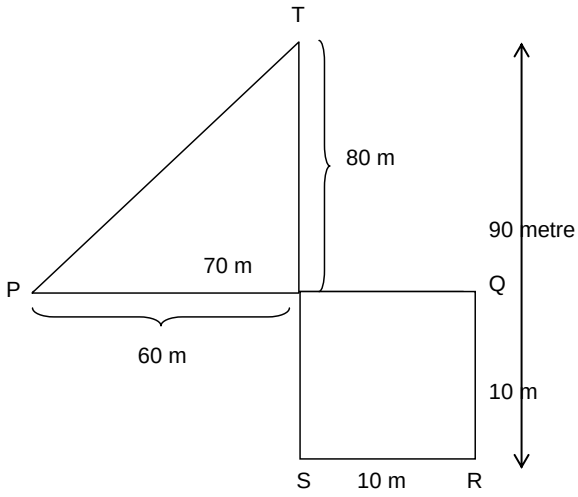
PRE-SERIES-OLT-2021-T1-FT-I-KVPY-CLASS-XI
FULL TEST – I

PART – I
MATHEMATICS

1. Sanjay went 70 m in the east before turning to his right. He went 10 metre, before turning to his right again and went 10 metre from this point. From here he went 90 m to the north. How far was he from the starting point?
(A) 80 metre (B) 100 metre
(C) 140 metre (D) 250 metre

Ans. B

Sol. $PT = \sqrt{80^2 + 60^3}$
$PT = 100m$



2. If the roots of the equation $a(b-c)x^2 + b(c-a)x + c(a-b) = 0$ are real and equal and α, β be the roots of the equation $ax^2 + bx + c = 0$ then H.M. of α and β is
(A) $1-\alpha\beta$ (B) $1+\alpha\beta$
(C) $\alpha\beta - 1$ (D) $-1-\alpha\beta$

Ans. D

Sol. Both roots of the equation are 1.
$$\frac{c(a-b)}{a(b-c)} = 1 \Rightarrow b = \frac{2ac}{a+c}$$
H.M. of $\alpha, \beta = \frac{2\alpha\beta}{\alpha+\beta} = \frac{2c/a}{-b/a}$
$$= -\left(\frac{a+c}{a}\right) = -1-\alpha\beta$$

3. If length of one diagonal of a parallelogram is 4 units and Area of parallelogram is 8 sq. units. Then length of other diagonal is (if angle between the diagonal is $\tan^{-1}\frac{3}{4}$).

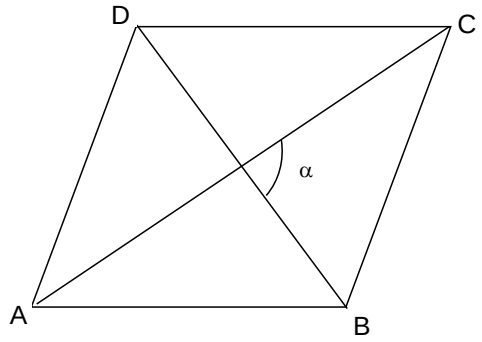
(A) $\frac{10}{3}$ (B) $\frac{20}{3}$

(C) 2 (D) 5

Ans. B

Sol. Area of parallelogram ABCD is $= \left|\frac{1}{2}AC.BD.\sin\alpha\right|$

Length of other diagonal is $\frac{20}{3}$ units



4. The sum of the infinite series $\frac{1}{2}+\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+\frac{5}{32}+\frac{8}{64}+\frac{13}{128}+\frac{21}{256}+\frac{34}{512}+.....$ is ___

(A) 3 (B) 2

(C) 4 (D) 5

Ans. B

Sol. The denominators of the terms are $2^1,2^2,2^3,.....$ The numerator are 1, 2, 3, 4, 5, 8, 13, 21, 34,…….From the third term each term is the sum of the previous two terms. If we write the n th term as $\frac{a_n}{2^n}$, then $a_n = a_{n-1}+a_{n-2}$, for $n \geq 3$. Thus we have

$$S=\sum_{n=1}^{\infty}\frac{a_n}{2^n}=\frac{1}{2}+\frac{1}{4}+\sum_{n=3}^{\infty}\frac{a_{n-1}+a_{n-2}}{2^n}$$

$$=\frac{1}{2}+\frac{1}{4}+\sum_{n=3}^{\infty}\frac{a_{n-1}}{2^n}+\sum_{n=3}^{\infty}\frac{a_{n-2}}{2^n}$$

$$=\frac{1}{2}+\frac{1}{4}+\frac{1}{2}\sum_{n=3}^{\infty}\frac{a_{n-1}}{2^{n-1}}+\frac{1}{2^2}\sum_{n=3}^{\infty}\frac{a_{n-2}}{2^{n-2}}$$

$$=\frac{1}{2}+\frac{1}{4}+\frac{1}{2}\sum_{n=2}^{\infty}\frac{a_n}{2^n}+\frac{1}{2^2}\sum_{n=1}^{\infty}\frac{a_n}{2^n}$$

$$=\frac{3}{4}+\frac{1}{2}\left(S-\frac{1}{2}\right)+\frac{1}{4}S$$

$$=\frac{1}{2}+\frac{3}{4}S$$

Hence $\frac{S}{4}=\frac{1}{2}$ and $S=2$

5. The minimum value of $\dfrac{\left(x+\frac{1}{x}\right)^6-\left(x^6+\frac{1}{x^6}\right)-2}{\left(x+\frac{1}{x}\right)^3+x^3+\frac{1}{x^3}}$

(A) 12 (B) 14
(C) 36 (D) 6

Ans. D

Sol. Use A.M $\geq$ G. M.

6. If at least one value of complex number $z=x+iy$ satisfy condition $\left|z+\sqrt{2}\right|=\sqrt{a^2-3a-2}$ and inequality $\left|z+i\sqrt{2}\right|<a$, then

(A) $a>6$ (B) $a=6$
(C) $a<6$ (D) None of these

Ans. A

Sol. 1st point represents point on circle with centre at $\left(-\sqrt{2},0\right)$ and radius $=\sqrt{a^2-3a-2}$

2nd equation represents points within a circle centered at $\left(0,-\sqrt{2}\right)$ and radius a For at least 1 intersection point $C_1C_2<r_1+r_2$, $\sqrt{2+2}<\sqrt{a^2-3a-2}+a$

7. Let $p(x)=x^2-5x+a$ and $q(x)=x^2-3x+b$, where a and b are positive integers. Suppose $\text{hcf}\left(p(x),q(x)\right)=x-1$ and $k(x)=\text{lcm}\left(p(x),q(x)\right)$. If the coefficient of the highest degree term of k(x) is 1, the sum of the roots of $(x-1)+k(x)$ is

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

Ans. D

Sol. $P(x)=x^2-5x+a$

$=(x-1)(x-4) \qquad (a=4)$

$q(x)=x^2-3x+b$

$=(x-1)(x-2) \quad (b=2)$

$(x-1)+k(x)=(x-1)+(x-1)(x-2)(x-4)$

$=(x-1)\left(x^2-6x+9\right)$

$=(x-1)(x-3)^2$

Sum of roots $3+3+1=7$

Correct option (D)

8. Let $P(x)=x^2+\frac{1}{2}x+b$ and $Q(x)=x^2+cx+d$ be two polynomials with real coefficients such that $P(x)Q(x)=Q(P(x))$ for all real x. Then the number of real roots of $P(Q(x))=0$ is/are

(A) 0 (B) 1
(C) 2 (D) 4

Ans. C

Sol. Observe that

$$P(x)Q(x)=x^4+\left(c+\frac{1}{2}\right)x^3+\left(b+\frac{c}{2}+d\right)x^2+\left(\frac{d}{2}+bc\right)x+bd$$

Similarly, $Q(P(x))=\left(x^2+\frac{1}{2}x+b\right)^2+c\left(x^2+\frac{1}{2}x+b\right)+d$

$$=x^4+x^3+\left(2b+\frac{1}{4}+c\right)x^2+\left(b+\frac{c}{2}\right)x+b^2+bc+d$$

Equating coefficients of corresponding powers of x, we obtain

$$c+\frac{1}{2}=1,\ b+\frac{c}{2}+d=2b+\frac{1}{4}+c,\ \frac{d}{2}+bc=b+\frac{c}{2},\ b^2+bc+d=bd$$

Solving these, we obtain $c=\frac{1}{2}, d=0, b=\frac{-1}{2}$

Thus the polynomial are $P(x)=x^2+\frac{1}{2}x-\frac{1}{2}$, $Q(x)=x^2+\frac{1}{2}x$

Therefore, $P(Q(x))=\left(x^2+\frac{1}{2}x\right)^2+\frac{1}{2}\left(x^2+\frac{1}{2}x\right)-\frac{1}{2}$

$$=x^4+x^3+\frac{3}{4}x^2+\frac{1}{4}x-\frac{1}{2}.$$

It is easy to see that $P(Q(-1))=0$, $P\left(Q\left(\frac{1}{2}\right)\right)=0$

Thus $(x+1)$ and $\left(x-\frac{1}{2}\right)$ are factors of $P(Q(x))$. The remaining factor is

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

The Discriminant of $h(x)$ is $D=\left(\frac{1}{4}\right)-4<0$. Hence $h(x)=0$ has no real roots.

Therefore the only real roots of $P(Q(x))=0$ are –1 and $\frac{1}{2}$

9. The population of cattle in a farm increases so that the difference between the population in year n + 2 and that in year n is proportional to the population in year n + 1. If the populations in years 2010, 2011 and 2013 were 39, 60 and 123, respectively, then the population in 2012 was

(A) 81 (B) 84
(C) 87 (D) 90

Ans. B

Sol. Let population at year equals P(n)
Given that $P(n+2)-P(n)\ \alpha\ P(n+1)$

$\Rightarrow \frac{p(n+2)-P(n)}{P(n+1)}$ = constant

$\Rightarrow \frac{P(2012)-P(2010)}{P(2011)}=\frac{P(2013)-P(2011)}{P(2012)}$

$\Rightarrow \frac{K-39}{60}=\frac{123-60}{K}\left(\text{Let } P(2012)=k\right)$

10. The sum of the digits of a two – digit number is subtracted from the number. The units digits of the result is 6. How many two – digit numbers have this property?
(A) 5 (B) 7
(C) 9 (D) 10

Ans. D

Sol. Let the number be $10a+b$ where a and b are the tens and units digits of the number. So $(10a+b)-(a+b)=9a$ must have a units digit of 6. This is only possible if $9a=36$, so a = 4 is the only way this can be true. So the number that have this property are 40, 41, 42, 43, 44, 45, 46, 47, 48, 49. Therefore the answer is $10\Rightarrow D$

11. A solid cube has side length 3 inches. A 2 – inch by 2 – inch square hole is cut into the center of each face. The edges of each cut are parallel to the edges of the cube, and each hole goes all the way through the cube. What is the volume, in cubic inches, of the remaining solid?
(A) 7 (B) 8
(C) 10 (D) 12

Ans. A

Sol. Imagine making the cuts one at a time. The first cut removes a box $2\times2\times3$. The second cut removes two boxes, each of dimensions $2\times2\times0.5$, and the third cut does the same as the second cut, on the last two faces. Hence the total volume of all cuts is $12+4+4=20$.
Therefore the volume of the rest of the cube is $3^3-20=27-20=\boxed{7(A)}$

12. 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
$P(2) + P(-2) = 12k + 2k = D \rightarrow \boxed{14k}$

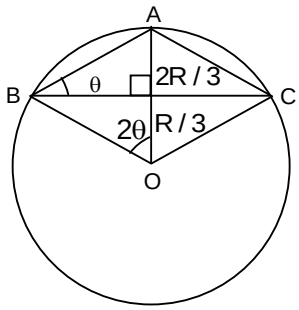
13. In an isosceles triangle, the altitude drawn to the base is $\frac{2}{3}$ times the radius of the circumcircle. The base angle of the triangle is

(A) $\cos^{-1}\left(\frac{2}{3}\right)$ (B) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(C) $2\cos^{-1}\sqrt{\frac{2}{3}}$ (D) $\cos^{-1}\sqrt{\frac{2}{3}}$

Ans. D

Sol. $\cos 2\theta = \frac{R/3}{R} = \frac{1}{3} \Rightarrow \cos\theta = \sqrt{\frac{2}{3}}$



14. ABC and DBC are two equilateral triangles on the same base BC. A point P is taken on the circle with center D and radius BD. Then

(A) $PA^2 + PC^2 = 2PB^2$ (B) $PB = \sqrt{PA.PC}$

(C) $PA + PC = PB$ (D) $PA^2 = PB^2 + PC^2$

Ans. D

Sol. Clearly ABDC is a rhombus. Let E be the mid point of BC. The diagonals AD and BC bisect each other at E.
In triangle APD, by Appolonies theorem, we have
$PA^2 + PD^2 = 2PE^2 + 2DE^2$
$= 2PE^2 + 2(BD^2 + BE^2)$

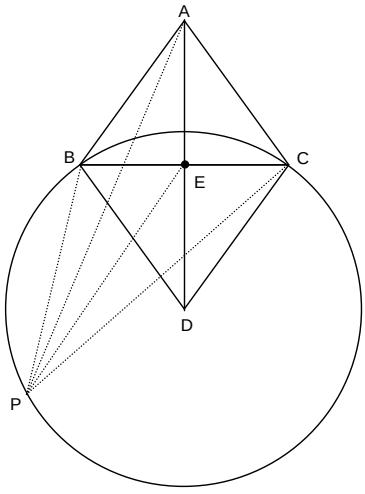
Thus, $PA^2 = 2PE^2 + 2(BD^2 - BE^2) - PD^2$

$= 2PE^2 + BD^2 - 2BE^2 \qquad (\because PD = BD)$

$= 2PE^2 + 4BE^2 - 2BE^2$

$= 2PE^2 + 2BE^2$

$= PB^2 + PC^2$ (from ΔPBC)



15. The area of equilateral triangle formed by points (x, y) satisfying the equation $x^3 + y^3 + 3xy = 1$is

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

(C) $\frac{3\sqrt{3}}{2}$ (D) $4\sqrt{3}$

Ans. C

Sol. Given equation is $(x + y - 1)\left((x - y)^2 + (x + 1)^2 (y + 1)^2\right) = 0$

$\Rightarrow$ Two of the points (x, y) will lie on $x + y - 1 = 0$ and the third point (x, y) will be (–1, –1)

Altitude $= \frac{\sqrt{3}}{2} a = \frac{|-1-1-1|}{\sqrt{2}} \Rightarrow a = \sqrt{6}$

$\Rightarrow$ Area $= \frac{\sqrt{3}}{4} a^2 = \frac{3\sqrt{3}}{2}$

PHYSICS

16. A block of mass 2kg is gently placed over a massive plank moving horizontally over a smooth surface with velocity 6 m/s. The coefficient of friction between the block and plank is 0.2. The distance traveled by the block till it slides on the plank is (g=10 m/s^2)

(A) 4 m (B) 6 m

(C) 9 m (D) 12 m

Ans. C

Sol. $a = \mu g$

$6^2 = 0^2 + 2 \times \mu g S$

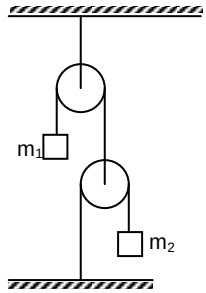
17. Find the ratio of the acceleration of m_1 and m_2. All the pulleys are smooth and frictionless. a_{m_1} / a_{m_2} = ?

(A) 2 : 1

(B) 1 : 2

(C) 1 : 1

(D) the system is not stable



Ans. B

Sol. $\sum \vec{T} \cdot \vec{a} = 0 \Rightarrow a_{m_2} = 2a_{m_1}$

18. The speed of a wave on a string is 150 m/s when the tension is 120 N. The percentage increase in the tension in order to raise the wave speed by 20% is:

(A) 44% (B) 40%

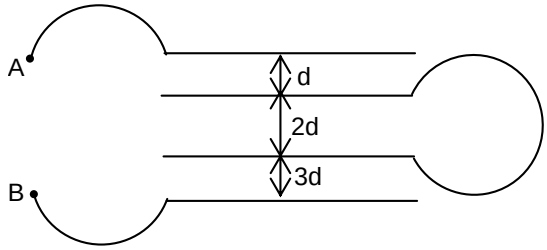
(C) 20% (D) 10%

Ans. A

Sol. $v = \sqrt{\frac{T}{\mu}}$; $V' = \frac{6V}{5}$

$V' = \sqrt{\frac{T'}{\mu}}$; $T' = \frac{36}{25}T$; % T = 44%

19. If area of each plate is A and the successive separation are d, 2d and 3d, then equivalent capacitance across A and B is



(A) $\frac{\epsilon_0 A}{6d}$

(B) $\frac{\epsilon_0 A}{4d}$

(C) $\frac{3\epsilon_0 A}{4d}$

(D) $\frac{\epsilon_0 A}{3d}$

Ans. B

Sol. The middle plate will become short.

$\Rightarrow$ Capacitance = $\frac{\varepsilon_0 A}{4d}$.

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

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

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

Ans. A

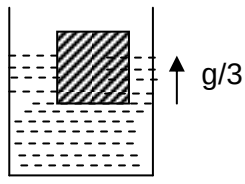
Sol. $\Delta Pm = 2\Delta P_0 \cos kx$ (assuming closed end as origin)

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

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

$\therefore$ Required ratio = 1 : 2

21. A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with a net acceleration of g/3. The fraction of volume immersed in the liquid will be



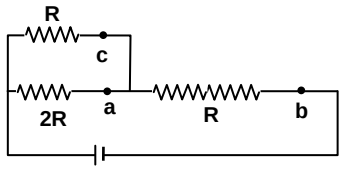
(A) 1/2 (B) 3/8

(C) 2/3 (D) 3/4

Ans. A

Sol. The apparent weight of block and apparent weight of fluid are changed by same amount.

22. Referring to the shown circuit, the current will be minimum in



(A) a
(B) b
(C) c
(D) same in all the branches

Ans. A

Sol. $I_a = \frac{3V}{15R}$, $I_b = \frac{3V}{5R}$

$I_c = \frac{6V}{15R}$.

23. A point source is emitting sound in all directions. The ratio of distance of two points from the point source where the difference in loudness levels is 3 dB is: ($\log_e 2 = 0.3$)

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

(C) $\frac{1}{4}$ (D) $\frac{2}{3}$

Ans. B

Sol. $3 = 20 \log \left(\frac{r_2}{r_1} \right)^2$

24. The minimum force required to punch a hole of diameter ‘d’ in a plate of thickness ‘t’ when the ultimate shear stress of steel = ‘s’ is given by

(A) π d s t (B) $\pi \left(\frac{d}{2} \right)^2$ s t

(C) 2π d s t (D) $\pi \frac{d}{2}$ s t

Ans. A

Sol. Shear stress = $\frac{F_{tangential}}{A} = \frac{F}{2\pi rh}$ = s

25. A stone thrown into still water, creates a circular wave pattern moving radially outwards. If r is the distance measured from the centre of the pattern, the amplitude of the wave varies as

(A) $r^{-1/2}$ (B) r^{-1}

(C) r^{-2} (D) $r^{-3/2}$

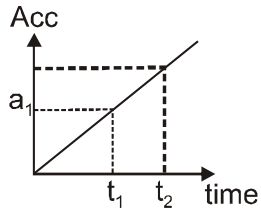
Ans. A

Sol. If energy associated with dropping of stone spreads symmetrically to all sides following a cylindrical pattern of depth 'h' on surface.

Intensity (I) = $\frac{E}{A(t)} = \frac{\text{Power}}{A} \Rightarrow I = \frac{P}{2\pi rh}$

$\Rightarrow I \propto \frac{1}{r} \Rightarrow$ Amplitude $\propto \frac{1}{r^{1/2}}$

26. Acceleration time graph of a particle is shown. Work done by all the forces acting on the particle on the particle of mass m in time interval from t_1 to t_2 while a_1 is the acceleration at time t_1, is given by :



(A) $\frac{ma_1^2}{4t_1}(t_2^3 - t_1^3)$ (B) $\frac{ma_1^2}{8t_1^2}(t_2^4 - t_1^4)$

(C) $\frac{ma_1^2}{4t_1^2}(t_2^4 - t_1^4)$ (D) $\frac{ma_1}{2t_1}(t_2^2 - t_1^2)$

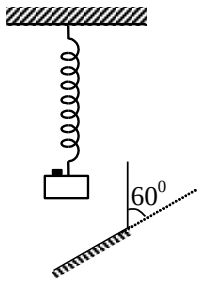
Ans. B

Sol. $W = K_f - K_i = \frac{1}{2}m\left(v_f^2 - v_i^2\right)$

$= \frac{1}{2}m\left[\left(\frac{1}{2}a_2t_2\right)^2 - \left(\frac{1}{2}a_1t_1\right)^2\right]$

$= \frac{1}{8}m\left[\frac{t_2^4}{t_1^2}a_1^2 - a_1^2t_1^2\right]\left(\text{Since, } a_2 = \frac{t_2}{t_1}a_1\right) = \frac{ma_1^2}{8t_1^2}(t_2^4 - t_1^4)$

27. An insect of negligible mass is sitting on a block of mass *M*, tied with a spring of force constant *k*. The block performs simple harmonic motion with amplitude *A* infront of a plane mirror placed as shown. The maximum speed of insect relative to its image will be



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

(C) $A\sqrt{3}\sqrt{\frac{k}{M}}$ (D) $\frac{A}{2}\frac{k}{\sqrt{M}}$

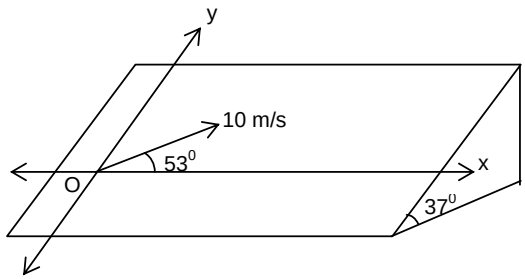
Ans. C

Sol. The maximum velocity of the insect is $A\sqrt{\frac{k}{M}}$.

Its component perpendicular to the mirror is $A\sqrt{\frac{k}{M}}\sin 60^0$.

Thus maximum relative speed $= \sqrt{3}A\sqrt{\frac{k}{M}}$.

28. Taking y – axis along line of greatest slope of the given inclined plane and x – axis perpendicular to it as shown in figure. A body is projected along the inclined plane with speed 10 m/s at an angle 53^0 with x – axis from origin O (g = 10 m/s^2). Time after which body is moving perpendicular to initial direction is (approx)

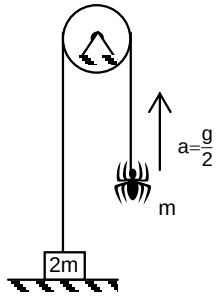


(A) 2.1 sec
(B) 1.8 sec
(C) 3 sec
(D) 3.6 sec

Ans. A

Sol. Question number 8, 9: Take components of $\vec{V}$ and $\vec{a}$ along X and Y axis. If at time 't', velocity is $\vec{V}_t$. Then, if $\vec{V}_t$ is $\perp$ to $\vec{V}_i$. We have $\vec{V}_t \cdot \vec{V}_i = 0$.

29. 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:



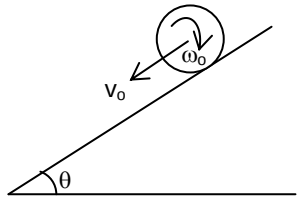
(A) $\frac{3mg}{2}$
(B) mg
(C) 2mg
(D) $\frac{mg}{2}$

Ans. D

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

$N = 2mg - T = \frac{mg}{2}$

30. A hollow cylinder of mass M, length L and radius R spinned about its centre with angular velocity ω_o as shown and placed on a smooth inclined plane. Which of the following is correct?



(A) v_o and w_o both always increase
(B) v_o always decreases, ω_o keeps on changing
(C) v_o always increases and ω_o keeps on changing
(D) v_o always increases and ω_o is constant

Ans. D

Sol. Due to Mg sin θ, V_o will increase. Net torque about centre of mass is zero. So, ω_o remains constant.

CHEMISTRY

31. 100 mL of $FeSO_4$ solution required 200 mL of 0.1 M acidified $KMnO_4$ solution for complete reaction. What is the molarity of the $FeSO_4$ solution?

$MnO_4^- + Fe^{2+} + H^+ \longrightarrow Mn^{2+} + Fe^{3+} + H_2O$

(A) 0.5 M (B) 1 M
(C) 2 M (D) 1.5 M

Ans. B

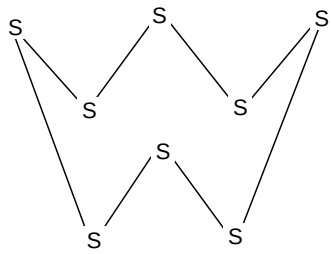
Sol. Meq. of $FeSO_4$ = Meq. of $KMnO_4$
or, $N_1V_1 = N_2V_2$
or, $100 \times N_1 = 200 \times 0.1 \times 5$
$\therefore N_1 = 1$, also M = 1

32. Which of the following molecule has the highest value of dipole moment?
(A) PCl_3F_2 (B) PCl_2Br_3
(C) PCl_2F_3 (D) PCl_5

Ans. C

Sol. It has unsymmetrical structures.

33. The oxidation number and hybridization of sulphur in S_8 molecule are respectively:
(A) +2 and sp^2
(B) +2 and sp^3
(C) zero and sp^2
(D) zero and sp^3



Ans. D

Sol. Sulphur forms two sigma bonds with two lone pairs.

34. Which of the following is most soluble in water?
(A) $BeSO_4$ (B) $MgSO_4$
(C) $CaSO_4$ (D) $BaSO_4$

Ans. A

Sol. $BeSO_4$ forms complex with water i.e. $[Be(H_2O)_4]^{2+}$. Hence it is most soluble.

35. Which of the following relation is correct for an equilibrium system?
(A) $\Delta S_{system} = 0$ (B) $\Delta S_{surrounding} = 0$
(C) $\Delta S_{Total} = 0$ (D) $\Delta S_{system} = \Delta S_{surrounding}$

Ans. C

Sol. For equilibrium system, $\Delta S(\text{system}) = -\Delta S(\text{surrounding})$

36. The relation between the molar conductance ($\wedge_m$) and equivalent conductance ($\wedge_e$) of the solution of $MgCl_2.KCl.6H_2O$ is

(A) $\wedge_m = \wedge_e \times 8$ (B) $\wedge_m = \wedge_e \times 3$

(C) $\wedge_e = \wedge_m \times 3$ (D) $\wedge_e = \wedge_m \times 8$

Ans. B

Sol. $\frac{\Lambda_m}{\Lambda_e} = 3 \Rightarrow \Lambda_m = 3\Lambda_e$

n-factor of $MgCl_2.KCl.6\ H_2O = 3$.

37. How many effective no. of Na^+ ions are present in the unit cell of NaCl if the ions along all the body diagonals of the unit cell are removed?

(A) 4 (B) 3

(C) 2 (D) 1

Ans. B

Sol. One Na^+ is removed and remaining three (effective no. per unit cell) are present.

38. $Zn(s)|\ Zn^{2+}(1M)||\ Cu^{2+}(1M)|Cu(s)$

$E^0_{Zn^{2+}/Zn} = -0.76\,V$ and $E^0_{Cu^{2+}/Cu} = 0.34\,V$

Which of the following relation(s) is/are correct for the above electrochemical cell?

(A) $E^0_{cell} > 0$ (B) $E_{cell} > 0$

(C) $E_{cell} = E^0_{cell}$ (D) All are correct

Ans. D

Sol. $E^0_{cell} = E^0_{cell} > 0$ (due to 1 M concentration of ions)

39. Give mechanistic symbols (S_N1, S_N2, E1 and E2) that are most consistent with the following statements.

(i) These reaction mechanisms represent concerted processes.

(ii) Methyl halide reacts with sodium ethoxide in ethanol only by this mechanism.

(iii) These reaction mechanism involve carbocation intermediates.

(iv) The principal substitution product obtained by solvolysis of tert.butylbromide in ethanol arises from this mechanism.

(v) These reaction mechanism is most likely involved when the products have different carbon skeleton from starting material.

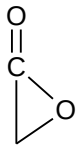
	i	ii	iii	iv	v
(A)	S_N2, E_2	S_N2	S_{N_1}, E_2	S_N1	S_N1, E_1
(B)	S_N2, E_2	S_N2	S_{N_1}, E_1	S_N2	S_N1, E_1
(C)	S_N1, E_1	S_N2	S_{N_1}, E_1	S_N2	E_1, E_2
(D)	S_N2, E_2	S_N2	S_{N_1}, E_1	S_N1	S_N1, E_1

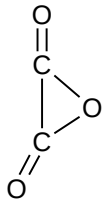
Ans. D

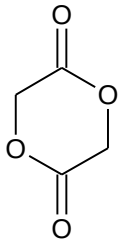
Sol. S_n2 and E_2 are conceerted mechanism. S_N1 and E_1 have carbocation intermediate multistep path. Hence D

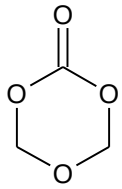
40. $2-\text{Butene} \xrightarrow[(ii)Me_2S]{(i)O_3} [X] \xrightarrow{SeO_2} [Y] \xrightarrow[(ii)H^+/H_2O]{(i)HO^-} (Z)$

The end product [Z] is

(A) 

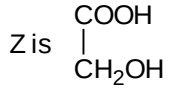
(B) 

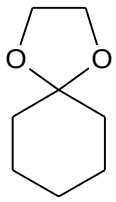
(C) 

(D) 

Ans. C

Sol. X = CH_3CHO, Y = Glyoxal

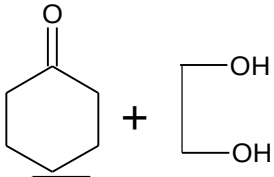
Z is  , Hence (C)

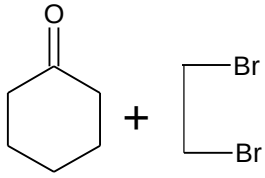
41.  $\xrightarrow[HBr]{Br_2}$?(organic compound)

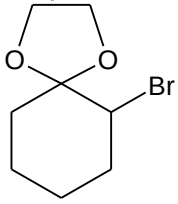
anhydrous

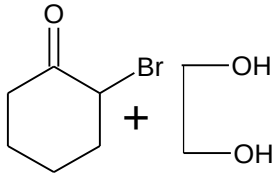
condition

The major organic compound(s) is/are

(A) 

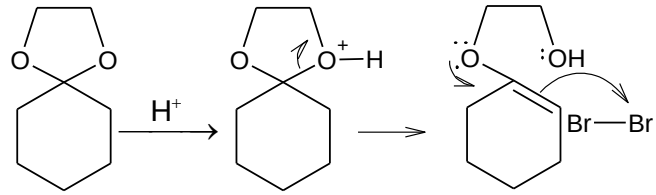
(B) 

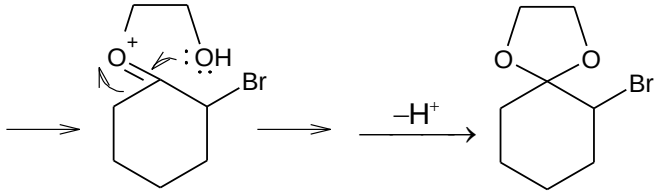
(C) 

(D) 

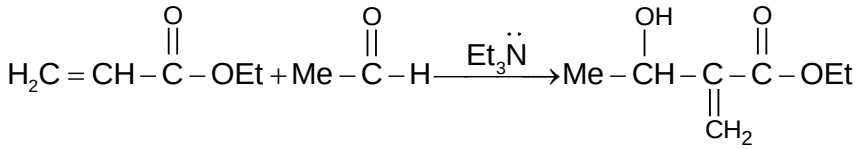
Ans. C

Sol.





42.



In the above reaction $Et_3\ddot{N}$ acts as catalyst which of the following statements is correct for its catalytic action?

(A) It will attack on carbonyl carbon of aldehyde
(B) It removes the acidic α-hydrogen of unsaturated ester to generate carbanion nucleophile.
(C) It will attack on carbonyl carbon of ester.
(D) It undergoes conjugate addition on unsaturated ester

Ans. D

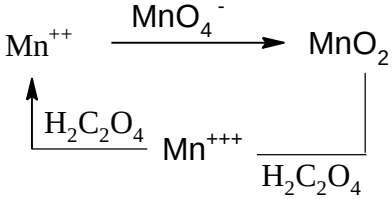
Sol. There will be conjugate addition of 3^o amine on unsaturated ester.

43. When a dilute, aqueous solution of potassium permanganate is run from a burette into a flask containing dilute, aqueous oxalic acid and dilute sulphuric acid, the rate of reaction suddenly increases considerably as more potassium permaganate is added. The reason for this is that

(A) the manganese (II) ions produced catalyse the reaction.
(B) the pH of solution in the flask increases.
(C) the reaction is exothermic and the heat energy liberated affects the rate.
(D) the sulphuric acid removed water and so causes the reaction to proceed more rapidly to completion.

Ans. A

Sol. In acidic medium, MnO_4^- reduces into Mn(II), which catalyses the reaction. The catalytic action of Mn(II) may be represented as



such reaction is known as auto catalysis.

44. $Mg_3B_2 \xrightarrow{HCl(aq)} [X] + MgCl_2$

$[X] + H_2O \xrightarrow{HCl(aq)} [Y] + H_2$

For [X] and [Y] the incorrect choice is

(A) [X] is BCl_3 and [Y] is H_3BO_3

(B) [X] is B_2H_6 and [Y] is H_3BO_3

(C) [X] with air and [Y] on strong heating (red heat) give same compound

(D) In [Y], B completes its octet by removing OH^- from water molecule

Ans. A

Sol. (A) $Mg_3B_2 \xrightarrow[\text{Hydrolysis}]{HCl(aq)} MgCl_2 + B_2H_6[X]$, X is not BCl_3, it is B_2H_6

(B) $B_2H_6 + 6H_2O \rightarrow 2H_3BO_3[Y] + 6H_2$

(C) Both [X] and [Y] gives B_2O_3; $B_2H_6 + 3O_2 \rightarrow B_2O_3 + 3H_2O$; $H_3BO_3 \xrightarrow[\text{heat}]{\text{Red}\,\Delta} B_2O_3$

(D) $B(OH)_3(aq) + 2H_2O \rightarrow B(OH)_4^- + H_3O^+(aq)$

So B, C and D are correct options

45. In the extraction of silver, leaching of Ag_2S is done with NaCN to convert it into soluble complex, $Na[Ag(CN)_2]$. A stream of air is also passed in the leaching process. The purpose of stream of air is to

(A) oxidizes Na_2S formed into $Na_2S_2O_3$ and SO_2.

(B) oxidizes Na_2S formed into Na_2SO_4 and S.

(C) oxidizes Na_2S into Na_2O and S.

(D) acts as catalyst.

Ans. D

Sol. $Ag_2S + 4Na_2CN \rightleftharpoons 2Na[Ag(CN)_2] + Na_2S$

$4Na_2S + 5O_2 + 2H_2O \longrightarrow 2Na_2SO_4 + 2S + 4NaOH$

BIOLOGY

46. DNA and RNA comprise of:

(A) sugar, phosphate, base (B) sugar, phosphate

(C) base, phosphate (D) sugar, base

Ans. A

Sol. DNA and RNA comprise of sugar, phosphate, base.

47. The vascular cambium and cork cambium are the examples of:

(A) apical meristem

(B) lateral meristem

(C) intercalary meristem

(D) elements of xylem and phloem

Ans. B

Sol. The vascular cambium and cork cambium are the examples of lateral meristem.

48. Cork cambium results in the formation of cork which becomes impermeable to water due to accumulation of:
(A) resin (B) suberin
(C) lignin (D) tannin

Ans. B

Sol. Cork cambium results in the formation of cork which becomes impermeable to water due to accumulation of suberin.

49. Ground tissue consists of:
(A) epidermis and cortex
(B) all tissues internal to endodermis
(C) all tissues external to endodermis
(D) all tissues except epidermis and vascular tissue

Ans. D

Sol. Ground tissue consists of all tissues except epidermis and vascular tissue.

50. The type of immunoglobulin present in the colostrum is:
(A) IgD (B) IgA
(C) IgM (D) IgE

Ans. B

Sol. Colostrum is maternal milk of mammal formed during the first few days after the birth. It contains antibodies (IgA is the major immunoglobulin in it) that provide passive immunity to the new born infant.

51. Sexual stage (gametocytes) of *Plasmodium* occurs in:
(A) salivary glands of mosquito (B) human RBC
(C) intestine of mosquito (D) human liver

Ans. B

Sol. Sexual stage (gametocytes) of *Plasmodium* occurs in **human RBC**.

52. A man has a wound. Normally a bleeding wound develops a clot and flow of blood stops. If this does not happen to the man, then he probably suffers from:
(A) AIDS (B) tetanus
(C) haemophilia (D) malaria

Ans. C

Sol. **Haemophilia** is a blood clotting disorder caused by a mutation of the factor VIII gene. In this the patient experiences prolonged bleeding following any injury or wound.

53. How many pair of cranial nerve is present in human:
(A) 31 (B) 32
(C) 12 (D) 14

Ans. C

Sol. **12 pair** of cranial nerve is present in human.

54. Bacteria that live around deep-sea, hot-water vents obtain energy by oxidising inorganic hydrogen sulphide. They use this energy to build organic molecules from carbon obtained from the carbon dioxide in the seawater. These bacteria are:
(A) photoheterotrophs (B) chemoautotrophs
(C) photoautotrophs (D) chemoheterotrophs

Ans. B

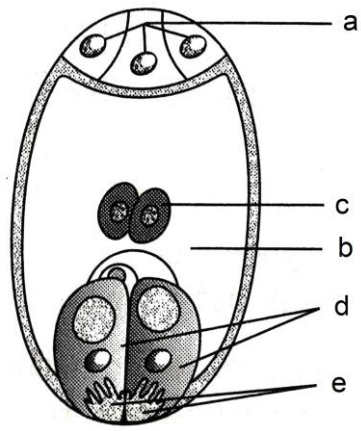
Sol. Bacteria that live around deep-sea, hot-water vents obtain energy by oxidising inorganic hydrogen sulphide. They use this energy to build organic molecules from carbon obtained from the carbon dioxide in the seawater. These bacteria are chemoautotrophs.

55. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of:
(A) homologous organs that have evolved due to divergent evolution
(B) analogous organs that have evolved due to convergent evolution
(C) analogous organs that have evolved due to divergent evolution
(D) homologous organs that have evolved due to convergent evolution

Ans. B

Sol. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function because of analogous organs that have evolved due to convergent evolution.

56. In the diagram given below, parts labeled as a, b, c, d and e are respectively identified as:



(A)	a – Antipodals,	b – Central cell,	c – Polar nuclei,	d – Synergids,	e – Filiform apparatus
(B)	a – Polar nuclei,	b –Egg,	c – Antipodals,	d – Central cell,	e – Filiform apparatus
(C)	a – Eggs,	b – Synergids,	c – Central cell,	d –Filiform apparatus,	e – Antipodals
(D)	a – Central cell,	b – Polar nuclei	c – Filiform apparatus,	d – Antipodals	, e – Synergids

Ans. A

Sol. a – Antipodals, b – Central cell, c – Polar nuclei, d – Synergids, e–Filiform apparatus

57. Precursor of Chipko Movement happened in Jodhpur in 1730 where many Bishnoi's protested under leadership of __[A]___ to guard Rajasthan's state tree __[B]___. Identify A and B?
(A) A – Birsa Munda, B – Banyan tree
(B) A – Amrita Devi, B – Khejri tree
(C) A – Sunderlal Bahuguna, B – Oak
(D) A – Sugathakumari, B – Date Palm

Ans. B

Sol. Precursor of Chipko Movement happened in Jodhpur in 1730 where many Bishnoi's protested under leadership of Amrita Devi to guard Rajasthan's state tree Khejri tree.

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

Ans. C

Sol. Sprain is caused by excessive pulling of ligaments in which some fibres of supporting ligaments are ruptured.

59. A man is admitted to a hospital. He is suffering from an abnormally low body temperature, loss of appetite, and extreme thirst. His brain scan would probably show a tumor in:
(A) Pons
(B) Cerebellum
(C) Hypothalamus
(D) Medulla oblongata

Ans. C

Sol. The man's brain scan would probably show a tumor in Hypothalamus.

60. 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. RNA lacks thymine instead RNA has Uracil.

PART – II

MATHEMATICS

61. The circum radius of a cyclic quadrilateral ABCD is 2. AC, BD cut at E such that $AE = EC$. If $AB = \sqrt{2}$ AE, $BD = 2\sqrt{3}$, the area of quadrilateral is

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

(C) $3\sqrt{3}$ (D) $4\sqrt{3}$

Ans. A

Sol. AE = EC

$AB = \sqrt{2}AE$

$\Rightarrow AB^2 = 2AE^2 = AE.AC$

Thus $\frac{AB}{AC} = \frac{AE}{AB}$ and $\angle EAB = \angle BAC$.

Thus $\Delta ABE \sim \Delta ACB$.

Hence $\angle ABE = \angle ACB = \angle ADB$ and it follows that ΔBAD is isosceles with AB = AD.

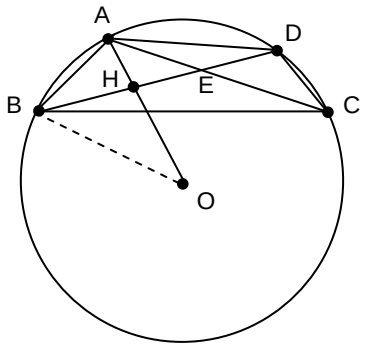
The vertex A bisects are BD and consequently, if O is the center of circum circle of ABCD, $OA \perp BD$. Let H be the point of intersection of OA and BD. H bisects BD and hence $BH = \sqrt{3}$ and $OH = \sqrt{OH^2 - BH^2} = 1$

$AH = OA - OH = 2 - 1 = 1$ and

$Ar(\Delta ABD) = \frac{1}{2} BD \times AH = \sqrt{3}$

Also, since AE = EC, triangles BCE and ABE have the same area and triangles CDE and ADE have the same area. Thus ΔCBD has the same area as that of ΔABD.

$\Rightarrow Ar(\square ABCD) = 2(Ar(\Delta ABD)) = 2\sqrt{3}$



62. Let a, b, c be non zero real numbers such that $a + b + c = 0$; let $q = a^2 + b^2 + c^2$ and $r = a^4 + b^4 + c^4$ Then

(A) $q^2 < 2r$ always

(B) $q^2 = 2r$ always

(C) $q^2 > 2r$ always

(D) $q^2 - 2r$ can take both positive and negative values

Ans. B

Sol. $(a + b + c)^2 = 0$

$a^2 + b^2 + c^2 + 2(ab + bc + ca) = 0$

$$q = -2(ab + bc + ca)$$
$$\frac{q^2}{4} = a^2b^2 + b^2c^2 + c^2a^2 + 2abc(a + b + c)$$
$$\frac{q^2}{4} = a^2b^2 + b^2c^2 + c^2a^2$$
$$q = a^2 + b^2 + c^2$$
$$q^2 = a^4 + b^4 + c^4 + 2(a^2b^2 + b^2c^2 + c^2a^2)$$
$$q^2 = r + 2\frac{q^2}{4}$$
$$q^2 = 2r \text{ (B)}$$

63. 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.

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

64. ΔABC is a right angled isosceles triangle, right angled at B. BD and BE are two lines on AC from B such that $AD^2 + EC^2 = DE^2$. Find the $\angle DBE$?

(A) 45^o (B) 30^o

(C) 22.5^o (D) 60^o

Ans. A

Sol. $2AB^2 = AC^2$

$2AB^2 = (AD + DE + EC)^2$

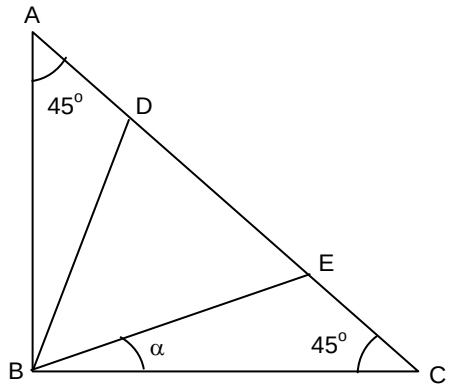
Given that $AD^2 + CE^2 = DE^2$

$2AB^2 = 2DC.AE$

$\frac{AB}{DC} = \frac{AE}{BC}$

$\Delta ADE \sim \Delta CDB$

$\angle DBE = 45^o$



65. The number 27000001 has exactly four prime factors. The sum of these factors is
(A) 573 (B) 612
(C) 643 (D) 652

Ans. D

Sol. $27000001 = 300^3 + 1$

$= (300 + 1)(300^2 - 300 + 1)$

$= 301 \times ((300 + 1)^2 - 900)$

$= 301 \times (300 + 1 + 30) \times (300 + 1 - 30)$

$= 301 \times 331 \times 271$

$= 7 \times 43 \times 331 \times 271$

Thus the prime factors are 7, 43, 271 and 331 and their sum is 652.

PHYSICS

66. A bob is hung from the ceiling of a train compartment. The train moves on an incline track of inclination 30^0 with horizontal. Acceleration of the train up the plane is g/2. The angle which the string supporting the bob makes with normal to the ceiling in equilibrium condition, is
(A) 30^0 (B) $\tan^{-1}(2)$
(C) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) 45^0

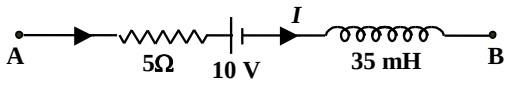
Ans. C

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

g + g cos 60°

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

67. The network shown in Figure is part of a complete circuit. If at a certain instant the current (I) is 5A, and is decreasing at a rate of 10^3 A/s, then $V_B - V_A$ =



(A) 35 V (B) –35 V
(C) Zero (D) 70 V

Ans. C

Sol. $V_A - V_B = i(5\Omega) + 10V + L\dfrac{di}{dt}$

$= 5(5) + 10 + L(-10^{+3})$

$V_A - V_B = 35 - 35 \times 10^{-3} \times 10^{+3} = 0.$

68. An ideal gas ($\gamma = 1.5$) is expanded adiabatically. How many times has the gas to be expanded to reduce the root mean square velocity of molecules 2.0 times
(A) 4 times (B) 16 times
(C) 8 times (D) 2 times

Ans. B

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

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

V_{rms} is to reduce two times i.e, temperature of the gas will have to reduce four times or

$\dfrac{T'}{T} = \dfrac{1}{4}$

During adiabatic process

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

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

$\therefore\ V' = 16V$

69. A concave mirror of focal length f produces an image n times the size of the object. If the image is real then the distance of the object from the mirror is

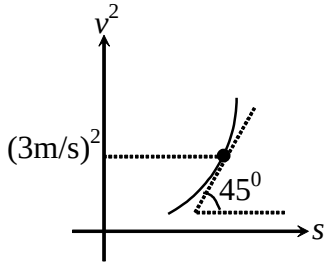
(A) $(n-1)f$ (B) $\dfrac{(n-1)}{n}f$

(C) $\dfrac{(n+1)}{n}f$ (D) $(n+1)f$

Ans. C

Sol. $-\dfrac{1}{nu} - \dfrac{1}{u} = \dfrac{-1}{f}$; $u = \left(\dfrac{n+1}{n}\right)f$

70. A particle is moving in a straight line and it velocity (v) and displacement are related as shown. Find the acceleration of particle when its velocity is 3 m/s.



(A) 1 m/s^2 (B) $\frac{1}{2}$ m/s^2

(C) 2 m/s^2 (D) $\frac{3}{2}$ m/s^2

Ans. B

Sol. $\frac{dv^2}{ds} = 1,\ 2v\frac{dv}{ds} = 1,\ v\frac{dv}{ds} = \frac{1}{2}$ m/s^2

CHEMISTRY

71. 200 mL of 0.4 M solution of CH_3COONa is mixed with 400 mL of 0.2 M solution of CH_3COOH. After complete mixing, 400 mL of 0.1 M NaCl is added to it. What is the pH of the resulting solution? [K_a of $CH_3COOH = 10^{-5}$]

(A) 5.4 (B) 6

(C) 5 (D) 6.2

Ans. C

Sol. $pH = p_{Ka} + \log\frac{[CH_3COONa]}{[CH_3COOH]} = 5 + \log\frac{200\times0.4}{400\times0.2} = 5$

72. Which of the following type of compound is mixed with detergent powder to provide brightness to fabrics?

(A) Borates (B) Peroxoborates

(C) Boranes (D) Borides

Ans. B

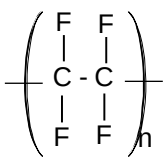
Sol. Peroxoborates contain peroxide linkages, which behave as bleaching agent.

73. Which of the following linkage is present in “Teflon”?

(A) H – C (B) F – F

(C) C – C (D) C = C

Ans. C

Sol. Teflon is 

74. Which of the following is an artificial sweetner?

(A) Sucrose (B) Sucrolose

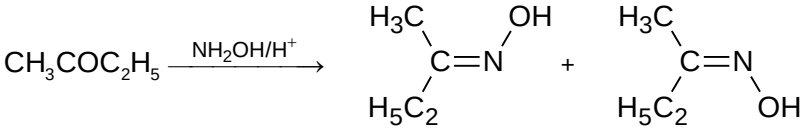
(C) Frcutose (D) Maltose

Ans. B

Sol. Sucrolose is an artificial sweetner.

75. Which of the following compound forms two stereoisomers when treated with NH_2OH in weakly acidic medium?
(A) CH_3COCH_3 (B) HCHO
(C) $CH_3COC_2H_5$ (D) $C_2H_5COCH_2CH_3$

Ans. C

Sol. 

BIOLOGY

76. The correct sequence of organelles without binding membrane and with single, double and triple binding membranes is:
I. sphaerosomes (plant lysosomes)
II. transosomes (in ovarian follicular cells)
III. ribosomes
IV. mitochondria
(A) III, I, IV, I (B) II, I, IV, III
(C) III, I, IV, II (D) II, IV, III, I

Ans. C

Sol.
Ribosomes → membraneless organelles
Sphaerosomes → sphaerosomes are single membrane bound cell organelles
Mitochondria → double membrane bound
Transosomes → triple membrane bound cell organelle

77. Cultivation of Bt cotton has been much in the news. The prefix Bt means:
(A) “barium-treated” cotton seeds
(B) “bigger thread” variety of cotton with better tensile strength
(C) produced by “biotechnology” using restriction enzymes and ligases
(D) carrying an endotoxin gene from *Bacillus thuringienesis*

Ans. D

Sol. Bt stands for ***Bacillus thuringienesis***.

78. Which one of the following features is common in silverfish, scorpion, dragonfly and prawn?
(A) Two pairs of legs and segmented body
(B) Living chitinous cuticle and two pairs of antennae
(C) Jointed appendages and chitinous exoskeleton
(D) Closed blood vascular system

Ans. C

Sol. Silverfish, scorpion, dragonfly and prawn all fall in Phylum Arthropoda which have jointed appendages and chitinous exoskeleton as a characteristic feature.

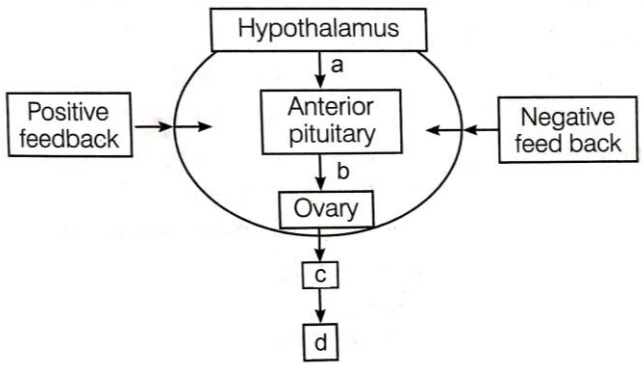
79. Some salient feature and phyla of organisms are given below. Select the option which shows correct combination of organism, its phylum and salient features.

(A)	Hydra	Coelenterata	Bilateral symmetry	Cnidoblasts present
(B)	Planaria	Platyhelminthes	Bilateral symmetry	High regeneration capacity
(C)	Ancylostoma	Annelida	Bilateral symmetry	Elongated and worm shape
(D)	Octopus	Mollusca	Radial symmetry	External skeleton of shell present

Ans. B

Sol. Hydra shows radial symmetry, Ancylostoma is an aschelminth. Octopus shows bilateral symmetry and also lacks an external skeleton of shell.

80. Choose the correct combination of labeling hormonal control of female reproductive system.



(A) a–GnRH, b–TSH, c-LTH, d-Uterus
(B) a–GnRH, b–LH/FSH, c-oestrogen or progesterone, d-Uterus
(C) a–GnRH, b–STH, c-LH, d-Uterus
(D) a–GnRH, b–ACTH, c-LH, d-Uterus

Ans. B

Sol.