KVPY – CLASS-XI
FULL TEST – 1
(OLTS-1819-T5-FT-1-KVPY-XI)

PART – I

MATHEMATICS

1. The number of permutation (a, b, c, x, y, z) of (1, 2, 3, 4, 5, 6) which satisfy the five inequalities $a < b < c, x < y < z, a < x, b < y$ and $c < z$ is

(A) 1 (B) 2
(C) 3 (D) 5

Ans. D

Sol. Notice that we must have a = 1, z = 6, Now, we can just list trying values for b, c; (1, 2, 3, 4, 5, 6), (1, 2, 4, 3, 5, 6), (1, 2, 5, 3, 4, 6), (1, 3, 4, 2, 5, 6), (1, 3, 5, 2, 4, 6). Thus, the answer is 5

2. Let $a_1, a_2, ...$ be a sequence fro which $a_1 = 2, a_2 = 3$ and $a_n = \frac{a_{n-1}}{a_{n-2}}$ for each positive integer $n \geq 3$. What is a_{2018}?

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

Ans. D

Sol. Looking at the first few terms of the sequence

$a_1 = 2, a_2 = 3, a_3 = \frac{3}{2}, a_4 = \frac{1}{2}, a_5 = \frac{1}{3}, a_6 = \frac{2}{3}, a_7 = 2, a_8 = 3, ...$

Clearly, the sequence repeats every 6 terms.

Since $2018 \equiv 2 \bmod 6$

$a_{2018} = a_2 = 3$

3. A wooden cube n units on a side is painted red on all six faces and then cut into n^3 unit cubes. Exactly one – fourth of the total number of faces of the unit cubes are red. What is n?

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

Ans. B

Sol. Since there are n^2 little faces on each face of the big wooden cube, there are $6n^2$ little faces painted red.

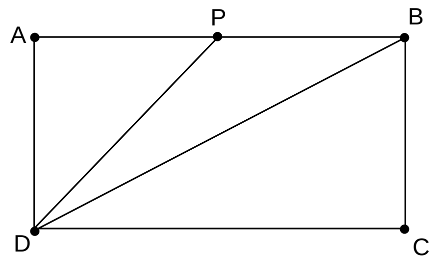
Since each unit cube has 6 faces, there are $6n^3$ little faces total.

Since one – fourth of the little faces are painted red, $\frac{6n^2}{6n^3} = \frac{1}{4}$

$\frac{1}{n} = \frac{1}{4}$

$n = 4$

4. In rectangle ABCD, AD = 1, P is on $\overrightarrow{AB}$, and $\overrightarrow{DB}$ and $\overrightarrow{DP}$ trisect $\angle ADC$. What is the perimeter of ΔBDP?



(A) $3+\frac{\sqrt{3}}{3}$ (B) $2+\frac{4\sqrt{3}}{3}$

(C) $2+2\sqrt{2}$ (D) $\frac{3+3\sqrt{5}}{2}$

Ans. B

Sol. $AD=1$

Since $\angle ADC$ is trisected,

$\angle ADP=\angle PDB=\angle BDC=30^{o}$

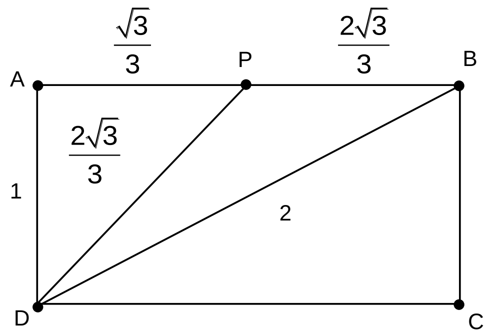
Thus, $PD=\frac{2\sqrt{3}}{3}$

$DB=2$

$DB=2$

$BP=\sqrt{3}-\frac{\sqrt{3}}{3}=\frac{2\sqrt{3}}{3}$

Adding, $2+\frac{4\sqrt{3}}{3}$.



5. Given that $-4\le x\le -2$ and $2\le y\le 4$, what is the largest possible value of $\frac{x+y}{x}$?

(A) –1 (B) $-\frac{1}{2}$

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

Ans. D

Sol. Rewrite $\frac{(x+y)}{x}$ as $\frac{x}{x}+\frac{x}{y}=1+\frac{y}{x}$. We also know that $\frac{y}{x}<0$ because x and y are of opposite sign. Therefore, $1+\frac{y}{x}$ is maximized when $\left|\frac{y}{x}\right|$is minimized, which occurs when $|x|$ is the largest and $|y|$is the smallest. This occurs at (–4, 2), so $\frac{x+y}{x}=1-\frac{1}{2}=\frac{1}{2}$

6. Let P be a cubic polynomial with P (0) =k, P (1) = 2k, and P (–1) = 3k. What is P (2) + P(–2)?

(A) 0 (B) k

(C) 7k (D) 14k

Ans. D

Sol. Let $P(x)=Ax^3+Bx^2+Cx+D$. Plugging in 0 for x, we find $D=k$, and plugging in 1 and –1 for x, we obtain the following equations: A + B + C + k = 2k – A + B – C + k = 3k Adding these two equations together, we get $2B=3k$. If we plug in 2 and –2 in for x, we find the $P(2)+P(-2)=8A+4B+2C+k+(-8A+4B-2C+k)=8B+2k$ multiplying the third equation by 4 and adding 2k gives us our desired result, so $P(2)+P(-2)=12k+2k=D\rightarrow \boxed{14k}$

7. For the consumer, a single discount of n% is more advantageous than any of the following discounts:
(1) two successive 15% discounts
(2) three successive 10% discounts
(3) a 25% discount followed by a 5% discounts
What is the smallest possible positive integer value of n?

(A) 28 (B) 29
(C) 31 (D) 33

Ans. B

Sol. Let the original price be x. Then, for option 1 the discounted price is $(1-.15)(1-.15)x=.7225x$. For option 2, the discounted price is $(1-.1)(1-.1)(1-.1)x=.729x$. Finally, for option 3, the discounted price is $(1-.25)(1-.05)=.7125x$. Therefore n must be greater than max $(x-.7225x,\ x-.729x,\ x-.7125x)$. It follows n must be greater than .2875. We multiply this by 100 to get the percent value, and then round up because n is the smallest integer that provides a greater discount than 28.75, leaving us with the answer of 29.

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

(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

9. Let $a_n=\sum_{k=1}^{n}\frac{1}{k(n+1-k)}$, then for $n\ge 2$

(A) $a_{n+1}>a_n$ (B) $a_{n+1}<a_n$
(C) $a_{n+1}=a_n$ (D) $a_{n+1}-a_n=\frac{1}{n}$

Ans. B

Sol. We have $a_n=\sum_{k=1}^{n}\left(\frac{1}{k}+\frac{1}{n+1-k}\right)$

$$=\frac{2}{n+1}\sum_{k=1}^{n}\left(\frac{1}{k}+\frac{1}{n+1-k}\right)$$

$$=\frac{2}{n+1}\sum_{k=1}^{n}\frac{1}{k}$$

For $n\ge 2$

$$\frac{1}{2}(a_n-a_{n+1})=\frac{1}{n+1}\sum_{k=1}^{n}\frac{1}{k}-\frac{1}{n+2}\sum_{k=1}^{n+1}\frac{1}{k}$$

$$=\left(\frac{1}{n+1}-\frac{1}{n+2}\right)\sum_{k=1}^{n}\frac{1}{k}-\frac{1}{(n+1)(n+2)}$$

$$=\frac{1}{(n+1)(n+2)}\sum_{k=2}^{n}\frac{1}{k}>0$$

$$\Rightarrow a_n>a_{n+1}$$

10. If $a - \log_{12} 18,\ b = \log_{24} 54$ then the value of $ab + 5(a-b)$ is

(A) 0 (B) 4

(C) 1 (D) none of these

Ans. C

Sol. We have $a = \log_{12} 18 = \dfrac{\log_2 18}{\log_2 12} = \dfrac{1+2\log_2 3}{2+\log_2 3}$ and $b = \log_{24} 54 = \dfrac{\log_2 54}{\log_2 24} = \dfrac{1+3\log_2 3}{3+\log_2 3}$

Putting $x = \log_2 3,$ we have

$$ab + 5(a-b) = \frac{1+2x}{2+x}\cdot\frac{1+3x}{3+x} + 5\left(\frac{1+2x}{2+x} - \frac{1+3x}{3+x}\right)$$

$$= \frac{6x^2 + 5x + 1 + 5(-x^2+1)}{(x+2)(x+3)} = \frac{x^2+5x+6}{(x+2)(x+3)} = 1$$

11. The number of functions f from the set A = $\{0, 1, 2\}$ in to the set $B = \{0,1,2,3,4,5,6,7\}$ such that $f(i) \le f(j)$ for $i < j$ and, $i, j \in A$ is

(A) ${}^8C_3$ (B) ${}^8C_3 + 2\left({}^8C_2\right)$

(C) ${}^{10}C_3$ (D) none of these

Ans. C

Sol. A function $f : A \to B$ such that $f(0) \le f(1) \le f(2)$ falls in one of the following four categories.

Case 1 $f(0) < f(1) < f(2)$

There are ${}^8C_3$ function in this category

Case 2 $f(0) = f(1) < f(2)$

There are ${}^8C_2$ function in this category

Case 3 $f(0) < f(1) = f(2)$

There are ${}^8C_2$ functions in this category

Case 4 $f(0) = f(1) = f(2)$

There are ${}^8C_1$ functions in this category

Thus, the number of desired functions is

$${}^8C_3 + {}^8C_2 + {}^8C_2 + {}^8C_1 = {}^9C_3 + {}^9C_2 = {}^{10}C_3$$

12. If D is the mid point of side BC of a triangle ABC and AD is perpendicular to AC, then

(A) $3b^2 = a^2 - c^2$ (B) $3a^2 = b^2 - 3c^2$

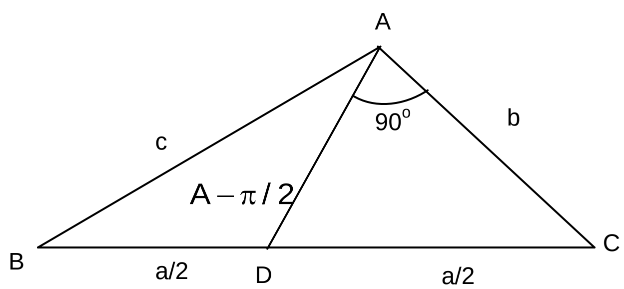
(C) $b^2 = a^2 - c^2$ (D) $a^2 + b^2 = 5c^2$

Ans. A

Sol. Form the right – angled triangle CAD (figure) we have

$$\cos C = \frac{b}{a/2} \Rightarrow \frac{2b}{a} = \frac{a^2+b^2-c^2}{2\,ab}$$

$$\Rightarrow a^2 + b^2 - c^2 = 4b^2 \Rightarrow a^2 - c^2 = 3b^2$$



13. Equation of a line which is parallel to the line common to the pair of lines given by $6x^2 - xy - 12y^2 = 0$ and $15x^2 + 14xy - 8y^2 = 0$ and the sum of whose intercepts on the axes is 7, is

(A) $2x - 3y = 42$ (B) $3x + 4y = 12$

(C) $5x - 2y = 10$ (D) none of these

Ans. B

Sol. $6x^2 - xy - 12y^2 = 0$

$\Rightarrow \quad (2x - 3y)(3x + 4y) = 0 \quad \ldots(i)$

and $\quad 15x^2 + 14xy - 8y^2 = 0$

$\Rightarrow \quad (5x - 2y)(3x + 4y) = 0 \quad \ldots(ii)$

Equation of the line common to (i) and (ii) is $3x + 4y = 0$

Equation of any line parallel to (ii) is $3x + 4y = k$ or $\frac{x}{k/3} + \frac{y}{k/4} = 1$

If $\frac{k}{3} + \frac{k}{4} = 7$, then $k = 12$ and the equation of the required line is $3x + 4y = 12$

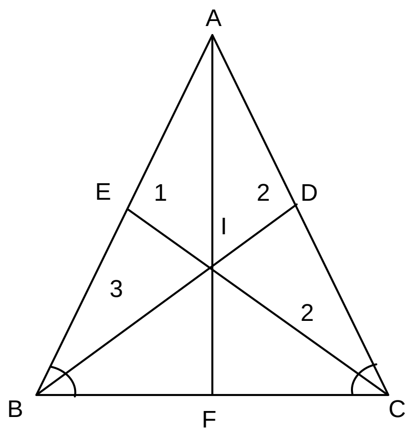
14. The angles bisectors BD and CE of a triangle ABC are divided by the incentre I in the ratios 3 : 2 and 2 : 1 respectively. Then the ratio in which I divides the angles bisector through A is

(A) 3 : 1 (B) 11 : 4

(C) 6 : 5 (D) 7 : 4

Ans. B

Sol. $\because \frac{AI}{IF} = \frac{b+c}{a} \quad \ldots..(1)$



$\because \frac{BI}{ID} = \frac{a+c}{b} = \frac{3}{2} \quad \ldots\ldots(2)$

$\because \frac{CI}{IE} = \frac{a+c}{c} = \frac{2}{1}$

$\Rightarrow a + b = 2c \quad \ldots\ldots(3)$

(2) 2a + 2c = 3b using to

$\Rightarrow 2a + a + b = 3b$ using (3)

$\Rightarrow 3a = 2b$

$\Rightarrow b = \frac{3}{2}a \quad \ldots..(4)$

Now again (3) $\Rightarrow 2c = a + b$

$= a + \frac{3}{2}a$

$\Rightarrow c + \frac{5}{4}a$

Hence $\frac{AI}{IF} = \frac{b+c}{a} = \frac{\frac{1}{2}a + \frac{5}{4}a +}{a} = \frac{11}{4}$

15. Let a and b be relatively prime integers with $a > b > 0$ and $3\left(a^3 - b^3\right) = 73(a-b)^3$. What is a – b?

(A) 1 (B) 2

(C) 3 (D) 4

Ans. C

Sol. Since a and b are both integers, $a^3 - b^3$ and $(a-b)^3$ are both integers as well. Then, for the given fraction to simplify to $\frac{73}{3}$, the denominator $(a – b)^3$ must be a multiple of 3. Thus, a – b is a multiple of 3. Looking at the answer choices, the only multiple of 3 is

PHYSICS

16. A block of mass 2 kg rest on a rough inclined plane making an angle 30° with horizontal of coefficient of friction 0.8. ($g = 10\ m/s^2$). The magnitude of resultant of friction and normal reaction on the block will be

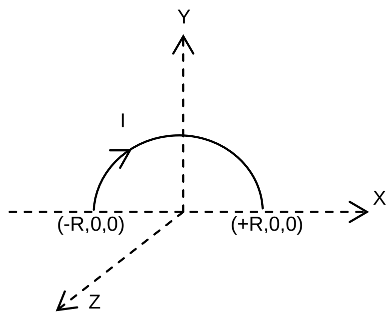
(A) $\sqrt{292}$ N (B) $\sqrt{364}$ N
(C) 20 N (D) 18 N

Ans. C

Sol. $\vec{N} + \vec{F}_s + m\vec{g} = 0$

$\therefore\ |\vec{N} + \vec{F}_s| = |-m\vec{g}| = 20$ N

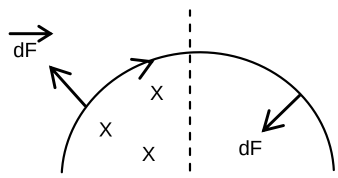
17. A semi circular current carrying wire having radius R is placed in x – y plane with its centre at origin 'O'. there is non uniform magnetic field $\vec{B} = \frac{B_0 x}{2R}\hat{k}$ (here B_0 is +ve constant) is existing in the region. The magnetic force acting on semi circular wire will be along



(A) – x – axis (B) + y – axis
(C) – y – axis (D) + x – axis

Ans. A

Sol. Hence, $\overrightarrow{F_{net}}$ is along (–x) –axis.



18. A body of mass 1kg is thrown upwards with a velocity 20m/s. It momentarily comes to rest after attaining a height of 18m. How much energy is lost due to air friction. ($g = 10\ m/s^2$)

(A) 10J (B) 20J
(C) 30J (D) 40J

Ans. B

Sol. Energy lost = $\frac{1}{2} \times 1 \times (20)^2 - 1 \times 10 \times 18$

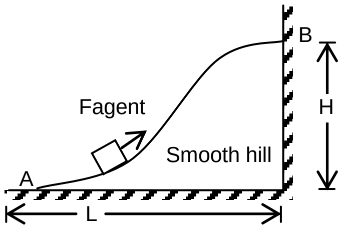
19. A stone is projected with a kinetic energy K at an angle of 60^0 with the horizontal. Its kinetic energy at the highest point of its trajectory will be

(A) 0 (B) $\frac{K}{4}$
(C) $\frac{K}{2}$ (D) $\frac{3K}{4}$

Ans. B

Sol. $\frac{1}{2}m\left(u\cos 60^0\right)^2$

20. A external agent moves the block m slowly from A to B, along a smooth hill such that every time he applies the force tangentially. Find the work done by agent in this interval.



(A) $\frac{m^2g^2H^2}{L}$ (B) $\frac{mgH^2}{L}$
(C) mg(H+L) (D) mgH

Ans. D

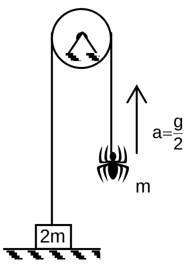
Sol. $W_{agent} - mgH = 0$
$W_{agent} = mgH$

21. A particle executes simple harmonic motion with a frequency f. Its kinetic energy oscillates with a frequency
(A) f (B) 2f
(C) f/2 (D) 4f

Ans. B

Sol. $x = A\sin\omega t$
$K.E. = \frac{1}{2}mV^2 = \frac{1}{2}m(A\omega\cos\omega t)^2$
$\Rightarrow$ Frequency of K.E. = 2f

22. An insect of mass m crawls along the hanging thread with an acceleration $a = \frac{g}{2}$. The reaction offered by ground on the block of mass 2 m is:



(A) $\frac{3mg}{2}$ (B) mg
(C) 2mg (D) $\frac{mg}{2}$

Ans. D

Sol. $T - mg = m\frac{g}{2}$
$N = 2\,mg - T = \frac{mg}{2}$

23. 40 gm of water at 30^oC is poured on a large block of ice at 0^oC. The mass of ice that melts is
(A) 30 gm (B) 80 gm
(C) 15 gm (D) 1600 gm

Ans. C

Sol. Since the block of ice at 0^oC is large, the whole of ice will not melt, hence final temperature is 0^oC.

$\therefore$ Q_1 = heat given up by water in cooling up to $0^{\circ}C$

= $ms\Delta\theta = 40\times1\times(30-0)$

= 1200 cal

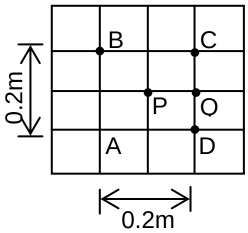
If m gm be the mass of ice melted, then

$Q_2 = mL = m\times80$

$Q_1 = Q_2$

$m\times80 = 1200$ or $m = 15$ gm

24. A, B, C, D, P and Q are points in a uniform electric field. The potentials at these points are V(A) = 2 volt. V(P) = V(B) = V(D) = 5 volt. V (C) = 8 volt. The electric field at P is



(A) $10Vm^{-1}$ along PQ
(B) $5Vm^{-1}$ along PC
(C) $15\sqrt{2}$ Vm^{-1} along PA
(D) 5 Vm^{-1} along PA

Ans. C

Sol. $E = -\frac{\Delta V}{\Delta r}$ directed perpendicular to an equipotential surface.

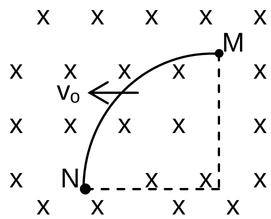
25. An object of mass m is hanging by a string from the ceiling of an elevator. The elevator is moving upward but slowing down. What is the tension in the sting

(A) less than mg
(B) exactly mg
(C) greater than mg
(D) zero

Ans. A

Sol. mg – T = ma [a is vertically downward]

26. A conducting wire is bent to form a quarter of circle of radius r and moved in a uniform magnetic field of induction B as shown in the figure. The emf induced across the ends of the wire will be

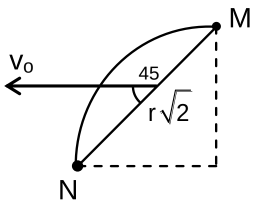


(A) Bv_or
(B) $\frac{\pi}{2}Bv_or$
(C) M will be at a higher potential with respect to N
(D) none of these

Ans. A

Sol. $E_{ind} = B(r\sqrt{2})V_o \sin 45$

$= Bv.r$



27. A simple pendulum has time period T_1. The point of suspension is now moved upward according to the relation. $y = Kt^2$. ($K = 1m/s^2$) where y is vertical displacement. The time period now become T_2. The ratio of $\frac{T_1^2}{T_2^2}$ is ($g = 10\ m/s^2$)

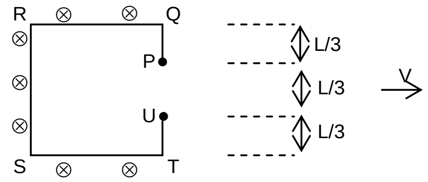
(A) 6/5
(B) 5/6
(C) 1
(D) 4/5

Ans. A

Sol. $a = \frac{d^2y}{dt^2} = 2k$, $T_1 = 2\pi\sqrt{\frac{\ell}{g}}$ and $T_2 = 2\pi\sqrt{\frac{\ell}{g+a}}$

$\frac{T_1^2}{T_2^2} = \frac{g+a}{g} = \frac{12}{10} = \frac{6}{5}$

28. A wire frame PQRSTU is moving horizontally with velocity v in a uniform magnetic field B acting perpendicular to its plane as shown in the figure. Choose the incorrect statement.



(A) the magnitude of inducted emf between P and Q is Bv $\left(\frac{2L}{3}\right)$

(B) the magnitude of induced emf between P and Q Bv$\left(\frac{L}{3}\right)$

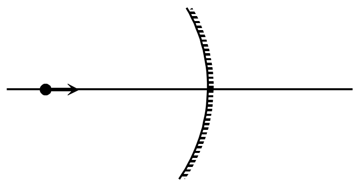
(C) The electric field in the portion RS of wire is non-zero.

(D) The electric field in the portion QP of wire is non-zero.

Ans. A

Sol. $\Delta V = Blv = B\frac{L}{3}V$ with 'P' at higher potential.

29. A point object is moving along the principal axis of a concave mirror at rest of focal length 30cm with speed 5m/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

30. If a rock is brought from the surface of the moon

(A) its mass will change

(B) its weight will change, but not mass

(C) both mass and weight will change

(D) its mass and weight will remain the same

Ans. B

Sol. The acceleration due to gravity on earth is 6 times the acceleration due to gravity on moon.

CHEMISTRY

31. When 10 g of 90% pure limestone is heated, the volume of CO_2(g) (in litre) liberated at STP is

(A) 22.4 litre (B) 2.24 litre
(C) 20.16 litre (D) 2.016 litre

Ans. D

Sol. $\because$ 100 g $CaCO_3$ gives 22.4 ℓ CO_2

$\therefore$ 9 g $CaCO_3$ gives $\frac{22.4 \times 9}{100} = 2.016\ell$

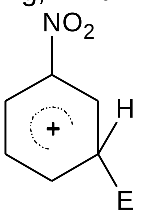
32. $Cr_2O_7^{2-} + X \xrightarrow{H^+} Cr^{3+} + H_2O +$ oxidised product of X, X in the above reaction cannot be

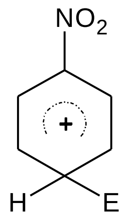
(A) $C_2O_4^{2-}$ (B) Fe^{2+}
(C) SO_4^{2-} (D) S^{2-}

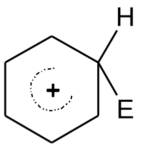
Ans. C

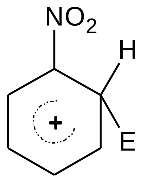
Sol. X should be a reducing agent (undergoes oxidation).

33. The electrophile, $E^{\oplus}$ attacks the benzene ring to generate the intermediate σ-complex. Of the following, which σ-complex is of lowest energy?

(A) 

(B) 

(C) 

(D) 

Ans. C

Sol. $-NO_2$ group attached on C_6H_6 ring deactivates for S_E reactions.

34. A neutral atom will have the lowest ionization potential when electronic configuration is

(A) $1s^1$ (B) $1s^2 2s^2 2p^6$
(C) $1s^2 2s^2 2p^6 3s^1$ (D) $1s^2 2s^2 2p^2$

Ans. C

Sol. $_{11}Na - 1s^2, 2s^2, 2p^6, 3s^1$

after removal it will achieve noble gas configuration.

35. When equal volumes of the following solutions are mixed, precipitation of AgCl ($K_{sp} = 1.8 \times 10^{-10}$) will occur only with:

(A) 10^{-4} M(Ag^+) and 10^{-4} M(Cl^-) (B) 10^{-5} M(Ag^+) and 10^{-5} M(Cl^-)
(C) 10^{-6} M(Ag^+) and 10^{-6} M(Cl^-) (D) 10^{-10} M(Ag^+) and 10^{-10} M(Cl^-)

Ans. A

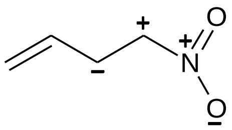
Sol. $\left[Ag^{+}\right]\left[Cl^{-}\right] > K_{SP}$ (for precipitation)
(Ionic Product)

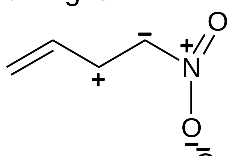
36. At 0ºC, the density of a gaseous oxide at 2 bar is same as that of nitrogen at 5 bar. What is molecular mass of oxide?
(A) 80 gm
(B) 70 gm
(C) 60 gm
(D) 50 gm

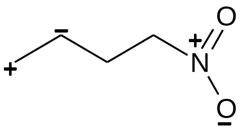
Ans. B

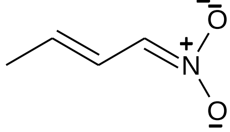
Sol. $P_1MM_1 = P_2MM_2$

37. The least stable resonance structure among the following is:

(A) 

(B) 

(C) 

(D) 

Ans. A

Sol. Due to similar charge on two nearest atoms.

38. Among KO_2, AlO_2^-, BaO_2 and NO_2^+ unpaired electron is present in:
(A) KO_2 only
(B) NO_2^+ and BaO_2
(C) KO_2 and AlO_2^-
(D) BaO_2 only

Ans. A

Sol. Unpaired electron is present in Superoxides.

39. The mass of sulphuric acid needed for dissolving 3 g magnesium carbonate is
(A) 3.5 g
(B) 7.0 g
(C) 1.7 g
(D) 17.0 g

Ans. A

Sol. $\underset{\substack{84\,g \\ 3\,g}}{MgCO_3} + \underset{\substack{98\,g \\ \frac{98}{84}\times 3 = 3.5g}}{H_2SO_4} \longrightarrow MgSO_4 + H_2O + CO_2$

40. 8 moles of gas AB_3 are introduced into a 1.0 dm^3 vessel. It dissociates as $2AB_3(g) \rightleftharpoons A_2(g) + 3B_2(g)$. At equilibrium 2 moles of A_2 are found to be present. The equilibrium constant for the reaction is
(A) 2 $mol^2\ L^{-2}$
(B) 3 $mol^2\ L^{-2}$
(C) 27 $mol^2\ L^{-2}$
(D) 36 $mol^2\ L^{-2}$

Ans. C

Sol. $\underset{\substack{8 \\ 4}}{2AB_{3(g)}} \longrightarrow \underset{\substack{0 \\ 2}}{A_{2(g)}} + \underset{\substack{0 \\ 6}}{3B_{2(g)}}$

$$K_a = \frac{2\times(6)^3}{4^2} = 27$$

41. According to Graham's law, at a given temperature the ratio of the rates of diffusion r_A/r_B of the gases A and B is given by:
(A) $(P_A/P_B)\,(M_A/M_B)^{1/2}$
(B) $(M_A/M_B)\,(P_A/P_B)^{1/2}$
(C) $(P_A/P_B)\,(M_B/M_A)^{1/2}$
(D) $(M_A/M_B)\,(P_B/P_A)^{1/2}$

Ans. C

Sol. $r \propto P\sqrt{\frac{1}{M}}$

42. Enthalpy of combustion of carbon to CO_2 is -398.5 kJ $mole^{-1}$. Calculate the heat released upon formation of 35.2 g of CO_2 from carbon and dioxygen gas.
(A) 134.2 kJ
(B) 318.8 kJ
(C) 234.2 kJ
(D) 421.2 kJ

Ans. B

Sol. For 44 g CO_2 heat released = 398.5 kJ
For 35.2 g CO_2 heat released = 318.8 kJ

43. The number of moles of $KMnO_4$ required to oxidise 1 mol of FeC_2O_4 in acidic medium is
(A) 0.6
(B) 1.67
(C) 0.2
(D) 0.4

Ans. A

Sol. $3KMnO_4 + 5FeC_2O_4 \longrightarrow Fe^{+3} + CO_2 + Mn^{+2}$
5 moles of $FeC_2O_4 \equiv$ 3 moles of $KMnO_4$
$\therefore$ 1 moles of $FeC_2O_4 \equiv$ 3/5 moles of $KMnO_4$
= 0.6 moles

44. Five molecules of a gas moving with speeds 1, 2, 3, 4, 5 km/sec. What is their root mean square speed?
(A) $\sqrt{55}$ km/sec
(B) $\sqrt{44}$ km/sec
(C) $\sqrt{11}$ km/sec
(D) $\sqrt{6}$ km/sec

Ans. C

Sol. $C = \sqrt{\frac{C_1^2 + C_2^2 + C_3^2 + C_4^2 + C_5^2}{n}}$

45. The correct order of decreasing first I.E. is
(A) C > B > Be > Li
(B) C > Be > B > Li
(C) B > C > Be > Li
(D) Be > Li > B > C

Ans. B

Sol. In II[nd] period order of IE is C > Be > B > Li

BIOLOGY

46. If kidney fails to reabsorb water, the tissue would:
(A) No change
(B) Swell
(C) Shrink
(D) Absorb more O_2

Ans. C

Sol. If kidney fails to reabsorb water, the tissue would shrink.

47. Diversification in plant life appeared:
(A) Due to abrupt change
(B) Suddenly on earth
(C) By seed dispersal
(D) Long periods of evolutionary changes

Ans. D

Sol. Diversification is a result of long period of evolutionary changes.

48. The cause of speciation is:
(A) Coacervates
(B) Geographical isolation
(C) Hybridisation
(D) Migration

Ans. B

Sol. Geographical isolation causes speciation.

49. CNS (Central Nervous System) developed from which type of germ layer.
(A) Ectoderm
(B) Mesoderm
(C) Endoderm
(D) Both B and C

Ans. A

Sol. CNS (Central Nervous System) developed from Ectoderm

50. Black soil is productive because of abundant:-
(A) Gravel and calcium
(B) Clay and humus
(C) Silt and earthworm
(D) Sand and zinc

Ans. B

Sol. Black soil is productive because of abundant clay and humus.

51. *Gambusia* is a
(A) Part of fish
(B) Parasitic fish
(C) Predator of mosquito larvae
(D) None

Ans. C

Sol. *Gambusia* is predator of mosquito larvae.

52. Litmus is obtained from
(A) Algae
(B) Lichen
(C) Fungi
(D) Protist

Ans. B

Sol. Litmus is obtained form lichen.

53. Fungus without mycelium is
(A) *Puccinia*
(B) *Albugo*
(C) *Agaricus*
(D) *Saccharomyces*

Ans. D

Sol. *Saccharomyces* is fungus without mycelium.

54. Plasmodesmata are located in narrow areas of ___
(A) Cell wall (B) Protoplasm
(C) Cellulose (D) Nuclei

Ans. A

Sol. Plasmodesmata are located in narrow areas of cell wall.

55. Bacteria fails to survive in highly salted pickles because
(A) They are killed by plasmolysis (B) Salt inhibit reproduction
(C) Pickles lack nutrient (D) None of these

Ans. A

Sol. Salt kills bacteria by plasmolysis.

56. Pectin in cell wall is___
(A) Excretory product (B) Secretory product
(C) Waste product (D) All

Ans. B

Sol. Pectin is secretory product.

57. Golgi body originate from :-
(A) Plasma membrane (B) Endoplasmic reticulum
(C) Ribosome (D) Mitochondria

Ans. B

Sol. Golgi body originate from Endoplasmic reticulum.

58. Vitamin C is helpful in
(A) Formation of visual pigment (B) Growth of Bones
(C) Treatment of pernicious anaemia (D) Wound healing

Ans. D

Sol. Vitamin C helps in wound healing.

59. In man, gall bladder is situated in
(A) Left lobe of liver (B) Cuadate lobe
(C) Quadrate lobe (D) Right lobe of liver

Ans. D

Sol. In man, gall bladder is situated in a depression on posterior surface of right lobe of liver.

60. Floating respiration is
(A) When lungs are filled with water and mucus
(B) Use of fats as substrate for respiration
(C) Use of proteins as substrate for respiration
(D) Lungs detatch and dislocates

Ans. B

Sol. Floating respiration use fats as substrate for respiration.

PART – II

MATHEMATICS

61. An object in the plane moves from one integer point to another. At each step, the object may move one unit to the right, one unit to the left, one unit up, or one unit down. If the object starts at the origin and takes a ten – step path, how many different points could be the final point?

(A) 120 (B) 121
(C) 221 (D) 230

Ans. B

Sol. Let the starting point be (0, 0). After 10 steps we can only be in locations (x, y) where $|x|+|y|\le 10$. Additionally, each step changes the parity of exactly one coordinate. Hence after 10 steps we can only be in locations (x, y) where x + y is even. It can easily be shown that each location that satisfies these two conditions is indeed reachable.

Once we pick $x\in\{-10, ...10\}$, we have $11-|x|$ valid choices for y, giving a total of 121 possible positions.

62. Equiangular hexagon ABCDEF has side lengths AB = CD = EF = 1 and BC = DE = FA = r. The area of ΔACE is 70% of the area of the hexagon. What is the sum of all possible values of r?

(A) $\frac{4\sqrt{3}}{3}$ (B) $\frac{10}{3}$
(C) 6 (D) $\frac{17}{4}$

Ans. C

Sol. It is clear that ΔACE is an equilateral triangle. From the Law of Cosines, we get that $AC^2 = r^2+1^2-2r\cos\frac{2\pi}{3} = r^2+r+1$. Therefore, the area of ΔACE is $\frac{\sqrt{3}}{4}\left(r^2+r+1\right)$

If we extend BC, DE and FA so that FA and BC meet at X, BC and DE meet at Y, and DE and FA meet at Z, we find that hexagon ABCDEF is formed by taking equilateral triangle XYZ of side length r + 2 and removing three equilateral triangles, ABC, CDY and EFZ, of side length 1. The area of ABCDEF is therefore $\frac{\sqrt{3}}{4}(r+2)^2-\frac{3\sqrt{3}}{4}=\frac{\sqrt{3}}{4}\left(r^2+4r+1\right)$.

Based on the initial conditions,

$$\frac{\sqrt{3}}{4}\left(r^2+r+1\right)=\frac{7}{10}\left(\frac{\sqrt{3}}{4}\right)\left(r^2+4r+1\right)$$

Simplifying this gives us $r^2-6r+1=0$. By Vieta's Formulas we know the sum of the possible value of r is (C) 6.

63. A Boy writes down four integers $w>x>y>z$ whose sum is 44. The pairwise positive differences of these numbers are 1, 3, 4, 5, 6 and 9. What is the sum of the possible values of w?

(A) 16 (B) 31
(C) 48 (D) 62

Ans. B

Sol. Assume that y – z = a, x – y = b, w – x = c, w – z results in the greatest pair wise difference, and thus it is 9. This means a + b +c = 9. a, b, c must be in the set 1, 3, 4, 5, 6. The only way for 3 numbers in the set to add up to 9 is if they are 1, 3, 5.. a+ b , and b + c then must be the remaining two numbers which are 4 and 6. The ordering of (a, b, c) must be either (3, 1, 5) or (5, 1, 3).

Case 1 (a, b, c) = (3, 1, 5) x = w – 5 y = w – 5 –1 x = w – 5 – 1 – 3

w + x + y + z = 4w – 20 = 44w = 16

Case 2 (a, b, c) = (5, 1, 3) x = w – 3y = w – 3 – 1 x = w – 3 – 1 – 5

w + x + y + z = 4w – 16 = 44 w = 15

The sum of the two w's is 15 + 16 = 31 (B)

64. The first four 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 $\frac{d}{y}$ because they are the same thing $xy=x-3y$

$xy-x=-3y$

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

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

Substitute into our other equation.

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

$=-3y-5y(y-1)0=5y^2-2y-30=(5y+3)(y-1)y=-\frac{3}{5}, 1$

But y cannot be 1 because then every term would be equal to x. Therefore $y=-\frac{3}{5}$.

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

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

65. Let a and b be positive real numbers such that $ab(a-b)=1$. Which of the followings can a^2+b^2 take?

(A) 1 (B) 2

(C) $2\sqrt{2}$ (D) $\sqrt{11}$

Ans. D

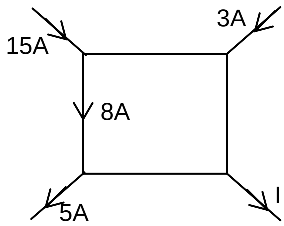
Sol. Let $u := a - b$, Then $a^2 + b^2 = u^2 + 2ab = u^2 + \frac{2}{u}$

By AM $\geq$ GM, we have $u^2 + \frac{2}{u} \geq 3\sqrt[3]{u^2 . \frac{1}{u} . \frac{1}{u}} = 3$

Thus, $a^2 + b^2 \geq 3$, but this condition is satisfied only by $\sqrt{11}$

PHYSICS

66. Value of I for the given network graph is:

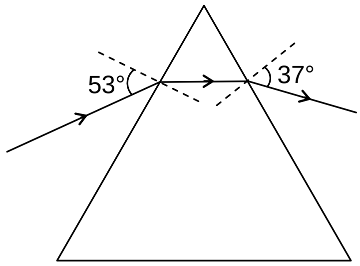


(A) 3 A
(B) 13 A
(C) 23 A
(D) 0 Amp

Ans. B

Sol. Apply Kirchhoff's law at all the junctions.

67. A ray incident at an angle 53° on prism emerges at an angle 37° as shown in the figure. If the angle of incidence is made 50°, which of the following is a possible value of angle of emergence



(A) 35° (B) 42°
(C) 40° (D) 38°

Ans. D

Sol. By the δ vs i graph if i is decreased e will increase less i.e. it may increase by (2° or 1°).

68. A ball is thrown with speed v and angle of projection with horizontal is θ. If the coefficient of restitution between ball and horizontal plane is e then the horizontal distance travelled by the ball after long time will be

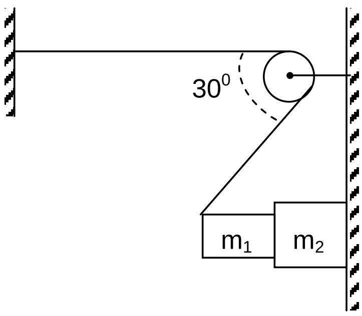
(A) $\frac{u^2 \sin^2\theta}{g}\left(\frac{1}{1-e^2}\right)$ (B) $\frac{u^2 \sin^2\theta}{g}\left(\frac{1}{1+e^2}\right)$

(C) $\frac{u^2 \cos^2\theta}{g}\left(\frac{1}{1-e^2}\right)$ (D) None of these

Ans. D

Sol. Velocity in horizontal direction is constant.

69. Two blocks with masses m_1 and m_2 of 10 kg and 20 kg respectively are placed as shown in the figure , μ_s = 0.2 between all surfaces, if block m_1 is at rest then the minimum tension in string and acceleration of m_2 block will be



(A) 250 N, 3 m/s^2
(B) 200 N, 6 m/s^2
(C) 306 N, 4.7 m/s^2
(D) 400 N, 6.5 m/s^2

Ans. C

Sol. For equilibrium of m_1

$T \sin 30° = m_1 g + f$

$f = \mu(T \cos 30°)$

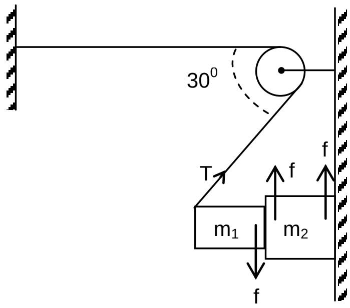
$\Rightarrow \quad T = 306$ N

For block m_2

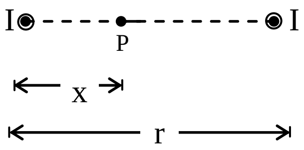
$m_2 g - 2f = m_2 a$

$f = \mu N = \mu(T \cos 30°)$

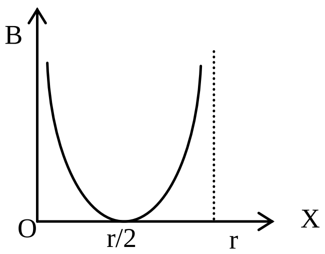
$\Rightarrow \quad a \approx 4.75 \text{ ms}^{-2}$



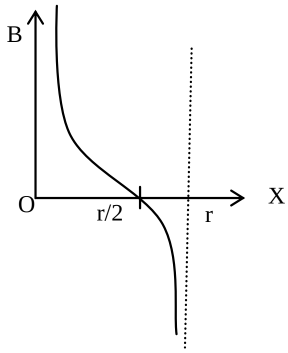
70. Two thin long straight wires are parallel to each other at a separation r apart and they carry current I each along the same directions as shown then induction of magnetic field B, between the wires, varies with x according to



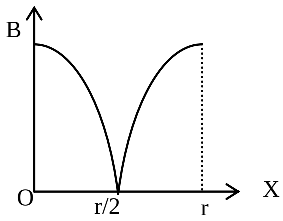
(A)



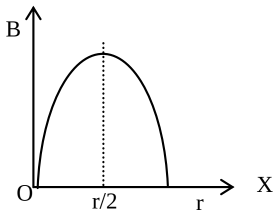
(B)



(C)



(D)



Ans. B

Sol. If we consider a point very close to one wire than magnetic field due to this wire will dominate.

CHEMISTRY

71. In alkaline solution, the following equilibria exists

a. $S^{2-} + S \longrightarrow S_2^{2-}$ equilibrium constant K_1

b. $S_2^{2-} + S \longrightarrow S_3^{2-}$ equilibrium constant K_2

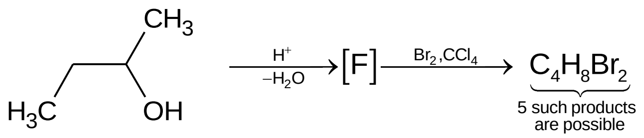
K_1 and K_2 have values 12 and 11 respectively.

$S_3^{2-} \longrightarrow S^{2-} + 2S$. What is the equilibrium constant for the reaction?

(A) 132
(B) 7.58×10^{-3}
(C) 1.09
(D) 0.918

Ans. B

Sol. $\frac{1}{K_1} \times \frac{1}{K_2} = \frac{1}{132}$

72. 

How many structures of F are possible?

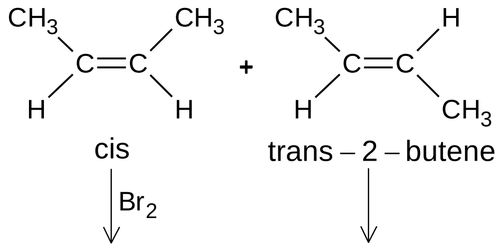
(A) 2 (B) 5

(C) 6 (D) 3

Ans. D

Sol.

$$CH_3-\underset{\underset{OH}{|}}{CH}_2CHCH_3 \xrightarrow{H^+} CH_3CH_2CH=CH_2 \xrightarrow{Br_2} \underset{d\text{-and } \ell\text{-forms}}{CH_3CH_2CHBr\cdot CH_2Br}$$



$CH_3CHBr\cdot CHBrCH_3$
Racemic (d and ℓ)
of 2,3 – dibromobutane

$CH_3CHBr\cdot CHBrCH_3$
Meso-2,3-dibromobutane

73. The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order:

(i) K_2CO_3, (ii) $MgCO_3$, (iii) $CaCO_3$, (iv) $BeCO_3$

(A) i < ii < iii < iv (B) iv < ii < iii < i

(C) iv < ii < i < iii (D) ii < iv < iii < i

Ans. B

Sol. $BaCO_3 < MgCO_3 < CaCO_3 < K_2CO_3$

74. The increasing order of stability of the following free radicals is:

(A) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C}$

(B) $(C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

(C) $(C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C} < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

(D) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H$

Ans. A

Sol. $(C_6H_5)\dot{C}, (C_6H_5)_2\dot{C}H$ are more stable due to resonance, $(CH_3)_3\dot{C}$ and $(CH_3)_2\dot{C}H$ (hyperconjugation).

75. The degeneracy of the level of the hydrogen atom that has the energy $\left(-\frac{R_H}{9}\right)$ is

(A) 6 (B) 3
(C) 9 (D) 5

Ans. C

Sol. $E_n = -\frac{R_H}{n^2} = -\frac{R_H}{9}$
n = 3
at 3rd level, one – 3s, three – 3p
five-3d orbitals

BIOLOGY

76. Baby has been born with a small tail. It is a case of:
(A) Mutation (B) Retrogressive evolution
(C) Atavism (D) Metomorphism

Ans. C

Sol. Atavism is instance when organism posses traits closer to remote ancestor.

77. DCT (Distal Convoluted Tubule) is lined by
(A) Cuboidal epithelium (B) Ciliated squamous epithelium
(C) Pseudostratified epithelium (D) Columnar epithelium

Ans. A

Sol. DCT is lined by Cuboidal epithelium.

78. If Testa (Seed coat) is removed from water soaked gram seed, the remaining structure is
(A) Cotyledon with mature embryo (B) Cotyledon with endosperm
(C) Cotyledon filled with starch (D) All of these

Ans. A

Sol. If testa in seed coat is removed, then remaining structure is cotyledon with mature embryo.

79. If a colourblind woman marries a normal visioned man, their sons will be:
(A) Three-fourth colourblind and one fourth normal
(B) One – half colourblind and one half normal
(C) All normal visioned
(D) All colourblind

Ans. D

Sol. According to the Punnet square = Colourblind women = X^CX^C, Normal male = XY

♀ \ ♂	X	Y
X^C	X^CX	X^CY
X^C	X^CX	X^CY

In conclusion, all males are colourblind.

80. Contamination with Radio active pollutant is very dangerous as it may cause:-

(A) Eutrophication (B) Gene mutation

(C) Ozone depletion (D) All of these

Ans. B

Sol. Contamination with radio active pollutants is very dangerous as it may cause gene mutation.