MATHEMATICS

Sol. 1 (C)

$3^{1/3}$	$7^{1/7}$	1
0	0	10
3	0	7
6	0	4
9	0	1
3	7	0
0	7	3

$\therefore$ no. of terms are 6

Sol. 2 (B)

Given that $T_5 + T_6 = 0$

${}^nC_4\, a^{n-4} (-b)^4 + {}^nC_5\, a^{n-5} (-b)^5 = 0$

$\Rightarrow a^{n-5}b^4\, [{}^nC_4\, a - {}^nC_5 b] = 0$

$\Rightarrow {}^nC_4 a = {}^nC_5 b$ ($\because a \neq 0, b \neq 0$)

$$\Rightarrow \frac{a}{b} = \frac{{}^nC_5}{{}^nC_4} = \frac{n-4}{5}$$

Sol. 3 (D)

Origin lies left to the line. Points (2, 3/4) & (1/4, −1/4) lie in the smaller part & also in the circle so only two points.

Sol. 4 (A)

$$\frac{z_1}{r_1} = \frac{z}{r} = e^{i\pi}$$

$$\frac{z_1}{3r} = -\frac{-z}{r}$$

$z_1 = -3z = -3(4 - 3i)$

$z_1 = -12 + 9i$

Sol. 5 (A)

$\bar{z} z^3 + z \bar{z}^3 = 350$

$z\bar{z}(\bar{z}^2 + z^2) = 350$

Put $z = x + iy$

$(x^2 + y^2)(x^2 - y^2) = 175$

$(x^2 + y^2)(x^2 - y^2) = 5.5.7$

$x^2 + y^2 = 25$

$x^2 - y^2 = 7$

$x = \pm 4,\ y = \pm 3$

$x, y \in I$

Area = 8 × 6 = 48 sq. units

Sol. 6 (C)

common diff. = d, in A.P.

$T_7 = 9 \Rightarrow a + 6d = 9 \Rightarrow a = (9 - 6d)$

$T_1T_2T_7 = a \,.\, (a + d)\, 9 = (9 - 6d)(9 - 5d)\, 9$

$= 9\,(30d^2 - 99d + 81) = 27\,(10d^2 - 33d + 27)$

$$\text{Min value at } d = \frac{-(-33)}{2 \cdot 10} = \frac{33}{20}$$

Sol. 7 (B)

$x^2 - |x + 2| + x > 0$

Case - I $x \geqslant -2 \Rightarrow x^2 - x - 2 + x > 0$

$\Rightarrow x \in (-\infty, -\sqrt{2}) \cup (\sqrt{2}, \infty)$

$\therefore x \in [-2, -\sqrt{2}) \cup (\sqrt{2}, \infty)$

Case - II $x < -2$

$\Rightarrow x^2 + x + 2 + x > 0$

$\Rightarrow x^2 + 2x + 2 > 0$

$\Rightarrow x \in R$ ($\because D < 0$)

$\therefore x \in (-\infty, -2)$

$x \in$ (Case - I) $\cup$ (Case - II)

$\Rightarrow x \in (-\infty, -\sqrt{2}) \cup (\sqrt{2}, \infty)$

Ailter $|x + 2| < x^2 + x \Rightarrow -(x^2 + x) < x + 2 < x^2 + x$

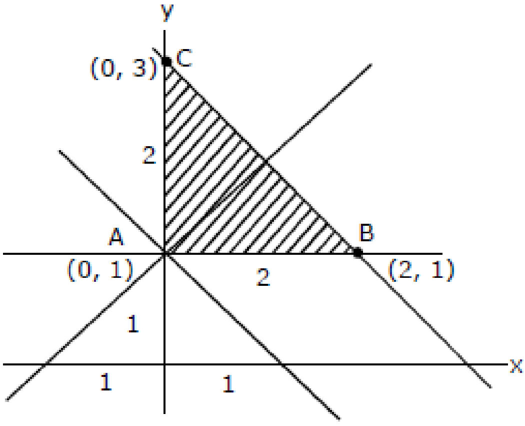
Sol. 8 (A)

$x^2 - y^2 + 2y - 1 = 0$

$x^2 (y - 1)^2 = 0$

$(x + y - 1)(x - y + 1) = 0$

$x + y = 1 \quad \& \; x - y + 1$



angle bisector are

$y = 1 \;\&\; x = 0$

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

area $\Delta ABC = \frac{1}{2}.\,2.\,2 = 2$ sq. units

Sol. 9 (B)

$$0 < \cos\phi = \frac{1}{3} < \frac{1}{2} \;\&\; \theta = \frac{\pi}{6}$$

$$\Rightarrow \cos\frac{\pi}{2} < \cos\phi < \cos\frac{\pi}{6}$$

$$\Rightarrow \frac{\pi}{2} > \phi > \frac{\pi}{3} \Rightarrow \frac{\pi}{3} < \phi < \frac{\pi}{2}$$

$$\Rightarrow \frac{\pi}{3} + \frac{\pi}{6} < \phi + \theta < \frac{\pi}{2} + \frac{\pi}{6} \Rightarrow \frac{\pi}{2} < \phi + \theta < \frac{2\pi}{3}$$

Sol. 10 (A)

Hyp. $xy - 3x - 2y = 0$

$f(x, y) = xy - 3x - 2y$

$\frac{\delta f}{\delta x} = 0 \Rightarrow y = 3$

$\frac{\delta f}{\delta y} = 0 \Rightarrow x = 2 \qquad$ Centre (2, 3)

Asy. $xy - 3x - 2y + C = 0$

will pass through (2, 3)

$C = 6$

$xy - 3x - 2y + 6 = 0$

$(y - 3)(x - 2) = 0$

$x - 2 = 0,\; y - 3 = 0$

Sol. 11 (A)

Given, $f(x) = \log_e\left(\frac{1-x}{1+x}\right), |x| < 1$, then

$$f\left(\frac{2x}{1+x^2}\right) = \log_e\left(\frac{1 - \frac{2x}{1+x^2}}{1 + \frac{2x}{1+x^2}}\right) \qquad \left[\because \left|\frac{2x}{1+x^2}\right| < 1\right]$$

$$= \log_e\left(\frac{\frac{1+x^2-2x}{1+x^2}}{\frac{1+x^2+2x}{1+x^2}}\right)$$

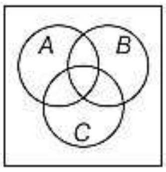
$$= \log_e\left(\frac{(1-x)^2}{(1+x)^2}\right) = \log_e\left(\frac{1-x}{1+x}\right)^2$$

$$= 2\log_e\left(\frac{1-x}{1+x}\right) \; [\because \log_e|A|^m = m\log_e|A|]$$

$$= 2f(x) \qquad \left[\because f(x) = \log_e\left(\frac{1-x}{1+x}\right)\right]$$

Sol. 12 ( )

Exp. (c)



Let A be the set of even numbered students

then $n(A) = \left[\frac{140}{2}\right] = 70$

([.] denotes greatest integer function)

Let B be the set of those students whose number is divisible by 3,

then $n(B) = \left[\frac{140}{3}\right] = 46$

([.] denotes greatest integer function)

Let C be the set of those students whose number is divisible by 5,

then $n(C) = \left[\frac{140}{5}\right] = 28$

([.] denotes greatest integer function)

Now, $n(A \cap B) = \left[\frac{140}{6}\right] = 23$

(numbers divisible by both 2 and 3)

$n(B \cap C) = \left[\frac{140}{15}\right] = 9$

(numbers divisible by both 3 and 5)

$n(C \cap A) = \left[\frac{140}{10}\right] = 14$

(numbers divisible by both 2 and 5)

$n(A \cap B \cap C) = \left[\frac{140}{30}\right] = 4$

(numbers divisible by 2, 3 and 5)

and $n(A \cup B \cup C)$

$= \Sigma n(A) - \Sigma n(A \cap B) + n(A \cap B \cap C)$

$= (70 + 46 + 28) - (23 + 9 + 14) + 4 = 102$

$\therefore$ Number of students who did not opt any of the three courses

$=$ Total students $- n(A \cup B \cup C) = 140 - 102 = 38$

Sol. 13 (C)

Given $f(x) = x^3 + 5x + 1$

Now, $f'(x) = 3x^2 + 5 > 0, \ \forall \ x \in R$

Thus, $f(x)$ is strictly increasing function.

So, $f(x)$ is one-one function.

Clearly, $f(x)$ is a continuous function and also increasing on R.

$\therefore \lim_{x \to -\infty} f(x) = -\infty$ and $\lim_{x \to \infty} = \infty$

Hence, $f(x)$ takes every value between $-\infty$ and ∞.

Thus, $f(x)$ is onto function.

Sol. 14 (A)

Let $W = \{CAT, TOY, YOU, \ldots\}$

Clearly, R is reflexive and symmetric but not transitive. $[\because {}_{CAT}R_{TOY},\ {}_{TOY}R_{YOU} \not\Rightarrow {}_{CAT}R_{YOU}]$

Sol. 15 (D)

Since, for every elements of A, there exists elements $(3, 3), (6, 6), (9, 9), (12, 12) \in R \Rightarrow R$ is reflexive relation.

Now, $(6, 12) \in R$ but $(12, 6) \notin R$, so it is not a symmetric relation.

Also, $(3, 6), (6, 12) \in R \Rightarrow (3, 12) \in R$

$\therefore R$ is transitive relation.

Sol. 16 (D)

Given, function $f(x) = a^x, a > 0$ is written as sum of an even and odd functions $f_1(x)$ and $f_2(x)$ respectively.

Clearly, $f_1(x) = \frac{a^x + a^{-x}}{2}$ and $f_2(x) = \frac{a^x - a^{-x}}{2}$

So, $f_1(x+y) + f_1(x-y)$

$= \frac{1}{2}[a^{x+y} + a^{-(x+y)}] + \frac{1}{2}[a^{x-y} + a^{-(x-y)}]$

$= \frac{1}{2}\left[a^x a^y + \frac{1}{a^x a^y} + \frac{a^x}{a^y} + \frac{a^y}{a^x}\right]$

$= \frac{1}{2}\left[a^x\left(a^y + \frac{1}{a^y}\right) + \frac{1}{a^x}\left(\frac{1}{a^y} + a^y\right)\right]$

$= \frac{1}{2}\left(a^x + \frac{1}{a^x}\right)\left(a^y + \frac{1}{a^y}\right)$

$= 2\left(\frac{a^x + a^{-x}}{2}\right)\left(\frac{a^y + a^{-y}}{2}\right) = 2f_1(x) \cdot f_1(y)$

SOL. 17 (C)

Given function $f(x) = \frac{1}{4-x^2} + \log_{10}(x^3 - x)$

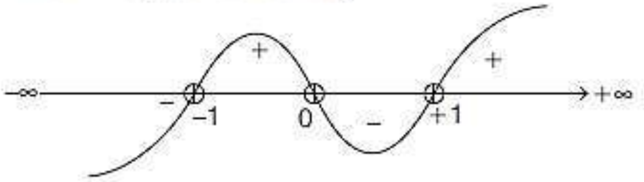
For domain of $f(x)$

$$4 - x^2 \neq 0 \Rightarrow x \neq \pm 2 \quad \ldots(i)$$

and $x^3 - x > 0$

$\Rightarrow x(x-1)(x+1) > 0$

From Wavy curve method,

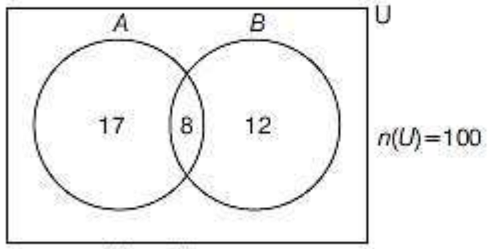


From Eqs. (i) and (ii), we get the domain of $f(x)$ as $(-1, 0) \cup (1, 2) \cup (2, \infty)$.

Sol . 18 (D)

Let the population of city is 100.

Then, $n(A) = 25$, $n(B) = 20$ and $n(A \cap B) = 8$



Venn diagram

So, $n(A \cap \overline{B}) = 17$ and $n(\overline{A} \cap B) = 12$

According to the question, Percentage of the population who look into advertisement is

$$= \left[\frac{30}{100} \times n(A \cap \overline{B})\right] + \left[\frac{40}{100} \times n(\overline{A} \cap B)\right] + \left[\frac{50}{100} \times n(A \cap B)\right]$$

$$= \left(\frac{30}{100} \times 17\right) + \left(\frac{40}{100} \times 12\right) + \left(\frac{50}{100} \times 8\right)$$

$= 5.1 + 4.8 + 4 = 13.9$

Sol. 19 (A)

According to given information, we have if $k \in \{4, 8, 12, 16, 20\}$

Then, $f(k) \in \{3, 6, 9, 12, 15, 18\}$

$[\because \text{codomain } (f) = \{1, 2, 3, \ldots, 20\}]$

Now, we need to assign the value of $f(k)$ for $k \in \{4, 8, 12, 16, 20\}$ this can be done in $^6C_5 \cdot 5!$ ways $= 6 \cdot 5! = 6!$ and remaining 15 element can be associated by 15! ways.

$\therefore$ Total number of onto functions $= \lfloor 15 \lfloor 16 = 15!\, 6!$

SOL. 20 (B)

Given A set $X = \{1, 2, 3, 4, 5\}$

To find The number of different ordered pairs (Y, Z) such that $Y \subseteq X$, $Z \subseteq X$ and $Y \cap Z = \phi$.

Since, $Y \subseteq X$, $Z \subseteq X$, hence we can only use the elements of X to construct sets Y and Z.

Method 1

n (Y)	Number of ways to make Y	Number of ways to make Z such that $Y \cap Z = \phi$
0	$^5C_0$	2^5
1	$^5C_1$	2^4
2	$^5C_2$	2^3
3	$^5C_3$	2^2
4	$^5C_4$	2^1
5	$^5C_5$	2^0

Let us explain anyone of the above 6 rows say third row. In third row,

Number of elements in $Y = 2$

$\therefore$ Number of ways to select $Y = {}^5C_2$ ways

Because any 2 elements of X can be part of Y.

Now, if Y contains any 2 elements, then these 2 elements cannot be used in any way to construct Z, because we want $Y \cap Z = \phi$.

And from the remaining 3 elements which are not present in Y, 2^3 subsets can be made each of which can be equal to Z and still $Y \cap Z = \phi$ will be true.

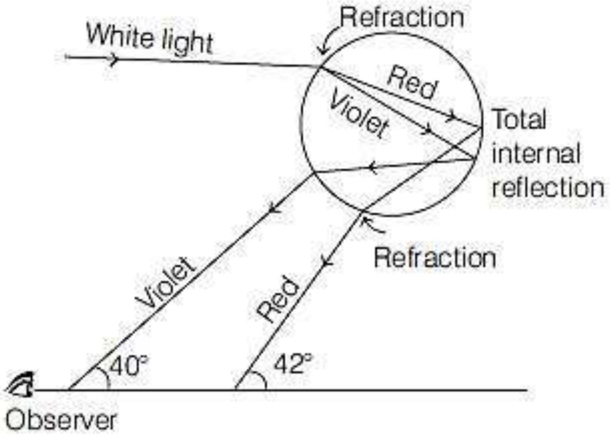
Hence, total number of ways to construct sets Y and Z such that $Y \cap Z = \phi$

$$= {}^5C_0 \times 2^5 + {}^5C_1 \times 2^{5-1} + \ldots + {}^5C_5 \times 2^{5-5}$$

$$= (2+1)^5 = 3^5$$

PHYSICS

Sol.21 (a) Formation of rainbow is shown below. So, processes involved in formation of rainbow in correct order are: refraction, total internal reflection, refraction. Hence, the correct order is given in option (a).



Sol. 22

. *(a)* Here, 10 divisions of vernier scall $= 11$ main scale divisions

So, 1 vernier scale division $= \frac{11}{10}$ main scale divisions

Now, we use formula for least count,

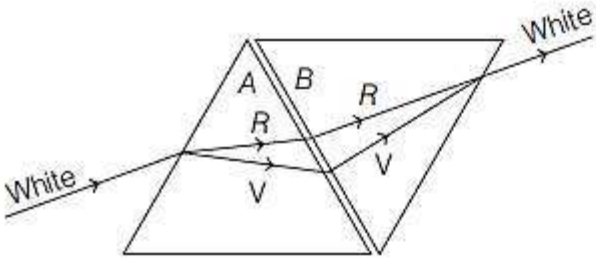
Least count = 1 main scale division − 1 vernier scale division.

$$\Rightarrow \quad LC = 1MSD - 1VSD$$
$$= \left(1 - \frac{11}{10}\right) MSD$$
$$= -\frac{1}{10} MSD$$
$$= -\frac{1}{10} \times 1 mm$$
$$= -0.1 mm$$

So, magnitude of least count is 0.1 mm.

SOL. 23 (c) Frosted glass has a rough layer which causes irregular refraction and makes glass translucent.
When a transparent tape which has refractive index close to that of glass is pasted over the rough surface of glass, the tape glue fills the roughness of glass. This makes glass surface more smooth and so refraction is more regular. This makes region of tape transparent

SOL. 24
(d) Prism B is inverted relative to prism A. So, dispersion of light caused by prism A and B is in opposite direction.
If bending of light caused by B is less than or more than that of A, then out going beam of light is not white.
So, when both prisms are filled with water at different temperatures, their refractive indices are different and the dispersion produced by A and B are not equal and opposite. Hence, with condition in (d) beam to right of prism B will be coloured.



SOL. 25

(b) Surface area over which rain is received, $A = 600 \text{ km}^2$

$$= 600 \times (10^3)^2 \text{ m}^2$$
$$= 6 \times 10^8 \text{ m}^2$$

Average rainfall, $h = 2.4$ m

Volume of water received by rain, V

$$= A \times h = 6 \times 10^8 \times 2.4 \text{ m}^3$$

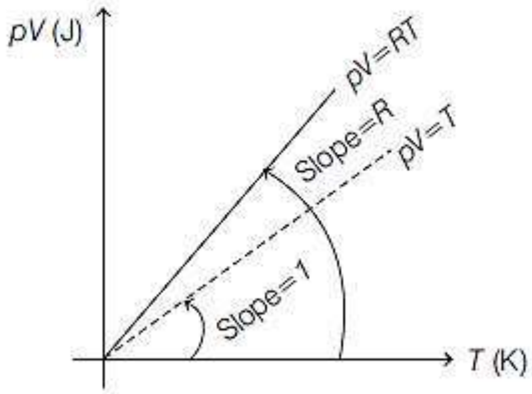
Water conserved = 10% of volume received by rain

$$= 6 \times 10^8 \times \frac{10}{100} \times 2.4 \text{m}^3 = 1.44 \times 10^8 \text{ m}^3$$
$$= 1.4 \times 10^8 \times 10^3 \text{ L} = 1.4 \times 10^{11} \text{ L}$$

Percentage of total water consumption received by rain is

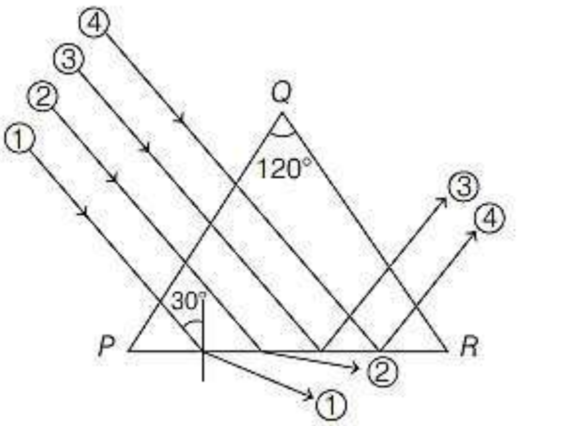
$$= \frac{1.4 \times 10^{11} \times 100}{1.4 \times 10^{12}} = 10\%$$

SOL. 26 (a) From gas equation,
pV = Nrt Here, n = 1mole
So, pV = RT ...(i) Substituting the value of R in Eq. (i), we get pV = 8.3T Clearly, slope of pV versus T line is 8.3, which is greater than one. Hence, following graph is correct.



Sol.27

(c) Total internal, reflection occurs when $n \geq \frac{1}{\sin i_c}$.



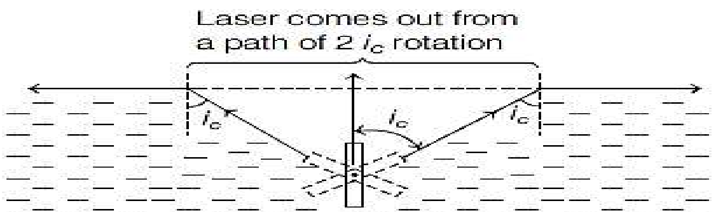
In given situation, angle of incidence of each of ray is 30° over face PR.

So, $i = 30°$

$$\Rightarrow \qquad \frac{1}{\sin i} = \frac{1}{\sin 30°} = 2$$

Hence, for total internal reflection at surface PR, $n \geq 2$. As refractive index for 3 and 4 is more than 2, only rays 1 and 2, pass from face PR while rays 3 and 4 pass through face QR (as shown in diagram).

Sol. 28 (c) When angle of incidence of laser on surface of water is less than critical incidence, it goes out otherwise reflected back into the tank



For water, $i_c = \sin^{-1}\left(\frac{1}{n}\right) = \sin^{-1}\left(\frac{1}{1.33}\right)$

$\Rightarrow i_c = \sin^{-1}(0.75)$

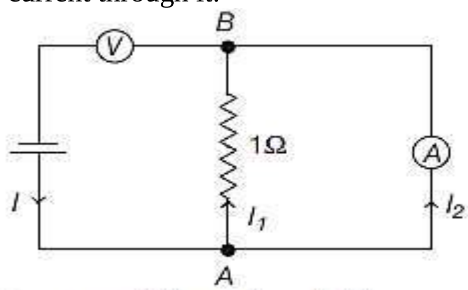
$\Rightarrow i_c \approx 50°$

If ω = angular speed and t = time to travel an arc of $2\,i_c$, then using $\omega t = 2i_c$.

We have, $t = \frac{2i_c}{\omega}$

$$= \frac{2 \times \frac{50}{180} \times \pi}{\left(\frac{2\pi}{60}\right)} = 16.67\,\text{s}$$

Sol.29 (b) When a voltmeter put in series, it still reads potential drop and when an ammeter is connected in parallel, it still shows current through it.



Let I = current through cell, then potential drop read by voltmeter is

$V = I \cdot R_V$ (this is reading of voltmeter)

Where, R_V is the resistance of voltmeter

In loop AB,

$V_{AB} = I_1 \times 1 = I_2 \times R_A$ and $I = I_1 + I_2$

Where, R_A is the resistance of ammeter

We substitute for I_1 from above equation to get

$\Rightarrow \quad I = I_2 R_A + I_2 = I_2(R_A + 1)$

$\Rightarrow \quad I_2 = \frac{I}{(R_A + 1)}$

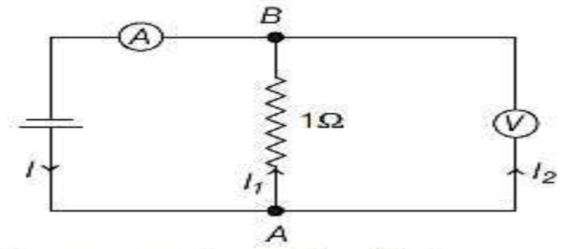
(this is reading of ammeter)

Now given,

$$\frac{\text{voltmeter reading}}{\text{ammeter reading}} = 1 \times 10^3 = \frac{IR_V}{\left(\frac{I}{R_A + 1}\right)}$$

So, $R_V(R_A + 1) = 1000$ ...(i)

Case b



Let I = current through cell, then ammeter reading in this case is I.

Also, in loop AB,

$V_{AB} = I_1 \times 1 = I_2 \times R_V$

As, $I = I_1 + I_2 = I_2 R_V + I_2$

$= I_2(R_V + 1)$

So, $I_2 = \dfrac{I}{(R_V + 1)}$

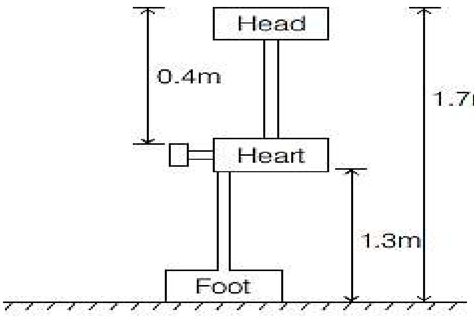
Hence, voltmeter reading is $V = I_2 R_V$

$= \dfrac{IR_V}{(R_V + 1)}$ (this is reading of voltmeter

Now given, voltmeter reading ÷ ammete reading = 0.999 Ω.

Sol. 30

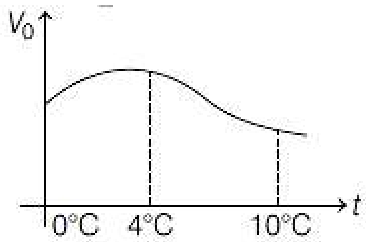
(c)



$$\text{Pressure at head level} = p_{heart} - \rho g h$$
$$= 13.3 - 10^3 \times 10 \times 0.4$$
$$= 9.3\,\text{kPa}$$
$$\text{Pressure at foot level} = p_{heart} + \rho g h$$
$$= 13.3 + 10^3 \times 10 \times 1.3$$
$$= 26.3\,\text{kPa}$$
$$\text{So, ratio} = \frac{26.3}{9.3} \approx 2.9 \text{ or } 3$$

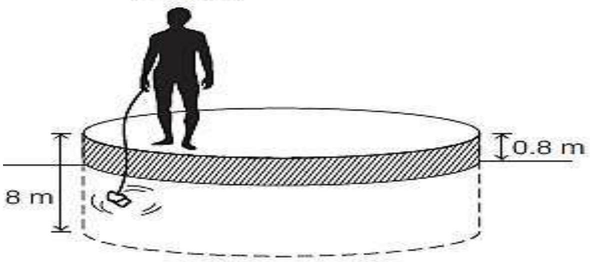
Sol. 31 (a) As temperature of water is increased from 0°C to 10°C, density of water initially increases upto a maximum at 4°C and then it reduces.So, buoyant force on block of wood also increases till temperature reaches 4°C and then decreases from 4°C to 10°C.

Hence, volume of block above water also increases upto 4°C and then decreases from 4°C to 10°C.\Variation ofV0 versus t as shown below.



SOL. 32 (c) Fraction of thickness of ice block out of water is

$$x = 1 - \left(\frac{\rho_{ice}}{\rho_{water}}\right) = 1 - \frac{0.9}{1} \text{ or } x = 0.1$$



So, minimum length of rope required » thickness of ice × 0.1= 8 × 0.1 = 0.8m.

Hence, nearest option is 0.9 m.

SOL. 33(d) When box with hole is in free fall, both water and box cover equal distance downwards in equal time.

Hence, no water comes out of hole in free fall of box.

SOL.34

(c) Water evaporated in two hours

$= m = 2\,h \times 20\,g/h$

$= 40\,g = 40 \times 10^{-3}$ kg

Heat absorbed by water during evaporation is

$Q =$ Mass evaporated $\times$ Latent heat

$$Q = mL \qquad \ldots(i)$$

Assuming this heat is taken entirely from water in earthen pot, if ΔT is decrease of temperature of pot then,

$$Q = Ms\Delta T \qquad \ldots(ii)$$

where, $M =$ mass of water in pot

and $s =$ specific heat of water.

Equating Eqs. (i) and (ii), we get

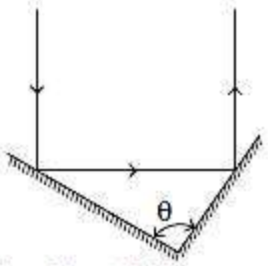
$mL = Ms\Delta T$

or $\Delta T = \frac{m}{M} \times \frac{L}{s} = \frac{40 \times 10^{-3}}{4} \times 540 = 5.4°C$

SOL. 35 (d) As emergent ray is parallel to incident ray, deviation angle d is 180°.

But $\delta = 360° - 2\theta$

where, $\theta =$ angle between inclined mirrors.



So, $360° - 2\theta = 180°$

or $2\theta = 180° \Rightarrow \theta = 90°$

SOL. 36 (a) From principle of thermometry

(a) From principle of thermometry,

$\frac{T - T_{LFP}}{T_{UFP} - T_{LFP}} =$ a constant for every thermometric scale.

Now, for any temperature L on a thermometer designed with given liquid and equivalent temperature C on centigrade scale, we have

$$\left(\frac{L - T_{LFP}}{T_{UFP} - T_{LFP}}\right)_{\text{Liquid based scale}} = \left(\frac{C - T_{LFP}}{T_{UFP} - T_{LFP}}\right)_{\text{Centigrade scale}}$$

$$\Rightarrow \frac{L - (-50)}{150 - (-50)} = \frac{C - 0}{100 - 0}$$

$$\frac{L + 50}{150 + 50} = \frac{C}{100}$$

$$\Rightarrow L + 50 = 2C$$

Now at 0°L, centigrade scale reading will be

$0 + 50 = 2C$ or $C = \frac{50}{2} = 25°$ L

and at 100° L, centigrade scale reading will be

$100 + 50 = 2C$ or $C = \frac{150}{2} = 75°$ L

SOL. 37

(b) An alpha-volt (α-V) is the energy acquired by an α-particle (charge 2e units) when accelerated by a potential difference of 1 V.

$\therefore \quad 1\,\alpha\text{-}V = q\,(\Delta V)$

$= 2e \times 1\,V = 2\,eV$

SOL. 38

30. (a) For the ball, we have

$u = 45\ ms^{-1}$, $g = -10\ ms^{-2}$

Now using, $v^2 - u^2 = 2gh$, we have

$v^2 = (45)^2 - 20h$

$\Rightarrow \quad v = \sqrt{2025 - 20h}$

At $v = 0$, $h = \frac{2025}{20} \approx 101$ m

at $h = 0$, $v = 45\ ms^{-1}$

As velocity decreases with height, slope of v-h graph must be negative at all points.

Hence, correct graph is (a).

SOL. 40 (d) IfQ is charge contained in L length of beam of area A, then L × A × r = Q

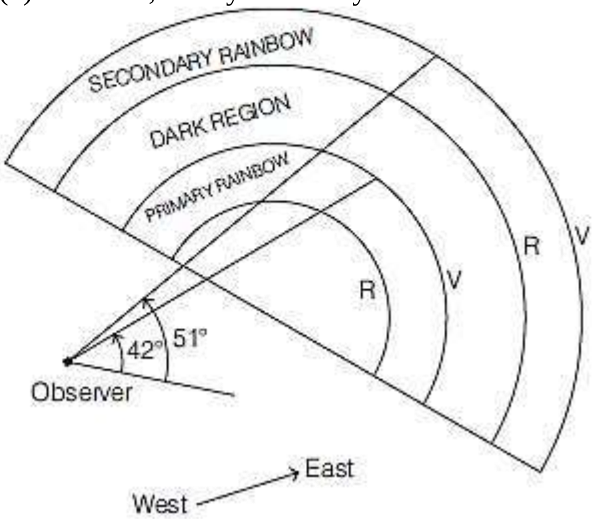
where, r = charge density of beam.

So, $\rho = \frac{Q}{L \times A} = \frac{Q/t}{L/t \times A} = \frac{I}{v \times A}$

$$= \frac{500 \times 10^{-6}}{3 \times 10^{7} \times 1.50 \times 10^{-6}}$$

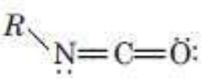
$$= \frac{5}{3 \times 1.5} \times 10^{-5} = 1.1 \times 10^{-5}\ Cm^{-3}$$

SOL.39 (No option is matching) In late afternoon rainbow is visible in east side when light of sun in west side is reflected and refracted by a layer of water droplets. Rainbow is circular because locous of reflected rays reaching eye of observer is a circle. Its roundness is not due to roundness of earth.There is no rainbow on moon due to lack of atmosphere.In case of a primary rainbow, violet colour is on inside and red colour is on outside of arc. In case of a secondary rainbow, red colour is on inside and violet colour is on outside of arc. So, none of the option is correct. Option (b) is correct, if only secondary rainbow is considered.



CHEMESTARY

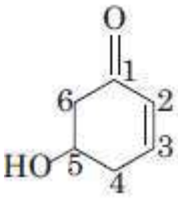
SOL. 41 (a) Hybridisation is determined from the steric number (number of atoms bonded to the central atom + the number of lone pairs). Number of hybrid orbitals must be equal to the steric number.
From the Lewis structure.
(i) Steric number of N-atom = 3 (2 bonded atoms + 1 lone pair),\Hybridisation = sp^2 (3 hybrid orbitals).
(ii) Steric number of C-atom = 2(2 bonded atoms), \Hybridisation = sp (2 hybrid orbitals).
(iii) Steric number of O-atom = 3



(1 bonded atom + 2 lone pair)
\Hybridisation = sp^2 (3 hybrid orbitals).

Sol. 42 (d) One isomer is an alkyne and the other one is an alkadiene. Since, they have two different functional groups, they are functional group isomers

sol. 43



Principal functional group is ketone.\C1 is carbonyl carbon atom.Locants for hydroxyl groups and double bonds are 5 and 2, which are preferred over 3 and 5, since the lower number at first difference (2 compared to 3) is preferred. Hence, the IUPAC name of given compound is 5-hydroxycyclohex-2-en-1-one.

Sol. 44 (d) Water-gas shift reaction is

$$CO + H_2O \xrightarrow{FeO \cdot Cr_2O_3\ (Catalyst)} CO_2 + H_2$$

In this reaction, hydrogen gas is produced from the reaction of steam with carbon dioxide.

Sol. 45 (c) Temporary hardness (caused by bicarbonates of calcium or magnesium)
can be removed by using lime, $Ca(OH)_2$.

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

Sol. 46 (b) Among anions with same charge, the one having greatest size has maximum polarisability. Thus, I–ion having most polarisability.

Sol. 47 (a) Of all the s-block elements, Mg and Be salts do not impart colour to flame.

Sol. 48 (d) For a spontaneous process in an isolated system, the change in entropy is positive, i.e, ΔS > O. However, if a system is not isolated, the entropy change of both the system and surroundings are to be taken into account because system and surroundings together constitute the isolated system thus, the total entropy change (ΔS) total is sum of the change in entropy of the system (ΔS) system and the change in entropy of the surroundings $(\Delta S_{surroundings})$,
i.e., $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$ for a spontenceus process, ΔS_{total} must be positive, i.e., ΔS_{total} is also termed as $\Delta S_{universe}$.

Sol. 50 (a) (i) Energy of the 2sorbital of different elements decreases as nuclear charge (equal to atomic number) of atom increases.
(ii) There are n^2 orbitals in a shell with principal quantum number n.\total number of electrons = $2n^2$

(iii) Extra stability of half-filled orbitals is due to greater exchange energy.
(iv) For two electrons will be in the same orbital, their spin quantum numbers must be different. It is not irrespective of their spin

Sol. 49

(c) (a) $PbO + HCl \longrightarrow PbCl_2 + H_2O$
(not correct option)

(b) $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$
(not correct option)

(c) $Pb_3O_4 + 4HNO_3 \longrightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$ (correct option)

(d) Pb + air (contains O_2, H_2O and CO_2) $\xrightarrow[\text{temperature}]{\text{room}}$

Protective layer of varying composition, mainly $PbCO_3$ is formed only on the surface. (not correct option)

Sol. 51 From ideal gas equation pV = nRT
maximum number of moles in container,

$$n = \frac{pV}{RT} = \frac{2 \times 2.24}{0.0821 \times 298}$$

$$= 0.18 \text{ moles}$$

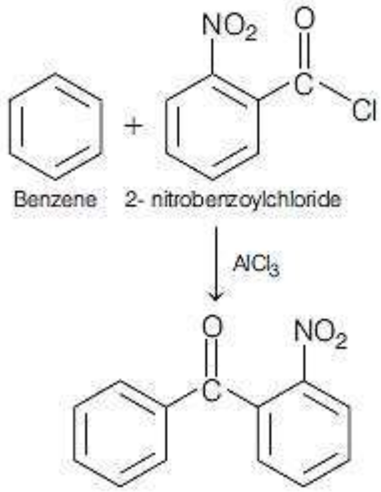
Maximum weight of N_2 in container

$$= 0.183 \times 28 = 5.127 \text{ g}$$

At 5.127 g exploding can occur. Thus, it must be less than 5.127. Thus, the maximum amount of nitrogen that can be safely put in this container at 298 temperature and exert pressure less than 2 atm will be closest to 4.2 g.

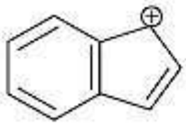
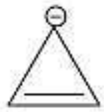
SOL. 52

(a)

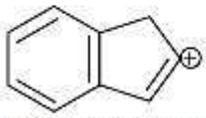
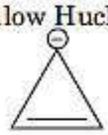


This reaction is Friedal-Craft acylation. In this reaction, benzene reacts with acyl halide or acid anhydride in the presence of Lewis acid like AlCl3 to yield acylbenzene.

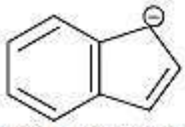
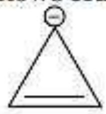
SOL. 53 (d) The specie which follows Huckel's rule (4n + 2)p will be most stable species

(a)  and 

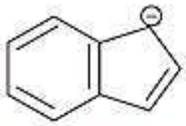
It has $8\pi e$'s, doesn't follow Huckel's rule | It has $4\pi e$'s, doesn't follow Huckel's rule

(b)  

It has $8\pi e$'s, doesn't follow Huckel's rule | It has $2\pi e$'s, follows Huckel's rule

(c)  

It has $10\pi e$'s, follows Huckel's rule | It has $4\pi e$'s, doesn't follow Huckel's rule

(d)  

It has $10\pi e$'s, follows Huckel's rule | It has $2\pi e$'s, follows Huckel's rule

As both the species in option (d) follow Huckel's rule. Thus, it is correct option.

SOL. 54 (a) As the atomic number increases, the energy of orbital decreases. This is because the atomic radii decreases (nuclear charge increases) with increase in atomic number. The atomic number of H, Li, Na and K respectively, are 1, 3, 11 and 19.Thus, the correct order of energy of 2s-orbitals is
K < Na < Li < H.

SOL. 55

(c) The hybridisation of any compound can be calculated as,

$$X = \frac{1}{2} \text{ [Valence electrons + Number of monoatomic } \mp \text{ Anion/cations]}$$

$\therefore$ For XeF_4 $(X) = \frac{1}{2}(8 + 4 - 0) = 6$

$\therefore$ The hybridisation is sp^3d^2.

SOL. 56

(c) In $Cr_2O_7^{2-}$,

Let the oxidation state of Cr be x

$$\therefore \quad 2(x) + 7(-2) = -2$$
$$2x - 14 = -2$$
$$2x = 12$$
$$x = +6$$

In ClO_3^-,

Let the oxidation state of Cl be x

$$\therefore \quad 1(x) + 3(-2) = -1$$
$$x - 6 = -1$$
$$x = +5$$

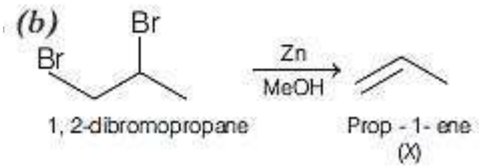
SOL. 57 (c) As, a filter paper soaked in salt X turns brown when exposed to HNO_3 vapour, then salt X must be a strong reducing agent which will reduce HNO_3 to NO_2 (brown gas). Among the given salt, KI is the strongest reducing agent. Thus, salt X is KI.

$$2KI + 4HNO_3 \longrightarrow I_2 + 2NO_2 + 2KNO_3 + 2H_2O$$

SOL. 58 (b) The role of haemoglobin is to transport oxygen from lungs or gills to different parts of the body. There it releases the oxygen to permit aerobic respirisation to provide energy to power the functions of the organism in the process called metabolism.

SOL. 59

(b)



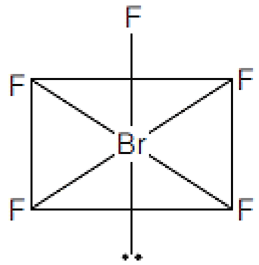
Moles of 1, 2-dibromo propane

$$= \frac{20.2}{202} = 0.1 \text{ mole}$$

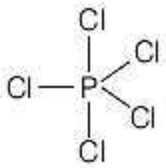
$$\text{Moles of prop-1-ene} = \frac{3.58}{42}$$
$$= 0.085 \text{ mole}$$

$$\% \text{ yield} = \frac{0.085}{0.1} \times 100 = 85\%$$

SOL. 60 (d) The geometry of BrF5 is square pyramidal. Here, the lone pair occupies the axial position and hence axial bonds will suffer more repulsion than axial bonds. Thus, the axial Br—F bond length will be different than equitorial Br—F.



The geometry of PCl_5 is triangular pyramidal.



The axial bonds suffer more repulsions than equitorial bonds, so they are larger in bond length.