FT-V-KVPY-CLASS-XI
FULL TEST – V

PART – I
MATHEMATICS

1. The sum of the infinite series : $\frac{1}{10}+\frac{2}{10^2}+\frac{3}{10^3}...+\frac{n}{10^n}+...$

(A) $\frac{1}{9}$ (B) $\frac{10}{81}$

(C) $\frac{1}{8}$ (D) $\frac{17}{22}$

Ans. A

Sol. $S=\frac{1}{10}+\frac{2}{10^2}+\frac{3}{10^3}+...+\frac{n}{10^n}+...\infty$

$\frac{S}{10}=\frac{1}{10^2}+\frac{2}{10^3}+......\infty$

Substracting,

$\frac{9S}{10}=\frac{1}{10}+\frac{1}{10^2}+\frac{1}{10^3}+......\infty$

$\frac{9S}{10}=\frac{\frac{1}{10}}{1-\frac{1}{10}}$

$\frac{9S}{10}=\frac{1}{9}$

$S=\frac{10}{81}$

2. The number $(1024)^{1024}$ is obtained by raising $(16)^{16}$ to the power n. What is the value of n?

(A) 64 (B) 64^2

(C) 64^{64} (D) 160

Ans. D

Sol. $(1024)^{1024}=(16)^{16n}$

$\left(2^{10}\right)^{1024}=\left(2^4\right)^{16n}$

$10\times1024=4\times16n$

$n = \frac{10 \times 1024}{4 \times 16}$

n = 160

3. The smallest value the expression $x^2 + 6x + 8$ attains on the set $\left\{x \in R \middle| x^2 - 2x - 8 \le 0\right\}$ is

(A) 0 (B) –1
(C) 8 (D) 3

Ans. A

Sol. $x^2 + 6x + 8$

$x \in R$

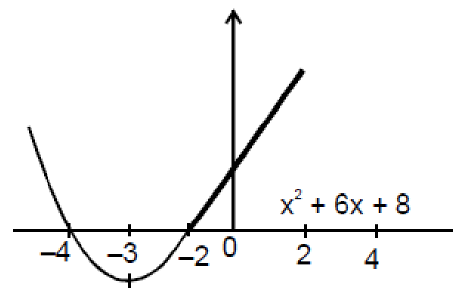
$x^2 - 2x - 8 \le 0$

$x^2 - 2x - 8 =$ $\quad x^2 + 2x - 4x - 8$

$x(x+2) - 4(x+2) \le 0$

$x \in [-2, 4]$

Clearly value of expression is 0
at x = –2



4. In triangle ABC, with $\angle A = 90^o$, the bisectors of the angles B and C meet at P. The distance from P to the hypotenuse is $4\sqrt{2}$. The distance AP is:

(A) 8 (B) 4
(C) $8\sqrt{2}$ (D) $4\sqrt{2}$

Ans. A

Sol. Angle bisector

$\therefore$ Incircle is formed whose radius $= 4\sqrt{2}$

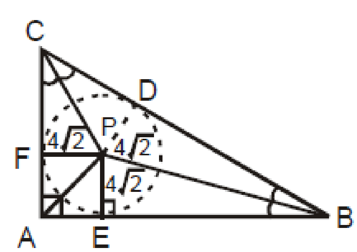
PE = $r = 4\sqrt{2}$

$PF = r = 4\sqrt{2}$ also PF = AE

$\therefore$ $\Delta APE, (AP)^2 = (AE)^2 + (PE)^2$

$= \left(4\sqrt{2}\right)^2 + \left(4\sqrt{2}\right)^2 = 64$

$\therefore$ AP = 8



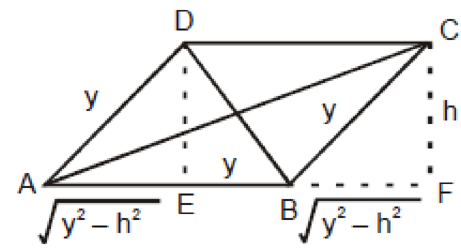
5. In a rhombus one of the diagonals is twice the other diagonal. Let A be the area of the rhombus in square units. Then each side of the rhombus is :

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

(C) $\frac{1}{2}\sqrt{5A}$ (D) $\frac{1}{4}\sqrt{4A}$

Ans. C

Sol. Area of rhombus $= \frac{1}{2} d_1 d_2$



Let one diagonal = x

$$= \frac{1}{2} \times (x)(2x) = x^2$$

$A = x^2$

Let side of rhombus = y and height = h

ΔAFC,

$$\left(y + \sqrt{y^2 - h^2}\right)^2 + h^2 = (AC)^2 = 4x^2$$

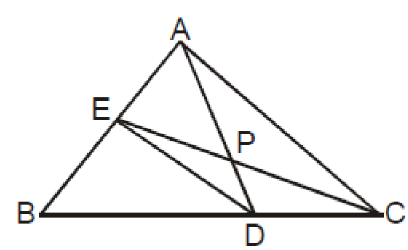
$$\Delta DEB \left(y - \sqrt{y^2 - h^2}\right) + h^2 = (AC)^2 = 4x^2$$

$$\Delta DEB \left(y - \sqrt{y^2 - h^2}\right)^2 + h^2 = (BD)^2 = x^2$$

Adding $4y^2 = 5x^2$

$$y = \sqrt{\frac{5x^2}{4}} = \frac{\sqrt{5A}}{2}$$

6. In the following, AE = EB, BD = 2DC What is the ratio of the areas of PED and ABC?

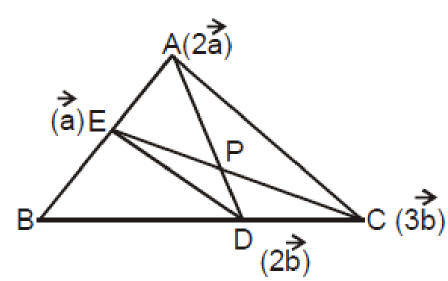


(A) $\frac{1}{4}$ (B) $\frac{1}{6}$

(C) $\frac{1}{9}$ (D) $\frac{1}{12}$

Ans. D

Sol. Let B is origin and the position vector of A and C are $2\vec{a}$ and $3\vec{b}$



Then P.V. of $E = \vec{a}$ and P.V. of $D = 2\vec{b}$

Now, let P divides AD in $\lambda : 1$ ratio

and P divides EC in $\mu : 1$

$$\therefore \quad \frac{2\vec{b}\lambda + 2\vec{a}}{\lambda + 1} = \frac{3\vec{b}\mu + \vec{a}}{\mu + 1}$$

$$2\vec{b}\lambda\mu + 2\vec{b}\lambda + 2\vec{a}\mu + 2\vec{a} = 3\vec{b}\lambda\mu + \vec{a}\lambda + 3\vec{b}\mu + \vec{a}$$

$$\vec{a}(2\mu + 2 - \lambda - 1) = \vec{b}(3\lambda\mu + 3\mu - 2\lambda\mu - 2\lambda)$$

But $\vec{a}$ and $\vec{b}$ are not collinear.

$2\mu - \lambda + 1 = 0$ and $\lambda\mu + 3\mu - 2\lambda = 0$

We get $\mu = 1$

Now, P.V. of P is $=\frac{\vec{a}+3\vec{b}}{2}$

Now,

$$\frac{ar\,\Delta PED}{ar\Delta ABC}=\frac{\frac{1}{2}\left|\left(\vec{a}-\frac{\vec{a}+3\vec{b}}{2}\right)\times\left(2\vec{b}-\frac{\vec{a}+3\vec{b}}{2}\right)\right|}{\frac{1}{2}\left|2\vec{a}\times 3\vec{b}\right|}$$

$$=\frac{\frac{1}{4}\left|\left(\vec{a}-3\vec{b}\right)\times\left(\vec{b}-\vec{a}\right)\right|}{6\left|\vec{a}\times\vec{b}\right|}=\frac{1}{12}$$

7. The real numbers x satisfying $\frac{\sqrt{x+5}}{1-x}>1$ are precisely those which satisfy

(A) $x<1$ (B) $0<x<1$

(C) $-5<x<1$ (D) $-1<x<1$

Ans. D

Sol. $\sqrt{x+5}\ge 0$

$\therefore 1-x\ge 0$

$x<1$ ....(i)

$\sqrt{x+5}>1-x$

$x+5>1+x^2-2x$

$x^2-3x-4<0$

$(x-4)(x+1)<0$

$x\in(-1,4)$ ...(ii)

Using (i) and (ii) $x\in(-1,1)$

8. How many positive real number x satisfy the equation $x^3-3|x|+2=0$?

(A) 1 (B) 3

(C) 4 (D) 6

Ans. A

Sol. $x^3-3|x|+2=0$

[Let $x>0$]

$x^3-3x+2=0$

$(x-1)\left(x^2+x-2\right)=0$

$$x = 1,\ x = \frac{-1+\sqrt{9}}{2} = 1$$

Now, let $x < 0$

$x^3 + 3x + 2 = 0$

No solution

x = 1 only one solution

9. Let $(1+2x)^{20} = a_0 + a_1x + a_2x^2 + ... + a_{20}x^{20}$. Then,

$3a_0 + 2a_1 + 3a_2 + +2a_3 + 3a_4 + 2a_5 + ...2a_{19} + 3a_{20}$ equal to :

(A) $\frac{5.3^{20} - 3}{2}$ (B) $\frac{5.3^{20} + 3}{2}$

(C) $\frac{5.3^{20} + 1}{2}$ (D) $\frac{5.3^{20} - 1}{2}$

Ans. C

Sol. $(1+2x)^{20} = a_0 + a_1x + a_2x^2 + ... + a_{20}x^{20}$

put $x = 1$ $3^{20} = a_0 + a_1 + a_2 + ... + a_{20}$

x = –1 $1 = a_0 - a_1 + a_2 - a_3 ...... + a_{20}$

subtract $3^{20} - 1 = 2(a_1 + a_3 + ... + a_{19}]$

add $3^{20} + 1 = 2(a_0 + a_2 + ... + a_{20}]$

$$2(a_1 + a_3 + ... + a_{19}) + 3[a_0 + a_2 + ... + a_{20}] = (3^{20} - 1) + \frac{3}{2}(3^{20} + 1)$$

$$= \frac{5.3^{20} + 1}{2}$$

10. In a right triangle ABC. The in circle touches the hypotenuse AC at D. If AD = 10 and DC = 3, the inradius of ABC is

(A) 5 (B) 4

(C) 3 (D) 2

Ans. D

Sol. $(r+3)^2 + (r+10)^2 = (13)^2$

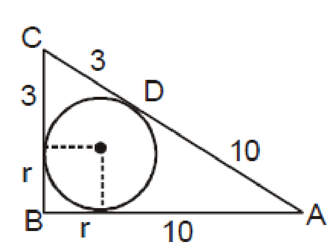
$\Rightarrow$ $r^2 + 9 + 6r + r^2 + 100 + 20r = 169$

$\Rightarrow$ $2r^2 + 26r - 60 = 0$

$\Rightarrow$ $r^2 + 13r - 30 = 0$

$\Rightarrow$ $(r+15)(r-2) = 0$

$\Rightarrow$ $r = 2$

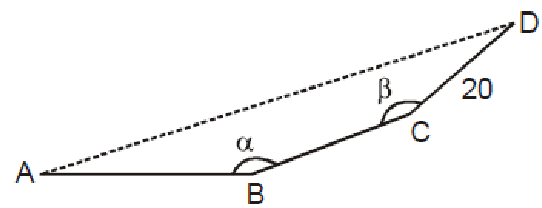


11. The sides of a quadrilateral are all positive integers and three of them are 5, 10, 20. How many possible value are there for the fourth sides?

(A) 29 (B) 31
(C) 32 (D) 34

Ans. D

Sol. To find possible integral value of 4th side minimum possible value of 4th side greater than 0 is 1. For maximum possible value.



let angle α, β are slightly smaller than 180^o

if $\alpha, \beta = 180^o$

AD = 35

$\therefore$ maximum value of 4th side is 34

$\therefore 1, 2, 3, ...34$ are possible value of 4th side

$\therefore$ 34 values are possible.

12. If the volume of a sphere increases by 72.8%, then its surface area increases by

(A) 20% (B) 44%
(C) 24.3% (D) 48.6%

Ans. B

Sol. $$\frac{V'}{V} = \frac{172.8}{100} = \frac{\frac{4}{3}\pi R'^3}{\frac{4}{3}\pi R^3}$$

$$\frac{R'}{R} = 1.2$$

Now, ratio of surface area $= \frac{S'}{S} = \frac{4\pi R'^2}{4\pi R^2}$

$$= \frac{S'}{S} = 1.44$$

Hence surface area increased by 44%

13. Total number of 5 digit numbers having all different digits and divisible by 4 that can be formed using the digits {1, 2,3, 6, 8, 9} , is equal to:

(A) 192 (B) 32
(C) 1152 (D) 384

Ans. A

Sol. A number is divisible by 4, if the last two digits of the number of divisible by 4. In this case, last two digits can be 12, 16, 28, 32, 36, 68, 92, 98 which are eight.

$\therefore$ Total number of such numbers

• • • • •

$= 4 \times 3 \times 2 \times 1 \times 8 = 192$

14. The tens digit of $1!+2!+3!+....+29!$ is:

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

Ans. A

Sol. $1!+2!+3!+4!=33$,
$5!=120, 6!=720, 7!=5040, 8!=40320$,
$9!=362880$.
$\therefore$ tens digit of $1!+2!+....+9!=1$
Also $n!$ is divisible by 100 for all $n \geq 10$.
Therefore, tens digit in $1!+2!+3!+...+29!=1$.

15. The moon's distance from the earth is 3,50,000 kilometre and its diameter subtends an angle of 31' at the eye of the observer. The diameter of the moon is:

(A) $3157\left(\frac{11}{27}\right)$km
(B) $315\left(\frac{11}{27}\right)$km
(C) $3050\left(\frac{11}{27}\right)$km
(D) None of these

Ans. A

Sol. Let l be the diameter of moon and a its distance from the earth. If the moon subtends an angle θ at the eye of the observe, then

$$l = a\theta = 350000 \times \left(\frac{31}{60} \times \frac{\pi}{180}\right)$$

$$= \frac{3500 \times 31}{6 \times 18} \times \frac{27}{7} = 3157\frac{11}{27}\text{km}.$$

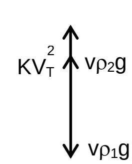
PHYSICS

16. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2 (\rho_2 < \rho_1)$. Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed ν. i.e., $F_{viscous} = -k\nu^2$ $(k > 0)$. The terminal speed of the ball is

(A) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$
(B) $\frac{Vg\rho_1}{k}$
(C) $\sqrt{\frac{Vg\rho_1}{k}}$
(D) $\frac{Vg(\rho_1 - \rho_2)}{k}$

Ans. A

Sol. $v\rho_2 g + KV_T^2 = v\rho_1 g$
The ball is dynamic equilibrium.



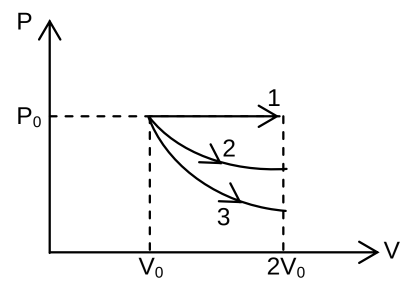
17. A force $\vec{F} = -K(y\ \hat{i} + x\ \hat{j})$ (where k is a positive constant) acts on a particle moving in the X-Y plane. Starting from the origin, the particle is taken along the positive X-axis to the point (a, 0) and then parallel to the Y-axis to the point (a, a). The total work done by the force $\vec{F}$ on the particle is

(A) $-2Ka^2$ (B) $2Ka^2$
(C) $-Ka^2$ (D) Ka^2

Ans. C

Sol. For motion along x-axis, y = 0
$\therefore$ work done from (0, 0) to (a, 0) is
$w = \int f_x dx = \int -kx\hat{j}.dx\hat{i} = 0$
for motion along Y-axis, x = a
$\therefore\ w = \int_0^a -k\left(y\hat{i} + a\hat{j}\right).dy\hat{j}\ = -ka^2$

18. A gas is expanded from volume V_0 to $2V_0$ under different processes. Process (1) is isobaric (2) is isothermal and (3) is adiabatic. Let ΔU_1, ΔU_2 and ΔU_3 be the change in internal energy of the gas in these three processes then:



(A) $\Delta U_1 > \Delta U_2 > \Delta U_3$
(B) $\Delta U_1 < \Delta U_2 < \Delta U_3$
(C) $\Delta U_2 < \Delta U_1 < \Delta U_3$
(D) $\Delta U_2 > \Delta U_1 > \Delta U_3$

Ans. A

Sol. Isothermal $\rightarrow \Delta U_2 = 0$
Isobaric $\rightarrow \Delta U_1 = nC_V\left(2T_0 - T_0\right) = nC_VT_0 = \dfrac{P_0V_0C_V}{R}$
Adiabatic $\rightarrow\ \Delta U_3\ = - \Delta W$ = negative

19. The relation between time t and distance x moved by a particle is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is (if v represents velocity)

(A) $2\alpha V^3$ (B) $2\beta V^3$
(C) $2\alpha\beta V^3$ (D) $2\beta^2 V^3$

Ans. A

Sol. $\alpha x^2 + \beta x - t = 0 \ \Rightarrow\ x = \dfrac{-\beta \pm \sqrt{\beta^2 + 4\alpha t}}{2\alpha}$

$V = \dfrac{dx}{dt} = \dfrac{4\alpha}{2 \times 2\alpha\sqrt{\beta^2 + 4\alpha t}} = \pm\dfrac{1}{\sqrt{\beta^2 + 4\alpha t}}$

$a = \dfrac{dv}{dt} = \pm\dfrac{1}{(\beta^2 + 4\alpha t)^{3/2}}\left(\dfrac{-1}{2}\right) \times 4\alpha = (-2\alpha)V^3$

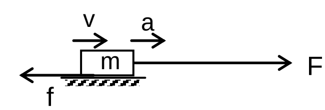
20. A block of mass m is moving with a constant acceleration a on a frictional plane. If the coefficient of friction between the block and ground is μ, the power delivered by the external agent after a time t from the beginning is equal to:

(A) ma^2t (B) $\mu mgat$

(C) $\mu m(a+\mu g)gt$ (D) $m(a+\mu g)at$

Ans. D

Sol. Instantaneous power delivered $= P = \vec{F}.\vec{v} = Fv$



where, $F - f = ma$

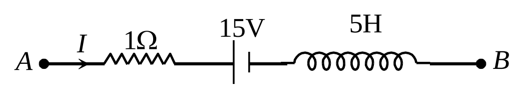
$\Rightarrow F = f + ma$

$\Rightarrow P = (f + ma)\ v$

Put $f = \mu mg$

$\therefore\ P = (\mu mg + ma)v = m(a + \mu g).at$

21. The network shown in the following figure is part of a circuit. What is the potential difference ($V_A - V_B$) when current I is 5A and is decreasing at a rate of 1 As^{-1}?



(A) 5 V (B) 10 V

(C) 15 V (D) zero

Ans. C

Sol. $V_A - IR - E + L\frac{dI}{dt} = V_B$ or $V_B - V_A = -IR - E + L\frac{dI}{dt}$

Since I is decreasing with t, $\frac{dI}{dt}$ is negative.

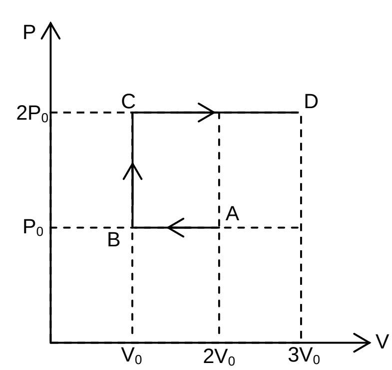
$V_B - V_A = -5\times1 - 15 + (5)\times(1) = -5 - 15 + 5 = -15V$

$\Rightarrow\ V_A - V_B = 15\ V$

22. P –V diagram of an ideal gas is as shown, work done by the gas in the process ABCD is

(A) $4\ P_0V_0$ (B) $2\ P_0V_0$

(C) $3\ P_0V_0$ (D) P_0V_0



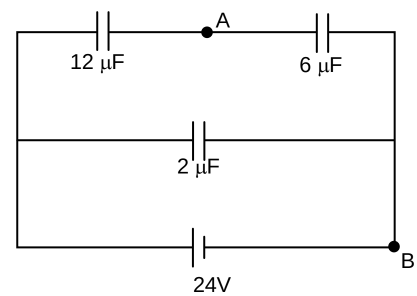
Ans. C

Sol. $W_{AB} = -P_0V_0$

$W_{CD} = +4P_0V_0$

$W_{ABCD} = +3P_0V_0$

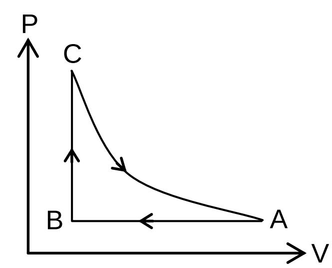
23. In figure, if the potential at point B is taken as zero, then the potential at point A will be
(A) 8V
(B) 16V
(C) 24V
(D) 21V

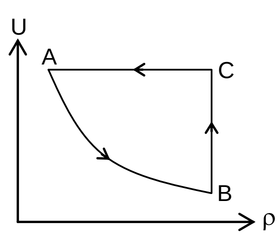


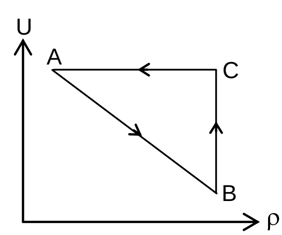
Ans. B

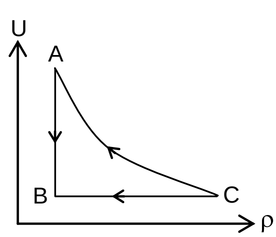
Sol. The voltage across 6 μF = 16 V.

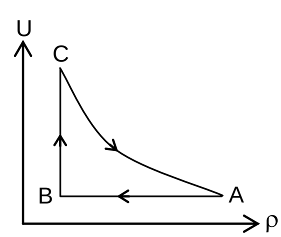
24. P-V plot of an ideal mono-atomic gas is shown in the figure. C → A is part of a rectangular hyperbola. Then which of the following (U → internal energy of the gas and ρ → density of the gas) graph is correct.



(A)


(B)


(C)


(D)


Ans. A

Sol. $U = nC_vT$, $P = \dfrac{\rho RT}{M}$

In process CA, T is constant, ∴ U is constant.

$\dfrac{U}{P} = \dfrac{3nM}{2\rho}$ $\left(\because \ C_v = \dfrac{3R}{2}\right)$

$U\rho$ = constant if P is constant

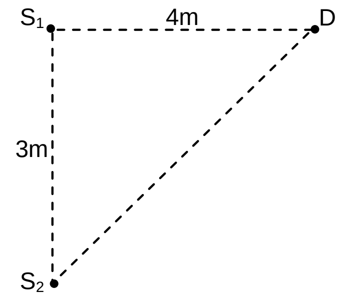
∴ Process AB will be hyperbola in U-ρ graph.

In process BC, V is constant.

∴ ρ is constant.

25. In the figure the intensity of waves arriving at D from two coherent sources S_1 and S_2 is I_0. The wave length of the wave is λ = 4m. Resultant intensity at D will be

(A) $4I_0$ (B) I_0
(C) $2I_0$ (D) zero



Ans. C

Sol. Path difference = 5 – 4 = 1 m

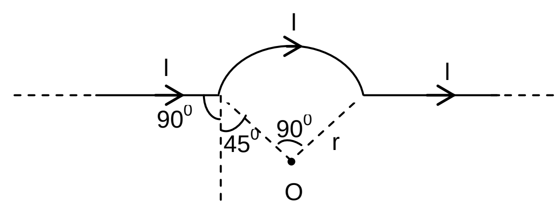
Phase difference = $\Delta\phi = \frac{2\pi}{\lambda}.\Delta x = \frac{2\pi}{4} = \frac{\pi}{2}$

$I_R = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\Delta\phi)$

$I_R = I_0 + I_0 + 0$

$I_R = 2I_0$

26. The magnetic field at the centre O of the arc in figure is (r is the radius of circular arc)



(A) $\frac{\mu_0 I}{4\pi \times r}\left[\sqrt{2}+\pi\right]$ (B) $\frac{\mu_0 I}{2\pi r}\left[\frac{\pi}{4}+1\left(\sqrt{2}-1\right)\right]$

(C) $\frac{\mu_0}{4\pi}\times\frac{I}{r}\left[\sqrt{2}+r\right]$ (D) $\frac{\mu_0}{4\pi}\times\frac{I}{r}\left[\sqrt{2}+\frac{\pi}{4}\right]$

Ans. B

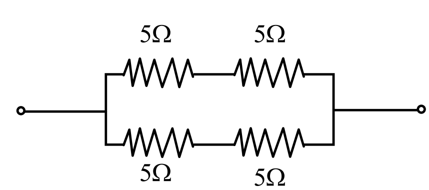
Sol. $B = 2\left[\frac{\mu_0 I}{4\pi r\cos 45^0}\right]\left(\sin 90^0 - \sin 45^0\right) + \frac{\mu_0 I}{4\pi r}\left(\frac{\pi}{2}\right)$

27. Four wires of equal length and of resistance 5 ohm each are connected in the form of a square. The equivalent resistance between the diagonally opposite corners of the square is

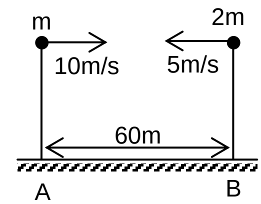
(A) 5 ohm (B) 10 ohm
(C) 20 ohm (D) 5/4 ohm

Ans. A

Sol. Equivalent circuit is



28. Two particles one of mass m and the other of mass 2m are projected horizontally towards each other from the same level above the ground with velocities 10 m/s and 5 m/s respectively. They collide in air and stick to each other. The distance from A where the combined mass finally land is

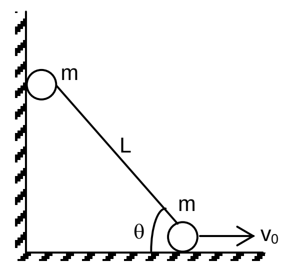


(A) 40 m
(B) 20 m
(C) 30 m
(D) 45 m

Ans. A

Sol. Collision will occur after 4 seconds, when distance travelled by m in horizontal direction is 40 m.
$P_{ix} = 0$, before collision and remains 0 after collision.

29. In the shown diagram two point masses m are joined by a massless rod of length 5.5 m. The lower end of the mass system is dragged with constant velocity v_0 rightwards. The magnitude of velocity of centre of mass when $\theta = 37^0$, will be



(A) $\frac{5v_0}{6}$
(B) $2v_0$
(C) $v_0\sqrt{2}$
(D) $\frac{6v_0}{5}$

Ans. A

Sol. $x^2 + y^2 = \ell^2$

$$\frac{dy}{dt} = -\frac{x}{y}\left(\frac{dx}{dt}\right)$$

If $\theta = 37°$

$$\frac{dy}{dt} = -\frac{x}{y}\frac{dx}{dt} = -\frac{4}{3}v_o \quad ; \quad \vec{v}_{cm} = \frac{mv_o\hat{i} - m\frac{4v_o}{3}\hat{y}}{2m}$$

$$\left|\vec{V}_{cm}\right| = \frac{5v_o}{6}$$

30. In Young's double slit experiment, double slit of separation 0.1 cm is illuminated by white light. A coloured interference pattern is formed on a screen 100 cm away. If a pin hole is located on this screen at a distance of 2 mm from the central fringe, the wavelength in the visible spectrum which will be absent in the light transmitted through the pin-hole are
(A) 5714 Å and 4444 Å
(B) 6000 Å and 5000 Å
(C) 5500 Å and 4500 Å
(D) 5200 Å and 4200 Å

Ans. A

Sol. Absent wavelengths correspond to interference minima

$\therefore \quad d\sin\theta = (2n-1)\frac{\lambda}{2} \Rightarrow d\frac{y}{D} = (2n-1)\frac{\lambda}{2} \Rightarrow \lambda = \frac{2yd}{D(2n-1)} = \frac{40000}{2(n-1)}$

$= 13333$ Å, 80000 Å, 5714 Å, 4444 Å, 3636 Å

CHEMISTRY

31. Which of the following electronic transition in H-atom results in a line in the visible region of spectrum?

(A) $n_1 = 6 \rightarrow n_2 = 3$
(B) $n_1 = 5 \rightarrow n_2 = 1$
(C) $n_1 = 4 \rightarrow n_2 = 2$
(D) $n_1 = 6 \rightarrow n_2 = 4$

Ans. C

Sol. Balmer series is obtained in the visible region.

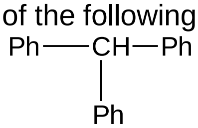
32. Which of the following compounds possesses zero dipole moment?

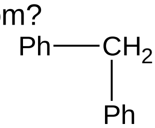
(A) $BeCl_2$
(B) $SnCl_2$
(C) $PbCl_2$
(D) SCl_2

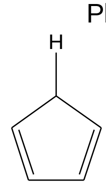
Ans. A

Sol. $BeCl_2$ is a linear molecule.

33. Which of the following contains most acidic H atom?

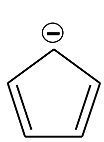
(A) 

(B) 

(C) 

(D) $PhCH_3$

Ans. C

Sol.  is aromatic

34. Which of the following constant is a measure of intermolecular force between gas molecules?

(A) gas constant (R)
(B) Boltzman constant (K)
(C) Van der Waal's constant (a)
(D) Van der Waal's constant (b)

Ans. C

Sol. Intermolecular force is measured by 'a' only.

35. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Reaction in above equilibrium will proceed to which direction by decreasing the volume of the vessel?

(A) forward direction
(B) backward direction
(C) no change
(D) none of these

Ans. A

Sol. Reaction shifts towards less no. of moles.

36. Calculate the root mean square speed and average speed for a sample of gas having 5, 10 and 15 molecules each one in a set is moving with a speed of 15×10^2, 5×10^2 and 10×10^2 ms^{-1} respectively.

(A) 9.79×10^2
(B) 18.34×10^2
(C) 36×10^3
(D) 87×10^2

Ans. A

Sol.

$$u_{rms} = \sqrt{\frac{n_1 u_1^2 + n_2 u_2^2 + n_3 u_3^2 + \ldots}{n_1 + n_2 + n_3 + \ldots}}$$

$$= \sqrt{\frac{5 \times (15 \times 10^2)^2 + 10 \times (5 \times 10^2)^2 + 15 \times (10 \times 10^2)^2}{5 + 10 + 15}}$$

$$= \mathbf{9.79 \times 10^2 \text{ m sec}^{-1}}$$

$$\text{Also, } u_{AV} = \frac{n_1 u_1 + n_2 u_2 + n_3 u_3 + \ldots}{n_1 + n_2 + n_3 + \ldots}$$

$$= \frac{(5 \times 15 \times 10^2) + (10 \times 5 \times 10^2) + (15 \times 10 \times 10^2)}{5 + 10 + 15}$$

$$= \mathbf{9.17 \times 10^2 \text{ m sec}^{-1}}$$

37. If the pressure is tripled and temperature (in kelvins) is halved, the volume of a given mass of an ideal gas becomes

(A) 3/2 times its original volume
(B) 2/3rd of its original volume
(C) 1/6th of its original volume
(D) 6 times its original volume

Ans. C

Sol. $V' = \frac{nRT}{P} = \frac{nRT}{3P \times 2} = \frac{1}{6} \times \frac{nRT}{P} = \frac{1}{6} \times V$

38. Which of the following pair is diamagnetic according to MOT?

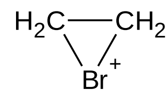
(A) O_2^- and O_2^{2-}
(B) B_2 and C_2
(C) N_2 and O_2^{2+}
(D) O_2^+ and H_2^+

Ans. C

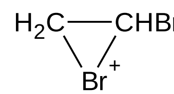
Sol. N_2 and O_2^{2+} contain no unpaired electrons.

39. Ethylene reacts with Br_2 to give 1, 2 dibromoethane. The anti addition takes place due to the formation of the intermediate

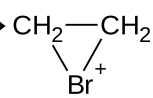
(A) $CH_2Br-CH_2^+$

(B) 

(C) $BrCH=CH^+$

(D) 

Ans. B

Sol. $CH_2=CH_2+Br_2 \longrightarrow$  $+Br^-$

40. The composition of the equilibrium mixture $\left(Cl_2 \rightleftharpoons 2Cl\right)$, which is attained at 1200°C, is determined by measuring the rate of effusion through a pinhole, It is observed that at 1.80 mm Hg pressure, the mixture effuses 1.16 times as fast as krypton effuses under the same conditions. Calculate the fraction of chlorine molecules dissociated into atoms. (Atomic wt. of Kr = 84)

(A) 13.7%
(B) 15.7%
(C) 31.7%
(D) 51.7%

Ans. A

Sol.

$$\frac{\gamma_{mix}}{\gamma_{Kr}}=\sqrt{\left(\frac{M_{Kr}}{M_{mix}}\right)} \quad \text{or} \quad 1.16=\sqrt{\left(\frac{84}{M}\right)}$$

$\therefore \quad M=62.425$

For $\quad Cl_2 \rightleftharpoons 2Cl$

$\quad\quad 1 \quad\quad 0$

$\quad\quad (1-\alpha) \quad 2\alpha$

$$\frac{\textbf{Normal mol. wt.}}{\textbf{Exp. mol. wt.}}=1+\alpha$$

$$\frac{71}{62.425}=1+\alpha$$

$\alpha=\mathbf{0.137}$ or **13.7%**

41. An aqueous mixture of sodium ethanoate and sodium propanoate is electrolysed. The product of the reaction is

(A) $CH_3CH_2CH_3$
(B) $CH_3CH_2CH_2CH_3$
(C) CH_3CH_3
(D) all of these

Ans. D

Sol. $CH_3CH_2COONa \longrightarrow CH_3CH_2^{\bullet}+CO_2$

$$CH_3COONa \longrightarrow \dot{C}H_3 + CO_2$$
$$CH_3\dot{C}H_2 + \dot{C}H_3 \longrightarrow CH_3CH_2CH_3$$
$$\dot{C}H_3 + \dot{C}H_3 \longrightarrow CH_3CH_3$$
$$CH_3\dot{C}H_2 + CH_3\dot{C}H_2 \longrightarrow CH_3CH_2CH_2CH_3$$

42. The maximum number of electrons in p-orbital with n = 6, m = 0 is

(A) 2 (B) 6
(C) 10 (D) 14

Ans. A

Sol. The orbital is either $3p_x$, $3p_y$ or $3p_z$.

43. Complete the following reaction:

$$H_3C-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } B_2H_6} ?$$

(A) $Me_3C-CH_2-CH_2-OH$ (B) $Me_3C-CH(-OH)-CH_3$

(C) $Me-\underset{OH}{\overset{Me}{\underset{|}{\overset{|}{C}}}}-\underset{CH_3}{\underset{|}{CH}}-CH_3$ (D) none

Ans. A

Sol. Anti Markownikoff addition takes place.

44. In aromatic sulphonation, the attacking species is

(A) $\overset{+}{S}O$ (B) SO_2
(C) SO_3 (D) HSO_4^-

Ans. C

Sol. SO_3 behaves as an electrophile.

45. 2.1 gm of Fe combines with S evolving 3.77 kJ. The heat of formation of FeS in kJ/mol is

(A) -3.77 (B) -1.79
(C) -100.5 (D) none

Ans. C

Sol. Moles of Fe = $\frac{2.1}{56} = 0.0375$

0.0375 mole evolves 3.77 kJ

∴ One mole will evolve = $\frac{3.77}{0.0375}$ = 100.5 kJ mol^{-1}

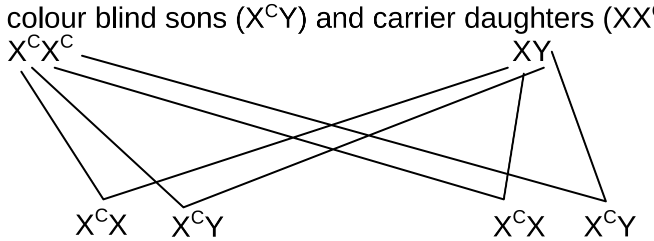
∴ The heat of formation = -100.5 kJ mol^{-1}

<u>BIOLOGY</u>

46. A marriage between normal visioned man and colour-blind woman will produce offspring:
(A) colour blind sons and 50% carrier daughter
(B) 50% colour blind sons and 50% carrier daughter
(C) normal males and carrier daughters
(D) colour blind sons and carrier daughters.

Ans. D

Sol. A marriage between normal visioned man (XY) and colour-blind woman (X^CY^C) produce colour blind sons (X^CY) and carrier daughters (XX^C).



<u>X^CX X^CX</u>
Carrier daughters

<u>X^CY X^CY</u>
Colour blind sons

47. Many cells function properly and divide mitotically even though they do not have:
(A) plasma membrane
(B) cytoskeleton
(C) mitochondria
(D) plastids

Ans. D

Sol. Plastids are the characteristics feature of plant cells but animal cells are devoid of them. Even then they function properly and divide mitotically similar to plant cells.

48. Aerobic respiration produces more usable chemical energy than fermentation, because fermentation involves:
(A) formation of lactic acid
(B) complete oxidation of food
(C) partial oxidation of food
(D) evolution of CO_2 and alcohol

Ans. C

Sol. During aerobic respiration, a glucose molecule produces 38 ATP while during fermentation incomplete oxidation of food materials in the absence of oxygen takes place.

49. A pregnant woman, who has done amniocentesis tests, finds an extra Barr body in her embryo. The syndrome which is likely to be associated with embryo is
(A) Edward's syndrome
(B) Down's syndrome
(C) Klinefelter's syndrome
(D) Patau's syndrome

Ans. C

Sol. This syndrome is characterised by trisomy (XXY). These are male individuals, who are phenotypically fairly normal but have a very low sperm count and are therefore sterile. As the syndrome has two X chromosomes, one Barr body is seen in this case.

50. One of the representatives of Phylum Arthropoda is:
(A) puffer fish (B) flying fish
(C) cuttle fish (D) silver fish

Ans. D

Sol. Phylum Arthropoda is the largest phylum of Animalia which includes insects like silver fish. Puffer fish and flying fish are examples of super class Pisces, while cuttle fish belongs to Mollusca.

51. Which one of the following is not an inclusion body found in prokaryotes?
(A) Glycogen granule (B) Polysome
(C) Phosphate granule (D) Cyanophycean granule

Ans. B

Sol. Polysome is a not an inclusion body. It is an aggression of ribosomes formed under conditions of high concentration of magnesium.

52. The movement of ions against the concentration gradient will be:
(A) active transport (B) osmosis
(C) diffusion (D) all of the above

Ans. A

Sol. Active transport involves movement of materials across the membrane against the concentration gradient of the solute particles. It requires energy in the form of ATP and carrier molecules.

53. Which of the following elements is a constituent of biotin?
(A) Magnesium (B) Calcium
(C) Phosphorus (D) Sulphur

Ans. D

Sol. Sulphur is present in two vitamins of B complex, thiamine and biotin. Biotin is important to hair. It is normally found in protein foods, such as eggs, sprout etc.

54. Cyclic photophosphorylation results in the formation of:
(A) ATP and NADPH (B) ATP, NADPH and O_2
(C) ATP (D) NADPH

Ans. C

Sol. In cyclic photophosphorylation 2 molecules of ATP are synthesized which are used in dark reaction.

55. Out of 38 ATP molecules produced per glucose, 32 ATP molecules are formed from NADH / $FADH_2$ in
(A) Respiratory chain (B) Krebs cycle
(C) Oxidative decarboxylation (D) EMP

Ans. A

Sol. During respiratory chain, complete degradation of one glucose molecule produced 38 ATP molecules. NAD and FAD is reduced to NADH / $FADH_2$.

56. Which of the following statements is not correct?
(A) Oxyntic cells are present in the mucosa of stomach and secrete HCl.
(B) Acini are present in the pancreas and secrete carboxypeptidase.
(C) Brunner's glands are present in the submucosa of stomach and secrete pepsinogen.
(D) Goblet cells are present in the mucosa of intestine and secrete mucus.

Ans. C

Sol. The Brunner's gland is branched tubular glands in duodenum. They secrete alkaline watery fluid, a little enzyme and mucus. They open into the crypts of Lieberkuhn.

57. Anxiety and eating spicy food together in an otherwise normal human, may lead to:
(A) Indigestion (B) Jaundice
(C) Diarrhoea (D) Vomiting

Ans. A

Sol. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating and spicy food.

58. Name the pulmonary, disease in which alveolar surface are involved in gas exchange is drastically reduced due to damage in the alveolar walls.
(A) Pneumonia (B) Asthma
(C) Pleurisy (D) Emphysema

Ans. D

Sol. Emphysema is an inflation or abnormal distension of the bronchioles or alveolar sacs of the lungs. Major causes of emphysema are cigarette smoking and inhalation of smoke or other toxic materials.

59. Then opening between the right atrium and the right ventricle is guarded by the valve named:
(A) Bicuspid valve (B) Tricuspid valve
(C) Mitral valve (D) Semilunar valve

Ans. B

Sol. The opening between the right atrium and right ventricle is guarded by a valve formed of three muscular flaps or cusps, the tricuspid valve.

60. Arbor vitae is composed of

(A) grey matter
(B) neuroglial cells
(C) white matter
(D) both (A) and (C)

Ans. C

Sol. The cerebellum lies behind the cerebrum and above medulla oblongata. The surface has grey matter while deeper down it has white matter giving the appearance of a tree or Arbor vitae.

MATHEMATICS

61. ab and cd are two 2 – digit natural numbers and $4b + a = 13k_1$ and $5d – c = 17k_2$ where k_1 and k_2 are natural numbers. Then find the largest number that will always divide product of ab and cd.

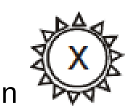
(A) 221 (B) 222
(C) 220 (D) 225

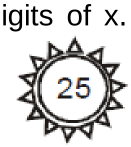
Ans. A

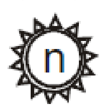
Sol. $ab \times cd = (10a + b)(10c + d)$

$$= [40b + 10a - 39b][51d - (50d - 10c)]$$
$$= [10(4b + a) - 39b][51d - 10(5d - c)]$$
$$= [10 \times 13k_1 - 39b][51d - 10 \times 17k_2]$$
$$= 13 \times 17(10k_1 - 3b)(3d - 10k_2)$$
$$= 221(10k_1 - 3b)(3d - 10k_2)$$

Hence, the largest number that will divide the product ab and cd is 221.

62. An operation define as the product of non zero digits of x. e.g. An operation 

defined as the product of non zero digits of x. e.g. 

$= 2 \times 5 = 10$, then find the sum of all the possible 

where n is a two digit number formed by the digits 1, 2, 3, 4, 5, 6, 7, 8 and 9.

(A) 2020 (B) 2025
(C) 2030 (D) 2035

Ans. B

Sol. Sum of numbers when tens digit is 1.
$S_1 = 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 = 45$
Sum of number when ten's digit is 2
$S_2 = 2 + 4 + 6 + ...+ 18 = 2(1 + 2 + 3 + ...+ 9) = 2 \times 45$
Similarly $S3 = 3 + 6 + 9 + ...+ 27$
$= 3(1 + 2 + 3 + ...+ 9)$
$= 3 \times 45$
$S_4 = 4 \times 45$
-
-
$S_9 = 9 \times 45$

$\therefore$ Total sum = $S_1 + S_2 + S_3 + ... + S_9$
= 45 + 2 × 45 + ...+ 9 × 45
= 45 (1 + 2 + 3 +.....+ 9)
= 45 × 45
= 2025.

63. A ray of light originating at the vertex A of a square ABCD passes through the vertex B after getting reflected by BC, CD and DA in that order. If θ is the angle of the initial position of the ray with AB then find the value of $\sin\theta$.

(A) $\frac{2}{\sqrt{13}}$ (B) $\frac{3}{\sqrt{13}}$
(C) $\frac{5}{\sqrt{13}}$ (D) $\frac{7}{\sqrt{13}}$

Ans. A

Sol. Let AB = a then $BE = a\tan\theta$

$\frac{CE}{CF} = \tan\theta$

$CF = a\cot\theta - a$

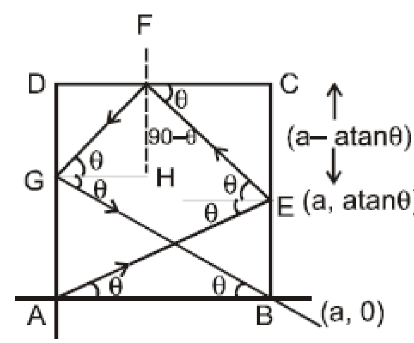
Now, In ΔGHF

$\tan\theta = \frac{HF}{GH} = \frac{1-\tan\theta}{2-\cot\theta}$

Solving we get

$\tan\theta = \frac{2}{3}$

$\therefore \quad \sin\theta = \frac{2}{\sqrt{13}}$



64. Three equal circles of unit radius touches each other. Then find area of the circle circumscribing the three circle is (in sq. unit).

(A) $\frac{\pi}{3}\left(2+\sqrt{3}\right)^2$ (B) $\frac{\pi}{3}\left(4+\sqrt{3}\right)^2$
(C) $\frac{\pi}{3}\left(3+\sqrt{3}\right)^2$ (D) None of these

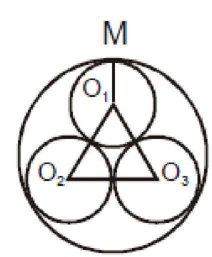
Ans. A

Sol. $O_1O_2 = O_2O_3 = O_3O_1 = 1+1=2$ unit

Height of equilateral triangle $O_1O_2O_3$

$= \frac{\sqrt{3}}{2} \times 2 = \sqrt{3}$ unit.

Centre of the bigger circle O will be the centroid of the triangle.



$$O_1O = \frac{\sqrt{3}\times 2}{3} = \frac{2}{\sqrt{3}}$$

So, the radius of bigger circle

$$= \left(1 + \frac{2}{\sqrt{3}}\right) = \left(\frac{\sqrt{3}+2}{\sqrt{3}}\right)$$

Hence, area of the bigger circle

$$= \pi\left(\frac{\sqrt{3}+2}{\sqrt{3}}\right)^2$$

$$= \frac{\pi}{3}\left(2+\sqrt{3}\right)^2 \text{ sq. unit}$$

65. What will be the last digit of $2^{3^{4^5}} - 2^{3^{5^4}}$.

(A) 1 (B) 2

(C) 3 (D) 4

Ans. D

Sol. $\left(2^3\right)^{4^5} - \left(2^3\right)^{5^4}$

Now as $4^5 > 5^4$

{for $x > 2, (x)^{x+1} > (x+1)^x$ always}

$\therefore \quad 2^{3^{4^5}} > 2^{3^{5^4}}$

Now all even power of 3 are of the form 4n + 1

$\therefore$ last term of first digit is 2

also all odd powers of 3 are of the form 4n + 3.

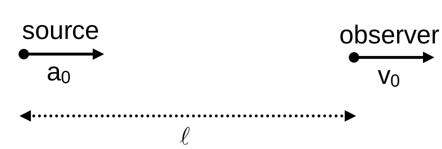
$\therefore$ last digit of the term is 8

[$\because$ By cyclicity of last digit]

Thus, the last digit of express 2-8 = 4.

PHYSICS

66. At t = 0, source starts accelerating with an acceleration a and observer starts moving with constant velocity v_0 as shown in the figure simultaneously. Source emits a frequency f_0 and velocity of sound in the air is v. The frequency detected by the observer initially is

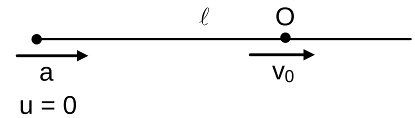


(A) $\frac{(v-v_o)f^2}{(2vf-a)}$ (B) $\frac{2(v-v_o)f^2}{(2vf-a)}$

(C) $\frac{(v-v_o)f^2}{2(2vf-a)}$ (D) $\frac{2(v-v_o)f^2}{(vf-a)}$

Ans. B

Sol. Let first pulse be released at t = 0.



Time when first pulse reaches O = $t_1 = \frac{\ell}{v - v_o}$

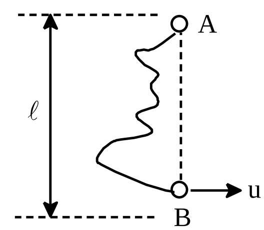
Time when second pulse reaches O =

$$t_2 = T + \frac{\ell + v_o T - \frac{1}{2}aT^2}{v - v_o}$$

$$T' = t_2 - t_1 = \frac{vT}{v - v_o} - \frac{aT^2}{2(v - v_o)}$$

$$\therefore \quad f' = \frac{2f^2(v - v_o)}{2fv - a}$$

67. Two balls A & B both of mass m & connected by a light inextensible string of length 2ℓ. Whole system is on a frictionless horizontal table. Ball B is given a velocity u (as shown) $\perp$r to AB. The velocity of ball A just after the string becomes taut is



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

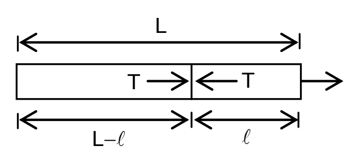
(C) $\frac{u\sqrt{3}}{2}$ (D) $\frac{u}{2}$

Ans. A

Sol. Applying momentum conservation in the direction of string

$$mu\frac{\sqrt{3}}{2} = 2\,mv \quad \Rightarrow \quad v = \frac{\sqrt{3}}{4}(u)$$

68. A uniform rope of length L, resting on frictionless horizontal surface is pulled at one end by a force F. Find the tension in the rope at distance ℓ from the end where force F is applied.



(A) $\frac{F\ell}{L}$ (B) $\frac{F(L - \ell)}{L}$

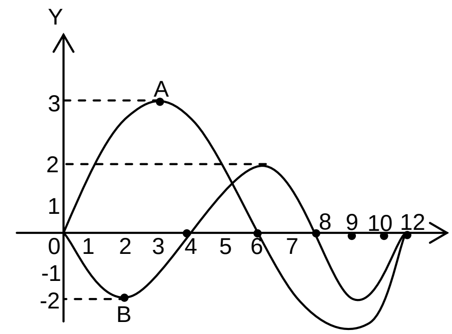
(C) $\frac{F\ell}{L + \ell}$ (D) $\frac{F\ell}{L - 1}$

Ans. B

Sol. Let $\frac{M}{L}$ be mass per unit length. Then mass of length (L - ℓ) is $M' = M\frac{(L - \ell)}{L}$.

$$T = M' \times \frac{F}{M} = \frac{M(L - \ell)}{L} \times \frac{F}{M} = \frac{(L - \ell)}{L}F$$

69. The displacement Vs time graph for two waves A and B which travel along the same string are shown in figure. Determine the ratio of their Intensity $\frac{I_A}{I_B}$



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

Ans. A

Sol. $\frac{I_A}{I_B} = \frac{a_A{}^2 f_A{}^2}{a_B{}^2 f_B{}^2} = 1$

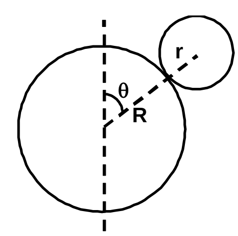
70. A uniform sphere of radius r rolls without slipping down the top of a sphere of radius R. The initial velocity of the sphere is negligible. The angular velocity of the sphere at the moment when it breaks off from the other sphere is

(A) $\sqrt{\frac{10g(R+r)}{17r^2}}$ (B) $\sqrt{\frac{17g(R+r)}{10r^2}}$

(C) $\sqrt{\frac{5g(R+r)}{10r^2}}$ (D) $\sqrt{\frac{5g(R+r)}{11r^2}}$

Ans. A

Sol. When the line joining the centers of the two spheres makes an angle θ with the vertical, then



$mg\cos\theta - N = \frac{mv^2}{R+r}$

When the contact breaks off, N= 0

$mg\cos\theta = \frac{mv^2}{R+r} = \frac{m\omega^2 r^2}{R+r}$ . . . (1) $[\because v = \omega r]$

From COE principle

$mg(R + r) = mg(R+r)\cos\theta + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$mg(R + r) = (R+r)\frac{m\omega^2 r^2}{R+r} + \frac{m\omega^2 r^2}{2} + \frac{1}{2}.\ \frac{2}{5}mr^2\omega^2$

or $g(R + r) = \frac{17}{10}\omega^2 r^2$

$\therefore\ \omega = \sqrt{\frac{10g(R+r)}{17r^2}}$

CHEMISTRY

71. Among NH_3, PH_3, AsH_3 and SbH_3 which one is a stronger reducing agent?

(A) NH_3 (B) PH_3
(C) AsH_3 (D) SbH_3

Ans. D

Sol. Top to bottom reducing agent character increases

72. A certain buffer solution contains equals concentration of X^- and HX. The K_a for HX is 10^{-3}. The pH of the buffer solution is

(A) 3 (B) 8
(C) 11 (D) 14

Ans. A

Sol. $pH = p^{K_a} + \log\frac{[X^-]}{[HX]}$

$= 3 + \log 1 = 3$

73. In the hydrolytic equilibrium

$A^- + H_2O \rightleftharpoons HA + OH^-$

$K_a = 1.0 \times 10^{-5}$, the degree of hydrolysis of 0.001M solution of the salt is

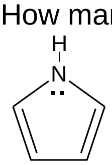
(A) 10^{-3} (B) 10^{-4}
(C) 10^{-5} (D) 10^{-6}

Ans. A

Sol. $K_h = \frac{K_w}{K_a} = \frac{10^{-14}}{10^{-5}} = 10^{-9}$

$\therefore h = \sqrt{\frac{K_h}{C}} = \sqrt{\frac{10^{-9}}{10^{-3}}} = \sqrt{10^{-6}} = 10^{-3}$

74. How many π electron are there in



(A) 2 (B) 4
(C) 6 (D) 8

Ans. C

Sol. π - electrons include pi-bond electrons and lone pair electrons.

75. The pH of a neutral solution at 50^0C is ($K_w = 10^{-13.26}$ at 50^0C)
(A) 7
(B) 6.0
(C) 7.23
(D) 6.63

Ans. D

Sol. $K_w = [H^+][OH^-] = [H^+]^2 = 10^{-13.26}$
or, $[H^+] = 10^{-6.63}$
$\therefore$ pH = -log[H^+] = 6.63

BIOLOGY

76. The preparation of sperm before penetration of ovum is called
(A) insemination
(B) coition
(C) spermiation
(D) capacitation

Ans. D

Sol. During capacitation coating substances of the sperm, especially acrosome is removed and the sperm becomes ready to receive the signal from ovulated egg. After this penetration occurs.

77. Viral diseases have no cure because
(A) viruses have no cell wall.
(B) viruses can multiply repeatedly within the host cell.
(C) presence of capsid.
(D) virus possesses no cytoplasm.

Ans. B

Sol. Viruses have the strong reproductive capacity within the host body, thus when viral disease occurs, several copies of that virus produced in the body and cure by taking medicines is almost impossible.

78. A condition of failure of kidney to form urine is called:
(A) anuria
(B) deamination
(C) uremia
(D) none of these

Ans. A

Sol. Anuria is the complete suppression of urine formation by the kidney. In this case most of the nephrons are destroyed.

79. About which day in a normal human female menstrual cycle does rapid secretion of LH (popularly called LH surge) normally occurs?
(A) 14^{th} day
(B) 20^{th} day
(C) 5^{th} day
(D) 11^{th} day

Ans. A

Sol. Both LH and FSH attain a peak level in the middle of menstrual cycle (about 14^{th} day). Rapid secretion of LH leading induces rupture of Graafian follicle and there by the release of ovum take place.

80. If one strand of DNA has the nitrogenous base sequence as ATCTG, what would be the complementary RNA strand sequence?

(A) TTAGU
(B) UAGAC
(C) AACTG
(D) ATCGU

Ans. B

Sol. In RNA, thymine is substituted with uracil (U) thus RNA strand complementary to DNA strand ATCTG will be UAGAC.