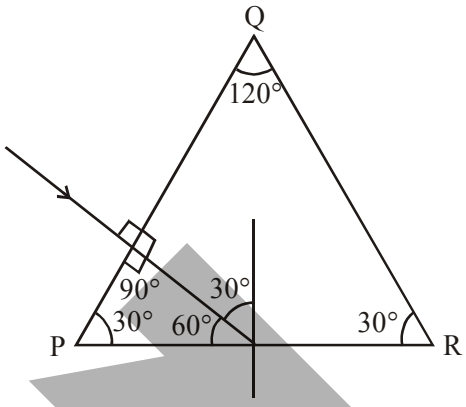
**30.** Four rays, 1, 2, 3 and 4 are incident normally on the face PQ of an isosceles prism PQR with apex angle $\angle Q = 120^\circ$. The refractive indices of the material of the prism for the above rays 1, 2, 3 and 4 are 1.85, 1.95, 2.05 and 2.15, respectively and the surrounding medium is air. Then the rays emerging from the face QR are

(A) 4 only (B) 1 and 2 only

(C) 3 and 4 only (D) 1, 2, 3 and 4

**Ans. (C)**

For apex angle 120° and normal incidence on PQ. For a ray to pass through QR it will get total internal reflection on PR. That means ray will not directly go to QR as shown in figure.




For all rays angle of incidence on PR is 30°. For TIR at PR

$$\sin^{-1}\left(\frac{1}{\mu}\right) < 30^\circ$$

$$\frac{1}{\mu} < \sin 30^\circ$$

$$\frac{1}{\mu} < \frac{1}{2}$$

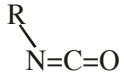
$\mu > 2$

So rays 3 and 4 will emerge out.

Correct answer (C)

## CHEMISTRY

**31.** The hybridizations of N, C and O shown in the following compound



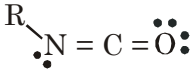

respectively, are

(A) $sp^2$, sp, $sp^2$ (B) $sp^2$, $sp^2$, $sp^2$

(C) $sp^2$, sp, sp (D) sp, sp, $sp^2$

**Ans.(A)**

**Sol.**




N→ $sp^2$ hybrid

C → sp hybrid

O → $sp^2$ hybrid

**32.** The following compounds

are

(A) geometrical isomers

(B) positional isomers

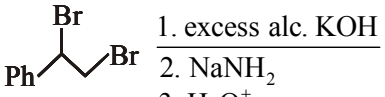
(C) optical isomers

(D) functional group isomers

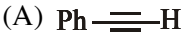
**Ans.(D)**

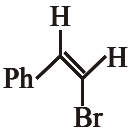
**Sol.** Alkyne and alkadienes are functional group isomers.

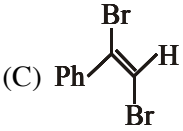
**33.** The major product of the following reaction

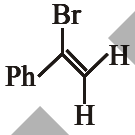



is

(A) 

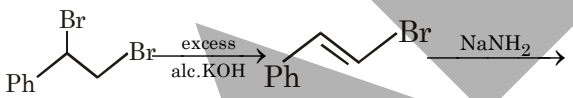
(B) 

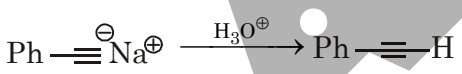
(C) 

(D) 

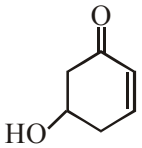
**Ans.(A)**

**Sol.**




**34.** IUPAC name of the following compound




is

(A) 1-hydroxycyclohex-4-en-3-one

(B) 1-hydroxycyclohex-3-en-5-one

(C) 3-hydroxycyclohex-5-en-1-one

(D) 5-hydroxycyclohex-2-en-1-one

**Ans.(D)**

**Sol.** IUPAC name is 5-hydroxycyclohex-2-en-1-one according to lowest locant set rule.

**35.** In water gas shift reaction, hydrogen gas is produced from the reaction of steam with

(A) methane

(B) coke

(C) carbon monoxide

(D) carbon dioxide

**Ans.(C)**

$$CO_{(g)} + H_2O_{(g)} \xrightarrow[\text{Catalyst}]{673K} CO_{2(g)} + H_{2(g)}$$

Above reaction is called water gas shift reaction, where steam is reacted with carbon monoxide.

**36.** Treatment with lime can remove hardness of water caused by

(A) $CaCl_2$ (B) $CaSO_4$

(C) $Ca(HCO_3)_2$ (D) $CaCO_3$

**Ans.(C)**

**Sol.** In Clark's method, lime is added to hard water. It precipitate bicarbonate of calcium and magnesium in form of insoluble calcium carbonate and magnesium hydroxide.

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$

$Mg(HCO_3)_2 + 2Ca(OH)_2 \longrightarrow 2CaCO_3\downarrow + Mg(OH)_2\downarrow + 2H_2O$

**37.** The most polarizable ion among the following is

(A) $F^-$ (B) $I^-$

(C) $Na^+$ (D) $Cl^-$

**Ans.(B)**

**Sol.** Larger the size of anion more is its polarisability (when the charge on anion is same)

order of polarisibility : $I^- > Cl^- > F^-$

**38.** For a multi-electron atom, the highest energy level among the following is

(A) n = 5, $l$ = 0, m = 0, s = +½

(B) n = 4, $l$ = 2, m = 0, s = +½

(C) n = 4, $l$ = 1, m = 0, s = +½

(D) n = 5, $l$ = 1, m = 0, s = +½

**Ans.(D)**

**Sol.** For multi electron system energy increase with increase in value of $(n+\ell)$.

If value of $(n+\ell)$ is same then higher is the value of 'n' higher is its energy.

**39.** The oxide which is neither acidic nor basic is

(A) $As_2O_3$ (B) $Sb_4O_{10}$

(C) $N_2O$ (D) $Na_2O$

**Ans.(C)**

**Sol.** $N_2O$ is a neutral oxide.

**40.** The element whose salts cannot be detected by flame test is

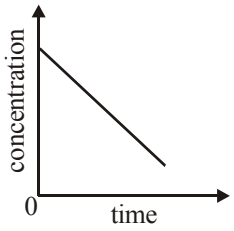
(A) Mg (B) Na

(C) Cu (D) Sr

**Ans.(A)**

**Sol.** Be and Mg cannot be detected by flame test due to high ionisation energy.

**41.** The plot of concentration of a reactant vs. time for a chemical reaction is shown below




The order of this reaction with respect to the reactant is

(A) 0

(B) 1

(C) 2

(D) not possible to determine from this plot

**Ans.(A)**

**Sol.** Rate of decrease in conc. od not change with time

$$-\frac{d[C]}{dt} = \text{constant}$$

$C_{A_t} = C_{A_0} - kt$

i.e. zero order reaction.

**42.** During the free expansion of an ideal gas in an isolated chamber,

(A) internal energy remains constant

(B) internal energy decreases

(C) work done on the system is negative

(D) temperature increases

**Ans.(A)**

**Sol.** $q = 0$

$P_{ext} = 0$ (for free expansion) $\Rightarrow$ work done is zero

$\therefore \Delta U = q + w = 0$

or internal energy remains constant.

**43.** The number of moles of water present in a spherical water droplet of radius 1.0 cm is

[Given : density of water in the droplet = 1.0 g $cm^{-3}$]

(A) $\frac{\pi}{18}$ (B) $\frac{2\pi}{27}$

(C) $24\pi$ (D) $\frac{2\pi}{9}$

**Ans.(B)**

**Sol.** Volume of water droplet

$$= \frac{4}{3}\pi(1)^3 cm^3$$

$d = 1\ g/\ cm^3$

$\therefore$ wt. of droplet $V \times d$

$$= 1 \times \frac{4}{3}\pi$$

$$= \frac{4}{3}\pi gram$$

$$\text{no. of mole} = \frac{4}{3}\frac{\pi}{18}$$

$$= \frac{2\pi}{27}$$

**44.** Among the following, the correct statement about cathode ray discharge tube is

(A) the electrical discharge can only be observed at high pressure and at low voltages

(B) in the absence of external electrical or magnetic field, cathode rays travel in straight lines

(C) the characteristics of cathode rays depend upon the material of electrodes

(D) the characteristics of cathode rays depend upon the gas present in the cathode ray tube

**Ans.(B)**

**Sol.** Cathode rays are stream of electrons and move undeflected in straight lines in absence of electrical and magnetic field.

**45.** For a spontaneous process

(A) enthalpy change of the system must be negative

(B) entropy change of the system must be positive

(C) entropy change of the surrounding must be positive

(D) entropy change of the system plus surrounding must be positive

**Ans.(D)**

**Sol.** By Second Law Thermodyanamics, for a spontaneous process total entropy change of the system and surrrounding must be positive.

## BIOLOGY

**46.** Which one of the following is a CORRECT statement about primate evolution ?

(A) Chimpanzees and gorillas evolved from macaques

(B) Humans and chimpanzees evolved from gorillas

(C) Humans, chimpanzees and gorillas evolved from a common ancestor

(D) Humans and gorillas evolved from chimpanzees

**Ans.(C)**

**47.** The crypts of Lieberkuhn are found in which one of the following parts of the human digestive tract ?

(A) Oesophagus (B) Small intestine

(C) Stomach (D) Rectum

**Ans.(B)**

**48.** Removal of the pancreas impairs the breakdown of

(A) lipids and carbohydrates only

(B) lipids and proteins only

(C) lipids, proteins and carbohydrates

(D) proteins and carbohydrates only

**Ans.(C)**

**49.** Microscopic examination of a blood smear reveals an abnormal increase in the number of granular cells with multiple nuclear lobes. Which one of the following cell types has increased in number ?

(A) Lymphocytes (B) Monocytes

(C) Neutrophils (D) Thrombocytes

**Ans.(C)**

**50.** Which one of the following genetic phenomena is represented by the blood group AB ?

(A) Codominance (B) Dominance

(C) Overdominance (D) Semidominance

**Ans.(A)**

**51.** The mode of speciation mediated by geographical isolation is referred to as

(A) adaptive radiation

(B) allopatric speciation

(C) parapatric speciation

(D) sympatric speciation

**Ans.(B)**

**52.** Which one of the following metabolic conversions requires oxygen ?

(A) Glucose to pyruvate

(B) Glucose to $CO_2$ and ethanol

(C) Glucose to lactate

(D) Glucose to $CO_2$ and $H_2O$

**Ans.(D)**

**53.** Where are the proximal and distal convoluted tubules located within the human body ?

(A) Adrenal cortex

(B) Adrenal medulla

(C) Renal cortex

(D) Renal medulla

**Ans.(C)**

**54.** In a diploid organism, when the locus X is inactivated, transcription of the locus Y is triggered. Based on this observation, which one the following statements is CORRECT ?

(A) X is dominant over Y

(B) X is epistatic to Y

(C) Y is dominant over X

(D) Y is epistatic to X

**Ans.(B)**

**55.** Which one of the following sequences represent the CORRECT taxonomical hierarchy ?

(A) Species, genus, family, order
(B) Order, genus, family, species
(C) Species, order, genus, family
(D) Species, genus, order, family

**Ans.(A)**

**56.** Which one of the following organs is NOT a site for the production of white blood cells ?

(A) Bone marrow (B) Kidney
(C) Liver (D) Spleen

**Ans.(B)**

**57.** Which one of the following anatomical structures is involved in guttation ?

(A) Cuticle (B) Hydathodes
(C) Lenticels (D) Stomata

**Ans.(B)**

**58.** Which one of the following parts of the eye is affected in cataract ?

(A) Cornea
(B) Conjunctiva
(C) Retina
(D) Lens

**Ans.(D)**

**59.** Which one of the following organisms is a bryophyte ?

(A) Liverwort (B) Volvox
(C) Chlamydomonas (D) Fern

**Ans.(A)**

**60.** During oogenesis in mammals, the second meiotic division occurs

(A) before fertilisation
(B) after implantation
(C) before ovulation
(D) after fertilisation

**Ans.(D)**

**PART - 2**

**Two- Mark Question**

## MATHEMATICS

**61.** Let a,b,c,d be distinct real number such that a,b are roots of $x^2 - 5cx - 6d = 0$, and c,d are roots of $x^2 - 5ax - 6b = 0$. then b + d is

(A) 180 (B) 162
(C) 144 (D) 126

**Ans. (C)**

**Sol.** $a + b = -5c$ ....(i)
$c + d = -5a$ ...(ii)
(i)- (ii) $\Rightarrow a - c + (b - d) = 5(a - c)$
$\Rightarrow 4(a - c) = (b - d)$
$a^2 - 5ac - 6d = 0$
$c^2 - 5ac - 6b = 0$
$(a + c)(a - c) - 6(d - b) = 0$

$$\Rightarrow (a + c) = \frac{6(d-b)}{a-c} = -24$$

Also (i) + (ii)
$(a + c) + (b + d) = -5(a + c)$
$\Rightarrow (b + d) = -6(a + c) = -6\times - 24 = 144$

**62.** Let S = {1,2,3, ..., 100}. Suppose b and c are chosen at random from the set S. The probability that $4x^2 + bx + c$ has equal roots is

(A) 0.001 (B) 0.004
(C) 0.007 (D) 0.01

**Ans. (A)**

**Sol.** For equal roots $b^2 - 16c = 0$.
$b^2 = 4 \times 4 \times c$
$\Rightarrow$ c has to be perfect square.
c = 1,4,9,16,25,36,49,64,81,100
$\therefore$ No. of ordred pair (b,c) will be 10

$$\text{Required probability} = \frac{10}{100\times100} = 0.001$$

**63.** Let $\mathbb{N}$ be the set of positive integers. For all $n \in \mathbb{N}$, let

and $$f_n = (n+1)^{1/3} - n^{1/3}$$

Then $$A = \left\{ n \in \mathbb{N} : f_{n+1} < \frac{1}{3(n+1)^{2/3}} < f_n \right\}$$

(A) A = $\mathbb{N}$ (B) A is a finite set
(C) the complement of A in $\mathbb{N}$ is nonempty, but finite
(D) A and its complement in $\mathbb{N}$ are both infinite

**Ans. (A)**

**Sol.** $f(n) = (n+1)^{1/3} - n^{1/3}$

$$f(n) = \frac{1}{(n+1)^{2/3} + (n)^{1/3}(n+1)^{2/3} + n^{2/3}}$$

clearly $\frac{1}{3(n+1)^{2/3}} < f(n) < \frac{1}{3n^{2/3}}$ ...(i)

$$\Rightarrow f(n+1) < \frac{1}{3(n+1)^{2/3}} \quad ...(ii)$$

$$\Rightarrow f(n+1) < \frac{1}{3(n+1)^{2/3}} < f(n) \forall n \in N$$

$\therefore A = \mathbb{N}$

**64.** A prime number p is called special if there exist primes $p_1$, $p_2$, $p_3$, $p_4$ such that

$$p = p_1 + p_2 = p_3 - p_4$$

The number of special primes is

(A) 0

(B) 1

(C) more than one but finite

(D) infinite

**Ans. (B)**

**Sol.** If non of $P_1, P_2, P_3, P_4$ is 2.
$\Rightarrow$ All $P_1, P_2, P_3, P_4$ are odd
$\Rightarrow P_1 + P_2$ and $P_3 - P_4$ are both odd and hence cannot be prime.
One of $P_1$ or $P_2$ (say $P_1$) and $P_4$ must be 2.
$\therefore P = 2 + P_2 = P_3 - 2$.
Above equation is satisfied only if .
$P = 5$, $P_2 = 3$ and $P_3 = 7$.

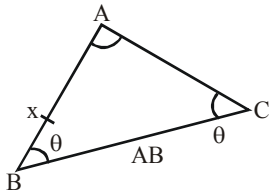
**65.** Let ABC be a triangle in which AB = BC. Let X be a point on AB such that AX : XB = AB : AX. If AC = AX, then the measure of $\angle ABC$ equals

(A) 18° (B) 36°

(C) 54° (D) 72°

**Ans. (B)**

**Sol.**




Given

$$\frac{AX}{XB} = \frac{AB}{AX} = \frac{1}{\lambda} \text{ (say)}$$

$\Rightarrow AX = \lambda AB$

$XB = \lambda AX = \lambda^2 AB$

$\therefore AB = AX + XB = \lambda AB + \lambda^2 AB$

$$\Rightarrow \lambda^2 + \lambda - 1 = 0 \Rightarrow \lambda = -\frac{1 \pm \sqrt{5}}{2}$$

$$\because \lambda > 0 \Rightarrow \lambda = \frac{\sqrt{5}-1}{2}$$

$$\cos\theta = \frac{(AB)^2 + (BC)^2 - (AC)^2}{2(AB)(BC)}$$

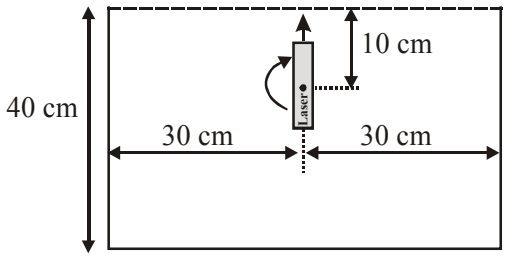
$$= \frac{2-\lambda^2}{2} \cdot \frac{\lambda+1}{2} \cdot = \frac{\frac{\sqrt{5}-1}{2}+1}{2}$$

$$= \frac{\sqrt{5}+1}{4}$$

$\theta = 36°$

## PHYSICS

**66.** A water-proof laser pointer of length 10 cm placed in a water tank rotates about a horizontal axis passing through its center of mass in a vertical plane as shown in the figure. The time period of rotation is 60 s. Assuming the water to be still and no reflections from the surface of the tank, the duration for which the light beam excapes the tank in one time period is close to (Refractive index of water = 1.33)

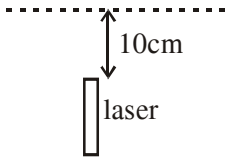



(A) 8.13 s (B) 14.05 s

(C) 16.27 s (D) 23.86 s

**Ans. (C)**

**Sol.**




Light will come out till the critical angle.

Critical angle

$\mu_1 \sin\theta_c = \mu_2 \sin 90°$

$\frac{4}{3}\sin\theta_c = 1 \times 1$.

$\therefore \sin\theta_c = 3/4.$

$\approx °50$

$2\pi \rightarrow 60$ secs

$\rightarrow \frac{60}{2\pi}$

$2\theta_c = \frac{60}{2\pi} \times 2 \times 50 \times \frac{\pi}{180} \approx 16.27$ secs

**67.** In an hour-glass approximately 100 grains of sand fall per second (starting from rest), and it takes 2 sec for each sand particle to reach the bottom of the hour-glass. If the average mass of each sand particle is 0.2 g then the average force exerted by the falling sand on the bottom of the hour-glass is close to

(A) 0.4 N (B) 0.8 N (C) 1.2 N (D) 1.6 N

**Ans. (A)**

**Sol.** $v = u + at$

$v = 0 + 10 \times 2$

$= 20$ m/s

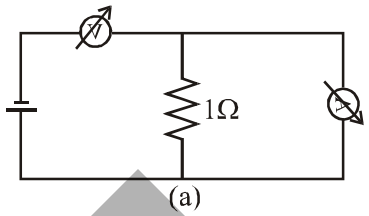
$\therefore P_i = (0.2 \times 10^{-3}) \times 20.$

$P_f = 0$

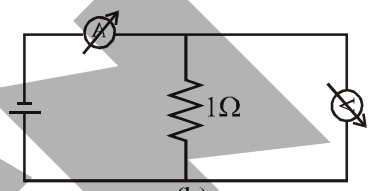
$\therefore |\Delta_P| = 4 \times 10^{-3}$ kg m/s.

$\therefore f = \frac{\Delta P}{\Delta t} \times n = 100 \times 4 \times 10^{-3} = 0.4N$

**68.** A student uses the resistance of a known resistor (1 Ω) to calibrate a voltmeter and an ammeter using the circuits shown below. The student measures the ratio of the voltage to current to be $1 \times 10^3$ Ω in circuit (a) and 0.999 Ω in circuit (b). From these measurements, the resistances (in Ω) of the voltmeter and ammeter are found to be close to:




(a)



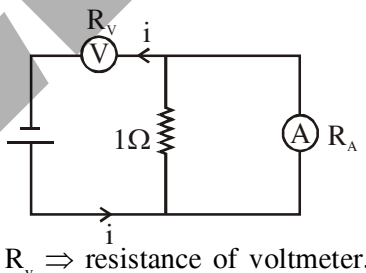

(b)

(A) $10^2$ and $10^{-2}$ (B) $10^3$ and $10^{-3}$

(C) $10^{-2}$ and $10^2$ (D) $10^{-3}$ and $10^3$

**Ans. (B)**

**Sol.** Case-1



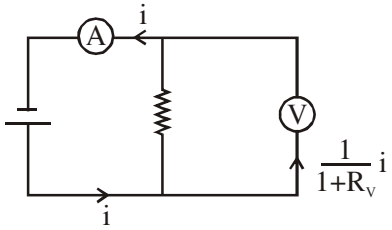

$R_v \Rightarrow$ resistance of voltmeter.

$R_A \Rightarrow$ resistance of ammeter.

$\frac{V}{A} = \frac{i(R_V)}{\frac{(i)}{1+R_A}} = R_V(1 + R_A)$

$(R_V)\ (1 + R_A) = 1000$ ....(i)

Case-2




$\frac{V}{A} = \frac{\left(\frac{i}{1+R_V}\right)R_V}{i} = \frac{R_V}{R_V+1} = 0.999$ ....(ii)

$R_V = 0.999 + 0.999\ R_V$

Resistance of voltmeter $R_V = 999\Omega$

**69.** A hot air balloon with a payload rises in the air. Assume that the ballon is spherical in shape with diameter of 11.7 m and the mass of the balloon and the payload (without the hot air inside) is 210 kg. Temperature and pressue of outside air are 27 °C and 1atm = $10^5$ N/m$^2$ respectively. Molar mass of dry air is 30 g. The temperature of the hot air inside is close to, [The gas constant R = 8.31 J/K/mol]

(A) 27 °C (B) 52 °C

(C) 105 °C (D) 171 °C

**Ans. (C)**

**Sol.** $210g + V\rho_{in}g = V\rho_0 g$

where

$\rho_{in}$ = density of air inside balloon

$\rho_0$ = density of air outside balloon

$V(\rho_0 - \rho_{in})g = 210g$

$$\rho_0 - \rho_{in} = \frac{210}{\left(\frac{4}{3}\pi r^3\right)}$$

$$\rho_0 - \rho_{in} = \frac{210\times 3}{4\pi r^3}$$

$$\frac{PM}{RT_0} - \frac{PT}{RT_{in}} = \frac{210\times 3}{4\pi r^3}$$

$$\frac{PM}{R}\left(\frac{1}{T_0} - \frac{1}{T_{in}}\right) = \frac{630}{4\pi\left(\frac{11.7}{2}\right)^3}$$

$$\frac{1}{T_0} - \frac{1}{T_{in}} = \frac{630\times 8}{4\pi\times(11.7)^3}\times\frac{8.31}{10^5\times 30\times 10^{-3}}$$

$$\frac{1}{T_{in}} = \frac{1}{T_0} - 0.0007$$

$$\frac{1}{T_{in}} = \frac{1}{300} - 0.0007$$

$$\frac{1}{T_{in}} = 0.0033 - 0.0007$$

$T_{in}$ = 380.22 K = 107.22 °C

Nearest Option is (C)

**70.** A healthy adult of height 1.7 m has an average blood pressure (BP) of 100 mm of Hg. The heart is typically at a height of 1.3 m from the foot. Take the density of blood to be $10^3$ kg/m$^3$ and note that 100 mm of Hg is equivalent to 13.3 kPa (kilo Pascals). The ratio of BP in the foot region to that in the head region is close to

(A) one (B) two

(C) three (D) four

**Ans. (C)**

**Sol.** Pressure at heart level = 100 mm of Hg = 13.3 kPa

$P_{foot} = P_{Heart} + \rho gh$

$= 13.3 + (1000)(10)1.3$

$P_{foot} = 26.3$

$P_{Head} = P_{Heart} - \rho gh$

$= 13.3 - 10^3(10)(0.4)$

$= 9.3$

$$\frac{P_{foot}}{P_{Heart}} = \frac{26.3}{9.3} \approx 3$$

## CHEMISTRY

**71.** $PbO_2$ is obtained from

(A) the reaction of PbO with HCl

(B) thermal decomposition of $Pb(NO_3)_2$ at 200 °C

(C) The reaction of $Pb_3O_4$ with $HNO_3$

(D) The reaction of Pb with air at room temperature

**Ans.(C)**

**Sol.** $Pb_3O_4 + 4HNO_3 \longrightarrow PbO_2\downarrow + 2Pb(NO_3)_2 + 2H_2O$

**72.** For one mole of van der Waals gas, the compressibility factor $Z\left(=\frac{PV}{RT}\right)$ at a fixed volume will certainly decrease if

[Given: "a", "b" are standard parameters for van der Waals gas]

(A) "b" increases and "a" decreases at constant temperature

(B) "b" decreases and "a" increases at constant temperature

(C) temperature increases at constant "a" and "b" values

(D) "b" increases at constant "a" and temperature

**Ans.(B)**

**Sol.** Higher the value of $\frac{a}{b}$, easier is the liquefaction and higher is the compressibility.

With increase in compressibility there is a decrease in value of Z.

Hence, with decrease is 'b' and increase in 'a' at constant temperature the value of compressibility factor, Z, decreases.

**73.** The correct statements among the following

i. $E_{2s}$ (H) > $E_{2s}$ (Li) > $E_{2s}$ (Na) > $E_{2s}$ (K)

ii. the maximum number of electrons in the shell with principal quantum number n is equal to $2n^2$

iii. Extra stability of half-filled subshell is due to smaller exchange energy

iv. Only two electrons, irrespective of their spin, may exist in the same orbital are

(A) i and ii (B) ii and iii

(C) iii and iv (D) i and iv

**Ans.(A)**

**Sol.** (i) Higher the value of Z lower is the value of $E_{2s}$

(ii) Maximum number of $e^{\ominus} = 2n^2$.

(iii) Extra stability of half-filled subshell is due to **higher** exchange energy.

(iv) Only two electrons with **opposite spin** can exist in the same orbital.

**74.** An organic compound contains 46.78% of a halogen X. When 2.00 g of this compound is heated with fuming $HNO_3$ in the presence of $AgNO_3$, 2.21 g AgX was formed. The halogen X is

[Given: atomic weight of Ag = 108, F = 19, Cl = 35.5, Br = 80, I = 127]

(A) F (B) Cl

(C) Br (D) I

**Ans.(C)**

**Sol.** Weigth halogen 'X' in organic compound,

$$W_X = 2 \times \frac{46.78}{100} = 0.9356\text{gm}$$

AgX ≡ X

108 + X ≡ X gram halogen .....(1)

2.21 g ≡ 0.9356 gm .....(2)

From (1) & (2)

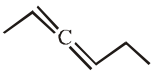
$$\frac{2.21}{108+X} = \frac{0.9356}{X}$$

On solving X = 79

⇒ X is Br.

**75.** An organic compound X with molecular formula $C_6H_{10}$, when treated with HBr, forms a gem dibromide. The compound X upon warming with $HgSO_4$ and dil. $H_2SO_4$, produces a ketone which gives a positive iodoform test. The compound X is

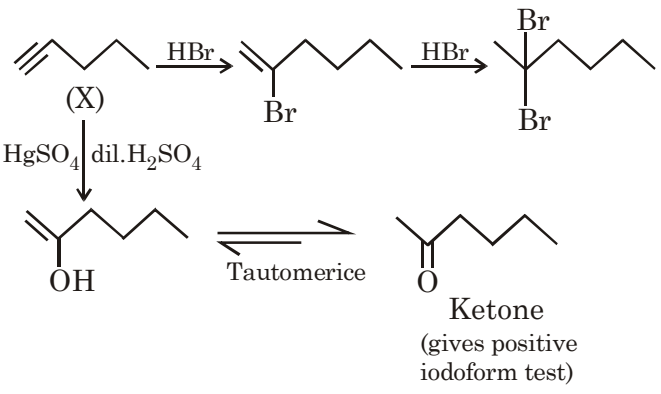
(A)  (B) 

(C)  (D) 

**Ans.(D)**

**Sol.** Treatment with HBr gives gem dibromide suggests that it is an alkyne.

Treatment with $HgSO_4$ and dil. $H_2SO_4$ produces a ketone which gives iodoform test suggests that the alkyne is terminal alkyne.



## BIOLOGY

**76.** A cell weighing 1 mg grows to double its initial mass before dividing into two daughter cells of equal mass. Assuming no death, at the end of 100 divisions what will be the ratio of the mass of the entire population of these cells to that of the mass of the Earth? Assume that mass of the Earth is $10^{24}$ kg and $2^{10}$ is approximately equal to 1000.

(A) $10^{-28}$ (B) $10^{-3}$

(C) 1 (D) $10^{3}$

**Ans.(C)**

**77.** Papaya is a dioecious species with XY sexual genotype for male and XX for female. What will be the genotype of the embryos and endosperm nuclei after double fertilization?

(A) 50% ovules would have XXX endosperm and XY embryo, while the other 50% would have XXY endosperm and XX embryo

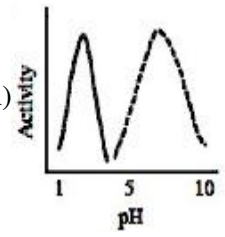
(B) 100% ovules would have XXX endosperm and XY embryo

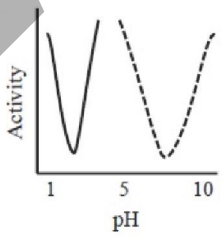
(C) 100% ovules would have XXY endosperm and XX embryo

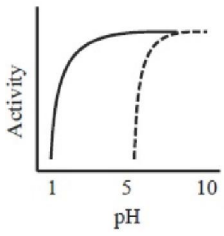
(D) 50% ovules would have XXX endosperm and XX embryo, while the other 50% would have XXY endosperm and XY embryo

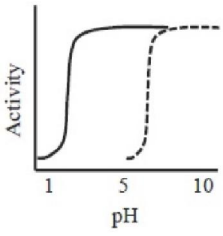
**Ans.(D)**

**78.** Solid and dotted lines represent the activities of pepsin and salivary amylase enzymes of the digestive tract, respectively. Which one of the following graphs best represents their activity vs pH ?

(A) 


(B) 


(C) 


(D) 


**Ans.(A)**

**79.** If the gene pool of the locus X in the human genome is 4, then what would be the highest possible number of genotypes in a large population?

(A) 6 (B) 8

(C) 10 (D) 16

**Ans.(C)**

**80.** Match the plant hormones in Column I with their primary function in Column II.

| Column I | Column II |
|---|---|
| P. Abscisic acid | i) Promotes disease resistance |
| Q. Ethylene | ii) Maintains seed dormancy |
| R. Cytokinin | iii) Promotes seed germination |
| S. Gibberellin | iv) Promotes fruit ripening |
| | v) Inhibits leaf senescence |

Choose the CORRECT combination

(A) P - iii, Q - iv, R - i, S - ii

(B) P - ii, Q - iv, R - v, S - iii

(C) P - v, Q - iii, R - ii, S - i

(D) P - iv, Q - ii, R - iii, S - v

**Ans.(B)**