FT-III-KVPY-CLASS-XI
FULL TEST – III

PART – I
MATHEMATICS

1. In an infinite geometric progression with common ratio r < 1, every term is 4 times as large as the sum of all its successive terms. The value of r is _____

(A) $\frac{4}{5}$ (B) $\frac{3}{4}$

(C) $\frac{2}{5}$ (D) $\frac{1}{5}$

Ans. D

Sol. Let the geometric progression be $a, ar, ar^2, ..., ar^{n-1}, ...$

Given that $ar^{n-1} = 4\left(ar^n + ar^{n+1} + ...\right)$

$= 4ar^n\left(1 + r + r^2 + ...\right)$

$= \frac{4ar^n}{1-r}$

Hence $\frac{4r}{1-r} = 1$ and hence $r = \frac{1}{5}$.

2. The smallest natural number n that satisfies $12^{200} < n^{300}$ is

(A) 5 (B) 6

(C) 7 (D) 8

Ans. B

Sol. $12^{200} < n^{300} \Rightarrow 144^{100} < \left(n^3\right)^{100} \Rightarrow 144 < n^3$

Now $5^3 < 144 < 6^3$

$\Rightarrow$ The smallest number is 6.

3. If $\sec x + \tan x = \frac{22}{7}$ and $\operatorname{cosec} x + \cot x = \frac{m}{n}$, where m, n are integers and have no common factors > 1, then the value of $m + n$ is

(A) 24 (B) 34

(C) 44 (D) 54

Ans. C

Sol. $\sec x + \tan x = \frac{22}{7} \Rightarrow \frac{1 + \sin x}{\cos x} = \frac{22}{7}$

$$\Rightarrow \frac{1+\sin x+\cos x}{1+\sin x-\cos x}=\frac{22+7}{22-7}=\frac{29}{15}$$

$$\Rightarrow \cot\frac{x}{2}=\frac{29}{15}$$

$$\Rightarrow \frac{1+\cos x}{\sin x}=\frac{29}{15}$$

4. A polygon has 44 diagonals. The number of its sides is
(A) 9 (B) 10
(C) 11 (D) 12

Ans. C

Sol. Let the number of sides of the polygon = n.

Then, number of diagonals $={}^{n}C_{2}-n=\frac{n(n-1)}{2}-n=\frac{n(n-3)}{2}$

Given, $\frac{n(n-3)}{2}=44 \quad \Rightarrow \quad n(n-3)=11\times 8\Rightarrow n=11$

5. The value of $\sqrt[3]{5+2\sqrt{13}}+\sqrt[3]{5-2\sqrt{13}}$ equals
(A) 0 (B) –1
(C) 1 (D) $4\sqrt{13}$

Ans. C

Sol. Let $x=\sqrt[3]{5+2\sqrt{13}}+\sqrt[3]{5-2\sqrt{13}}$

$$\Rightarrow x^3=5+2\sqrt{13}+5-2\sqrt{13}+3(-3)x$$

$$\Rightarrow x^3+9x-10=0$$

$$\Rightarrow (x-1)(x^2+x+10)=0\Rightarrow x=1$$

6. The sequence $S_1,S_2,S_3,...,S_{10}$ has the property that every term beginning with the third is the sum of the previous two, that is, $S_n=S_{n-2}+S_{n-1}$ for $n\geq 3$. Suppose that $S_9=110$ and $S_7=42$. What is S_4?
(A) 4 (B) 6
(C) 10 (D) 12

Ans. C

Sol. $S_9=110, S_7=42$

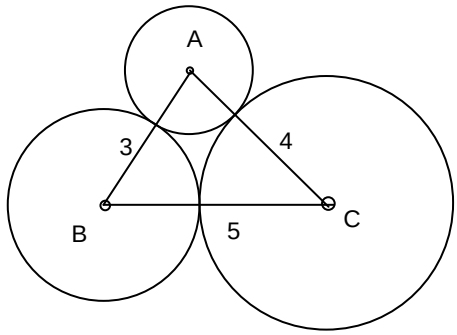
$$S_8=S_9-S_7=110-42=68$$

$$S_6=S_8-S_7=68-42=26$$

$$S_5=S_7-S_6=42-26=16$$

$$S_4=S_6-S_5=26-16=10$$

7. The vertices of a triangle with sides 3, 4, 5 are the centers of three mutually externally tangent circles, as shown. What is the sum of the areas of the three circles?



(A) 14π

(B) $\dfrac{25\pi}{2}$

(C) 13π

(D) $\dfrac{27\pi}{2}$

Ans. A

Sol. Let the radius of the smallest circle be a. We find that the radius of the largest circle is 4 – a and the radius of the second largest circle is 3 – a. Thus, $4-a+3-a=5 \Leftrightarrow a=1$. The radii of the other circles are 3 and 2. The sum of their areas is

$\pi+9\pi+4\pi=14\pi \Leftrightarrow (E)$

8. A solid cube has side length 3 inches. A 2–inch by 2–inch square hole is cut into the center of each face. The edges of each cut are parallel to the edges of the cube, and each hole goes all the way through the cube. What is the volume, in cubic inches, of the remaining solid?

(A) 7 (B) 8

(C) 10 (D) 12

Ans. A

Sol. Imagine making the cuts one at a time. The first cut removes a box of dimensions $2\times2\times3$. The second cut removes two boxes, each of dimensions $2\times2\times0.5$, and the third cut does the same as the second cut. Hence the total volume of all cuts is $12+4+4=20$.

Therefore the volume of the rest of the cube is $3^3-20=27-20=\boxed{7(A)}$

9. How many kilograms of sugar costing Rs.9 per kg must be mixed with 27 kg of sugar costing Rs.7 per kg so that there may be a gain of 10% by selling the mixture at Rs.9.24 per kg?

(A) 36 kg (B) 42 kg

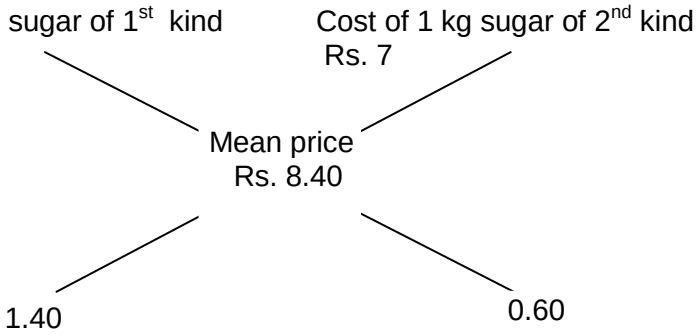
(C) 54 kg (D) 63 kg

Ans. D

Sol. S.P. of 1 kg of mixture = Rs. 9.24, Gain = 10%

$\therefore$ C.P. of 1 kg of mixture = Rs. $\left(\dfrac{100}{110}\times9.24\right)=$ Rs. 8.40

By the rule of allegation, we have



$\therefore$ Ratio of quantities of 1st and 2nd kind = 14 : 6 = 7 : 3

Let x kg of sugar of 1st kind be mixed with 27 kg of 2nd kind.

Then, $7:3=x:27$ or $x=\left(\frac{7\times 27}{3}\right)=63$ kg

10. If $a\in(0,1]$ satisfies the equation $a^{2016}-2a+1=0$ and $S=1+a+a^2+a^3+...+a^{2015}$, then the sum of all possible values of S is

(A) 2016 (B) 2018

(C) 2 (D) 1

Ans. B

Sol. If $a=1$, then $S=2016$

If $a\neq 1$, then $S=\frac{a^{2016}-1}{a-1}$

= 2

$\therefore$ Sum of all possible values of $S=2+2016=2018$

11. In a ΔABC, lengths of sides BC and CA are $\sqrt{3}+1$ and $\sqrt{3}-1$ respectively. If $\angle BCA=60^o$, then the value of $\angle BAC$ is

(A) 75^o (B) 22.5^o

(C) 105^o (D) 15^o

Ans. C

Sol. From tangent rule, $\tan\left(\frac{A-B}{2}\right)=\frac{a-b}{a+b}\cot\frac{C}{2}$

$\Rightarrow \tan\left(\frac{A-B}{2}\right)=\frac{\left(\sqrt{3}+1\right)-\left(\sqrt{3}-1\right)}{\left(\sqrt{3}+1\right)+\left(\sqrt{3}-1\right)}\cot 30^o$

$\Rightarrow \tan\left(\frac{A-B}{2}\right)=1 \quad \Rightarrow \frac{A-B}{2}=45^o \quad \Rightarrow A-B=90^o$

Also, $A+B+C=180^o$

$\Rightarrow A+B=180^o-60^o=120^o$

$\therefore \angle A=105^o$

12. If $a^5 + 5a^4 + 10a^3 + 3a^2 - 9a - 6 = 0$, where a is a real number other than –1, what is the value of $(a + 1)^3$?

(A) $3\sqrt{3}$ (B) 7

(C) 8 (D) 27

Ans. B

Sol. Rewrite this as $(a+1)^5 - 7(a+1)^2 = 0$ and now we have $(a+1)^3 = 7$. So our answer is B.

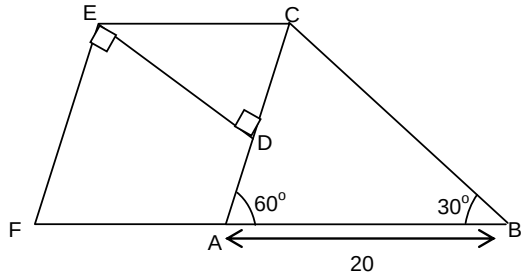
13. In the adjoining figure BAC is a $30^o - 60^o - 90^o$ triangle. D is the midpoint of AC. The perpendicular at D to AC meets the line parallel to AB through C at E. The line through E perpendicular to DE meets BA produced at F. If $DF = 5\sqrt{x}$, then x is equal to

(A) 6

(B) 7

(C) 8

(D) 9



Ans. B

Sol. In ΔABC,

$\sin 30^o = \frac{AC}{AB} = \frac{AC}{20}$

$\frac{1}{2} = \frac{AC}{20} \Rightarrow AC = 10$

$AD = DC = \frac{AC}{2} = 5$

$\angle 1 = 60^o$ $BF \parallel EC$

$\angle 3 = \angle 4 = 90^o$ $\therefore AC \parallel EF$

$\therefore$ FACE is a parallelogram

$EF = CA = 10$

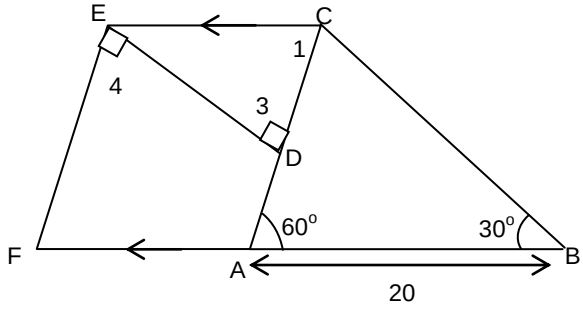
In ΔEDC, $\tan 60^o = \frac{ED}{DC}$

$\sqrt{3} = \frac{ED}{5} \Rightarrow ED = 5\sqrt{3}$

In ΔFED,

$FD = \sqrt{FE^2 + ED^2} = \sqrt{10^2 + \left(5\sqrt{3}\right)^2}$

$= \sqrt{175} = 5\sqrt{7}$



14. The number of ways in which three distinct numbers in A.P. can be selected from the set $\{1,2,3,...,24\}$, is equal to

(A) 66 (B) 132
(C) 198 (D) none of these

Ans. B

Sol. Let the numbers selected by x_1, x_2, x_3
We must have $2x_2 = x_1 + x_3$
$\Rightarrow\ x_1 + x_3 =$ even
$\Rightarrow x_1, x_3$ both are even, we can select them in ${}^{12}C_2$ ways. Similarly, if x_1 and x_2 both are odd, we can again select them in ${}^{12}C_2$ ways.
Thus, total ways $= 2.\ {}^{12}C_2 = 132$

15. If k be the number less than 100 that increases by 20% when its digits are reversed, then $\frac{k}{9}$ equals

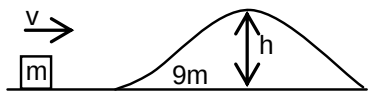
(A) 5 (B) 6
(C) 7 (D) 8

Ans. A

Sol. Let the number be ab. We have $10b + a = (1\cdot 2)(10a + b) \Rightarrow 4b = 5a \Rightarrow a = 4,\ b = 5$
$\Rightarrow k = 45$

PHYSICS

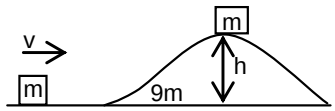
16. A small block of mass m and velocity v slides along a horizontal plane. The block meets a "hill" of mass 9m and height h that can also move along the plane. The block begins to slide up the "hill". Assume that all surfaces are frictionless. Find out minimum value of v so that block can cross the hill



(A) $\frac{1}{3}\sqrt{10gh}$ (B) $\frac{2}{3}\sqrt{5gh}$
(C) $\frac{2}{5}\sqrt{3gh}$ (D) $\frac{2}{3}\sqrt{7gh}$

Ans. B

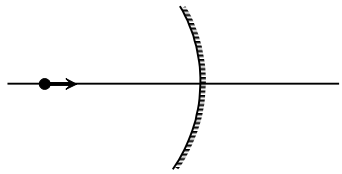
Sol $mv = 10mu \Rightarrow u = \frac{v}{10}$



$\frac{1}{2}mv^2 = \frac{1}{2}10mu^2 + mgh$

$\frac{mv^2}{2} = \frac{10mv^2}{2\times 100} + mgh,\ \ v = \frac{2}{3}\sqrt{5gh}$

17. A point object is moving along the principle axis of a concave mirror at rest of focal length 30cm with speed 5 m/s towards the mirror. Find the speed (in m/s) of image of object when object is at a distance 60cm from mirror.



(A) 5 (B) 10
(C) 2.5 (D) 30

Ans. A

Sol. $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, $u=-60$ $f=-30$,

$\frac{1}{-60}+\frac{1}{v}=-\frac{1}{30}$, $\frac{1}{v}=-\frac{1}{30}+\frac{1}{60}=-\frac{1}{60}$

$v = -60$ cm and $\frac{1}{v^2}\frac{dv}{dt}+\frac{1}{u^2}\frac{du}{dt}=0$, $\frac{du}{dt}=-\frac{v^2}{u^2}\left(\frac{du}{dt}\right)$

$\frac{dv}{dt}=-5$m/s ; $\therefore$ Speed = 5 m/s.

18. A uniform solid cylinder of mass m and radius R is set in rotation about its axis with an angular velocity ω_0 and lowered onto a horizontal plane and released. If co-efficient of friction between the cylinder and the plane is μ,then it will start pure rolling with angular velocity

(A) $\frac{\omega_0}{\mu}$ (B) $\frac{2\omega_0}{5\mu}$

(C) $\frac{\omega_0}{3}$ (D) $\frac{2\omega_0}{7}$

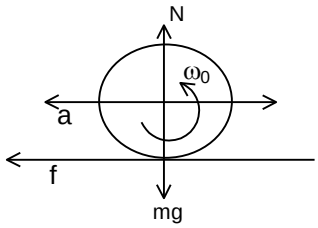
Ans. C

Sol. $a = \mu g$

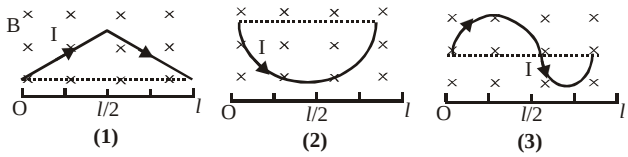
$\mu mg\, R = \frac{1}{2} mR^2\alpha \Rightarrow \alpha = \frac{2\mu g}{R}$ … by $\omega = \omega_0 - \alpha t$ and

$v = 0 + \mu g t$

$\Rightarrow \omega$ at the time of rolling = $\frac{\omega_0}{3}$



19. Three conductors 1, 2, and 3 each carrying the same current I are placed in a uniform magnetic field B, as shown in figure. The forces experienced by conductors 1, 2 and 3 are F_1, F_2 and F_3, respectively

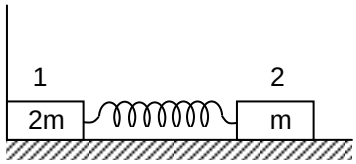


(A) $F_3 > F_2 > F_1$
(B) $F_1 \neq 0$; $F_1 \neq 0$; $F_3 = 0$
(C) F_1 acts upwards, F_2 acts downwards ; $F_3 = 0$
(D) All experience the same force in same direction

Ans. D

Sol. F is same for all.
Use $F = I(\vec{\ell} \times \vec{B})$

20. Two bars of masses 2m and m connected by a weightless spring of stiffness k rest on a smooth horizontal table. Bar 2 is shifted by a small distance x to left and then released. Find the velocity of the c.m. of the system after bar 1 breaks off the wall.



(A) $\frac{x}{2}\sqrt{\frac{k}{m}}$ (B) $\frac{x}{3}\sqrt{\frac{k}{m}}$

(C) $\frac{2x}{3}\sqrt{\frac{2k}{m}}$ (D) $\frac{x}{3}\sqrt{\frac{2k}{m}}$

Ans. B

Sol. When released let bar 2 moves to right with velocity v_2 as the spring attains its natural length. Then conservation of energy

$\frac{1}{2}kx^2 = \frac{1}{2}mv_2^2$ or $v_2 = \sqrt{\frac{k}{m}} \cdot x$

$v_{cm} = \frac{m_1 v_1' + m_2 v_2'}{m_1 + m_2} = \frac{x}{3}\sqrt{\frac{k}{m}}$

21. A bob is hung from the ceiling of a train compartment. The train moves on an incline track of inclination 30^0 with horizontal. Acceleration of the train up the plane is g/2. The angle which the string supporting the bob makes with normal to the ceiling in equilibrium condition, is

(A) 30^0 (B) $\tan^{-1}(2)$

(C) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) 45^0

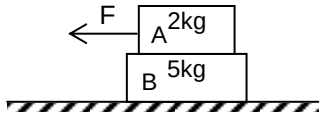
Ans. C

Sol. $\tan(90 - \alpha) = g \sin 60^o$

g + g cos 60°

$\text{Cot}\,\alpha = \frac{\sqrt{3}}{2}$

22. Two blocks of mass 2kg and 5kg rest one over the other on a smooth horizontal plane. The coefficient of static and dynamic friction between A and B is the same and is equal to 0.6. The maximum horizontal force that can be applied to A in order that both A & B do not have relative motion



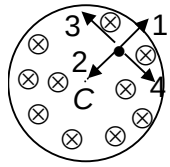
(A) 16.8 N (B) 42 N

(C) 54 N (D) 1.2 N

Ans. A

Sol. $\frac{F_{max}}{7} = \frac{0.6 \times 2 \times 10}{5} \Rightarrow F_{max} = 16.8\ N$

23. A uniform but time varying magnetic field exists in cylindrical region and directed into the paper. If field decreases with time and a positive charge placed at any point inside the region, then it moves



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

Ans. D

Sol. Due to the time varying magnetic field induced electric field will be set-up and its lines are in anticlockwise sense, so force on stationary charge q is along (4).

24. Two ends of a train pass an observer with velocity 20 ms^{-1} and 30 ms^{-1} respectively. The velocity of mid-point of train crossing the observer is (in ms^{-1}), assuming uniform acceleration

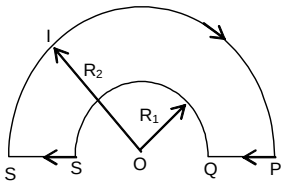
(A) 25 (B) 25.5
(C) 24.5 (D) 27.5

Ans. B

Sol. $\frac{V^2 - (20)^2}{(30)^2 - (20)^2} = \frac{2a\ell/2}{2a\ell}$

$\Rightarrow$ V = 25.5

25. The wire loop PQRSP formed by joining two semi-circular wires of radii R_1 and R_2 carries a current I as shown in figure. What is the magnetic induction at the centre O?



(A) $\frac{\mu_o}{4} I\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ into the page (B) $\frac{\mu_o}{2} I\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ out of the page

(C) $\frac{\mu_o}{2} I\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ into the page (D) $\frac{\mu_o}{4} I\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ out of the page

Ans. D

Sol. As the point O is along the length of the straight wire, so the field at O due to them will be zero and hence

$\vec{B} = \frac{\mu_o}{4\pi}\left[\frac{\pi\ I}{R_2} \otimes + \frac{\pi\ I}{R_1}\right] \odot$

$\Rightarrow \vec{B} = \frac{\mu_o}{4\pi}\pi\ I\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ out of the page

26. A particle executes SHM with an amplitude of 2 cm. When the particle is at 1 cm from the mean position the numerical value of its velocity is equal to that of its acceleration. Then its time period in second is

(A) $\frac{1}{2\pi\sqrt{3}}$ (B) $2\pi\sqrt{3}$

(C) $\frac{2\pi}{\sqrt{3}}$ (D) $\frac{\sqrt{3}}{2\pi}$

Ans. C

Sol. $V = \omega\sqrt{A^2 - x^2}$

$a = -\omega^2 x$

$\Rightarrow \omega = \sqrt{3}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{3}}$

27. If the flux of magnetic induction through a coil of resistance R changes from ϕ_1 to ϕ_2, then the magnitude of the charge that passes through the coil is

(A) $\frac{(\varphi_2 - \varphi_1)}{R}$ (B) $\frac{n(\varphi_2 - \varphi_1)}{R}$

(C) $\frac{(\varphi_2 - \varphi_1)}{nR}$ (D) $\frac{nR}{(\varphi_2 - \varphi_1)}$

Ans. A

Sol. Induced is emf is $|e| = \frac{\Delta\varphi}{\Delta t}$.

Now $\Delta q = I\Delta t = \frac{e}{R}\Delta t = \frac{\Delta\varphi}{R\Delta t} \times \Delta t = \frac{\Delta\varphi}{R} = \frac{(\varphi_2 - \varphi_1)}{R}$

28. A closed organ pipe of length *L* is vibrating in its first overtone. There is a point *Q* inside the pipe at a distance 7*L*/9 from the open end. The ratio of pressure amplitude at *Q* to the maximum pressure amplitude in the pipe is

(A) 1 : 2 (B) 2 : 1

(C) 1 : 1 (D) 2 : 3

Ans. A

Sol. $\Delta Pm = 2\Delta P_0 \cos kx$ (assuming closed end as origin)

At point *Q*, $x = L - \frac{7L}{9} = \frac{2L}{9}$

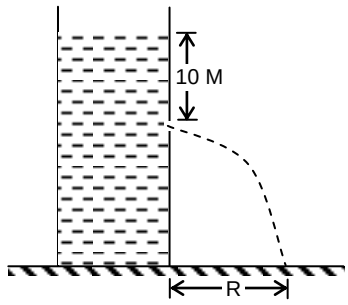
$\Delta Pm = 2\Delta P_0 \cos\left(\frac{2\pi}{\lambda} \times \frac{2L}{9}\right) = \Delta P_0$

$\therefore$ Required ratio = 1 : 2

29. The range of water flowing out of a small hole made at a depth 10 m below water surface in a large tank is R. Find the extra force per unit area applied on water surface so that range becomes 2R. (in atm an approximate value).

(A) 2 (B) 3

(C) 4 (D) 1



Ans. B

Sol. $P_o + P = P_o - \rho gh + \frac{1}{2}\rho v^2$ and $V = 2\sqrt{2gh}$

$P = 3\rho gh = 3 \times 10^5 = 3$ atm.

30. A uniform rod of length L has a mass per unit length λ and area of cross section A. The elongation in the rod is l due to its own weight if it is suspended from the ceiling of a room. The Young's modulus of the rod is

(A) $\frac{2\lambda gL^2}{Al}$ (B) $\frac{\lambda gL^2}{2Al}$

(C) $\frac{2\lambda gL}{Al}$ (D) $\frac{\lambda gl^2}{AL}$

Ans. B

Sol. $l = \int_0^L \frac{(L-x)mg\,dx}{LAY} = \frac{mgL}{2AY}$ (Here $m = \lambda L$), $Y = \frac{\lambda gL^2}{2Al}$

CHEMISTRY

31. How much charge is present in 14 g of N^{3-} ion?

(A) $(14 \times 6.022 \times 10^{23} \times 1.6 \times 10^{-19})$ coulomb

(B) $(3 \times 6.022 \times 10^{23} \times 1.6 \times 10^{-19})$ coulomb

(C) $(30 \times 6.022 \times 10^{23} \times 1.6 \times 10^{-19})$ coulomb

(D) $(6.022 \times 10^{6} \times 1.6 \times 10^{-19})$ coulomb

Ans. B

Sol. One ion carries $(3 \times 1.6 \times 10^{-19})$ coulomb charge

$\left(14g = \frac{14}{14} = 1\,\text{mole}\right)$ will carry $(3N \times 1.6 \times 10^{-19})$ coulomb charge

32. Two photons of wavelength 400 $\overset{o}{A}$ and 800 $\overset{o}{A}$ are absorbed consecutively by an atom and emitted as a single radiation. Assuming no loss, wavelength of emitted radiation is approximately.

(A) 600 $\overset{o}{A}$ (B) 800 $\overset{o}{A}$

(C) 267 $\overset{o}{A}$ (D) 1200 $\overset{o}{A}$

Ans. C

Sol. $$\frac{hc}{\lambda_1}+\frac{hc}{\lambda_2}=\frac{hc}{\lambda_{emitted}}$$

$$\frac{1}{400\,\overset{o}{A}}+\frac{1}{800\,\overset{o}{A}}=\frac{1}{\lambda_{emitted}}$$

33. What is the bond order of Li_2 molecule?

(A) 2 (B) 1

(C) 1.5 (D) 2.5

Ans. B

Sol. The bond order of Li_2(Li - Li) is one.

34. The correct order of chemical reactivity in terms of oxidizing property is

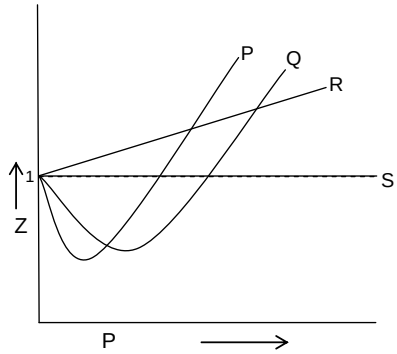
(A) F > Cl > O > N (B) F > O > Cl > N

(C) Cl > F > O > N (D) O > F > N > Cl

Ans. B

Sol. Along the period, oxidizing nature increases: F > O > N.
Down the group, oxidizing nature decreases: F > Cl
Since O is more electronegative than Cl, the oxidizing nature of O is more than that of Cl.

35. The variation of compressibility factor(Z) with pressure(P) for four gases is given below at 0^{o}C?



Which of the following line represents hydrogen gas?

(A) P (B) Q

(C) R (D) S

Ans. C

Sol. It shows only positive deviation from ideal behaviour at 0°C and any pressure.

36. Which of the following compounds liberate CO_2 on heating?
(A) Li_2CO_3 (B) Na_2CO_3
(C) K_2CO_3 (D) All of these

Ans. A

Sol. $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$

37. K_a of a weak monobasic acid(HA) is 10^{-8}. What will be the hydrolysis constant of A^- ion?
(A) 10^{-10} (B) 10^{-6}
(C) 10^{-8} (D) 10^{-4}

Ans. B

Sol. $K_h = \frac{K_w}{K_a} = \frac{10^{-14}}{10^{-8}} = 10^{-6}$

38. The conjugate base of HCO_3^- is
(A) H_2CO_3 (B) CO_3^{2-}
(C) CO_2 (D) None of these

Ans. B

Sol. $\underset{\text{Acid}}{HCO_3^-(aq)} + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + \underset{\text{Conjugate base}}{CO_3^{2-}(aq)}$

39. Which form of hydrogen exists in molecular form?
(A) Nascent hydrogen (B) Atomic hydrogen
(C) Ortho hydrogen (D) Adsorbed or occluded hydrogen

Ans. C

Sol. Ortho and para hydrogens exists in molecular form.

40. For which of the following reaction, ΔH(Change in enthalpy) is equal ΔU(Change in internal energy)
(A) $H_2(g) + I_2(s) \longrightarrow HI(g)$ (B) $C(\text{graphite}) + O_2(g) \longrightarrow CO(g)$
(C) $N_2(g) + O_2(g) \longrightarrow NO(g)$ (D) All of these

Ans. C

Sol. $N_2(g) + O_2(g) \longrightarrow 2NO(g); \Delta n_g = 0; \Delta H = \Delta U$

41. Which of the following compound is thermally least stable?
(A) BF_3 (B) BCl_3
(C) BBr_3 (D) BI_3

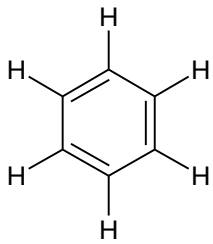
Ans. D

Sol. Due to weak B – I bond.

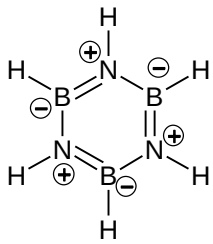
42. Among the given properties, which is correct for both borazine and benzene?
(A) They are aromatic compounds
(B) They are isoelectronic having total 42 electrons each
(C) The B and N-atoms in borazine and C-atoms in benzene are sp^2-hybridized
(D) All of these

Ans. D

Sol.



Benzene



Borazine

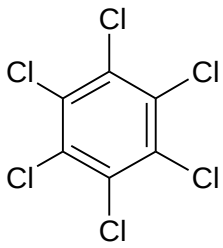
43. $BaO_2.8H_2O \xrightarrow{Heat} BaO_2 + 8H_2O$
In metallurgy, above reaction is called
(A) calcination (B) roasting
(C) smelting (D) self-reduction

Ans. A

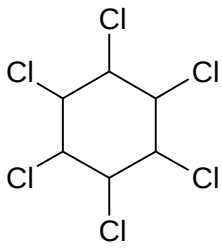
Sol. It is called calcination.

44. The correct structure for Gammaxane is

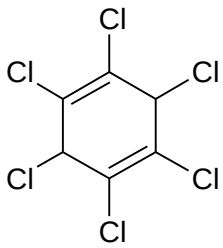
(A)



(B)



(C)



(D) None of these

Ans. B

Sol. Gammaxane is benzene hexachloride $C_6H_6Cl_6$.

45. Which of the following compound does not have isomers?
(A) C_2H_6 (B) C_2H_4
(C) C_3H_6 (D) C_4H_6

Ans. B

Sol. Ethylene has no isomers.

BIOLOGY

46. If parents have free ear lobes and the offspring has attached ear lobes, then the parents must be
(A) homozygous (B) heterozygous
(C) co-dominant (D) nullizygous

Ans. B

Sol. If parents have free ear lobes and the offspring has attached ear lobes, then the parents must be heterozygous.

47. During meiosis there is
(A) one round of DNA replication and one division
(B) two rounds of DNA replication and one division
(C) two rounds of DNA replication and two division
(D) one round of DNA replication and two division

Ans. D

Sol. During meiosis there is one round of DNA replication and two divisions.

48. Blood clotting involves the conversion of
(A) prothrombin to thromboplastin (B) thromboplastin to prothrombin
(C) fibrinogen to fibrin (D) fibrin to fibrinogen

Ans. C

Sol. Blood clotting involves the conversion of fibrinogen to fibrin.

49. The gall bladder is involved in
(A) synthesizing bile (B) storing and secreting bile
(C) degrading bile (D) producing insulin

Ans. B

Sol. The gall bladder is involved in storing and secreting bile.

50. Which one of the following colours is the LEAST useful for plant life?
(A) red (B) blue
(C) green (D) violet

Ans. C

Sol. Green colour is the LEAST useful for plant life.

51. At rest the volume of air that moves in and out per breath is called
(A) resting volume (B) vital capacity
(C) lung capacity (D) tidal volume

Ans. D

Sol. At rest the volume of air that moves in and out per breath is called tidal volume.

52. How many sex chromosomes does a normal human inherit from father?
(A) 1 (B) 2
(C) 23 (D) 46

Ans. A

Sol. Either X or Y chromosome 19/29.

53. Which ONE of the following conversions does NOT happen under anaerobic conditions?
(A) Glucose to ethanol by Saccharomyces.
(B) Lactose to lactic acid by Lactobacillus.
(C) Glucose to CO_2 and H_2O by Saccharomyces.
(D) Cellulose to glucose by Cellulomonas.

Ans. C

Sol. Glucose to CO_2 and H_2O by Saccharomyces does not happen under anaerobic conditions.

54. Retrogressive metamorphosis occurs in
(A) Balanoglossus
(B) Amphioxus
(C) Ascidian tadpole larva of Herdmamia
(D) None of the above

Ans. C

Sol. Retrogressive metamorphosis occurs in Ascidian tadpole larva of Herdmamia.

55. Sprain is caused by
(A) Excessive pulling of tendons
(B) Excessive pulling of muscles
(C) Excessive pulling of ligaments in which some fibres of supporting ligaments are ruptured
(D) Too much stretching and tearing of all ligaments

Ans. C

Sol. Sprain is caused by excessive pulling of ligaments in which some fibres of supporting ligaments are ruptured. 51. An abnormal rise in RBC count can be found during exercise and at high

56. Which ONE of the following molecules is derived from pantothenic acid?
(A) Thiamine pyrophosphate
(B) Nicotinamide adenine dinucleotide phosphate
(C) Flavin adenine dinucleotide phosphate
(D) Acetyl-CoA

Ans. D

Sol. Vitamin B_5 is pantothenic acid, that synthesize Co-enzyme A (CoA).

57. Match the disease given in Column I with the principal causal organism in Column II and choose the correct combination.

	Column –I		**Column –II**
(P)	AIDS	(i)	HBV
(Q)	Syphilis	(ii)	Neisseria sp.
(R)	Viral hepatitis	(iii)	Treponema sp.
(S)	Gonorrhoea	(iv)	HIV

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

Ans. A

Sol.

(P)	AIDS	(iv)	HIV
(Q)	Syphilis	(iii)	Treponema sp.
(R)	Viral hepatitis	(i)	HBV
(S)	Gonorrhoea	(ii)	Neisseria sp.

58. Chromosomes are classified based on the position of centromere. A chromosome having a terminal centromere is called:
(A) metacentric
(B) telocentric
(C) sub-metacentric
(D) acrocentric

Ans. B

Sol. A chromosome having a terminal centromere is called **telocentric**.

59. Which ONE of the following options lists the primary energy source (s) for all forms of life on earth?
(A) Light, Inorganic substances
(B) Inorganic substances, Organic substances
(C) Light, Organic substances
(D) N_2, CO_2

Ans. A

Sol. Autotrophs uses light for photosynthesis and some bacteria inorganic compound for chemosynthesis these organisms are produces in ecosystem.

60. Considering the following statements concerning food chains. Which of the following is/are correct statement(s)?
(1) Removal of 80% tigers from an area resulted in greatly increased growth of the vegetation.
(2) Removal of most of the carnivores resulted in increased population of deer's.
(3) The length of the food chains is generally limited to 3–4 trophic levels due to energy loss.
(4) The length of food chains may vary from 2 to 8 trophic levels.
(A) 1 and 2 (B) 2 and 3
(C) 3 and 4 (D) 1 and 4

Ans. B

Sol. The correct statements are: Removal of most of the carnivores resulted in increased population of deer's. The length of the food chains is generally limited to 3–4 trophic levels due to energy loss.

PART – II

MATHEMATICS

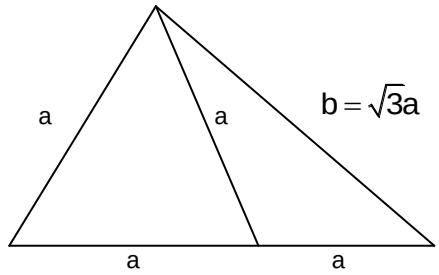
61. Four distinct points are arranged on a plane so that the segments connecting them have lengths a, a, a, a, 2a and b. What is the ratio of b to a?

(A) $\sqrt{3}$ (B) 2

(C) $\sqrt{5}$ (D) 3

Ans. A

Sol. When you see that there are lengths a and 2a, one could think of 30 – 60 – 90 triangles. Since all of the other's lengths are a, you could think that $b=\sqrt{3}a$. Drawing the points out, it is possible to have a diagram where $b=\sqrt{3}a$. It turns out that a, 2a, and b could be the lengths of a 30 – 60 – 90 triangle, and the other 3 a's can be the lengths of an equilateral triangle formed from connecting the dots. So, $b=\sqrt{3}a$, so, $b=a=\sqrt{3}=(A)$



62. The number of numbers of the form $30a0b03$ (where a, b are decimal digits) which are divisible by 13 is

(A) 5 (B) 6

(C) 7 (D) 0

Ans. C

Sol. $30a0b03=3000003+10000a+100b$

$=13k_1+6+13k_2+3a+13k_3+9b$

$=13(k_1+k_2+k_3)+(6+3a+9b)$

$=13(k_1+k_2+k_3)+3(2+a+3b)$

$\Rightarrow 2+a+3b$ should be divisible by 13

As a, b are digits

$\therefore 2+a+3b=13,26$

When $2+a+3b=13$,

then the possible values b are 1, 2, 3 so 3 cases are possible

When $2+a+3b=26$,

then the possible values b are 5, 6, 7, 8 so 4 cases are possible

So total cases 7.

63. The first four distinct terms in an arithmetic sequence are $x+y$, $x-y$, xy and $\frac{x}{y}$, in that order. What is the fifth term?

(A) $-\frac{6}{5}$ (B) 0

(C) $\frac{27}{20}$ (D) $\frac{123}{40}$

Ans. D

Sol. The difference between consecutive terms is $(x-y)-(x+y)=-2y$. Therefore we can also express the third and fourth terms as $x-3y$ and $x-5y$. Then we can set them equal to xy and $\frac{x}{y}$.

$xy = x-3y$

$xy - x = -3y$

$x(y-1) = -3y$

$x = \frac{-3y}{y-1}$

Substitute into the other equation.

$\frac{x}{y} = x-5y \Rightarrow \frac{-3}{y-1} = \frac{-3y}{y-1} - 5y$

$\Rightarrow -3y - 5y(y-1) = -3$

$\Rightarrow 5y^2 - 2y - 3 = 0$

$\Rightarrow (5y+3)(y-1) = 0$

$\Rightarrow y = -\frac{3}{5}, 1$

But y cannot be 1. Therefore $y = -\frac{3}{5}$.

Substituting the value for y into any of the equations, we get $x = -\frac{9}{8}$.

Finally, $\frac{x}{y} - 2y = \frac{9.5}{8.3} + \frac{6}{5} = \frac{123}{40}$

64. ABCD is a parallelogram and P is a point on AD such that $\frac{AP}{AD} = \frac{1}{2016}$. Q is the point of intersection of AC and BP. Then $\frac{AQ}{AC}$ is equal to

(A) $\frac{1}{2015}$ (B) $\frac{1}{2016}$

(C) $\frac{1}{2017}$ (D) $\frac{1}{2018}$

Ans. C

Sol. Let $AD = 2016x$

$AP = x$

$\therefore PD = AD - AP = 2016x - x = 2015x$

AD = BC = 2016x

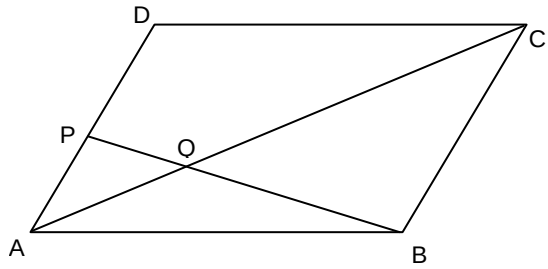
By AA similarity, $\Delta PQA \sim \Delta BQC$

$$\frac{PA}{BC} = \frac{AQ}{QC}$$

$$\frac{x}{2016x} = \frac{AQ}{QC}$$

$$\frac{1}{2016} = \frac{AQ}{QC}$$

$$\therefore \frac{AQ}{AC} = \frac{1}{2017}$$



65. The product of two of the four roots of $x^4 - 20x^3 + kx^2 + 590x - 1992 = 0$ is 24. The value of k is

(A) 41 (B) 40

(C) 42 (D) 43

Ans. A

Sol. Let the given equation be written as $f(x) = 0$, and let the roots of the equation be r_1, r_2, r_3, r_4 with $r_1 r_2 = 24$. Now $r_1 r_2 r_3 r_4 = -1992$, so $r_3 r_4 = \frac{-1992}{24} = -83$. Also,

$f(x) = (x - r_1)(x - r_2)(x - r_3)(x - r_4)$

$= (x^2 - cx + r_1 r_2)(x^2 - dx + r_3 r_4)$

$= (x^2 - cx + 24)(x^2 - dx - 83)$,

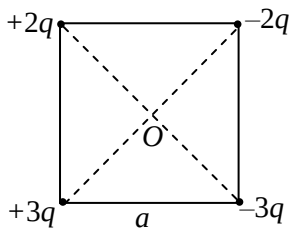
with $c = r_1 + r_2$, $d = r_3 + r_4$. Comparing coefficients of x^3 and x we get $c + d = 20$ and $83c - 24d = 590$. This gives $c = 10, d = 10$. Comparing coefficients of $x^2, k = cd - 83 + 24 = 100 - 83 + 24 = 41$.

PHYSICS

66. Four charges +2q, –2q, –3q and +3q are kept in the corners of a square of side a. The total field at the centre O is

(A) zero (B) $\frac{2\sqrt{2}\,q}{4\pi\varepsilon_0 a^2}$

(C) $\frac{\sqrt{2}\,q}{4\pi\varepsilon_0 a^2}$ (D) $\frac{10\sqrt{2}\,q}{4\pi\varepsilon_0 a^2}$



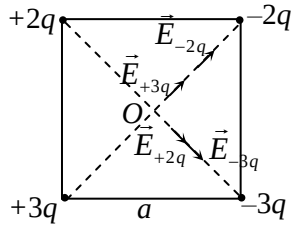
Ans. D

Sol. $\vec{E} = \vec{E}_{+2q} + \vec{E}_{-2q} + \vec{E}_{-3q} + \vec{E}_{+3q}$

$E = \sqrt{2}\left(E_{+3q} + E_{-2q}\right)$

$E = \sqrt{2}\dfrac{5q}{4\pi\varepsilon_0\left(\dfrac{a}{\sqrt{2}}\right)^2}$

$E = \dfrac{10\sqrt{2}\,q}{4\pi\varepsilon_0 a^2}$



67. A 1.5 kg block is initially at rest on a horizontal frictionless surface when a horizontal force in the positive direction of x-axis is applied to the block. The force is given by $\vec{F} = \left(4 - x^2\right)\hat{i}$ N, where x is in metre and the initial position of the block is x = 0. The maximum kinetic energy of the block between x = 0 and x = 2 m is

(A) 2.33 J (B) 8.67 J
(C) 5.33 J (D) 6.67 J

Ans. C

Sol. $\vec{a} = \dfrac{d\vec{v}}{dt} = \dfrac{\vec{F}}{m} = \dfrac{\left(4 - x^2\right)}{1.5}\hat{i}$

$\Rightarrow v\dfrac{dv}{dx} = \dfrac{4 - x^2}{1.5}$

$\therefore \int_o^v v\,dv = \dfrac{1}{1.5}\int_o^x \left(4 - x^2\right)dx$

$\Rightarrow \dfrac{v^2}{2} = \dfrac{1}{1.5}\left[4x - \dfrac{x^3}{3}\right]$

$\therefore k = \dfrac{1.5v^2}{2} = \left[4x - \dfrac{x^3}{3}\right]$

$\dfrac{dk}{dx} = 0 \Rightarrow 4 - 3x^2 = 0 \Rightarrow x = 2m$

$\dfrac{d^2k}{dx^2} = -6x$

$\therefore$ k is maximum at x = 2

$\therefore \quad k_{max} = 8 - \dfrac{8}{3} = \dfrac{16}{3}J = 5.33J$

68. An ideal gas (γ = 1.5) is expanded adiabatically. How many times has the gas to be expanded to reduce the root mean square velocity of molecules 2.0 times

(A) 4 times (B) 16 times
(C) 8 times (D) 2 times

Ans. B

Sol. $V_{rms} = \sqrt{\frac{3RT}{M}}$

$\therefore\ V_{rms} \propto \sqrt{T}$

V_{rms} is to reduce two times i.e, temperature of the gas will have to reduce four times or $\frac{T'}{T} = \frac{1}{4}$

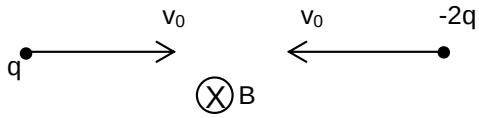
During adiabatic process

$TV^{\gamma-1} = T'V'^{\gamma-1}$

or, $\frac{V'}{V} = \left(\frac{T}{T'}\right)^{\frac{1}{\gamma-1}} = (4)^{\frac{1}{1.5-1}} = 4^2 = 16$

$\therefore\ V' = 16V$

69. A charge particle q of mass m is placed at a distance d from another charge particle – 2q of mass 2m in a uniform magnetic field B as shown. If particles are projected towards each other with equal speed v_0, so that the two particles touches each other without collision during its motion. (Assume only force due to magnetic field acts on the particle) find v_o



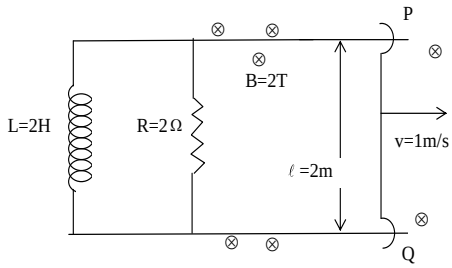
(A) $\frac{qBd}{m}$ (B) $\frac{qBd}{2m}$

(C) $\frac{2qBd}{m}$ (D) $\frac{3qBd}{2m}$

Ans. B

Sol. $d = \frac{mv_0}{qB} + \frac{2mv_0}{2qB}$

70. The given figure shows an inductor and resistance fixed on a conducting wire. A movable conducting wire PQ starts moving on the fixed rails from t = 0 with constant velocity 1m/s. The work done by the external force on the wire PQ in 2 seconds is



(A) 16 J
(B) 32 J
(C) 48 J
(D) 64 J

Ans. B

Sol. $W = B^2V^2\ell^2t\left[\frac{1}{R} + \frac{t}{2L}\right] = 32$ J

CHEMISTRY

71. $CH_3\underset{Cl}{\underset{|}{C}}H\underset{Cl}{\underset{|}{C}}HCH_3 \xrightarrow[\text{reactions}]{\text{Elimination}} \text{Products}$

Which is not a product of above reaction?

(A) $CH_3CH = CHCH_3$ (B) $CH_3CH_2CH = CH_2$

(C) $CH_3C \equiv CCH_3$ (D) $CH_2 = CH - CH = CH_2$

Ans. B

Sol. $CH_3CH_2CH = CH_2$ is not formed in the reaction.

72. Fluorine reacts with uranium to produce uranium hexafluoride, UF_6 as

$U(s) + 3F_2(g) \longrightarrow UF_6(g)$

How many fluorine molecules are required to produce 2.0 mg of Uranium hexafluoride, UF_6 from an excess of Uranium? The mass of UF_6 is 360 g/mol.

(A) 1.0×10^{19} (B) 2.0×10^{19}

(C) 1.0×10^{20} (D) 2.0×10^{20}

Ans. A

Sol. Moles of UF_6 produced = $\frac{2\times10^{-3}}{360}$ mol

Moles of F_2 required = $3 \times \frac{2\times10^{-3}}{360}$ mol

Molecule of F_2 required = $3 \times \frac{2\times10^{-3}}{360} \times 6.02 \times 10^{23}$

73. What is the hybridization of sulphur in SOF_4?

(A) sp^3d (B) sp^3d^2

(C) sp^3d^3 (D) sp^3

Ans. A

Sol. Sulphur undergoes sp^3d hybridization in SOF_4.

74. The correct stability order of the following resonance structure is

$\underset{(I)}{H_2C=\overset{+}{N}=\overline{N}}$ $\underset{(II)}{H_2\overset{+}{C}-N=\overline{N}}$ $\underset{(III)}{H_2\overline{C}-\overset{+}{N}\equiv N}$ $\underset{(IV)}{H_2\overline{C}-N=\overset{+}{N}}$

(A) (I) > (II) > (IV) > (III) (B) (I) > (III) > (II) > (IV)

(C) (II) > (I) > (III) > (IV) (D) (III) > (I) > (IV) > (II)

Ans. B

Sol. Negative charge is more stable on more electronegative atom and structure in which all atoms have complete octet are more stable.

75. Pyrolysis of boron hydrides produce
(A) pure boron (B) impure boron
(C) borohydride ions (D) boron oxides

Ans. A

Sol. $B_2H_6 \xrightarrow{\Delta} 2B + 3H_2$

BIOLOGY

76. Which of these is mismatched?
(A) Elaioplasts $\rightarrow$ Store oils or fats
(B) Amyloplasts $\rightarrow$ Store protein granules
(C) Leucoplasts $\rightarrow$ Contain colourless pigment
(D) Chloroplasts $\rightarrow$ Contain chlorophyll pigments
(E) Chromoplasts $\rightarrow$ Contain coloured pigments other than chlorophyll

Ans. B

Sol. Amyloplasts do not store protein granules. They are responsible for the synthesis and storage of starch granules, through the polymerization of glucose. Amyloplasts also convert this starch back into sugar when the plant needs energy.

77. Which is not correct with respect to human kidney?
(A) The peripheral region is called cortex and central medulla
(B) Malpighian capsules are present in the cortex region
(C) Blood enters glomerulus through efferent arterioles
(D) The concave part of kidney is called hilus

Ans. C

Sol. Blood enters the glomerulus through efferent arterioles.

78. A plant of F_1-generation has genotypes 'AABbCC'. On selfing of this plant, the phenotypic ratio in F_2-generation will be
(A) 3 : 1
(B) 1 : 1
(C) 9 : 3 : 3 : 1
(D) 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1

Ans. A

Sol. Since, AABbCC contains only one heterozygous allelic pair Bb', the cross would behave as monohybrid cross leading to 3 : 1 phenotypic ratio in F.

79. Match the hormones listed under column –I with their functions listed under column–II choose the answer, which gives the correct combination of the alphabets of the two columns: Column-I

	Column –I		Column –II
(a)	Oxytocin	(1)	Stimulates ovulation
(b)	Prolactin	(2)	Implantation and maintenance of pregnancy
(c)	Luteinising hormone	(3)	Lactation after child birth
(d)	Progesterone	(4)	Uterine contraction during labour
		(5)	Reabsorption of water by nephrons

(A) a $\rightarrow$ 4; b $\rightarrow$ 2; c $\rightarrow$ 3; d $\rightarrow$ 5
(B) a $\rightarrow$ 5; b $\rightarrow$ 3; c $\rightarrow$ 1; d $\rightarrow$ 4
(C) a $\rightarrow$ 4; b $\rightarrow$ 3; c $\rightarrow$ 1; d $\rightarrow$ 2
(D) a $\rightarrow$ 2; b $\rightarrow$ 3; c $\rightarrow$ 1; d $\rightarrow$ 4

Ans. C

Sol.

(a)	Oxytocin	(4)	Uterine contraction during labour
(b)	Prolactin	(3)	Lactation after child birth
(c)	Luteinising hormone	(1)	Stimulates ovulation
(d)	Progesterone	(2)	Implantation and maintenance of pregnancy

80. Which of the following are viral and mosquito borne diseases?
(A) Filaria and typhus
(B) Kala-azar and diphtheria
(C) Malaria and chagas disease
(D) Yellow fever and dengue

Ans. D

Sol. Yellow fever and dengue are viral and mosquito borne diseases.