KVPY-2012

Date : 04-11-2012 **Duration : 3 Hours** **Max. Marks : 100**

GENERAL INSTRUCTIONS

- The Test Booklet consists of **80** questions.
- There are Two parts in the question paper. The distribution of marks subjectwise in each part is as under for each correct response.

MARKING SCHEME :

PART-I :

MATHEMATICS

Question No. **1 to 15** consist of **ONE (1)** mark for each correct response.

PHYSICS

Question No. **16 to 30** consist of **ONE (1)** mark for each correct response.

CHEMISTRY

Question No. **31 to 45** consist of **ONE (1)** mark for each correct response.

BIOLOGY

Question No. **46 to 60** consist of **ONE (1)** mark for each correct response.

PART-II :

MATHEMATICS

Question No. **61 to 65** consist of **TWO (2)** marks for each correct response.

PHYSICS

Question No. **66 to 70** consist of **TWO (2)** marks for each correct response.

CHEMISTRY

Question No. **71 to 75** consist of **TWO (2)** marks for each correct response.

BIOLOGY

Question No. **76 to 80** consist of **TWO (2)** marks for each correct response.

PART-I
One Mark Questions

MATHEMATICS

1. Let f(x) be a quadratic polynomial with f(2) = 10 and f(–2) = –2. Then the coefficient of x in f(x) is

(A) 1 (B) 2 (C) 3 (D) 4

Sol. $f(x) = ax^2 + bx + c$

$10 = 4a+2b+c$ ..... (1)

$-2 = 4a - 2b + c$ ..... (2)

$12 = 4b \Rightarrow b = 3$

2. The square-root of $\frac{(0.75)^3}{1-(0.75)} + (0.75 + (0.75)^2 + 1)$ is

(A) 1 (B) 2 (C) 3 (D) 4

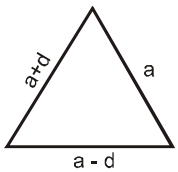
Sol. $\frac{(.75)^3 + (1)^3 - (.75)^3}{1-(0.75)} = \frac{1}{.25} = 4$

square root = 2

3. The sides of a triangle are distinct positive integers in an arithmetic progression. If the smallest side is 10, the number of such triangles is

(A) 8 (B) 9 (C) 10 (D) infinitely many

Sol.



$10, 10+d, 10+2d, d \in I, d \geq I$

$10+2d < 10+10+d$

$d < 10$

$\therefore$ d = 1, 2, 3, ... 9

9 triangles are possible

Ans. **(B)**

4. If a, b, c, d are positive real numbers such that $\frac{a}{3} = \frac{a+b}{4} = \frac{a+b+c}{5} = \frac{a+b+c+d}{6}$, then $\frac{a}{b+2c+3d}$ is

(A) $\frac{1}{2}$ (B) 1 (C) 2 (D) not determinable

Sol. a = 3k

b = k

c = 5k – 4k = k

d = 6k – 5k = k

$\frac{a}{b+2c+3d} = \frac{3k}{k+2k+3k} = \frac{1}{2}$

5. For $\frac{2^2+4^2+6^2+...+(2n)^2}{1^2+3^2+5^2+...+(2n-1)^2}$ to exceed 1.01, the maximum value of n is

(A) 99 (B) 100 (C) 101 (D) 150

Sol. $\dfrac{2^2[1^2+2^2+.....+n^2]}{[1^2+3^2+5^2+.....+(2n-1)^2]}$

$1^2 + 2^2 + 3^2 + ... + (2n)^2 = \dfrac{2n(2n+1)(4n+1)}{6}$

$[1^2 + 3^2 ..... + (2n-1)^2 + 2^2 \quad [1^2 + 2^n .....+ n^2]$

$= \dfrac{2n(2n+1)(4n+1)}{6}$

$S + 4\dfrac{n(n+1)(2n+1)}{6} = \dfrac{2n(2n+1)(4n+1)}{6}$

$S + \dfrac{2n(2n+1)(4n+1)}{6} - \dfrac{4n(n+1)(2n+1)}{6}$

$= 2n\left(\dfrac{2n+1}{6}\right)[4n+1-2n-2]$

$= \dfrac{2n(2n+1)(2n-1)}{6}$

Ratio $= \dfrac{4n(n+1)(2n+1)}{6} \times \dfrac{6}{2n(2n+1)(2n-1)} = \dfrac{2n+2}{2n-1}$

$\dfrac{2n+2}{2n-1} > \dfrac{101}{100}$

$200n + 200 > 202n - 101$

$2n < 301$

$n < \dfrac{301}{2} \Rightarrow$ maximum value = 150

6. In triangle ABC, let AD, BE and CF be the internal angle bisectors with D,E and F on the sides BC, CA and AB respectively. Suppose AD, BE and CF concur at I and B, D, I, F are concyclic, then $\angle$IFD has measure

(A) 15° (B) 30° (C) 45° (D) any value $\leq 90°$

Sol. $\angle ADB = 180° - \left(\dfrac{A}{2} + B\right)$

$\angle BFC = 180° - \left(\dfrac{C}{2} + B\right)$

$180° - \dfrac{A}{2} - B + 180° - \dfrac{C}{2} - B = 180°$

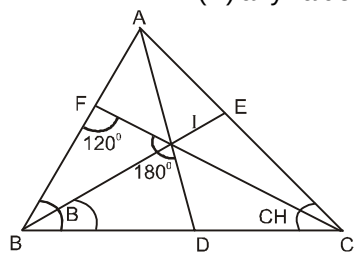
$180° = \dfrac{A+C}{2} + 2B$

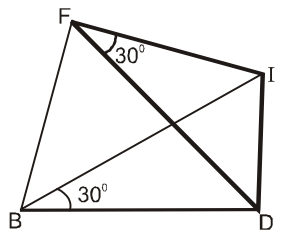
$\Rightarrow$ $360° = A + C + 4B$

$360° = A + B + C + 3B$

$\Rightarrow$ $B = 60°$

$\angle IFD = \angle IBD = \dfrac{B}{2} = 30°$

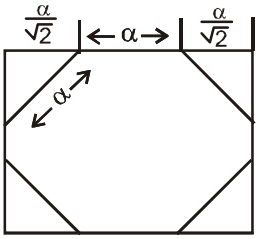




7. A regular octagon is formed by cutting congruent isosceles right–angled triangles from the corners of a square. If the square has side–length 1, the side-length of the octagon is

(A) $\dfrac{\sqrt{2}-1}{2}$ (B) $\sqrt{2}-1$ (C) $\dfrac{\sqrt{5}-1}{4}$ (D) $\dfrac{\sqrt{5}-1}{3}$

Sol.

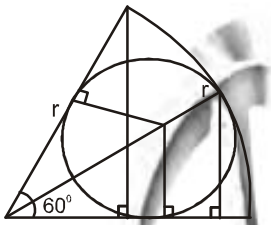


$$\alpha + \frac{\alpha}{\sqrt{2}} + \frac{\alpha}{\sqrt{2}} = 1$$

$$\alpha + \sqrt{2}\alpha = 1$$

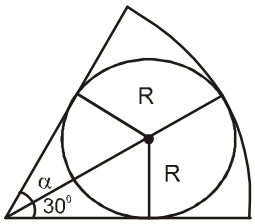
$$\alpha = \frac{1}{\sqrt{2}+1} = \sqrt{2}-1$$

8. A circle is drawn in a sector of a larger circle of radius, r, as shown in the adjacent figure. The smaller circle is tangent to the two bounding radii and the arc of the sector. The radius of the small circle is



(A) $\frac{r}{2}$ (B) $\frac{r}{3}$ (C) $\frac{2\sqrt{3r}}{5}$ (D) $\frac{r}{\sqrt{2}}$

Sol.



$$\frac{R}{\alpha} = \frac{1}{2}$$

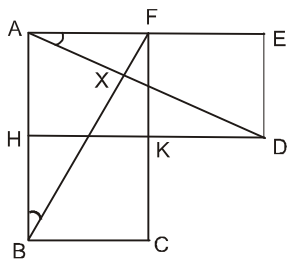
$\Rightarrow$ $\alpha = 2R$

Now $\alpha + R = r$

$3R = r$

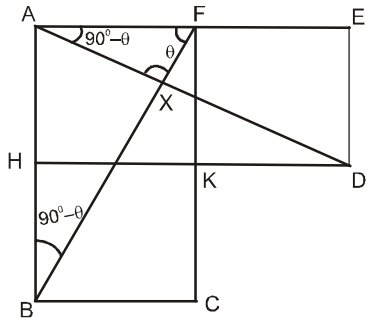
$R = r/3.$

9. In the figure, AKHF, FKDE and HBCK are unit squares; AD and BF intersect in X. Then the ratio of the areas of triangles AXF and ABF is



(A) $\frac{1}{4}$ (B) $\frac{1}{5}$ (C) $\frac{1}{6}$ (D) $\frac{1}{8}$

Sol. $\tan\theta = \frac{AB}{AF}$, $\angle x = 90°$



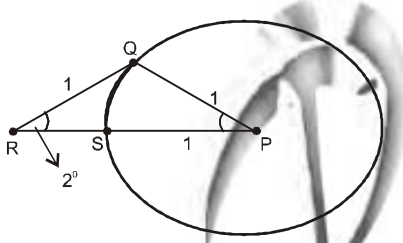
$\tan\theta = \frac{2}{1}$

$\sin\theta = \frac{AX}{AF}$

$\frac{2}{\sqrt{5}} = AX$; $XF = \frac{1}{\sqrt{5}}$

$$\frac{\text{Area of } \Delta AXF}{\text{Area of } \Delta ABF} = \frac{\frac{1}{2}\times(AX)\times(XF)}{\frac{1}{2}(AB\times AF)} = \frac{\frac{1}{2}\times\frac{2}{\sqrt{5}}\times\frac{1}{\sqrt{5}}}{\frac{1}{2}\times 2\times 1} = \frac{1}{5}$$

10. Suppose Q is a point on the circle with centre P and radius 1, as shown in the figure; R is a point outside the circle such that QR = 1 and $\angle$QRP = 2°. Let S be the point where the segment RP intersects the given circle. Then measure of $\angle$RQS equals

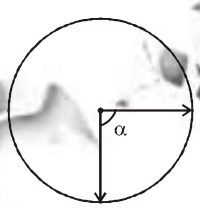


(A) 86° (B) 87° (C) 88° (D) 89°

Sol. $\angle$ RQP = 176º
$\angle$SPQ = 2º
$\angle$SQP = 89º (SP = PQ)
$\angle$SQR = 176 – 89 = 87º

11. Observe that, at any instant, the minute and hour hands of a clock make two angles them whose sum is 360°. At 6:15 the difference between these two angles is
(A) 165° (B) 170° (C) 175° (D) 180°

Sol.



$\alpha = 90 + 15\times\left(\frac{1}{2}\right)^{\circ} = \frac{195^{\circ}}{2}$

$\beta = 360 - \frac{195}{2} = \frac{720-195}{2} = \frac{525}{2}$

Difference $= \frac{525-195}{2} = \frac{330}{2} = 165º$

12. Two workers A and B are engaged to do a piece of work. Working alone, A takes 8 hours more to complete the work than if both worked together. On the other hand, working alone, B would need $4\frac{1}{2}$ hours more to complete the work than if both worked together. How much time would they take to complete the job working together?

(A) 4 hours (B) 5 hours (C) 6 hours (D) 7 house

Sol. Let A take x

B take y has together is hours = $\left(\frac{1}{x}+\frac{1}{y}\right)$ in of work

Let time be t

$$t\left(\frac{1}{x}+\frac{1}{y}\right)+8=\frac{t+8}{x}$$

$$\frac{t}{y}=\frac{8}{x}$$

$$t\left(\frac{1}{x}+\frac{1}{y}\right)=\frac{t+4.5}{y}$$

$$\frac{t}{x}=\frac{4.5}{y}$$

$$\frac{x}{y}=\frac{8}{t}; \qquad \frac{x}{y}=\frac{t}{4.5}$$

$$\frac{8}{t}=\frac{t}{4.5}$$

$\Rightarrow$ $t^2 = 36$

t = 6 hours.

13. When a bucket is half full, the weight of the bucket and the water is 10 kg. When the bucket is two–thirds full, the total weight is 11 kg. What is the total weight, in kg, when the bucket is completely full?

(A) 12 (B) $12\frac{1}{2}$ (C) $12\frac{2}{3}$ (D) 13

Sol. Let weight of bucket be α and weight of water is β

$\Rightarrow$ 2a + b = 20 ..... (1)

and 3a + 2b = 33 ..... (2)

$\alpha = 7$

$\beta = 6$

total weight = $\alpha + \beta = 13$

14. How many ordered pairs of (m,n) integers satisfy $\frac{m}{12}=\frac{12}{n}$?

(A) 30 (B) 15 (C) 12 (D) 10

Sol. mn = 144

(m, n) = total 15 positive ordered pairs and negative ordered pairs are possible

15. Let S = {1, 2, 3, ..., 40} and let A be a subset of S such that no two elements in A have their sum divisible by 5. What is the maximum number of elements possible in A?

(A) 10 (B) 13 (C) 17 (D) 20

Sol.

0	5, 10, 15, ... 40
1	2, 7, ... 36
3	3, 8, ... 38
4	4, 9, ... 39

PHYSICS

16. A clay ball of mass m and speed v strikes another metal ball of same mass m, which is at rest. They stick together after collision. The kinetic energy of the system after collision is :
(A) $mv^2/2$ (B) $mv^2/4$ (C) $2mv^2$ (D) mv^2

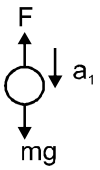
Sol. Momentum conservation

$mv = (m + m)v$

$v' = \frac{v}{2}$

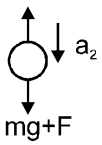
K.E. $= \frac{1}{2} \times 2m \left(\frac{v}{2}\right)^2 = mv^2/4.$

17. A ball falls vertically downward and bounces off a horizontal floor. The speed of the ball just before reaching the floor (u_1) is equal to the speed just after leaving contact with the floor (u_2) ; $u_1 = u_2$. The corresponding magnitudes of accelerations are denoted respectively by a_1 and a_2. The air resistance during motion is proportional to speed and is not negligible. If g is acceleration due to gravity, then :
(A) $a_1 < a_2$ (B) $a_1 = a_2 \neq g$ (C) $a_1 > a_2$ (D) $a_1 = a_2 = g$

Sol. Down : 

$mg - F - ma_1$

$a_1 = g - \frac{F}{m}$

Up : 

$mg + F = ma_2$

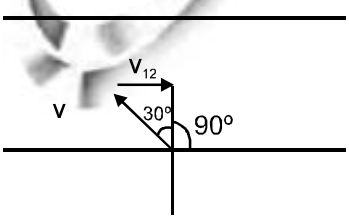
$a_2 = g + \frac{F}{m}$

$a_2 > a_1$.

18. Which of the following statements is true about the flow of electrons in an electric circuit ?
(A) Electrons always flow from lower to higher potential
(B) Electrons always flow from higher to lower potential
(C) Electrons flow from lower to higher potential except through power sources
(D) Electrons flow from higher to lower potential, except through power sources

Ans. **(C)**

19. A boat crossing a river moves with a velocity v relative to still water. The river is flowing with a velocity v/2 with respect to the bank. The angle with respect to the flow direction with which the boat should move to minimize the drift is :
(A) 30º (B) 60º (C) 150º (D) 120º

Sol. 

$\theta = 30º + 90º$
$= 120º$.

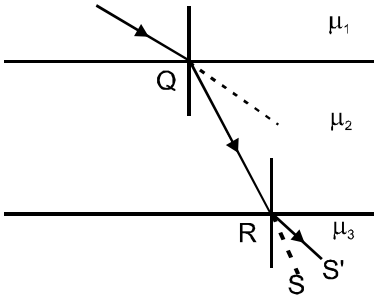
20. In the Arctic region hemispherical houses called Igloos are made of ice. It is possible to maintain inside an Igloo as high as 20ºC because :

(A) ice has high thermal conductivity (B) ice has low thermal conductivity

(C) ice has high specific heat (D) ice has higher density than water

Ans. **(B)**

21. In the figure below, PQRS denotes the path followed by a ray of light as it travels three media in succession. The absolute refractive indices of the media are μ_1,μ_2 and μ_3 respectively. (The line segment RS' in the figure is parallel to PQ). Then :

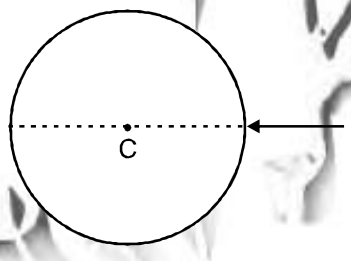


(A) $\mu_1 > \mu_2 > \mu_3$ (B) $\mu_1 < \mu_2 \ \mu_3$ (C) $\mu_1 = \mu_3 < \mu_2$ (D) $\mu_1 < \mu_3 < \mu_2$

Sol. **(D)**

Snell's law.

22. A ray of white light is incident on a spherical water drop whose center is C as shown below. When observed from the opposite side, the emergent light :



(A) will be white and will emerge without deviating

(B) will be internally reflected

(C) will split into different colors such that the angles of deviation will be different for different colors

(D) will split into different colors such that the angles of deviation will be same for all colors

Sol. i = r = 0

So, $\delta = 0$

No dispersion.

23. A convex lens of focal length 15 cm is placed infront of a plane mirror at a distance 25 cm from the mirror. Where on the optical axis and from the centre of the lens should a small object be placed such that the final image coincides with the object :

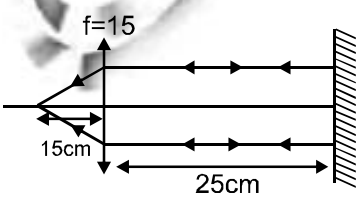
(A) 15 cm and on the opposite side of the mirror

(B) 15 cm and between the mirror and the lens

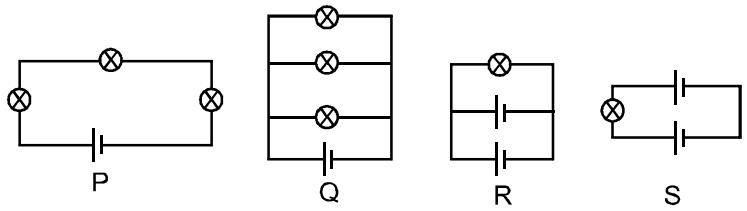
(C) 7.5 cm and on the opposite side of the mirror

(D) 7.5 cm and between the mirror and the lens

Sol.



24. Following figures show different combinations of identical bulb(s) connected to identical battery(ies). Which option is correct regarding the total power dissipated in the circuit ?



(A) P < Q < R < S (B) R < Q < P < S (C) P < Q < R = S (D) P < R < Q < S

Sol. In $P = \frac{v^2}{3R}$

In $Q = \frac{3v^2}{R}$

In $R = \frac{v^2}{R}$

In $S = \frac{4v^2}{R}$

So, P < R < Q < S

25. A circular metallic ring of radius R has a small gap of width d. The coefficient of thermal expansion of the metal is α in appropriate units. If we increase the temperature of the ring by an amount ΔT, then width of the gap:

(A) will increase by an amount $d\alpha\Delta T$ (B) will not change

(C) will increase by an amount $(2\pi R - d)\alpha\Delta T$ (D) will decrease by an amount $d\alpha\Delta T$

Sol. In length $2\pi R$ change $\rightarrow 2\pi R\alpha\Delta T$

$1 \rightarrow \alpha\Delta T$

In $d \rightarrow d\alpha\Delta T$

Ans. (A)

26. A girl holds a book of mass m against a vertical wall with a horizontal force F using her finger so that the book does not move. The frictional force on the book by the wall is :

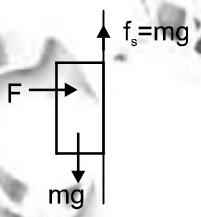
(A) F and along the finger but pointing towards the girl

(B) μF upwards where μ is the coefficient of static friction

(C) mg and upwards

(D) equal and opposite to the resultant of F and mg

Sol.



$f_s = mg$.

27. A solid cube and a solid sphere both made of same material are completely submerged in water but to different depths. The sphere and the cube have same surface area. The buoyant force is :

(A) greater for the cube than the sphere

(B) greater for the sphere than the cube

(C) same for the sphere and the cube

(D) greater for the object that is submerged deeper

Sol. $6a^2 = 4\pi r^2$

$$\frac{a}{r} = \sqrt{\frac{4\pi}{6}}$$

$B_S = \frac{4}{3}\pi r^3 \rho g$

$B_C = a^3 \rho g$

$\frac{B_S}{B_C} = \frac{4\pi}{3}\frac{r^3}{a^3} = \frac{4\pi}{3}.\frac{6}{4\pi}\sqrt{\frac{6}{4\pi}} = 2\sqrt{\frac{3}{2\pi}} > 1$

$B_S > B_C$.

28. $^{238}_{92}U$ atom disintegrates to $^{214}_{84}Po$ with a half life of 4.5×10^9 years by emitting six alpha particle and n electrons. Here n is :

(A) 6 (B) 4 (C) 10 (D) 7

Sol. $^{238}_{92}U \rightarrow {}^{214}_{84}Po + 6a + ne$

$^{238}_{92}U \rightarrow {}^{214}_{84}Po + 6{}_2He^4 + ne$

So, n = 4

Ans. (B)

29. Which statement about the Rutherford model of the atom is NOT true ?

(A) There is a positively charged centre in an atom called the nucleus

(B) Nearly all the mass of an atom resides in the nucleus

(C) Size of the nucleus is comparable to the atom

(D) Electrons occupy the space surrounding the nucleus

Ans. (C)

30. A girl brings a positively charged rod near a thin neutral stream of water from a tap. She observes that the water stream bends towards her. Instead, if she were to bring a negatively charged rod near to the stream, it will :

(A) bend in the same direction

(B) bend in the opposite direction

(C) not bend at all

(D) bend in the opposite direction above and below the rod

Sol. Due to attraction in both case bend in the same direction.

Ans. (A)

CHEMISTRY

31. The weight of calcium oxide formed by burning 20 g of calcium in excess oxygen is :

(A) 36 g (B) 56 g (C) 28 g (D) 72 g

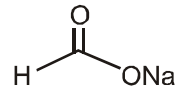
Ans. (C)

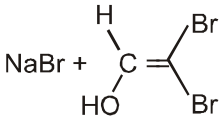
Sol. $2Ca + \underset{\text{(excess)}}{O_2} \xrightarrow{\Delta} 2CaO$

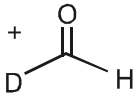
$\frac{20}{40} = \frac{1}{2}$ mole $\frac{1}{2}$ mole

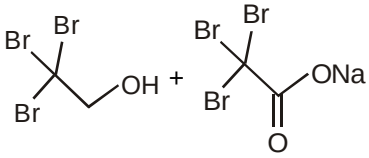
$\frac{1}{2}$ mole of CaO will be formed i.e., $\frac{1}{2}\times 56 = 28g$

32. The major products in the reaction $Br_3CCHO \xrightarrow{NaOH}$ are :

(A) $CHBr_3$ + 

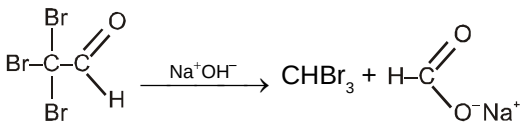
(B) NaBr + 

(C) NaOBr + 

(D) 

Ans. **(A)**

Sol. It is an example of bromoform reaction (similar to Iodoform reaction).



33. The number of electrons plus neutrons in $^{40}_{19}K^+$ is

(A) 38 (B) 59 (C) 39 (D) 40

Ans. **(C)**

Sol. $^{40}_{19}K^+$

$e^-s = 19 - 1 = 18$

$N = 40 - 19 = 21$

$\therefore$ electrons + Neutrons = 18 + 21 = 39

34. Among the following, the most basic oxide is

(A) Al_2O_3 (B) P_2O_5 (C) SiO_2 (D) Na_2O

Ans. **(D)**

Sol. Na_2O is most basic Oxide as it will form NaOH on dissolving in water which is strong base.

35. By dissolving 0.35 mole of sodium chloride in water, 1.30 L of salt solution is obtained. The molarity of the resulting solution should be reported as :

(A) 0.3 (B) 0.269 (C) 0.27 (D) 0.2692

Ans. **(B)**

Sol. $\text{Molarity} = \dfrac{\text{moles of solute}}{\text{lit of solution}}$

or $\dfrac{0.35}{1.3} = 0.269\ M = 0.27\ M$

36. Among the quantities, density (ρ), temperature (T), enthalpy (H), heat capacity (C_p), volume (V) and pressure (P), a set of intensive variables are :

(A) (ρ, T, H) (B) (H, T, V) (C) (V, T, C_p) (D) (ρ, T, P)

Ans. **(D)**

Sol. Density (ρ), temperature (T) and pressure (p) are intensive variables because they donot depend upon mass.

37. The value of 'x' in $KAl(SO_4)_x, 12H_2O$ is :

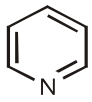
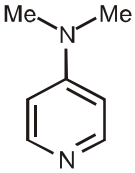
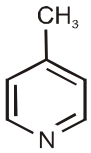
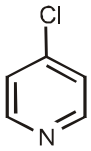
(A) 1 (B) 2 (C) 3 (D) 4

Ans. **(B)**

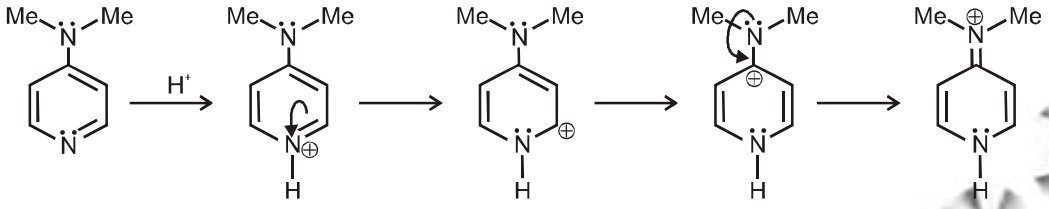
Sol. Potash alum is $K_2SO_4.Al_2(SO_4)_3.24H_2O$

$\therefore$ Empirical formula is $KAl(SO_4)_2.12H_2O$

38. Among the following substituted pyridines, the most basic compound is :

(A)  (B)  (C)  (D) 

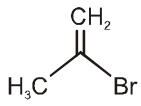
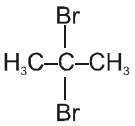
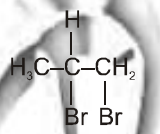
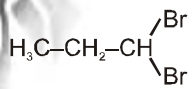
Ans. **(B)**

Sol. 

The conjugate acid is resonance stabilized.

39. The major product in the following reaction is :

$H_3C–C\equiv C–H + HBr(excess)$

(A)  (B)  (C)  (D) 

Ans. **(B)**

Sol. It is example of electrophilic addition reaction following the markownikov rule.

40. The major product in the following at 25°C is :

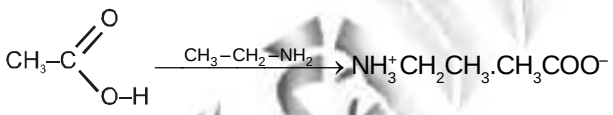
$CH_3COOH \xrightarrow{CH_3CH_2NH_2}$

(A) $CH_3CONHCH_2CH_3$ (B) $CH_3CH{=}NCH_2CH_3$

(C) $NH_3^+CH_2CH_3.CH_3COO^-$ (D) $CH_3CON{=}CHCH_3$

Ans. **(C)**

Sol. At room temperature, it is a simple acid-base reaction resulting in the formation of salt.



41. A reaction with reaction quotient Q_C and equilibrium constant K_C, will proceed in the direction of the products when :

(A) $Q_C = K_C$ (B) $Q_C < K_C$ (C) $Q_C > K_C$ (D) $Q_C = 0$

Ans. **(B)**

Sol. If $Q_C < K_C$ then reaction will move in forward direction.

42. Acetylsalicylic acid is a pain killer and is commonly known as :

(A) paracetamol (B) aspirin (C) ibuprofen (D) penicillin

Ans. **(B)**

Sol. Acetyl salicylic acid is commonly known as aspirin.

43. The molecule which does not exhibit strong hydrogen bonding is :

(A) methyl amine (B) acetic acid (C) diethyl ether (D) glucose

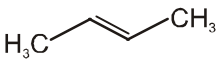
Ans. **(C)**

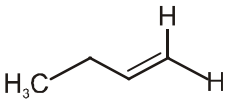
Sol. There is not any acidic proton in diethyl ether, hence it does not exhibit strong hydrogen bonding.

Or

For H–bonding in molecule highly electronegative element & H should be directly connected. In $(C_2H_5)_2O$, H is connected to carbon.

44. The following two compounds are :



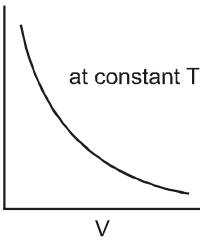


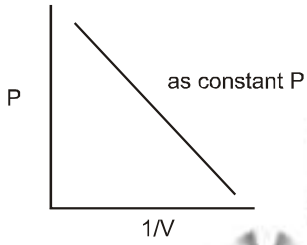
(A) geometrical isomers (B) positional isomers
(C) functional group isomers (D) optical isomers

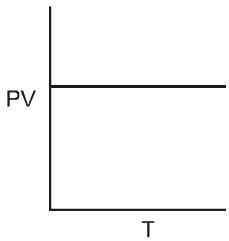
Ans. **(B)**

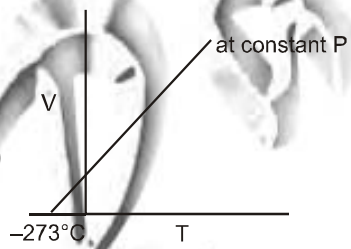
Sol. Both A and B differs in position of double bond, hence they are positional isomers.

45. The graph that does **not** represent the behaviour of an ideal gas is :

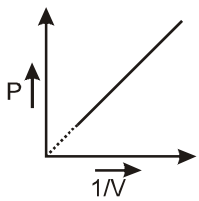
(A)


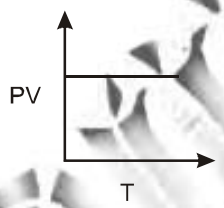
(B)


(C)


(D)


Ans. **(B,C)**

Sol. (B)


(C)


BIOLOGY

46. A smear of blood from a healthy individual is stained with a nuclear stain called hematoxylin and then obseved under a light microscope. Which of the following cell type would be highest in number ?
(A) neutrophils (B) lymphocytes (C) eosinophils (D) monocytes

Ans **(C)**

47. Which of the following biological phenomenon involves a bacteriophage ?
(A) transformation (B) conjugation (C) translocation (D) transduction

Ans **(D)**

48. In which compartment of cell does the process of glycolysis takes place ?
(A) Golig complex (B) cytoplasm (C) mitochondria (D) ribosome

Ans **(B)**

49. Huntingtion's disease is disease of the
(A) nervous system (B) circulatory system (C) respiratory system (D) excretory system

Ans **(A)**

50. A cell will experience the highest level of endosmosis when it is kept in
(A) distilled water (B) sugar solution (C) salt solution (D) protein solution
Ans (A)

51. When the leaf of the 'touch-me-not' (chui-mui, Minosa pudica) plant is touched, the leaf droops because
(A) a nerve signal passes through the plant
(B) the temperature of the plant increases
(C) water is lost from the cell at the base of the leaf
(D) the plant dies
Ans (C)

52. If you are seeing mangroves aroud you, which part to India are you visiting
(A) Western Ghats (B) Thar desert (C) Sunderbans (D) Himalayas
Ans (C)

53. Myeloid tissue is a type of
(A) haematopoietic tissue (B) cartilage tissue (C) muscular tissue (D) areolar tissue
Ans (C)

54. The heart of an amphibian is usually
(A) two chambered (B) three chambered (C) four chambered (D) three and half chambered
Ans (B)

55. Gigantism and acromegaly are due to defects in the function of the following gland
(A) adrenals (B) thyroid (C) pancreas (D) pituitary
Ans (D)

56. The pH of 10^{-8} M HCI solution is,
(A) 8 (B) close to 7 (C) 1 (D) 0
Ans (B)

57. Which one of the following organelles can synthesize some of its own proteins
(A) lysozome (B) Golgi apparatus (C) vacuole (D) mitochondrion
Ans (D)

58. Maltose is a polymer of
(A) one glucose and one fructose molecule
(B) one glucose and galactose molecule
(C) two glucose molecules
(D) two fructose molecules
Ans (C)

59. The roots of some higher plants get associated with a fungal partner. The roots provide food to the fungus while the funus supplies water to the roots. The structure so formed is known as
(A) lichen (B) anabaena (C) mycorrhiza (D) rhizobium
Ans (C)

60. Prehistoric forms of life are found in fossils. The probability of finding fossils of more complex organisms
(A) Increases from lower to upper strata
(B) decreases from lower to upper strata
(C) remains constant in each stratum
(D) uncertain
Ans (A)

PART-II
Two Mark Questions

MATHEMATICS

61. Let a, b, c be positive integers such that $\frac{a\sqrt{2}+b}{b\sqrt{2}+c}$ is a rational number, then which of the following is always an integer?

(A) $\frac{2a^2+b^2}{2b^2+c^2}$ (B) $\frac{a^2+b^2-c^2}{a+b-c}$ (C) $\frac{a^2+2b^2}{b^2+2c^2}$ (D) $\frac{a^2+b^2+c^2}{a+c-b}$

Sol. $\frac{a\sqrt{2}+b}{b\sqrt{2}+c} \times \frac{b\sqrt{2}-c}{b\sqrt{2}-c} = \frac{2ab-\sqrt{2}ac+b^2\sqrt{2}-bc}{2b^2-c^2} = \frac{2ab-bc+\sqrt{2}(b^2-ac)}{2b^2-c^2}$

$\Rightarrow$ $b^2 = ac$, number are a, ar, ar^2

(A) $\frac{2a^2+b^2}{2b^2+c^2} = \frac{2a^2+ac}{2ac+c^2} = \frac{a(2a+c)}{c(2a+c)} = \frac{a}{c} = \frac{1}{r^2}$ may or may not be integer.

(B) $\frac{a^2+2b^2}{b^2+2c^2} = \frac{a^2+2a^2r^2}{a^2r^2+2a^2r^4} = \frac{a^2(2r^2+1)}{a^2r^2(2r^2+1)} = \frac{1}{r^2}$

(C) $\frac{a^2+b^2-c^2}{a+b-c} = \frac{a^2+a^2r^2-a^2r^4}{a+ar-ar^2} = a\left(\frac{1+r^2-r^4}{1+r-r^2}\right)$

(D) $\frac{a^2+b^2+c^2}{a+c-b} = \frac{a^2(1+r^2+r^4)}{a(r^2-r+1)} = a(r^2+r+1) = a+b+c =$ Integer

62. The number of solutions (x, y, z) to the sytem of equations $x + 2y + 4z = 9$, $4yz + 2xz + xy = 13$, $xyz = 13$, such that at least two of x, y, z are integers is

(A) 3 (B) 5 (C) 6 (D) 4

Sol. $z = \frac{3}{xy}$, $x + 2y + 4 \times \frac{3}{xy} = 9$

$x + 2y + \frac{3(4-3xy)}{xy} = 0$

$xy(x + 2y - 9) = -12$

C – I $xy = 1$, $x + 2y = -3$

$x + \frac{2}{x} + 3 = 0$ $(-1, -1, 3)$

$x^2 + 3x + 2 = 0$ $-1, -2$ $\left(-2, \frac{-1}{2}, 3\right)$

C – II $xy = -1$, $x + 2y = 21$ $\Rightarrow$ $x = \frac{21 \pm \sqrt{449}}{2}$

$x + \frac{2(-1)}{x} = 3$, $x^2 - 3x - 2 = 0$

$x = \frac{3 \pm \sqrt{9-4(-2)}}{2} = \frac{3 \pm \sqrt{17}}{2}$

C – III $xy = 2$, $x + 2y = -6 + 9 = 3$

$x + 2.\frac{2}{x} = 3 \quad \Rightarrow \quad x^2 - 3x + 4 = 0$

$D = 9 - 4.1.4 < 0$

C – IV $xy = -2,\ x + 2y - 9 = 6$

$x + 2y = 15, \qquad x^2 - 15x - 4 = 0$

$x + 2\left(\frac{-2}{x}\right) = 15, \qquad 15^2 + 4.1.4$

C –V $xy = 3,\ x + 2y - 9 = -4, \qquad x + 2y = 5$

$x + 2.\frac{3}{x} = 5 \quad \Rightarrow \quad x^2 - 5x + 6 = 0$

$\Rightarrow \quad x = 2, 3$

$x = 2, \quad y = \frac{3}{2}, \ z = 1 \quad (2, \frac{3}{2}, 1)$

$x = 3, \quad y = 1, \quad z = 1 \quad (3, 1, 1)$

C – VI $xy = -3,\ x + 2y - 9 = 4$

$x + 2y = 13$

$x + \frac{2(-3)}{x} = 13$

$x^2 - 13x - 6 = 0 \qquad D = 13^2 + 4 \times 6 = 193$

C – VII $xy = 4$

$x + 2y - 9 = -3$

$x + 2y = 6$

$x + 2.\frac{4}{x} = 6$

$\Rightarrow \quad x^2 - 6x + 8 = 0$

$x = 2,4$

$x = 2, y = 4, z = \frac{3}{4} \qquad (2, 4, \frac{3}{4})$

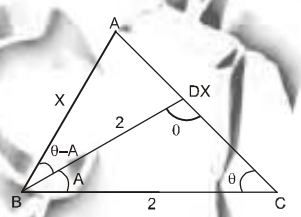
$x = 4, y = 1, z = \frac{3}{4} \qquad (4, 1, \frac{3}{4})$

$\therefore$ six solution (C)

63. In a triangel ABC, it is known that AB = AC. Suppose D is the mid–point of AC and BD = BC = 2. Then the area of the triangle ABC, is

(A) 2 (B) $2\sqrt{2}$ (C) $\sqrt{7}$ (D) $2\sqrt{7}$

Sol.



AB = AC

$\Delta ABC \sim \Delta BDC$

$\frac{AB}{BD} = \frac{BC}{DC} = \frac{AC}{BC}$

$\cos A = \frac{x^2 + x^2 - 2^2}{2xx} = \frac{2^2 + 2^2 - \left(\frac{x}{2}\right)^2}{2.2.2}$

$$\frac{2x^2-4}{x^2} = \frac{8-\frac{x^2}{4}}{4}$$

$$8x^2 - 16 = 8x^2 - \frac{x^4}{4}$$

$x^4 = 64$

$x = 2\sqrt{2}$

$$s = \frac{2\sqrt{2}+2\sqrt{2}+2}{2} = 2\sqrt{2} + 1$$

area of $\Delta ABC = \sqrt{(2\sqrt{2}+1)(2\sqrt{2}-1)(1)(1)}$

$= \sqrt{7}$

64. A train leaves Pune at 7:30 am and reaches Mumbai at 11:30 am. Another train leaves Mumbai at 9:30 am and reaches Pune at 1:00 pm. Assuming that the two trains travel at constant speeds, at what time do the two trains cross each other?

(A) 10:20 am (B) 11:30 am (C) 10:26 am (D) data not sufficient

Sol. Let distance b/w Pune and Mumbai be ℓ speed of 1st train = $\frac{\ell}{4}$

2nd train = $\frac{\ell}{3\frac{1}{2}}$

$= \frac{2\ell}{7}$

distance covered by 1st train in 2 hours = $\frac{\ell}{4} \times 2 = \frac{\ell}{2}$

at 9:30 relative distance to be covered = $\frac{\ell}{2}$

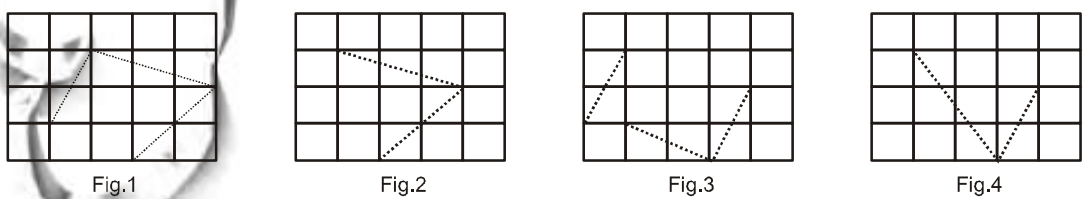
Let they meet at time t

$$\frac{\ell}{2} = \left(\frac{\ell}{4} \times t\right) + \frac{2\ell}{7} t$$

$$\frac{\ell}{2} = \ell t\left(\frac{7+8}{28}\right) \Rightarrow \quad t = \frac{14}{15} \text{ hours or } 56$$

$\therefore$ Ans. 9: 30 + 56 min = 10 : 26

65. In the adjacent figures, which has the shortest path?



(A) Fig.1 (B) Fig.2 (C) Fig.3 (D) Fig.4

Sol. Applying pythogorus theorem.

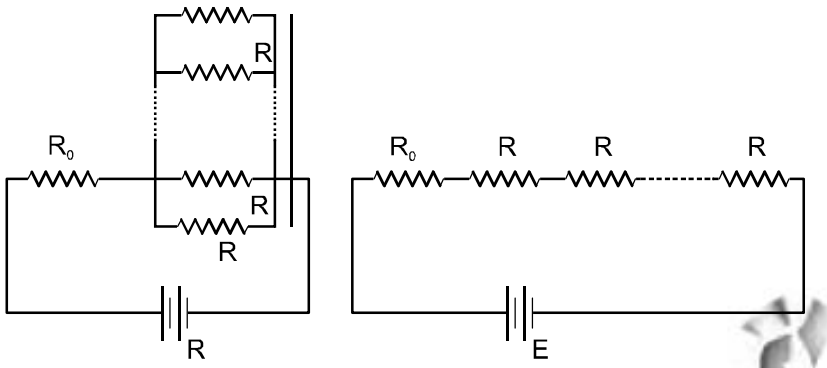
Path = $\sqrt{2^2+2^2} + \sqrt{3^2+1^2}$

$= \sqrt{8} + \sqrt{10}$

in option (B)

PHYSICS

66. In the circuit shown, n identical resistors R are connected in parallel (n > 1) and the combination in series to another resistor R_0. In the adjoining circuit n resistors of resistance R are all connected in series along with R_0 .



The batteries in both circuits are identical and net power dissipated in the n resistors in both circuit is same. The ratio R_0/R is :

(A) 1 (B) n (C) n^2 (D) 1/n

Sol. In parallel combination

$$I = \left(\frac{E}{R_0 + \frac{R}{n}}\right)$$

$$P_1 = \left(I^2 . \frac{R}{n}\right) = \left(\frac{E}{R_0 + \frac{R}{n}}\right)^2 . \frac{R}{n}$$

In series combination

$$I = \frac{E}{R_0 + nR}$$

$$P_2 = \left(\frac{E}{R_0 + nR}\right)^2 .nR$$

But $P_1 = P_2$

$$\left(\frac{E}{R_0 + \frac{R}{n}}\right)^2 . \frac{R}{n} = \left(\frac{E}{R_0 + nR}\right)^2 . nR$$

$$\frac{n}{nR_0 + R} = \left(\frac{n}{R_0 + nR}\right)$$

$R_0 + nR = nR_0 + R$

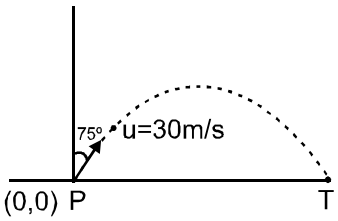
$R_0(1 – n) = R(1 – n)$

$$\frac{R_0}{R} = 1$$

67. A firecracker is thrown with velocity of 30 ms^{-1} in a direction which makes an angle of 75° with the vertical axis. At some point on its trajectory, the firecracker split into two identical pieces in such a way that one piece falls 27 m far from the shooting point. Assuming that all trajectories are contained in the same plane, how far will the other piece fall from the shooting point ? (Take g = 10 ms^{-2} and neglect air resistance)

(A) 63 m or 144 m (B) 28 m or 72 m (C) 72 m or 99 m (D) 63 m or 117 m

Sol.



$$R = \frac{u^2 \sin 2\theta}{g} = \frac{30^2 \sin 150^\circ}{10} = 90 \times \frac{1}{2} = 45 \text{ m}$$

COM of firecracker at 45 m from projection point

$$x_{Cm} = \frac{m_1 r_1 + m_2 r_2}{m_1 + m_2}$$

$$45 = \frac{\frac{m}{2}(27) + \frac{m}{2} r_2}{m}$$

$90 = 27 + r_2$

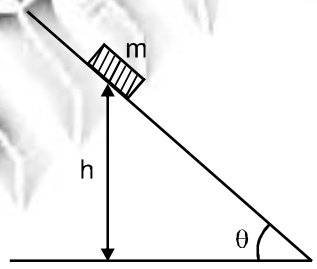
$r_2 = 90 - 27 = 64$ m

If $r_2 = -27$ m then

$90 = -27 + r_2$

$r_2 = 117$ m.

68. A block of mass m is sliding down an inclined plane with constant speed. At a certain instant t_0, its height above the ground is h. The coefficient of kinetic friction between the block and the the plane is μ. If the block reaches the ground at a later instant t_g , then the energy dissipated by friction in the time interval $(t_g - t_0)$ is:



(A) μmgh (B) mgh (C) $\mu mgh/\sin\theta$ (D) $\mu mgh/\cos\theta$

Sol. Using w.f.t

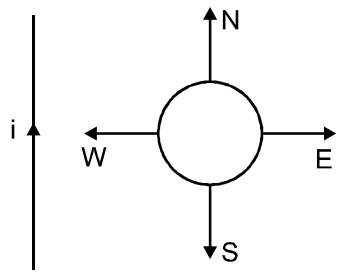
$K_f - K_i = W_g + W_f$

$$\frac{1}{2} mu^2 - \frac{1}{2} mu^2 = mgh + W_f$$

$W_f = -mgh$

Which is equal to energy loss in process.

69. A circular loop of wire is in the same plane as an infinitely long wire carrying a constant current i. Four possible motions of the loop are marked by N,E,W and S as shown :



A clockwise current is induced in the loop when loop is pulled towards :

(A) N (B) E (C) W (D) S

Sol. Magnetic field due to wire is inwards when loop moves towards E current is clockwise.

70. 150 g of ice is mixed with 100 g of water at temperature 80ºC. The latent heat of ice is 80 cal/g and the specific heat of water is 1 cal/g-ºC. Assuming no heat loss to the environment, the amount of ice which does not melt is :

(A) 100 g (B) 0 g (C) 150 g (D) 50 g

Sol. Heat given by water = 100 × 1 × 800 = 8000 cal

Heat taken by ice = 8000 cal = m × 80

m = 100 gm

So amount of ice which does not melt = 150 – 100 = 50 gm.

CHEMISTRY

71. Upon fully dissolving 2.0 g of a metal in sulfuric acid, 6.8 g of the metal sulfate is formed. The equilvalent weight of the metal is :

(A) 13.6 g (B) 20.0 g (C) 4.0 g (D) 10.0 g

Ans. **(B)**

Sol. Metal + $H_2SO_4 \longrightarrow$ Metal sulphate

No. of Eq. of metal = No. of eq. of metal sulphate

$$\frac{2}{E} = \frac{6.8}{\left(E + \frac{96}{2}\right)}, \quad E = 20 \textbf{ Ans.}$$

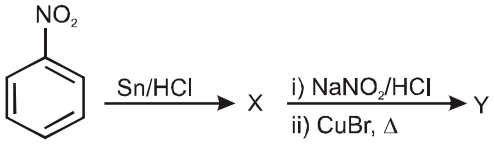
72. Upon mixing equal volumes of aqueous solutions of 0.1 M HCl and 0.2 M H_2SO_4, the concentration of H^+ in the resulting solution is :

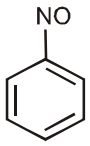
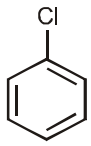
(A) 0.30 mol/L (B) 0.25 mol/L (C) 0.15 mol/L (D) 0.10 mol/L

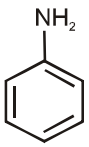
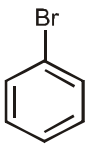
Ans. **(B)**

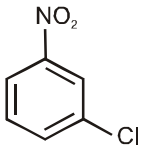
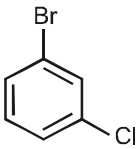
Sol. $[x^+]_f = \frac{V \times 0.1 + V \times 0.2 \times 2}{2V} = \frac{0.5V}{2V} = 0.25$ M **Ans.**

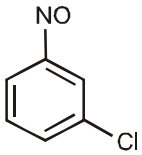
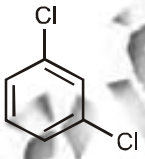
73. The products X and Y in the following reaction sequence are :



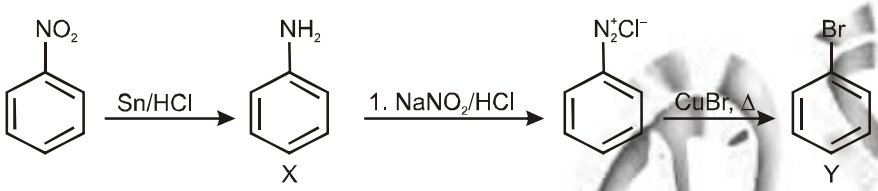
(A) X :  Y : 

(B) X :  Y : 

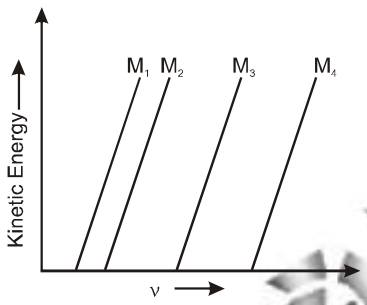
(C) X :  Y : 

(D) X :  Y : 

Ans. **(B)**

Sol. 

74. A plot of the kinetic energy ($\frac{1}{2}mv^2$) of ejected electrons as a function of the frequency (ν) of incident radiation for four alkali metals (M_1, M_2, M_3, M_4) is shown below :



The alkali metals M_1, M_2, M_3 and M_4 are, respectively :

(A) Li, Na, K, and Rb (B) Rb, K, Na, and Li

(C) Na, K, Li, and Rb (D) Rb, Li, Na, and K

Ans. **(B)**

Sol. $\frac{1}{2}mv^2 = h\nu - W$

High is the thershold frequency of metal greater will be the work function.

So,

$M_1 \longrightarrow Rb$; $M_2 \longrightarrow K$; $M_3 \longrightarrow Na$; $M_4 \longrightarrow Li$

75. The number of moles of Br_2 produced when two moles of potassium permanganate are treated with excess potassium bromide in aqueous acid medium is :

(A) 1 (B) 3 (C) 2 (D) 4

Ans. **(Bonus)**

Sol. $\underset{2\,mole}{KMnO_4} + \underset{(excess)}{KBr} \xrightarrow{H^+} Mn^{2+} + Br_2$

No. of eq. of $KMnO_4$ = No. of eq. of Br_2

$2 \times 5 = n_{Br_2} \times 2$

$n_{Br_2} = 5$ mole

BIOLOGY

76. A baby is born with the normal number and distribution of rods, but no cones in his eyes. We would expect that the baby would be
(A) color blind (B) night blind (C) blind in both eyes (D) blind in one eye
Ans (A)

77. In mammals, pleural membranes cover the lungs as well as insides of the rib cage. The pleural fluid in between the two membranes
(A) dissolves oxygen for transfer to the alveoli
(B) dissolves CO_2 for transfer to the blood
(C) provides partial pressure
(D) reduces the friction between the ribs and the lungs
Ans (D)

78. At which phase of the cell cycle, DNA polymerase activity is at its highest
(A) Gap 1 (G1) (B) Mitotic (M) (C) Synthetic (S) (D) Gap 2 (G2)
Ans (C)

79. Usain Bolt, an Olympic runner, at the end of a 100 mater sprint, will have more of the following in his muscles
(A) ATP (B) Pyruvic acid (C) Lactic acid (D) Varbon dioxide
Ans (C)

80. Desert temperature often varies between 0 to 50ºC. The DNA polymerase isolated from a Camel living in the desert will be able to synthesize DNA most efficiently at
(A) 0 ºC (B) 37 ºC (C) 50 ºC (D) 25 ºC
Ans (B)