KVPY – CLASS-XI
PART TEST – 3
(OLTS-1819-T3-PT-3-KVPY-XI)

PART – I

MATHEMATICS

1. 'n' is selected from the set $\{1,2,3,.....,100\}$ and the number $2^n+3^n+5^n$ is formed. Total number of ways of selecting 'n' so that the formed number is divisible by 4, is equal to:
(A) 50 (B) 48
(C) 49 (D) None

Ans. C

Sol. Let $x=2^n+3^n+5^n, n\in\{1,2,3,.....100\}$.
Case I : If n is odd, then
$2^n=4\lambda_i, n>1, 3^n=4\lambda_2-1, 5^n=4\lambda_3+1$
$\therefore$ for $n>1$, and odd, $x=4\lambda_1+4\lambda_2+4\lambda_3$
$\Rightarrow$ x is divisible by 4 for $n=3,5,7,....99$ i.e. ,. n can take 49 different values.

Case II : n is even, then
$2^n=4\mu_1, 3^n=4\mu_2+1, 5^n=4\mu_3+1$
then $x=4(\mu_1+\mu_2+\mu_3)+2$ which is not divisible by 4 for any even n.
Hence required number of $n=49$.

2. Total number of ways of selecting 3 small squares on a normal chess board so that they don't belong to the same row, column or diagonal line, is equal to:
(A) 18816 (B) 18424
(C) 18368 (D) None

Ans. B

Sol. Number of ways of selecting 3 squares when they do not lie in same row or same column
$=(64\times49\times36)\times\frac{1}{3!}=18816$
Total ways of selecting the squares when they lie in the same diagonal line
$=2\left\{{}^8C_3+2\left({}^7C_3+{}^6C_3+{}^5C_3+{}^4C_3+{}^3C_3\right)\right\}$
= 392
$\therefore$ Required number of ways
$=18816-392=18424$,

3. The total number of 5 digit numbers of different digits in which the digit in the middle is the largest, is:
(A) $\sum_{n=4}^{9}{}^nP_4$ (B) $\sum_{n=4}^{9}{}^nP_4-\frac{1}{3!}\sum_{n=3}^{9}{}^nP_3$
(C) $30(3!)$ (D) None of these

Ans. D

Sol. Since the largest digit is in the middle, the middle digit is greater than or equal to 4, the number of numbers with 4 in the middle

$= {}^4P_4 - {}^3P_3$.

(∵ the other four places are to be filled by 0, 1, 2 and 3, and a number cannot begin with 0).

Similarly, the numbers of numbers with 5 in the middle $= {}^5P_4 - {}^4P_3$, etc.

$\therefore$ The required number of numbers $= \left({}^4P_4 - {}^3P_3\right) + \left({}^5P_4 - {}^4P_3\right) + \left({}^6P_4 - {}^5P_3\right) + ... + \left({}^9P_4 - {}^8P_3\right)$

$= \sum_{n=4}^{9} {}^nP_4 - \sum_{n=3}^{8} {}^nP_3$

4. If $x\cos\theta = y\cos\left(\theta + \frac{2\pi}{3}\right) = z\cos\left(\theta + \frac{4\pi}{3}\right)$, then $xy + yz + zx = \lambda$

(A) 1 (B) –1

(C) 3 (D) 0

Ans. D

Sol. $xy + yz + zx$

$= \lambda\left[\sec\theta\sec\left(\theta + \frac{2\pi}{3}\right) + \sec\left(\theta + \frac{4\pi}{3}\right)\sec\theta + \sec\left(\theta + \frac{2\pi}{3}\right)\sec\left(\theta + \frac{4\pi}{3}\right)\right]$

$= \frac{\lambda\left[\cos\theta + \cos\left(\theta + \frac{2\pi}{3}\right) + \cos\left(\theta + \frac{4\pi}{3}\right)\right]}{\cos\theta\cos\left(\theta + \frac{2\pi}{3}\right)\cos\left(\theta + \frac{4\pi}{3}\right)}$

Numerator $= \cos\theta + 2\cos(\theta + \pi)\cos\frac{\pi}{3}$

$= \cos\theta - \cos\theta = 0$

$\therefore xy + yz + zx = 0$

5. If in ΔABC, straight angled at B with $BD \perp AC$ AC = 4BD then Q may be

(A) 15^o (B) 30^o

(C) 45^o (D) 60^o

Ans. A

Sol. $\sin\theta = \frac{BD}{BC}$ and $\cos\theta = \frac{BC}{AC}$

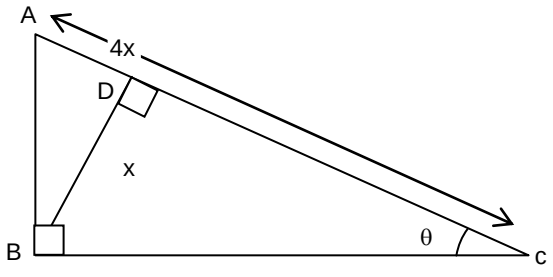
$\therefore \sin\theta.\cos\theta = \frac{BD}{AC} = \frac{1}{4}$

$\therefore 2\sin\theta\cos\theta = \frac{1}{2}$

$\Rightarrow \sin 2\theta = \frac{1}{2}$

$\Rightarrow 2\theta = 30^o$

$\Rightarrow \theta = 15^o$



6. A said to B “I am 5 times as old as you were when I was as old as you are now”. If $A + B = 64$ years the A – B =

(A) 8 (B) 16

(C) 24 (D) 40

Ans. B

Sol. $5\left(B-\left(A-B\right)\right)=A$ and $A+B=64$

$10B-5A=A\Rightarrow 6A=10B\Rightarrow 3A=5B$

$\Rightarrow A=40, B=24$

7. If $(11)^{27}+(21)^{27}$ when divided by 16 leaves the remainder

(A) 0 (B) 1

(C) 2 (D) 14

Ans. A

Sol. $a^n+b^n=\left(a+b\right)\left(Q\left(a,b\right)\right)$ if n is odd i.e. a^n+b^n is divisible by a + b if n is odd

8. A certain number of persons can dig a trench 100 m long, 50 m broad and 10 m deep in 10 days. The same number of persons can dig another trench 20 m broad and 15 m deep in 30 days. The length of the second trench is:

(A) 400 m (B) 500 m

(C) 800 m (D) 900 m

Ans. B

Sol. Let the required length be x metres.

More breadth, Less length (Indirect Proportion)

More depth, Less length (Indirect Proportion)

More days, More length (Direct Proportion)

$$\left.\begin{array}{lll}\text{Breadth} & 20 : & 50\\ \text{Depth} & 15 : & 10\\ \text{Days} & 10 : & 30\end{array}\right\} :: 100 :: x$$

$\therefore 20\times 15\times 10\times x=50\times 10\times 30\times 100$

$\Leftrightarrow x=\dfrac{\left(50\times 10\times 30\times 100\right)}{\left(20\times 15\times 10\right)}\Leftrightarrow x=500$

9. The number of solution of the equation $x^3+x^2+4x+2\sin x=0$ in $0\le x\le 2\pi$ is:

(A) zero (B) one

(C) two (D) infinite

Ans. B

Sol. Here, $x^3+\left(x+2\right)^2+2\sin x=4$

Clearly, $x=0$ satisfies the equation

If $0<x\le \pi$, $x^3+\left(x+2\right)^2+2\sin x>4$

If $\pi<x\le 2\pi, x^3+\left(x+2\right)^2+2\sin x>27+25-2$

So, $x=0$ is the only solution.

10. X can do $\dfrac{1}{4}$ of a work in 10 days, Y can do 40% of the work in 40 days and Z can do $\dfrac{1}{3}$ of the work in 13 days. Who will complete the work first?

(A) X (B) Y

(C) Z (D) X and Z both

Ans. C

Sol. Whole work will be done by X in $(10\times 4)=40$ days

Whole work will be done by Y in $\left(40\times\frac{100}{40}\right)=100$ days

Whole work will be done by Z in $(13\times 3)=39$ days

$\therefore$ Z will complete the work first.

11. A machine P can print one lakh books in 8 hours, machine Q can print the same number of books in 10 hours while machine R can print them in 12 hours. All the machines are started at 9 a.m. while machine P is closed at 11 a.m. and the remaining two machine complete the work. Approximately at what time will the work be finished?

(A) 11 : 30 a.m. (B) 12 noon

(C) 12 : 30 p.m. (D) 1 p.m.

Ans. D

Sol. $(P+Q+R)$'s 1 hour's work $=\left(\frac{1}{8}+\frac{1}{10}+\frac{1}{2}\right)=\frac{37}{120}$.

Work done by P, Q and R in 2 hours $=\left(\frac{37}{120}\times 2\right)=\frac{37}{60}$

Remaining work $=\left(1-\frac{37}{60}\right)=\frac{23}{60}$.

$(Q+R)$'s 1 hour's work $=\left(\frac{1}{10}+\frac{1}{12}\right)=\frac{11}{60}$

Now, $\frac{11}{60}$ work is done by Q and R in 1 hour.

So, $\frac{23}{60}$ work will be done by Q and R in $\left(\frac{60}{11}\times\frac{23}{60}\right)=\frac{23}{11}$ hours = 2 hours

So, the work will be finished approximately 2 hours after 11 a.m. i.e. around 1 p.m.

12. If $x=\frac{(mn)!}{m!(n!)^m}$, $y=\frac{(mn)!}{n!(m!)^n}$ and I is the set of all integers, then:

(A) $x\in I, y\notin I$ (B) $x\notin I, y\in I$

(C) $x\in I, y\in I$ (D) $x\notin I, y\notin I$

Ans. C

Sol. x = Number of ways of dividing mn different things in m sets each having n things = an integer.

y = Number of ways of dividing mn different things in n sets having m things = an integer.

13. Number of positive unequal integral solutions of the equation $x+y+z=6$ is:

(A) $4!$ (B) $3!$

(C) $5!$ (D) $2\times 4!$

Ans. B

Sol. $x+y+z=6$

Let $x<y<z$ .....(i)

Let $\alpha=x, \beta=y-x, \gamma=z-y$

i.e., $x=\alpha,\ y=\alpha+\beta,\ z=\alpha+\beta+\gamma$

Then form equation (i), $3\alpha+2\beta+\gamma=6,$ where $\alpha,\beta,\gamma\le 1$

Its only solution is $\alpha=1,\ \beta=1,\ \gamma=1$

$\therefore\ x=1,\ y=2,\ z=3$

$\therefore$ Total number of solutions $=3!$

14. A basket ball team consists of 12 pairs of twin brothers. On the first day of training, all 24 players stand in a circle in such a way that all pairs of twin brothers are neighbours. Number of ways this can be done is:

(A) $(12)!2^{11}$ (B) $(11)!2^{12}$

(C) $(12)!2^{12}$ (D) $(11)!2^{11}$

Ans. B

Sol. 12 pairs will stand in circle in $(12-1)!=11!$ ways

Every pair can be arranged in 2! Way.

Hence B is the correct answer

15. The remainder when $2^{30}.3^{20}$ is divided by 7 is:

(A) 1 (B) 2

(C) 4 (D) 6

Ans. B

Sol. $2^{30}.3^{20}=(2.3)^{20}.2^{10}=2.(6)^{20}.8^{3}=2(7-1)^{20}(7+1)^{3}$

$=2(7k+1)(7k'+1)$

Hence B is the correct answer.

PHYSICS

16. A particle executes S.H.M. then displacement from the mean position where kinetic energy is equal to the potential energy is

(A) A/2 (B) A/4

(C) 3A/4 (D) A/√2

Ans. D

Sol. Since K = U

$\frac{1}{2}m\omega^2(A^2-x^2)=\frac{1}{2}m\omega^2x^2$

or $2x^2=A^2$ or $x=\frac{A}{\sqrt{2}}=0.707A$

17. A source of sound emitting a note of frequency 200Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is

(A) 50Hz (B) 100Hz

(C) 150Hz (D) 200Hz

Ans. D

Sol. No relative motion between source and observer.

18. Two pendulums of same amplitude but time period 3s and 7s start oscillating simultaneously from two opposite extreme positions. After how much time they will be in phase?

(A) $\frac{21}{8}$s (B) $\frac{21}{4}$s

(C) $\frac{21}{2}$s (D) $\frac{21}{10}$s

Ans. A

Sol. $y_1 = a\cos\omega_1 t$ and $y_2 = a\cos(\pi + \omega_2 t)$

For same phase $\omega_1 t = \pi + \omega_2 t$

$$t = \frac{\pi}{\omega_1 - \omega_2} = \frac{\pi}{\frac{2\pi}{3} - \frac{2\pi}{7}} = \frac{21}{8}\text{s}$$

19. 80 gm of water at $30^\circ C$ is poured on a large block of ice at $0^\circ C$. The mass of ice that melts is

(A) 30 gm (B) 80 gm

(C) 150 gm (D) 1600 gm

Ans. A

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

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

= $ms\Delta\theta = 80 \times 1 \times (30 - 0)$

= 2400 cal

If m gm be the mass of ice melted, then

$Q_2 = ML = m \times 80$

$Q_1 = Q_2$

$m \times 80 = 2400$ or $m = 30$ gm

20. An accurate and reliable audio oscillator is used to standardise a tuning fork. When the oscillator reading is 514, two beats are heard per second. When the oscillator reading is 510, the beat frequency is 6 Hz. The frequency of the tuning fork is

(A) 506 (B) 510

(C) 516 (D) 158

Ans. C

Sol. When the oscillator reading is 514, two beats are heard. Hence the frequency of the tuning fork is $514 \pm 2 = 516$ or 512. When the oscillator reading is 510, the frequency of the tuning fork is $510 \pm 6 = 516$ or 504. The common value is 516. Hence the frequency is 516 Hz.

21. A vessel contains 1 mole of O_2 and 1 mole of He. The value of γ for the mixture is

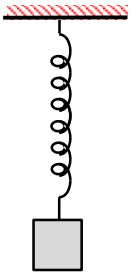
(A) 1.4 (B) 1.50

(C) 1.53 (D) none of these

Ans. B

Sol. $$\gamma = \frac{n_1 c_{p1} + n_2 c_{p2}}{n_1 c_{v1} + n_2 c_{v2}}$$

22. A block of mass m is suspended by a light vertical spring of stiffness k. The block is slightly displaced from its equilibrium position and then released. Its frequency of oscillation, will be



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

(C) $\frac{1}{\pi}\sqrt{\frac{m}{k}}$ (D) $\pi\sqrt{\frac{m}{k}}$

Ans. A

Sol. Let elongation in the spring is x_o when block is in equilibrium.

F.B.D. of the block

$\Rightarrow \quad kx_o = mg \qquad \ldots (1)$

If F be the net force on the block then when it is displaced by a further distance x, then,

$F = mg - k(x_o + x) \qquad \ldots (2)$

From (1) and (2), we get

$F = -kx \quad \Rightarrow \quad \frac{d^2x}{dt^2} = -\frac{k}{m}x$

Equation shows that the body will execute S.H.M.

Since $\omega = \sqrt{\frac{k}{m}} \quad \Rightarrow \quad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

Alternate method:

Total energy of the system, when displacement of the block from its equilibrium position is x is given by

$E = -mgx + \frac{1}{2}K(x + x_o)^2 + \frac{1}{2}mv^2$

$\because$ E is constant

$\Rightarrow \quad \frac{dE}{dt} = 0$

$\Rightarrow \quad -mg\frac{dx}{dt} + K(x + x_o)\frac{dx}{dt} + mv\frac{dv}{dt} = 0$

$\Rightarrow \quad \frac{d^2x}{dt^2} = -kx$

23. Find the value of molar heat capacity for an ideal gas during an adiabatic process

(A) zero (B) 5R/2

(C) 3R/2 (D) R

Ans. A

Sol. $Q = nCdT = 0$

The molar capacity is zero.

24. A SHM is represented by the equation $x = 20\sin[\pi t + (\pi/6)]$ in S. I. Units. Its amplitude, time period and maximum velocity respectively in that order are

(A) 20 m, 2 s, 20 π m/s (B) 10 m, 1 s, 5π m/s

(C) 5 m, 1 s, 5 π m/s (D) 5 m, 2 s, 10π m/s

Ans. A

Sol. Comparing the above equation with

$x = A\sin(\omega t + \phi_o)$, we get,

$A = 20$ m

$\omega = \pi s^{-1}$ and $\phi_0 = \pi/6$

$\because$ $T = 2\pi/\omega$

$\Rightarrow$ $T = 2$ s

$v_{max} = \omega A = 20\ \pi$ m/s.

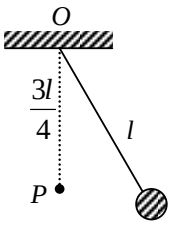
25. A metal sheet with circular hole of diameter d is heated. What happens to dimensions of hole.

(A) it will increase
(B) it will decrease
(C) it will remain same
(D) depends on the condition of heating

Ans. A

Sol. Expansion takes place radially outwards. The dimensions of sheet are magnified and the hole gets larger.

26. A pendulum has time period *T* for small oscillations. An obstacle *P* is situated below the point of suspension *O* at a distance $\frac{3l}{4}$. The pendulum is released from rest. Throughout the motion the moving string makes small angle with vertical. Time after which the pendulum returns back to its initial position is



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

Ans. B

Sol. After *P* length of pendulum becomes $\frac{l}{4}$.

Now, as $T \propto \sqrt{l}$, so after *P* time period will become $T' = T/2$.

Therefore, the desired time will be $t = \frac{T}{2} + \frac{T'}{2} = \frac{T}{2} + \frac{T}{4} = \frac{3T}{4}$

27. 3000 J of heat is given to a gas at constant pressure of 2×10^5 N/m^2. If its volume increases by 10 litres during the process find the change in the internal energy of the gas.
(A) 200 J
(B) 1000 J
(C) 2000 J
(D) 3000 J

Ans. B

Sol. $\Delta Q = 3000$ J

$W = P\ \Delta V = (2\times10^5\ N/m^2)\ (10\times10^{-3}m^3)$

$= 2 \times 10^3$ J

$\Delta U = \Delta Q - W = 3000 - 2000 = 1000$ J.

28. Two sources of intensity I and 4 I are used in an interference experiment. What is the intensity at points where the waves from the two sources superimpose with a phase difference of 90°?
(A) I
(B) 0
(C) 5 I
(D) 9 I

Ans. C

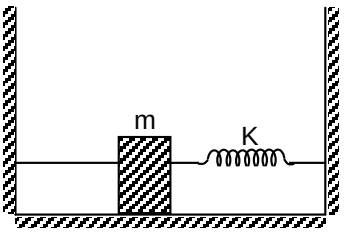
Sol. In case of interference of two waves of intensity I_1 and I_2 with phase difference ϕ,

$$I = I_1 + I_2 + 2\left(\sqrt{I_1 I_2}\right)\cos\phi$$

Here, $I_1 = I$ and $I_2 = 4I$

So $I = I + 4I + 2\sqrt{4I \times I}\cos\phi = 5I + 4I\cos\phi$

29. A block of mass 'm' is attached by a thin elastic string and by a spring as shown, initially both are unstretched. If the block is slightly displaced and released, find its time period of oscillation.



Given length of string is ℓ
Young's modulus is Y
Cross sectional area of string is A.
Spring constant k

(A) $2\pi\sqrt{\dfrac{m\ell}{\ell k + YA}}$ (B) $2\pi\sqrt{\dfrac{m}{k}}$

(C) $2\pi\sqrt{\dfrac{m\ell}{YA}}$ (D) $2\pi\sqrt{\dfrac{m}{k}} + \pi\sqrt{\dfrac{m\ell}{\ell k + YA}}$

Ans. D

Sol. When it is displaced right ward by x then

$$F = -\left(kx + \frac{YA}{\ell}x\right)$$

$$\Rightarrow \quad a = -\frac{\left(k + \dfrac{YA}{\ell}\right)}{m}x \quad ; \quad T_1 = 2\pi\sqrt{\frac{m\ell}{\ell k + YA}}$$

When it moves to the left of mean position then string becomes slack.

So $T_2 = 2\pi\sqrt{\dfrac{m}{k}}$

Total time of oscillation = $\dfrac{T_1 + T_2}{2} = \pi\sqrt{\dfrac{m}{k}} + \pi\sqrt{\dfrac{m\ell}{\ell k + YA}}$

30. A string of length 1 m and mass 10 gm is tightly clamped at its ends. The tension in the string is 4 N. Identical wave pulses are produced at one end at equal intervals of time t. What is the minimum value of t which allows a constructive interference between successive pulses?

(A) 0.05 s (B) 0.1 s
(C) 0.15 s (D) 0.2 s

Ans. B

Sol: $v = \sqrt{\dfrac{T}{\mu}} = \sqrt{\dfrac{4 \times 1}{10 \times 10^{-3}}} = 20 \quad m/s$

$t = \dfrac{2\ell}{v} = 0.1 \sec$

CHEMISTRY

31. ΔU^o of combustion of $CH_4(g)$ at a certain temperature is -393 kJ mol^{-1}. The value of ΔH^o is
(A) zero (B) $< \Delta U^o$
(C) $> \Delta U^o$ (D) equal to ΔU^o

Ans. B

Sol. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$
$\Delta ng = 1 - 3 = -2$
$\Delta H^o = \Delta U^o + \Delta ngRT$
$= \Delta U^o - 2RT$ so $\Delta H^o < \Delta U^o$

32. Aqueous solution of H_3BO_3 contains
(A) H^+ and BO_3^{3-} ions (B) H^+ and $H_2BO_3^-$ ions
(C) H_3O^+ and $\left[B(OH)_4\right]^-$ ions (D) H_3O^+ and HBO_3^{2-} ions

Ans. C

Sol. $H_3BO_3 + 2H_2O \rightleftharpoons \left[B(OH)_4\right]^- + H_3O^+$

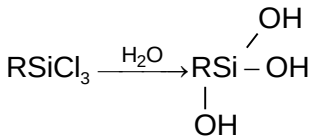
33. The bond energy of H_2, Br_2 and HBr are respectively x, y and z KCal $mole^{-1}$. What is the enthalpy change of the following reaction?
$H_2(g) + Br_2(g) \longrightarrow 2HBr(g)$
(A) (2z – x – y) KCal (B) (x + y – z) KCal
(C) (x + y - 2z) KCal (D) (z – x – y) Kcal

Ans. C

Sol. $\Delta H = (B.E)_R - (B.E)_P = (x + y - 2z)$

34. Which of the following compounds on hydrolysis followed by polymerization give rise to cross linked silicones?
(A) R_3SiCl (B) R_2SiCl_2
(C) $RSiCl_3$ (D) R_4Si

Ans. C

Sol.

Gives cross-linked silicones on polymerization.

35. B_2H_6 contains
(A) two (2c – 2e) and one (3c – 2e) bonds
(B) four (2c – 2e) and two (3c – 2e) bonds
(C) two (2c – 2e) and three (3c - 2e) bonds
(D) four (2c – 2e) and three (3c – 2e) bonds

Ans. B

Sol. B_2H_6 contains four 2c – 2e(B – H) bonds and two 3c – 2e(BHB) bonds.

36. Which of the following conditions must be satisfied for any spontaneous reaction?
(A) $\Delta S < 0$ (B) $\Delta H < 0$
(C) $\Delta G < 0$ (D) $\Delta U < 0$

Ans. C

Sol. ΔG should be negative for a spontaneous process.

37. Which of the following has layer structure?
(A) Borax (B) Aluminium chloride
(C) Boron nitride (D) Diborane

Ans. C

Sol. BN has a layer structure.

38. $Mg + B_2O_3 \longrightarrow$ Product(s)
The product(s) of the above reaction is/are:
(A) $Mg_3(BO_3)_2$ (B) $Mg_2B_4O_7$
(C) MgO + B (D) $Mg_3B_2 + O_2$

Ans. C

Sol. $3Mg + B_2O_3 \longrightarrow 3MgO + 2B$

39. Which of the following substances act as froth stabilizer in froth flotation process?
(A) Pine oil (B) Xanthates
(C) Cresol (D) none of the above

Ans. C

Sol. Cresols stabilize the froth.

40. Which of the following is NOT an anhydride of boric acid (H_3BO_3)?
(A) B_2O_3 (B) HBO_2
(C) H_2BO_2 (D) $H_2B_4O_7$

Ans. C

Sol. The anhydrides of boric acid are:
HBO_2, $H_2B_4O_7$ and B_2O_3

41. What is the relation between ΔS, ΔH and T at equilibrium?
(A) $T = \frac{\Delta S}{\Delta H}$ (B) $T = \frac{\Delta H}{\Delta S}$
(C) $\Delta S + T = \Delta H$ (D) $\Delta H + T = \Delta S$

Ans. B

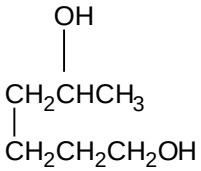
Sol. $\Delta G = \Delta H - T\Delta S$ and $\Delta G = 0$ at equilibrium.

42. Which of the following substances should be added to boric acid solution in order to titrate it with NaOH?

(A) 

(B) CH_3CH_2OH

(C) 

(D) 

Ans. A

Sol. Diols(Cis diols) form complex with $[B(OH)_4]^-$ and make ionisation of H_3BO_3 faster.

43. The basic structural unit in silicate is:
(A) SiO_2 (B) $(Si_2O_5)^{2-}$
(C) SiO_4^{-4} tetrahedron (D) $(Si_2O_7)^{2-}$

Ans. C

Sol. Silicates contain SiO_4^{4-} unit and other units of SiO_4^{4-} shared by oxygen atoms.

44. Which of the following compounds does NOT evolve any gas on thermal decomposition?
(A) $NaNO_3$ (B) $NaHCO_3$
(C) Na_2CO_3 (D) Li_2CO_3

Ans. C

Sol. Na_2CO_3 is thermally stable.

45. The radioactive isotope of hydrogen emits
(A) α- ray (B) β – ray
(C) γ - ray (D) x - ray

Ans. B

Sol. $^3_1T \longrightarrow ^3_2He + ^0_{-1}\beta$

BIOLOGY

46. Idioblasts are:
(A) Sclerenchymatous fibres found in the leaf of *Yucca*
(B) Specialized parenchyma cells which contain ergastic substances
(C) Collenchymatous cells possessing angular thickenings
(D) Crystals of calcium oxalate found in hard fruits

Ans. B

Sol. Idioblasts are specialized parenchyma cells which contain ergastic substances.

47. Which of the following is correct link between Meiosis I and Meiosis II?
(A) Interphase I (B) Interkinesis
(C) Interphase II (D) Anaphase I

Ans. C

Sol. Interphase II is correct link between Meiosis I and Meiosis II.

48. Which of the following stage is affected by colchicine?
(A) Metaphase (B) Prophase
(C) Interphase (D) Anaphase

Ans. A

Sol. Colchicine inhibit formation of spindle fibres in metaphase.

49. Polysome is formed by:
(A) Ribosomes attach to each other in linear arrangement
(B) Several ribosomes attached to single mRNA
(C) Many ribosomes attached to ER
(D) Ribosome with several subunits

Ans. B

Sol. Polysome is formed by several ribosomes attached to single mRNA.

50. Cytoskeleton is made up of
(A) Calcium carbonate (B) Cellulose
(C) Callose (D) Protein

Ans. D

Sol. Cytoskeleton is made up of protein.

51. Microbodies differ from lysosomes in that:
(A) Microbodies are surrounded by single unit membrane
(B) Microbodies are surrounded by double membrane
(C) Microbodies contain hydrolytic enzymes
(D) Lysosomes contain hydrolytic enzymes

Ans. D

Sol. Microbodies differ from lysosomes in that lysosomes contain hydrolytic enzymes.

52. Cell organelle showing extensive polymorphism is:
(A) Dictyosome (B) Chloroplast
(C) Endoplasmic Reticulum (D) Lysosome

Ans. D

Sol. Lysosome shows extensive polymorphism.

53. Use of certain chemicals and radiations change the base sequences of genes of crop plants is termed:
(A) Recombinant DNA technology (B) Transgenic mechanism
(C) Mutation breeding (D) Gene therapy

Ans. C

Sol. Use of certain chemicals and radiations change the base sequences of genes of crop plants is termed mutation breeding.

54. Transitional epithelium occurs in
(A) Blood vessels (B) Trachea
(C) Kidney (D) Ureter / Urinary bladder

Ans. D

Sol. Transitional epithelium, also called as urothelium is present in ureter / urinary bladder.

55. When collagen fibres are removed from areolar connective tissue ?
(A) Tissue becomes hard (B) Tissue become loose and elastic
(C) Tissue become hard and inelastic (D) Unchanged

Ans. B

Sol. When collagen fibres are removed from areolar connective tissue, tissue becomes loose and elastic.

56. The difference between white and yellow fibres is:
(A) Protein (B) Colour of fibres
(C) Both A and B (D) None

Ans. C

Sol. White fibre has collagen protein and is white in colour whereas yellow fibre has elastin protein and is yellow in colour.

57. White adipose tissue contain:
(A) Multilocular fat cells (B) Bilocular fat cells
(C) Unilocular fat cells (D) Alocular

Ans. C

Sol. White Adipose tissue contains unilocular fat cells.

58. Chromosome in which centromere is located at the end is ___
(A) Acrocentric (B) Telocentric
(C) Metacentric (D) Submetacentric

Ans. B

Sol. Chromosome in which centromere is located at the end is called telocentric chromosome.

59. Cart nets are used to catch
(A) Fresh water fish (B) Marine fish
(C) Estuary fish (D) All of these

Ans. D

Sol. Cart nets are used to catch fishes.

60. Name the connective tissue present in larynx?
(A) White fibrous cartilage (B) Hyaline cartilage
(C) Areolar tissue (D) Yellow elastic cartilage

Ans. B

Sol. Hyaline cartilage is present in larynx.

PART – II

MATHEMATICS

61. The number of ways in which three distinct numbers are 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 $= 2.\ {}^{12}C_2 = 132$

62. Three taps A, B, C fill up a tank independently in 10 hr, 20 hr, 30 hr, respectively. Initially the tank is empty and exactly one pair of taps is open during each hour and every pair of taps is open at least for one hour. What is the minimum number of hours required to fill the tank?
(A) 8 (B) 9
(C) 10 (D) 11

Ans. A

Sol. A 10 hr
B 20 hr
C 30 hr
Exactly are pair of taps is open during each hour and every pair of taps is open at least for one hour.
First A and B are open for 1 hour then B and C and then C and A

$$\underset{\text{first}}{\left(\frac{1}{10}+\frac{1}{20}\right)}+\underset{\text{second}}{\left(\frac{1}{20}+\frac{1}{30}\right)}+\underset{\text{third}}{\left(\frac{1}{30}+\frac{1}{10}\right)}=\frac{22}{60}$$

In three hours the tank will be filled $\left(\frac{22}{60}\right)^{th}$ part.

Now, for minimum time the rest tank must be filled with A and B taps $\left(\frac{1}{10}+\frac{1}{20}=\frac{9}{60}\right)$

So the rest $\left(\frac{38}{60}\right)^{th}$ part of tank will take 5 hours more.

So the tank will be filled in 8^{th} hour.

63. A person X is running around a circular track completing one round every 40 seconds. Another person Y running in the opposite direction meets X every 15 second. The time, expressed in seconds, taken by Y to complete one round is

(A) 12.5 (B) 24

(C) 25 (D) 55

Ans. B

Sol. $\theta = \frac{2\pi}{40} \times 15 = 2\pi - \frac{2\pi}{n} \times 15$

$\therefore \ \frac{3}{8} = 1 - \frac{15}{n}$

$\Rightarrow n = 24$

64. Number of different words that can be formed using all the letters of the word "DEEPMALA" if two vowels are together and the other two are also together but separated from the first two is

(A) 960 (B) 1200

(C) 2160 (D) 1440

Ans. D

Sol. DEEPMALA

_ D _ P_ M_ L _

For vowels select 2 places ${}^5C_2 = 10$ ways

$10 \times 4! \times \frac{4!}{2!2!} = {}^{100-2}C_3 = {}^{98}C_3$

65. The number of values of x in the interval $[0, 5\pi]$ satisfying the equation $3\sin^2 x - 7\sin x + 2 = 0$ is:

(A) 0 (B) 2

(C) 6 (D) 8

Ans. C

Sol. $3\sin^2 x - 7\sin x + 2 = 0$

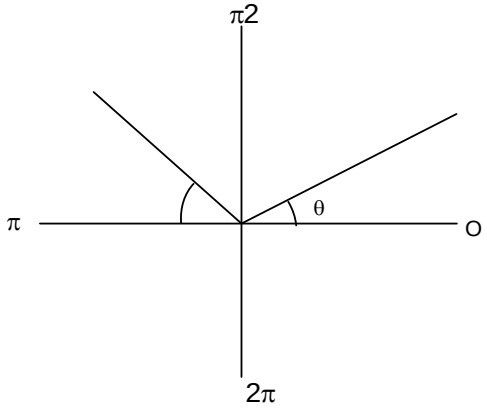
$3\sin^2 x - 6\sin x - \sin x + 2 = 0$

$(3\sin x - 1)(\sin x - 2) = 0$

$\sin x = \frac{1}{3}$

In $(0, \pi)$ there are two solution.

$\Rightarrow$ In $(0, 5\pi)$ there are thus six solutions



PHYSICS

66. A body cools from 62°C to 50°C in 10 minutes and to 42°C in the next 10 minutes. The temperature of surroundings is

(A) 20°C (B) 26°C

(C) 23°C (D) 25°C

Ans. B

Sol. For the first ten minutes,

$$\frac{dT}{dt} = -\left(\frac{62^\circ - 50^\circ}{10}\right) = -1.2^\circ C/min \text{ and}$$

$$\Delta T = \left(\frac{62^\circ + 50^\circ}{10}\right) - T_0 = (56 - T_0)^\circ C$$

$\Rightarrow -1.2^\circ C/min = -KA\,(56 - T_0)^\circ C$ …(1)

Similarly for the next ten minutes

$$\frac{dT}{dt} = \left[\frac{42^\circ - 50^\circ}{10}\right] = -0.8\ ^\circ C/min \text{ and}$$

$$\Delta T = \left(\frac{42^\circ + 50^\circ}{2}\right) - T_0 = (46 - T_0)^\circ C$$

$\Rightarrow -0.8^\circ C/min = -KA\,(46 - T_0)^\circ C$ …(2)

Dividing (1) by (2)

$$\frac{3}{2} = \frac{56 - T_0}{46 - T_0}$$

$\Rightarrow T_0 = 26^\circ C.$

Alternate Method:

$$\frac{dT}{dt} = -k\left(T - T_o\right)$$

$$\Rightarrow \int_{62}^{50} \frac{dT}{T - T_o} = \int_0^{10} -kdt \text{ ie } \ell n \frac{62 - T_o}{50 - T_o} = 10k \quad \text{…(i)}$$

$$\text{also } \int_{50}^{42} \frac{dT}{T - T_o} = \int_0^{10} -kdt \text{ i.e. } \ell n \frac{50 - T_o}{42 - T_o} = 10k \quad \text{…(ii)}$$

from (i) and (ii) $T_o = 26^oC$

67. A cylinder of radius R made of a material of thermal conductivity k_1 is surrounded by a cylindrical sheet of inner radius R and outer radius 2R made of material of thermal conductivity k_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. Calculate the effective thermal conductivity of the system.

(A) $k_1 + 3k_2$ (B) $\frac{k_1 + 3k_2}{2}$

(C) $\frac{k_1 + 3k_2}{3}$ (D) $\frac{k_1 + 3k_2}{4}$

Ans. D

Sol. Two cylinders are in parallel, therefore equivalent thermal resistance R is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

But $R = \frac{\ell}{kA}$

$$\therefore \quad \frac{kA}{\ell} = \frac{k_1 A_1}{\ell_1} + \frac{k_2 A_2}{\ell_2}$$

Here $\ell_1 = \ell_2 = \ell$, $A_1 = \pi R^2$

$A_2 = \pi(2R)^2 - \pi R^2 = 3\pi R^2$

and $A = \pi(2R)^2 = 4\pi R^2$

$\therefore \quad \frac{K\,4\pi R^2}{\ell} = \frac{K_1 \pi R^2}{\ell} + \frac{K_2\,3\pi R^2}{\ell}$

i.e. $4K = K_1 + 3K_2$

68. If the length of a simple pendulum is equal to the radius *R* of the earth, its time period will be

(A) $2\pi\sqrt{R/g}$ (B) $2\pi\sqrt{R/2g}$

(C) $2\pi\sqrt{2R/g}$ (D) $\pi\sqrt{R/2g}$

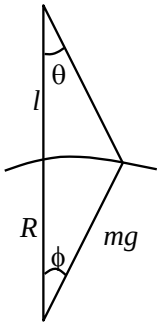
Ans. B

Sol. $F_{restoring} = -mg(\theta + \varphi)$

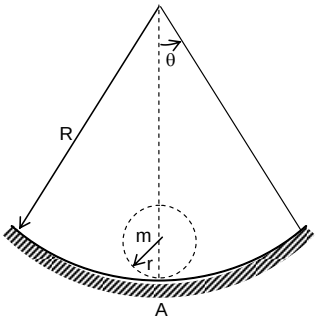
$a = -g\left(\frac{x}{l} + \frac{x}{R}\right)$

$l = R_e$

$a = -g\left(\frac{2}{R_e}\right)x \quad ; \quad T = 2\pi\sqrt{\frac{R}{2g}}$



69. A cylinder of radius r and mass m rests on a curved path of radius R as shown in figure. Show that the cylinder can oscillate about the bottom position when displaced and left to itself. Find the period of oscillation. Assume that the cylinder rolls without slipping.



(A) $2\pi\sqrt{\frac{R}{g}}$ (B) $2\pi\sqrt{\frac{R-r}{g}}$

(C) $2\pi\sqrt{\frac{2R}{3g}}$ (D) $2\pi\sqrt{\frac{3(R-r)}{2g}}$

Ans. D

Sol. Restoring torque acting on cylinder after a small displacement θ, about an axis through point of contact O with the curved path,

$\tau = -mg \sin\theta \; r \approx -mgr\theta \quad (\text{as for small } \theta, \sin\theta = \theta)$

Angular acceleration of cylinder,

$\alpha = \frac{d^2\phi}{dt^2} \quad ; \quad r\phi = (R-r)\theta \quad ; \quad \phi = \frac{(R-r)}{r}\theta$

Consequently $\alpha = \frac{d^2\phi}{dt^2} = \frac{(R-r)}{r}\frac{d^2\theta}{dt^2}$

Moment of inertia about contact point,

$I = \frac{3mr^2}{2}$

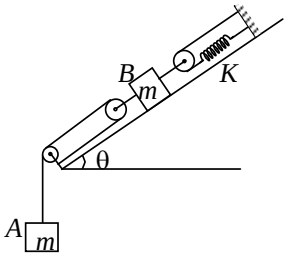
$-mgr\theta = \frac{3}{2}mr^2\frac{(R-r)}{r}\frac{d^2\theta}{dt^2}$

or $\frac{d^2\theta}{dt^2} + \frac{g}{\frac{3}{2}(R-r)}\theta = 0$

Hence $\omega = \sqrt{\dfrac{g}{\frac{3}{2}(R-r)}}$

or $T = 2\pi\sqrt{\dfrac{\frac{3}{2}(R-r)}{g}} = \pi\sqrt{\dfrac{6(R-r)}{g}}$

70. Two blocks *A* and *B*, each of mass *m* are connected by means of a pulley-spring system on a smooth inclined plane of inclination θ as shown in the figure. All the pulleys and spring are ideal. Now, *B* is slightly displaced from its equilibrium position. It starts to oscillate. Time period of oscillation of *B* will be (Take m = 4 kg, K = 5 N/m, π = 3.14)



(A) 3.14 s (B) 6.28 s
(C) 4.28 s (D) 5.14 s

Ans. B

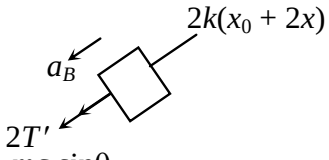
Sol. Let elongation of spring be x_0 in equilibrium. Then,

$2T + mg\sin\theta = 2kx_0$ …(i)

and $T = mg$ …(ii)

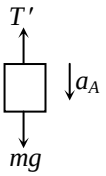
Let Block *B* is displaced by *x* down the inclination

F.B.D. of *B*



$-ma_B = 2k(x_0 + 2x) - 2T' - mg\sin\theta$ …(iii)

F.B.D. of *A*



$mg - T' = ma_A$

Also, $a_A = 2a_B$

$T' = mg - 2ma_B$

$-ma_B = 2kx_0 + 4kx - 2mg + 4ma_B - mg\sin\theta$

$-ma_B = 4kx + 4ma_B$

$a_B = -\dfrac{4k}{5m}x$

$\therefore \quad T = 2\pi\sqrt{\dfrac{5m}{4k}}$

T = 6.28 s.

CHEMISTRY

71. Which of the following is thermally most stable?
(A) $BeCO_3$ (B) $MgCO_3$
(C) $CaCO_3$ (D) $BaCO_3$

Ans. D

Sol. Thermal stability of group II carbonates increase down the group.

72. The stability of +1 oxidation states in group-13 is in the order
(A) $Ga^+ < In^+ < Tl^+$ (B) $In^+ < Ga^+ < Tl^+$
(C) $Tl^+ < In^+ < Ga^+$ (D) $Tl^+ < Ga^+ < In^+$

Ans. A

Sol. Stability of +1 oxidation state increases due to inert pair effect.

73. Which of the following statements is NOT correct?
(A) Silicon is used as a semiconductor (B) Carborundum is SiC
(C) Silicon occurs in free state in nature (D) Mica contains silicon

Ans. C

Sol. Silicon does not occur free in nature. It occurs in silicate form.

74. Which of the following type of hydrogen is produced in hydrogen torch which is used for welding of scrap metals?
(A) Nascent hydrogen (B) Atomic hydrogen
(C) Ortho hydrogen (D) Para hydrogen

Ans. B

Sol. Atomic hydrogens are produced in hydrogen torch.

75. Which of the following metal is extracted by Van Arkel's method?
(A) Cu (B) Ni
(C) Ti (D) Zn

Ans. C

Sol. Ti is extracted by Van Arkel's method.

BIOLOGY

76. Mark the correct statement:
(A) Unipolar neurons are found in early embryos of invertebrates and vertebrates.
(B) Inner membrane of nucleus have $F_0 – F_1$ particles or oxysomes.
(C) Cork cambium is differentiated or post – mitotic cell
(D) Secondary wall is first formed wall of the cell which is produced inner to middle lamella.

Ans. A

Sol. Unipolar neurons are found in early embryos of invertebrates and vertebrates.

77. Match the stages of meiosis in column I to their characteristic features in column II and select the correct option using the codes given below:

Column I	Column II
A. Pachytene	i. Pairing of homologous chromosome
B. Metaphase I	ii. Terminalisation of chiasmata
C. Diakinesis	iii. Crossing over takes place
D. Zygotene	iv. Chromosomes align at equatorial plate

(A) A - iii , B - iv, C - ii, D - i
(B) A - ii, B - i, C - iv, D - iii
(C) A - iv, B - iii, C - i, D - ii
(D) A - iii, B - i, C - ii, D - iii

Ans. A

Sol. Pachytene $\rightarrow$ crossing over takes place, Metaphase I $\rightarrow$ chromosomes align at equatorial plate, Diakinesis $\rightarrow$ terminalisation of chiasmata, Zygotene $\rightarrow$ pairing of homologous chromosome.

78. Identify the correct sequence of steps involves in process of hybridization.
(A) Selection $\rightarrow$ Emasculation $\rightarrow$ Selfing $\rightarrow$ Bagging $\rightarrow$ Artificial pollination
(B) Emasculation $\rightarrow$ Selection $\rightarrow$ Bagging $\rightarrow$ Tagging $\rightarrow$ Selfing
(C) Selection $\rightarrow$ Selfing $\rightarrow$ Emasculation $\rightarrow$ Bagging $\rightarrow$ Artificial pollination
(D) Selection $\rightarrow$ Artificial pollination $\rightarrow$ Bagging $\rightarrow$ Emasculation $\rightarrow$ Selfing

Ans. C

Sol. Selection $\rightarrow$ Selfing $\rightarrow$ Emasculation $\rightarrow$ Bagging $\rightarrow$ Artificial pollination

79. Which type of hybridization is done to obtain mule?
(A) Inbreeding hybridization
(B) Outbreeding hybridization
(C) Inter specific hybridization
(D) Intra specific hybridization

Ans. C

Sol. Mule is obtained by inter specific hybridization.

80. G_0 stage in cell denotes:
(A) Check point before entering the next phase
(B) Pausing in middle of cell cycle to cope with temporary delay
(C) Death of cells
(D) Exit from cell cycle

Ans. D

Sol. G_0 stage in cell denotes exit from cell cycle.