KVPY QUESTION PAPER-2016 (STREAM SA)

Part – I

One - Mark Questions

Date : 06 / 11 / 2016

MATHEMATICS

1. Suppose the quadratic polynomial $P(x) = ax^2 + bx + c$ has positive coefficients a, b, c in arithmetic progression in that order. If $P(x) = 0$ has integer roots and then + + equals

(A) 3 (B) 5 (C) 7 (D) 14

Ans. **[C]**

Sol. $P(x) = ax^2 + bx + c = a(x -)(x -)$

and + + + 1 – 1 = (+ 1) (+ 1) – 1

$= \frac{(a \quad b \quad c)}{a} \quad 1$

b

+ + = – 1 1 1

b

i.e., – is integer = 1

If b = a 1

then, c = a (2 1 – 1) {because a, b, c are in A.P.}

$P(x) = ax^2 + a\ _1x + a(2\ _1 - 1)$

$= a[x^2 + \ _1x + (2\ _1 - 1)]$

2

D = 1 – 4 2 (2 1 – 1) is perfect square for integral roots

D = 1 – 8 1 + 4 is perfect square

Let $D = (\ _1 - 4)^2 - 12 = k^2$ {where k

(1 – 4 – k) (1 – 4 + k) = 12

This gives 1 – 4 – k = 2

& 1 – 4 + k = 6

1 – 4 = 4 & k = 1

1 = 8

+ + =8–1=7

2. The number of digits in the decimal expansion of $16^5 5^{16}$ is

(A) 16 (B) 17 (C) 18 (D) 19

Ans. **[C]**

Sol. $16^5 5^{16}$

$= 16 \times 16^4 \times 5^{16}$

$= 16 \times 10^{16}$

It is 18 digit number

3. Let t be real number such that $t^2 = at + b$ for some positive integers a and b. Then for any choice of positive integers a and b, t^3 is never equal to

(A) 4t + 3 (B) 8t + 5 (C) 10t + 3 (D) 6t + 5

Ans. **[B]**

Sol. $t^2 = at + b$; a, b I^+

$t^3 = at^2 + bt$

$= a(at + b) + bt$

$= a^2t + bt + ab$

$t^3 = (a^2 + b)t + ab$, check possibility for a, bfrom options.

(A) $a^2 + b = 4$

ab = 3 possible

(B) $a^2 + b = 8$

ab = 5 not possible

(C) $a^2 + b = 10$

ab = 3 possible

(D) $a^2 + b = 6$

ab = 5 possible

4. Consider the equation $(1+ a\ b)^2 = 3(1+ a\ \ b^2)$, where a b are real numbers. Then

(A) there is no solution pair (a b)

(B) there are infinitely many solution pairs (a b)

(C) there are exactly two solution pairs (a b)

(D) there is exactly one solution pair (a b)

Ans. **[D]**

Sol. $(1 + a + b)^2 = 3 (1 + a^2 + b^2)$

$1\ a + a\ b + 1\ b = 1^2 + a^2 + b^2\ 1$

$= a = b$

exactly one pair.

5. Let $a_1, a_2, \ldots\ldots a_{100}$ be non-zero real numbers such that $a_1 + a_2 + \ldots\ldots + a_{100} = 0$, Then

(A) $^{100}_{i1}a_i\ 2^{a_i}\ 0$ and $^{100}_{i1}a_i\ 2\ ^{a_i}\ 0$

(B) $^{100}_{i1}a_i\ 2^{a_i}\ \ 0$and $^{100}_{i1}a_i\ 2\ ^{a_i}\ \ 0$

(C) $^{100}_{i1}a_i\ 2^{a_i}\ \ 0$ and $^{100}_{i1}a_i\ 2\ ^{a_i}\ \ 0$

(D) the sign of $^{100}_{i1}a_i\ 2^{a_i}$ or $^{100}_{i1}a_i\ 2\ ^{a_i}$ depends on the choice of a_i 's

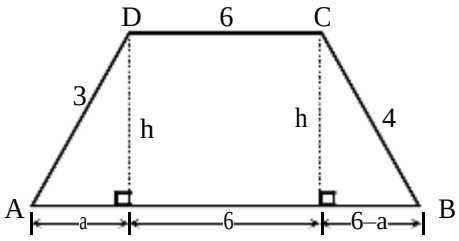
Ans. **[A]**

6. Let ABCD be a trapezium, in which AB is parallel to CD, AB = 11, BC = 4, CD = 6 and DA = 3. The distance between AB and CD is

(A) 2 (B) 2.4 (C) 2.8 (D) not determinable with the data

Ans. [B]

Sol.



Solve $a^2 + h^2 = 9$ ....(1)

and $(6 - a)^2 + h^2 = 16$ ....(2)

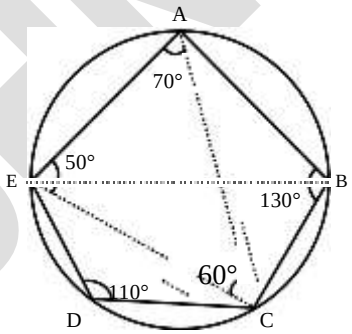
we will get h = 2.4

7. The points A,B,C,D,E are marked on the circumference of a circle in clockwise direction such that ABC = 130º and CDE = 110º. The measure of ACE in degrees is

(A) 50º (B) 60º (C) 70º (D) 80º

Ans. [B]

Sol.



8. Three circles of radii 1, 2 and 3 units respectively touch each other externally in the plane. The circumradius of the triangle formed by joining the centers of the circles is

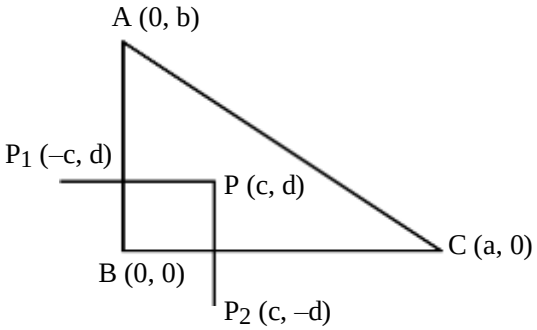
(A) 1.5 (B) 2 (C) 2.5 (D) 3

9. Let P be a point inside a triangle ABC with ABC = 90º. Let P_1 and P_2 be the images of P under reflection in AB and BC respectively. The distance between the circumcenters of triangles ABC and P_1 P P_2 is

(A) $\frac{AB}{2}$ (B) $\frac{AP\ BP\ CP}{3}$ (C) $\frac{AC}{2}$ (D) $\frac{AB\ BC\ AC}{2}$

Ans. **[C]**

Sol.



M is circumcentre of ABC

M $\frac{a}{2}\ \frac{b}{2}$,

& N is circumcentre of ABC

N = (0, 0) = B (Mid-point of P_1, & P_2).

So MN = $\frac{AC}{2}$

10. Let a and b be two positive real numbers such that a 2b 1. Let A_1 and A_2 be, respectively, the areas of circles with radii ab^3 and b^2. Then the maximum possible value of $\frac{A_1}{A_2}$ is

(A) $\frac{1}{16}$ (B) $\frac{1}{64}$ (C) $\frac{1}{16\sqrt{2}}$ (D) $\frac{1}{32}$

Ans. **[B]**

Sol. a + 2b 1

$A_1 = a^2b^6$

$A_2 = b^4$

$\frac{A_1}{A_2} a^2 b^2$

$1\ 2\sqrt{2ab\ 1}$

$4\ 2ab$

$\frac{1}{64}a^2b^2$

11. There are two candles of same length and same size. Both of them burn at uniform rate. The first one burns in 5 hours and the second one burns in 3 hours. Both the candles are lit together. After how many minutes the length of the first candle is 3 times that of the other?

(A) 90 (B) 120 (C) 135 (D) 150

Ans. **[D]**

Sol. Let V_1 & V_2 are rates of burning for both candles respectively & L is the length of each candle

$V_1 = \frac{L}{5}$ $V_2 = \frac{L}{3}$

Let after time 't', their lengths are $_1$ & $_2$

$_1 = L - \frac{L}{L}t$

$_2 = L - \frac{}{}t$

& $_1 = 3\ _2$ (Given)

$L \quad \frac{L}{5} \quad t \quad L \quad \frac{L}{3} \quad t\ 3$

$\frac{5\ t}{}3\ t\ 5$

$5 - t = 15 - 5t$

$4t = 10 \quad t = 2.5$ hrs $= 150$ min.

12. Consider a cuboid all of whose edges are integers and whose base is square. Suppose the sum of all its edges is numerically equal to the sum of the areas of all its six faces. Then the sum of all its edges is.

(A) 12 (B) 18 (C) 24 (D) 36

Ans. **[C]**

Sol. Let sides are a, a, h

So, $4a + 4h + 4a = 2(a + ah + ah)$

$a^2 - 4a = 2h\ (1 - a)$

$(a^2 - 1) + 1 - 4\ (a - 1) - 4 = 2h\ (1 - a)$

$(a - 1)\ (a + 1) - 4\ (a - 1) - 3 = 2h\ (1 - a)$

$2h = \frac{3}{a\ \ 1} + 4 - (a + 1)$

So a = 2 & h = 2 are the only integral solution (a & h are positive integers)

13. Let $A_1, A_2 \ldots, A_m$ be non-empty subsets of {1,2,3,..... ,100} satisfying the following conditions:

(1) the numbers $|A_1|, |A_2|, \ldots, |A_m|$ are distinct;

(2) $A_1, A_2, \ldots, A_m$ are pairwise disjoint.

(Here |A| denotes the number of elements in the set A.) Then the maximum possible value of m is

(A) 13 (B) 14 (C) 15 (D) 16

$\frac{m(m-1)}{2} \leq 100$

$m < 14$

14^{th} set will have the same size as that of one of the previous sets So, m = 13

14. The number of all 2-digit numbers n such that n is equal to the sum of the square of digit in its tens place and the cube of the digit in units place is

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

Ans. **[C]**

Sol. $n = ab$

$ab = a^2 + b^3$

$10a + b = a^2 + b^3$

$a(10 - a) + b(1 - b)(1 + b) =$

$0\ a(10 - a) = (b - 1)(b)(b + 1)$

If $b = 2$; $a(10 - a) = 6$ no value of 'a'

$b = 3$; $a(10 - a) = 24$ a 4, 6 .

{nos. are 43 & 63}

$b = 4$; $a(10 - a) = 60$ no value of a

$b = 5$; $a(10 - a) = 120$ no need to check further

nos. are 43 & 63.

15. Let f be a function defined on the set of all positive integers such that $f(xy) = f(x) + f(y)$ for all positive integers x, y. If $f(12) = 24$ and $f(8) = 15$, the value of $f(48)$ is

(A) 31 (B) 32 (C) 33 (D) 34

Ans. **[D]**

Sol. $f(x\ y) = f(x) + f(y)$

$f(x) = \log_a x$

So, $f(12) = 24$

$\log_a 12 = 24$

$12 = a^{24}$ & $f(8) = 15$

$\log_a 8 = 15$

$8 = a^{15}$ $2 = a^5$

So, $f(48) = \log_a 48 = \log_a 12 + \log_a 4$

$= \log_a 12 + \log_a 2^2$

$= 24+2\ 5$

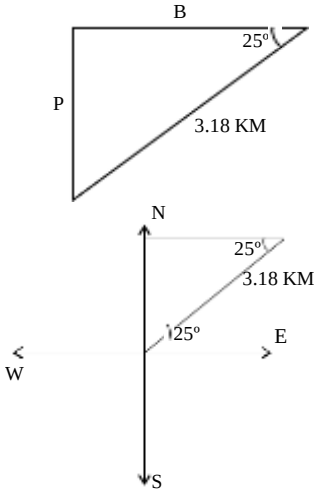
$= 34$

16. A person walks 25.0º north of east for 3.18 km. How far would she have to walk due north and then due east to arrive at the same location?

(A) towards north 2.88 km and towards east 1.34 km
(B) towards north 2.11 km and towards east 2.11 km
(C) towards north 1.25 km and towards east 1.93 km
(D) towards north 1.34 km and towards east 2.88 km

Ans. [D]

Sol.



$$\frac{P}{3.18} = \sin 25^\circ$$

$P = 3.18 \sin 25^\circ$

$= \boxed{1.34 \text{ KM}}$ along north

$B = 3.18 \cos 25^\circ$

$= \boxed{2.88 \text{ KM}}$ along east

17. The length and width of a rectangular room are measured to be 3.95 0.05 m and 3.05 0.05 m, respectively, the area of the floor is

(A) 12.05 0.01 m^2
(B) 12.05 0.005 m^2
(C) 12.05 0.34 m^2
(D) 12.05 0.40 m^2

Ans. [C]

Sol. $A = B$

$dA = dB + B\,d$

$$\frac{dA}{A} = \frac{dB}{B} + \frac{d}{}$$

$$= \frac{0.05}{3.05} + \frac{0.05}{3.95}$$

$= 0.016 + 0.012$

$= 0.028 \times$

$12.05\ dA = 0.33$

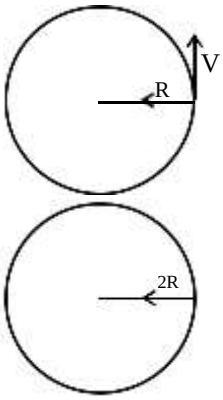
$12.05\ \ 0.34$ Ans. (C)

18. A car goes around uniform circular track of radius R at a uniform speed v once in every T seconds. The magnitude of the centripetal acceleration is a_C. If the car now goes uniformly around a larger circular track of radius $2R$ and experiences a centripetal acceleration of magnitude $8a_C$ then its time period is

(A) $2T$ (B) $3T$ (C) $T/2$ (D) $3/2\ T$

Ans. [C]

Sol.



$$T = \frac{2R}{V}$$

$$a_C = \frac{V^2}{R}$$

$$8\,a_C = \frac{V_2^{\ 2}}{2R}$$

$$(8)\frac{V^2}{R} = \frac{V^2}{2R}$$

$$V = 16V^2$$

$$V = 4V$$

$$\text{Time period} = \frac{(2\pi)R}{V}$$

$$= \frac{(2\pi)2R}{4V}$$

$$= \frac{R}{V}$$

$$= (T/2)$$

19. The primary and the secondary coils of a transformer contain 10 and 100 turns, respectively. The primary coil is connected to a battery that supplies a constant voltage of 1.5 volts. the voltage across the secondary coil is

(A) 1.5 V (B) 0.15 V (C) 0.0 V (D) 15 V

Ans. [C]

Sol. Since the voltage production is based upon A.C. supply and this voltage is D.C which is constant. Therefore, no flux will change in secondary and no voltage will be induced.
Answer is (C) 0V.

20. Water falls down a 500.0 m shaft to reach a turbine which generates electricity. How much water must fall per second in order to generate 1.00×10^9 Watts of power? (Assume 50% efficiency of conversion and $g = 10 m/s^2$)

(A) 250 m^3 (B) 400 m^3 (C) 500 m^3 (D) 200 m^3

Ans. [B]

Sol.

500 m

$$P = \frac{mah}{time}$$

$$= \frac{P_{out}}{P_{input}}$$

$$P_{in} = P_{out}$$

$= \frac{10^9}{0.5}$

$P_{in} = 2 \times 10^9$

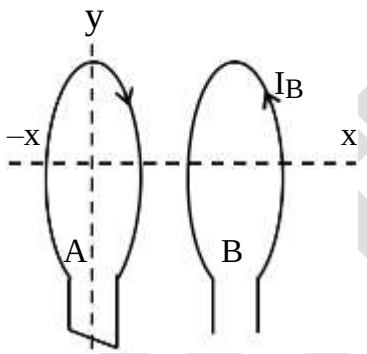
$\frac{mah}{time} = 2 \times 10^9$

$m/t = \frac{2\ 10_9}{10\ 500} = \frac{2}{5} \times 10^6$

$= 4 \times 10^5$

$= 400\ m^3$

21. The diagram below shows two circle loops of wire (A and B) centred on and perpendicular to the x-axis, and oriented with their planes parallel to each other. The y-axis passes vertically through loop A (dashed line). There is a current I_B in loop B as shown. Possible actions which we might perform on loop A are:



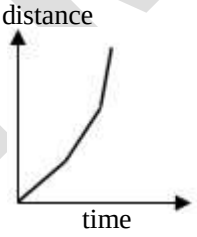
(i) Move A to the right along x axis closer to B
(ii) Move A to the left along x axis away from B
(iii) As viewed from above, rotate A clockwise about y axis
(iv) As viewed from above, rotate A anticlockwise about y axis
Which of these actions will induce a current in A only in the direction shown.
(A) Only (i) (B) Only (ii) (C) Only (i) and (iv) (D) Only (ii) and (iii)

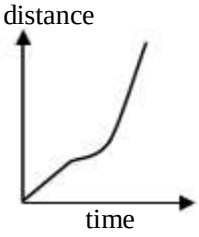
Ans. [A]

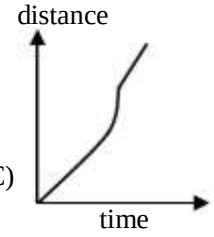
Sol. According to Lenz's Law

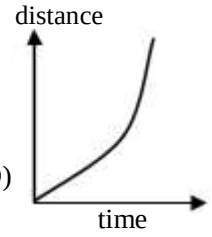
22. A rigid ball rolls without slipping on a surface shown below.

Which one of the following is the most likely representation of the distance traveled by the ball vs time graph?

(A) 

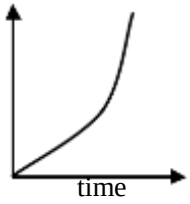
(B) 

(C) 

(D) 

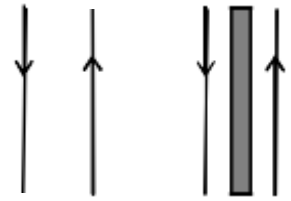
Ans. [D]

distance



Ans. (D)

23. In an experiment , setup A consists of two parallel wires which carry currents in opposite directions as shown in the figure. A second setup B is identical to setup A, except that there is a metal plate between the wires



Let F_A and F_B be the magnitude of the force between the two wires in setup A and setup B, respectively.

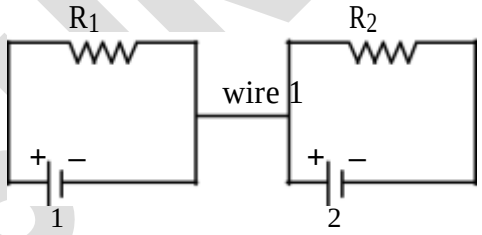
(A)$F_A > F_B$ 0 (B) $F_A < F_B$ (C)$F_A = F_B$ 0 (D) $F_A > F_B = 0$

Ans. [C]

Sol. In setup B, A metal is placed, due to which metal may get magnetized and it may also exert force on current carrying wire but force between two wire remain same however net force on wire may get charge due to magnetic field produced by magnetized metal.

Ans. (C)

24. In the circuit, wire 1 is of negligible resistance, Then



(A) Current will flow through wire 1 if $_1$ $_2$

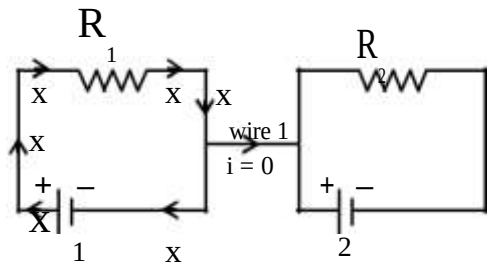
(B) Current will flow through wire 1 if $_1/R_1$ $_2/R_2$

(C) Current will flow through wire 1 if $(_1 + _2)/(R_1 + R_2)$ $(_1 - _2) / (R_1 - R_2)$

(D) No current will flow through wire 1.

Ans. **[D]**

Sol.



current through wire 1 = 0

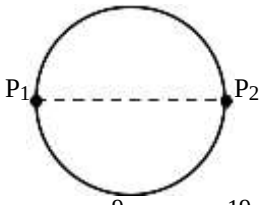
25. The radius of a nucleus is given by $r_0 A^{1/3}$ where $r_0 = 1.3 \times 10^{-15}$ m and A is the mass number of the nucleus, the Lead nucleus has A = 206. the electrostatic force between two protons in this nucleus is approximately

(A) 10^2 N (B) 10^7 N (C) 10^{12} N (D) 10^{17} N

Ans. **[A]**

Sol. $r = r_0 A^{1/3}$ $r_0 = 1.3 \times 10^{-15}$

$$F = \frac{1}{4 \quad 0} \quad \frac{q_1 q_2}{r^2}$$



$$F = \frac{9 \;\; 10^9 \;\; 1.6 \;\; 10^{-19} \quad 1.6 \;\; 10^{-19}}{r_0^2 A^{2/3}}$$

$$F = \frac{9 \;\; 10^9 \;\; 1.6 \;\; 10^{-19} \quad 1.6 \;\; 10^{-19}}{(1.3)^2 \;\; 10^{-30} \quad (206)^{2/3}}$$

$$= \frac{23.04 \;\; 10^{39} \quad 10^{-38}}{(1.69) \quad 34.81}$$

$$= \frac{23.04 \;\; 10}{1.69 \quad 34.81}$$

= 3.91 Newton

= 0.039×10^2 Ans. (A)

26. A hollow lens is made of thin glass and in the shape of a double concave lens. It can be filled with air, water of refractive index 1.33 or CS_2 of refractive index 1.6. It will act as a diverging lens if it is

(A) filled with air and immersed in water.

(B) filled with water and immersed in CS_2.

(C) filled with air and immersed in CS_2.

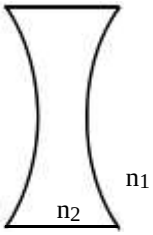
(D) filled with CS_2 and immersed in water.

Ans. **[D]**

Sol. $_{air} = 1$

$_{water} = 1.33$

$_{cs\ 2} = 1.6$



$$\frac{1}{f} = \frac{n_2}{n_1} - 1 - \frac{1}{R_1} - \frac{1}{R_2}$$

$$\frac{1}{f} = - \frac{n_2}{n_1} - 1 \frac{1}{R_1} \frac{1}{R_2}$$

for diverging lens f must be – ve.

for this $\frac{n_2}{n_1} > 1$

$n_2 > n_1$

Lens should be filled with liquid which has more refractive index in comparison to liquid in which lens is immersed.

Ans (D) is the correct option as

$_{cs2} > _{water}$

27. A stone thrown down with a seed *u* takes a time t_1 to reach the ground , while another stone, thrown upwards from the same point with the same speed, takes time t_2. The maximum height the second stone reaches from the ground is

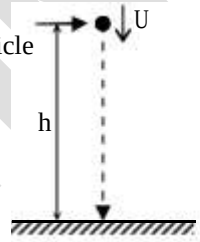
(A) ½ $gt_1 t_2$ (B) $g/8 (t_1 + t_2)^2$ (C) $g/8 (t_1 – t_2)^2$ (D) ½ gt_2^2

Ans. [B]

Sol.

$$– h = – Ut_1 + \frac{–1}{2} g t_1^2$$

point from where particle is thrown downward



$$h = Ut_1 + \frac{1}{2} g t_1^2 ..... (1)$$

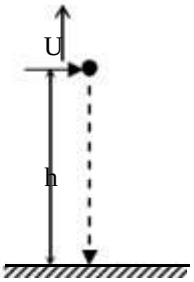
$$– h = Ut_2 – \frac{1}{2} g t_2^2 ..... (2)$$

$$Ut_1 + Ut_2 = \frac{1}{2} g t_2^2 – \frac{1}{2} g t_1^2 \quad \text{(from 1 \& 2)}$$

$$U(t_1 + t_2) = \frac{g}{2} (t_2 – t_1) \times (t_1 + t_2)$$

$$U = \frac{g}{2} (t_2 – t_1)$$

point from where particle is thrown upward



Max height = $h + \frac{U_2}{2g}$

$= (h) + \frac{U_2}{2g}$

$= Ut_1 + \frac{1}{2}gt_1^2 + \frac{U_2}{2g}$

$= \frac{g}{2}t_1(t_2 - t_1) + \frac{1}{2}gt_1^2 + \frac{1}{2g}\frac{g^2}{4}(t_2 - t_1)^2$

$= \frac{g}{2}(t_2 - t_1)t_1 + \frac{gt_1^2}{2} + \frac{g}{8}(t_2 - t_1)^2$

$= \frac{g}{2}\{(t_2 - t_1) + t_1\}^2 + \frac{(t_2 - t_1)^2}{4}\}$

$= g\{4t_2t_1 - 4t_1^2 \quad 4t_1^2 \quad t_2^2 \quad t_1^2 - 2t_1t_2\}$

$2 \qquad 4$

$= g\{t_1^2 \quad t_2^2 \quad 2t_1t_2\}$

$=$

$2 \qquad 4$

$= g(t_1 \quad t_2)^2$

$=$

$2 \qquad 4$

$= \boxed{\frac{g}{8}(t_1 + t_2)^2}$

Hence correct Answer is (B).

28. An electric field due to a positively charged long straight wire at a distance r from it is proportional to r^{-1} in magnitude. Two electrons are orbiting such a long straight wire in circular orbits of radii 1 **Å** and 2 **Å**. The ratio of their respective time periods is

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

Ans. [B]

Sol.

$\frac{K}{r}$

$E =$

$F = qE$ for 1^{st} electron

$(q)\frac{1}{r_1} = \frac{mv_1^2}{r_1}$

$q = mv_1^2$

$\boxed{v_1^2 = \frac{q}{M}}$

$v_1 = \sqrt{\frac{q}{M}}$

$= \frac{R_1}{v_1} \times \frac{v_2}{R_2} = \frac{1}{2}$

29. Two particles of identical mass are moving in circular orbits under a potential given by $V(r) = Kr^{-n}$, where K is a constant. If the radii of their orbits are r_1, r_2 and their speeds are v_1, v_2, respectively, then

(A) $v_1^2 r_1^n = v_2^2 r_2^n$ (B) $v_1^2 r_1^{-n} = v_2^2 r_2^{-n}$ (C) $v_1^2 r_1 = v_2^2 r_2$ (D) $v_1^2 r_1^{2-n} = v_2^2 r_2^{2-n}$

Ans. **[A]**

Sol. $V(r) = Kr^{-n}$

gravitational field $= E = \frac{dV}{}$

$= (-K)\frac{d}{dr}(r^{-n})$

$= (-K)(-n)\, r^{-n-1}$

$= \frac{Kn}{r^{n+1}}$

force on mass = E × M, where M = mass of body

$ME_1 = \frac{MV_1^2}{r_1}$ $ME_2 = \frac{MV_2^2}{r_2}$

$\frac{V_1^2}{V_2^2} = \frac{r_1 E_1}{r_2 E_2}$

$V_1^2 = r_1 \frac{Kn}{r_2} \frac{r_2^{n+1}}{r_1^{n+1}} \frac{}{Kn}$

$\frac{V_1^2}{V_2^2} = \frac{r_2^n}{r_1^n}$

$V_1^2 r_1^n = V_2^2 r_2^n$

30. Mercury is often used in clinical thermometers. Which one of the following properties of mercury is not a reason for this?

(A) The coefficient of the thermal expansion is large.

(B) It is shiny.

` (C) It is a liquid at room temperature.

(D) It has high density.

Ans. **[D]**

Sol. high density is not the reason for its uses in clinical thermometers.

31. One mole of one of the sodium salts listed below, having carbon content close to 14.3% produces 1 mole of carbon dioxide upon heating (atomic mass Na = 23, H = 1, C = 12, O = 16). The salt is

(A) C_2H_5COONa (B) $NaHCO_3$ (C) $HCOONa$ (D) CH_3COONa

Ans. **[B]**

Sol. $2\,NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

$$\% \text{ of } C = \frac{12}{84} 100 = 14.28\%$$

This Question can be done by checking % of carbon 14.2% comes only in $NaHCO_3$

32. Among formic acid, acetic acid, propanoic acid and phenol, the strongest acid in water is

(A) formic acid (B) acetic acid

(C) propanoic acid (D) phenol

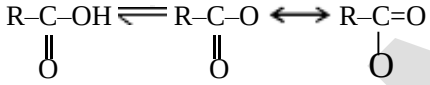
Ans. **[A]**

Sol. Formic Acid is Strongest Acid.

Acidic strength order $H-\underset{\underset{O}{\|}}{C}-OH > CH_3-\overset{+I}{\underset{\underset{O}{\|}}{C}}-OH > CH_3-CH_2-\overset{+I}{\underset{\underset{O}{\|}}{C}}-OH >$ 

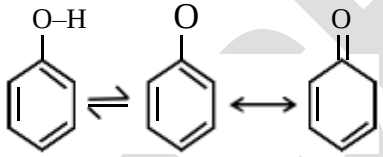
+I decrease acidic strength

Carboxylic Acid are more acidic Then phenol



More Acidic

More Stabilize by Powerful Resonance



Less Acidic Less Powerful Resonance

33. According to Graham's Law, the rate of diffusion of CO, O_2, N_2 and CO_2 follows the order:

(A) $CO = N_2 > O_2 > CO_2$

(B) $CO = N_2 > CO_2 > O_2$

(C) $O_2 > CO = N_2 > CO_2$

(D) $CO_2 > O_2 > CO = N_2$

Ans. **[A]**

Sol. $r \propto \frac{1}{\sqrt{M}}$ Rate of diffusion decrease with increase in molecular weight

Rate of diffusion order $CO \;\; N_2 \;\; O_2 \;\; CO_2$

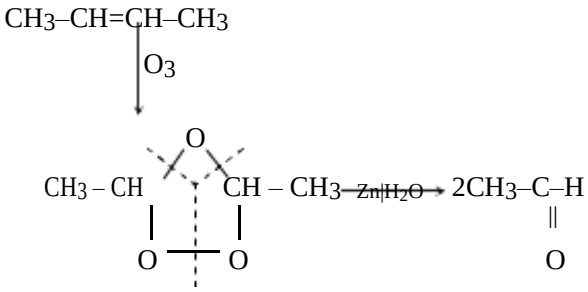
$(28) \;\; (28) \;\; (32) \;\; (44)$

34. The major product formed when 2-butene is reacted with O_3 followed by treatment with Zn/H_2O is

(A) CH_3COOH (B) CH_3CHO (C) CH_3CH_2OH (D) $CH_2=CH_2$

Ans. [B]

Sol. This is example of Reductive Ozonolysis



35. The IUPAC name for the following compound is

CH_3-CH_2-CH_2- CH_2-C-CH_2-CH_2-CH_3

CH_2

(A) 2-propylhex-1-ene

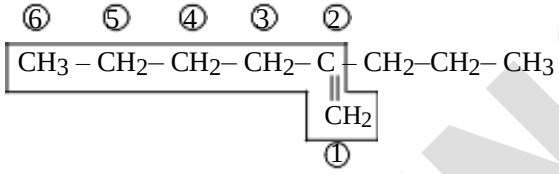
(B) 2-butylpent-1-ene

(C) 2-propyl-2- butylethene

(D) Propy1-1-butylethene

Ans. [A]

Sol.



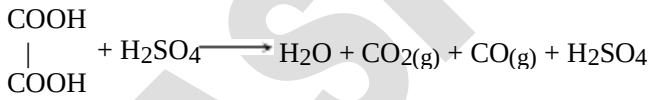
2 propyl hex – 1 ene

36. The major products obtained in the reaction of oxalic acid with conc. H_2SO_4 upon heating are

(A) CO, CO_2, H_2O (B) CO, SO_2, H_2O (C) H_2S, CO, H_2O (D) HCOOH, H_2S, CO

Ans. [A]

Sol.



37. LiOH reacts with CO_2 to form Li_2CO_3(atomic mass of Li=7). The amount of CO_2 (in g) consumed by 1g of LiOH is closest to

(A) 0.916 (B) 1.832 (C) 0.544 (D) 1.088

Ans. [A]

Sol. $2LiOH \quad CO_2 \quad Li_2CO_3 \quad H_2O$

$\frac{1}{24} \quad \frac{1}{24\ 2}$

No. of moles of CO_2 $\frac{1}{48}$

mass of CO_2 $\frac{1}{48}\ 44\ 0.916g$

38. The oxidation number of sulphur is +4 in

(A) H_2S (B) CS_2 (C) Na_2SO_4 (D) Na_2SO_3

Ans. **[D]**

Sol. H_2S^{-2}

CS_2^{2}

$Na_2\overset{6}{S}O_4$

$Na_2\overset{4}{S}O_3$

39. Al_2O_3 reacts with

(A) only water (B) only acids (C) only alkalis (D) both acids and alkalis

Ans. **[D]**

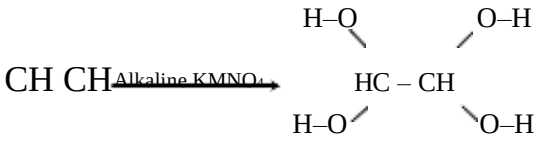
Sol. Al_2O_3 is amphoteric so it dissolve in acid as well in alkalis

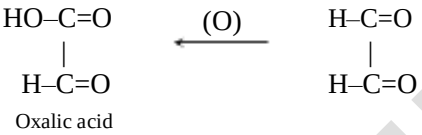
40. The major product formed in the oxidation of acetylene by alkaline $KMnO_4$ is

(A) ethanol (B) acetic acid (C) formic acid (D) oxalic acid

Ans. **[D]**

Sol.





Oxalic acid

41. In a closed vessel, an ideal gas at 1 atm is heated from 27º C to 327º C. the final pressure of the gas wil approximately be

(A) 3 atm (B) 0.5 atm (C) 2 atm (D) 12 atm

Ans. **[C]**

Sol. $P \quad T$ (V, n const)

$$\frac{P_1}{P_2} \quad \frac{T_1}{T_2}$$

$$\frac{1}{P_2} \quad \frac{300}{600}$$

$P_2 = 2atm$

42. Among the element Li,N,C and Be, one with the largest atomic radius is

(A) Li (B) N (C) C (D) Be

Ans. **[A]**

Sol. as we move left to right in a period atomic radius decrease due to increase in z_{eff}
so. greatest radius is of lithium.

43. A redox reaction among the following is

(A) $CdCl_2 + 2KOH \quad Cd(OH)_2 + 2KCl$

(B) $BaCl_2 + K_2SO_4 aSO_4 + 2KCl$

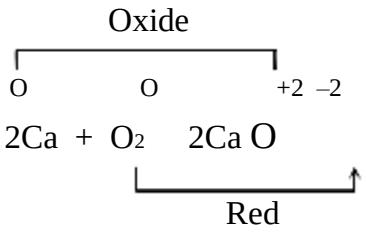
(C) $CaCO_3 \quad CaO + CO_2$

(D) $2\,Ca + O_2 CaO$

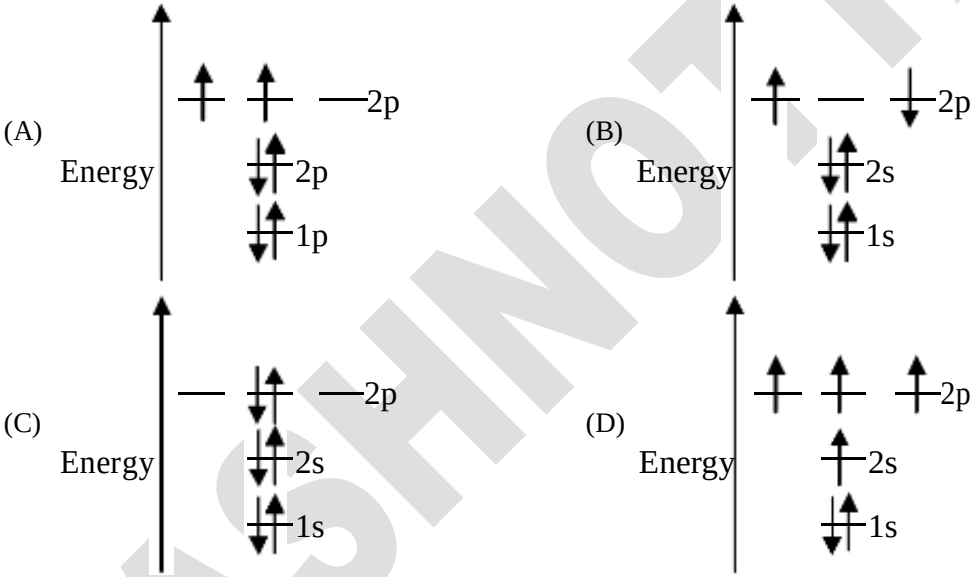
Ans. **[D]**

Sol. Redox reaction is the reaction in which oxidation & reduction take place simultaneously

So answer is (D)

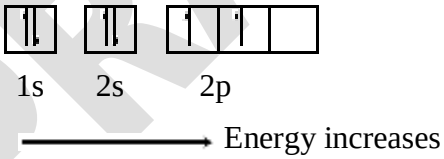


44. The electronic configuration which obeys Hund's rule for the ground state of carbon atom is

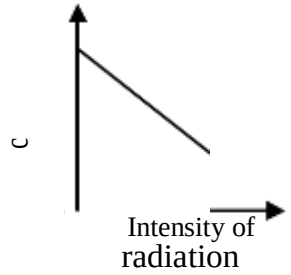


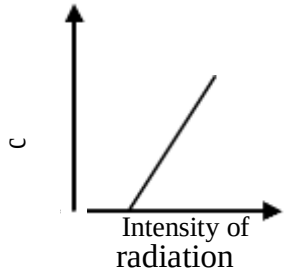
Ans. **[A]**

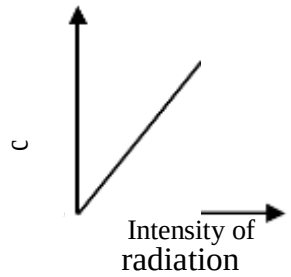
Sol. C $1s^2\ 2s^2\ 2p^2$

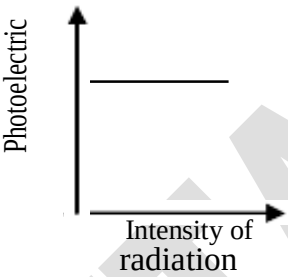


45. The graph that depicts Einstein photoelectric effect for a monochromatic source of frequency above the threshold frequency is

(A) 

(B) 

(C) 

(D) 

Ans. **[C]**

Sol. On increasing intensity of radiation, value of photo electric current increases because no. of photon incident increases

BIOLOGY

46. What is the length of human DNA containing 6.6×10^9 bp?

(A) 22 nm (B) 0.22 mm (C) 2.2 m (D) 22 m

Ans. **[C]**

Sol. The distance between 2 nucleotides / nitrogen bases is 3.4 Å and human DNA containing 6.6×10^9 bp multiplied by this distance gives a length of 2.2 meters

47. The *Diptheria, Pertussis ,Tetanus* (DPT) vaccine consists of

(A) live attenuated strains of *Diptheria, Pertussis, Tetanus*

(B) toxoid of *Diptheria, Tetanus* , and heat killed whole cells of *Pertussis*

(C) whole cell lysate of *Diptheria, Pertussis, Tetanus*

(D) heat killed strains of *Diptheria, Pertussis, Tetanus*

Ans. **[B]**

Sol. Vaccine of *Diphtheria, Pertussis* and *Tetanus* (DPT) consist of …….

(i) Toxoid of *Diptherian* and *Tetanus*

(ii) Heat killed cells of *Pertussis*

48. Which of the following is NOT an enzyme?

(A) Lipase (B) Amylase (C) Trypsin (D) Bilirubin

Ans. **[D]**

Sol. Lipase = Enzyme [Lipid digesting]

Amylase = Enzyme [Starch digesting]

Trypsin = Enzyme [Endopeptidase]

Bilirubin = Bile pigment

49. The pH of the avian blood is maintained by

(A) HCO_3^- (B) $H_2PO_4^-$ (C) CH_3COO^- (D) Cl^-

Ans. **[A]**

Sol. pH of Blood of bird is maintain by HCO_3^-

50. Podocyte layer that provides outer lining to the surface of glomerular capillaries are found in

(A) bowman's capsule (B) loop of Henle (C) renal artery (D) ureter

Ans. **[A]**

Sol. Podocyte are cells of squamous epithelium of bowman capsule of nephron

51. If a dsDNA has 20% adenine, what would be its cytosine content ?

(A) 20% (B) 30% (C) 40% (D) 80%

Ans. **[B]**

Sol. According to Chargaff's rule, the molar concentration of purines is equal to molar concentration of pyrimidines.

A+G=T+C

So if Adenine is 20% then T is also 20% because A always pairs with T.

Hence G is 30% and C is also 30%

52. Which one of the following is incapable of curing Pellagra?

(A) Niacine (B) Nicotine (C) Nicotinamide (D) Tryptophan

Ans. **[B]**

Sol. Pellagra can be cure by – Niacine
– Nicotinamide
– Tryptophan

53. In *Escherichia coli*, how many codons code for the standard amino-acids?

(A) 64 (B) 60 (C) 61 (D) 20

Ans. **[C]**

Sol. In all living organisms, there are 64 codons and 3 codons are stop or termination codons i.e. UAA, UAG & UGA which do not code for any amino acids.

54. *Bombyx mori* (silk worm) belongs to the order

(A) Lepidoptera (B) Diptera (C) Hymenoptera (D) Coleoptera

Ans. **[A]**

Sol. Order of Silkworm
(*Bombax mori*)

55. The source of mammalian hormone "Relaxin" is

(A) ovary (B) stomach (C) intestine (D) pancreas

Ans. **[A]**

Sol. Relaxin hormone secreted from ovary at the time of Parturition.

56. Which one of the following animals is a connecting link between reptiles and mammals?

(A) Platypus (B) Bat (C) Armadillo (D) Frog

57. What is the number of chromosomes in an individual with Turner's syndrome?

(A) 44 (B) 45 (C) 46 (D) 47

Ans. **[B]**

Sol. The genetic makeup of Turner's syndrome is 44 + XO, so these are a total of 45 chromosomes only.

58. Chipko movement in the year 1974 in Garhwal Himalayas involved

(A) protecting tigers

(B) preventing soil erosion by planting trees

(C) preventing pollution by closing down industries

(D) hugging trees to prevent the contractors from felling them

Ans. [D]

Sol. Chipko movement was headed by social activist Sunder Lal Bahuguna in Uttarakhand to save trees from felling.

59. Which of the following amino acids is NOT involved in gluconeogenesis ?

(A) Alanine (B) Lysine (C) Glutamate (D) Arginine

Ans. **[B]**

Sol. Lysine can not be convert in Glucose

60. Which of the following entities causes syphilis?

(A) *Treponema pallidum* (B) *Neisseria gonorrhoea*

(C) *HIV* (D) *Hepatitis B*

Ans. **[A]**

Sol. Causative agent of Syphilis is *Treponema Pallidum*

Part – II

Two - Mark Questions

MATHEMATICS

61. Suppose a is a positive real number such that $a^5 - a^3 + a = 2$. Then

(A) $a^6 < 2$ (B) $2 < a^6 < 3$ (C) $3 < a^6 < 4$ (D) $4\ a^6$

Ans. **[C]**

Sol. $a^5 - a^3 + a = 2$; $a \in R^+$

Let $f(a) = a^5 - a^3 + a - 2$; {Note $f(a) > 0 \ \forall\ a \in R$}

for $a^6 = 3$ $a = 3^{1/6} = 1.2$ {use calculator}

we get $f(1.2) < 0$ and at $a = 4^{1/6}$ $f(4^{1/6}) > 0$

so one root in a $(3, 4)$

62. Consider the quadratic equation $nx^2 - 7\sqrt{nx} + n = 0$, where n is a positive integer. Which of the following statements are necessarily correct ?

I. For any n, the roots are distinct.

II. There are infinitely many values of n for which both roots are real.

III. The product of the roots is necessarily an integer.

(A) III only (B) I and III only (C) II and III only (D) I, II and III

Ans. **[B]**

Sol. $D = 49n - 4n^2$

$= n(49 - 4n)$

$D \geq 0$ for any $n \in I^+$. So roots are distinct

For roots to be real $D \geq 0$

So $n \leq \frac{49}{4}$

So n can be {1, 2, 3, ... 12}

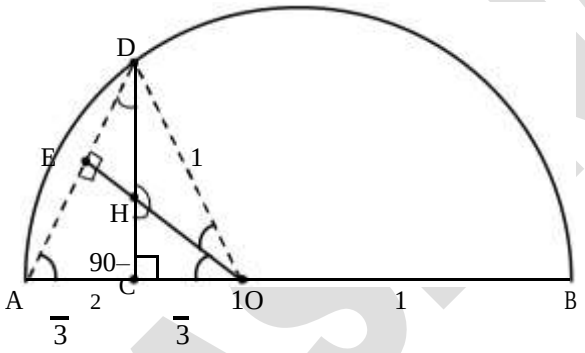
Clearly product of the roots is 1

63. Consider a semicircle of radius 1 unit constructed on the diameter AB, and let O be its centre. Let C be a point on AO such that AC : CO = 2:1. Draw CD perpendicular to AO with D on the semicircle. Draw OE perpendicular to AD with E on AD. Let OE and CD intersects at H. Then DH equals

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

Ans. **[C]**

Sol.



'E' is mid point of AD.

$\cos 2\theta = \frac{1}{3}$ $2\cos^2\theta - 1 = \frac{1}{3}$

$\cos^2\theta = \frac{2}{3}$

$\cos\theta = \frac{\sqrt{2}}{\sqrt{3}}$

$\sin\theta = \sqrt{1 - \frac{2}{3}} = \frac{1}{\sqrt{3}}$

$\frac{}{1}$ $\frac{}{\sqrt{3}}$

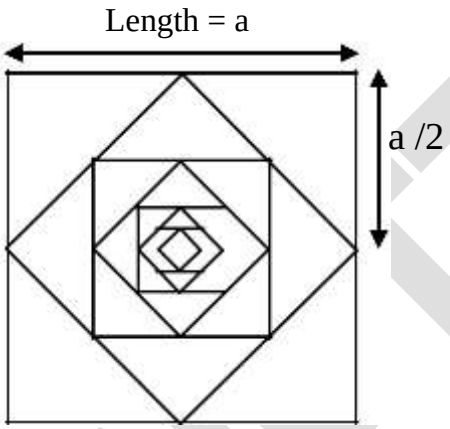
DH = ED sec

$= \frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{2}}$

$= \frac{1}{\sqrt{2}}$

64. Let S_1 be the sum of areas of the squares whose sides are parallel to coordinate axes. Let S_2 be the sum of areas of the slanted squares as shown in the figure. Then S_1 / S_2 is

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



Ans. **[A]**

Sol. $S_1 = a^2 + \frac{a^2}{4} + \frac{a^2}{16} + \ldots\ldots = \frac{a^2}{1 - \frac{1}{4}} = \frac{4a^2}{3}$

$S_2 = \frac{a^2}{2} + \frac{a^2}{8} + \frac{a^2}{32} + \ldots\ldots = \frac{\frac{a^2}{2}}{1 - \frac{1}{4}} = \frac{4a^2}{6}$

$\frac{S_1}{S_2} = 2$

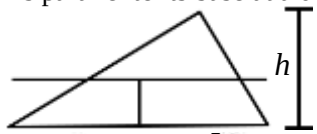
65. If a 3-digit number is randomly chosen, what is the probability that either the number itself or some permutation of the number (which is a 3-digit number) is divisible by 4 and 5?

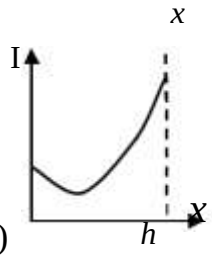
(A) $\frac{1}{45}$ (B) $\frac{29}{180}$ (C) $\frac{11}{60}$ (D) $\frac{1}{4}$

Ans. **[B]**

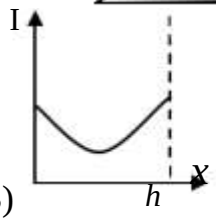
Sol. We need 3-digit number which is divisible by 4 & 5 both.

66. Which one of the following four graphs best depict the variation with x of the moment of inertia I of a uniform triangular lamina about an axis parallel to its base at a distance x from it

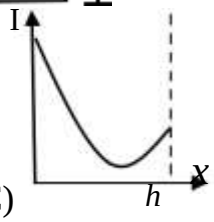




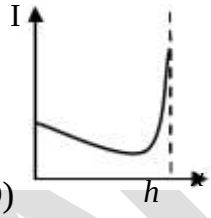
(A)



(B)



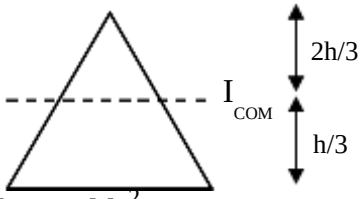
(C)



(D)

Ans. **[A]**

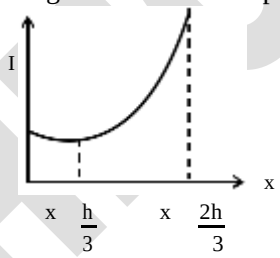
Sol.



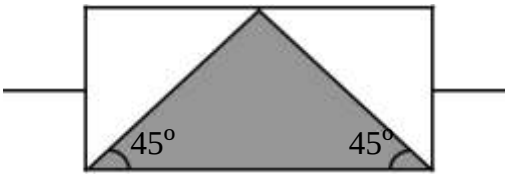
$I = I_{COM} + Mx^2$

First it will decrease because x is increasing and axis is coming closer to COM axis. After Passing COM axis, M & I will again increase

I is minimum about the axis passing through COM if we compare I about other parallel axis



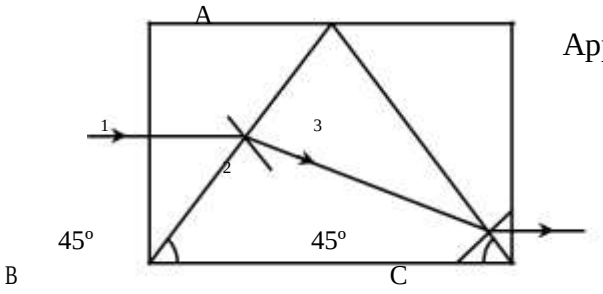
67. A rectangular block is composed of three different glass prisms (with refractive indices $_1$, $_2$ and $_3$) as shown in the figure below. A ray of light incident normal to the left face emerges normal to the right face. Then the refractive indices are related by



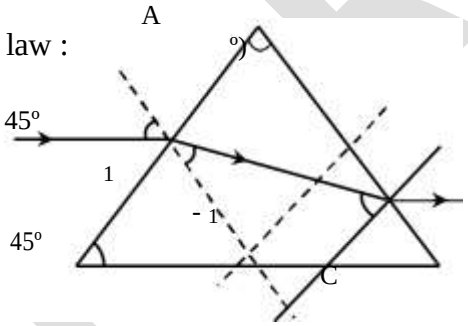
(A) $_1^2 + _2^2 = _3^2$ (B) $_1^2 + _2^2 = _3^2$ (C) $_1^2 + _3^2 = _2^2$ (D) $_2^2 + _3^2 = _1^2$

Ans. [C]

Sol.



Applying snell's law :



for surface AB:

$_1 \sin 45^\circ = _2 \sin$ $_1$ … (1)

for surface AC:

$_2 \sin(\ - _1) = _3 \sin 45$

$_3 \sin 45^\circ = _2 \cos$ $_1$ … (2) $= 90^\circ$

Squaring and adding equation (1) & (2)

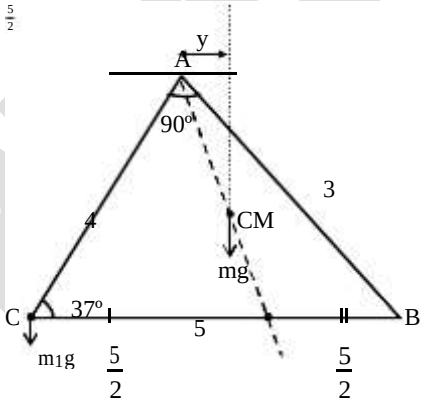
$\frac{_1 \ _2}{2} + \frac{_3 \ _2}{2} = _2^2$ $\quad _1^2 + _3^2 = 2 \ _2^2$

68. A uniform metal plate shaped like a triangle ABC has a mass of 540 gm. the length of the sides AB, BC and CA are 3 cm, 5 cm and 4 cm, respectively. The plate is pivoted freely about the point A . What mass must be added to a vertex , so that the plate can hang with the long edge horizontal ?

(A) 140 gm at C (B) 540 gm at C (C) 140 gm at B (D) 540 gm at B

Ans. [A]

Sol.



CM of triangular plate is on the median. If we put a mass say m_1 on C it will produce torque about A which balance the torque produce mg about A. Thus plate will can be in equilibrium position

$m_1 g \times 4 \cos 37 = mg \times y$

$m_1 g \times 4 \times \frac{4}{5} = mg \times y$

$m_1 = m \times y \times \frac{5}{16}$

$\frac{m_1}{m} = y \times \frac{5}{16}$

$y < 3 \qquad \frac{m_1}{m} < 1$

$m_1 < m$

$m_1 < 540$ g

from given option Ans. (A)

69. A 20gm bullet whose specific heat is 5000 J / (kg-ºC) and moving at 2000 m/s plunges into a 1.0 kg block of wax whose specific heat is 3000 J /(kg-ºC). Both bullet and wax are at 25 ºC and assume that (i) the bullet comes to rest in the wax and (ii) all its kinetic energy goes into heating the wax. Thermal temperature of the wax in ºC is close to

(A) 28.1 (B) 31.5 (C) 37.9 (D) 42.1

Ans. **[C]**

Sol. $M_B = 20 \times 10^{-3}$ Kg

$C_B = 5000$ J / Kg-ºC

$V = 2000$ M/s

$M_w = 1$ Kg

$C_w = 3000$ J / Kg – ºC

$T_f = 25$º C = 298 K

$\frac{1}{2} MV^2 = M_w C_w \ T_w + M_B C_B \ T_B$

$= \frac{1}{2} M_B V^2 = M_w C_w (T_w) + M_B C_B T_B$

$\frac{1}{2} \times 20 \times 10^{-3} \times 4 \times 10^6$ 2

$= (T) \{1 \times 3000 + 20 \times 10^{-3} \times 5000\}$

$40 \times 10^3 = T \{3000 + 100\}$

$T = \frac{40\ 10^3}{3100}$

$T = 12.9$

$T_f - 25 = 12.9$

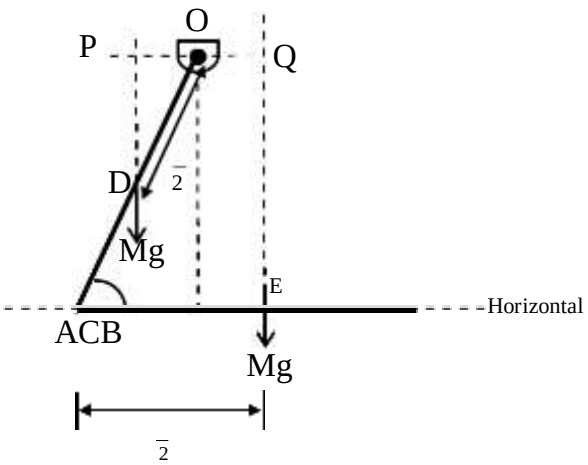
$T_f = 25 + 12.9 = 37.9$ºC

70. A"V" shaped rigid body has two identical uniform arms. What must be the angle between the two arms so that when the body is hung from one end, the other arm is horizontal ?

(A) $\cos^{-1}(1/3)$ (B) $\cos^{-1}(1/2)$ (C) $\cos^{-1}(1/4)$ (D) $\cos^{-1}(1/6)$

Ans. **[A]**

Sol.



For one arm to remain horizontal the net torque about O must be zero (in the position shown in the figure)

for this OP = OQ

OQ = cos 2

from figure

AE=AC+CE

AE = cos + OQ

= cos + cos

2 2

cos = 1

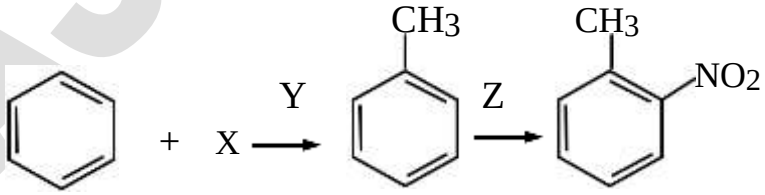
3

hence = $\cos^{-1}$ (1/3)

correct Answer is (A)

CHEMISTRY

71. In the following reactions, X,Y and Z are



(A) X = CH_3Cl;Y = anhydrous $AlCl_3$; Z = $HNO_3 + H_2SO_4$

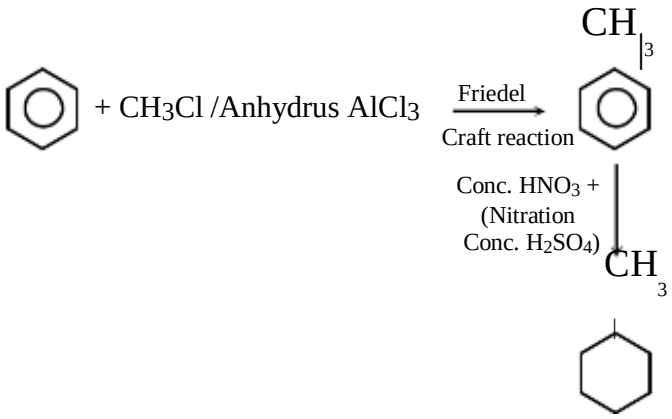
(B) X = CH_3COCl;Y = anhydrous $AlCl_3$; Z = $HNO_3 + H_2SO_4$

(C) X = CH_3Cl;Y = conc. H_2SO_4; Z = $HNO_3 + H_2SO_4$

(D) X = CH_3Cl; Y = dil. H_2SO_4; Z = HNO_3

Ans. [A]

Sol.



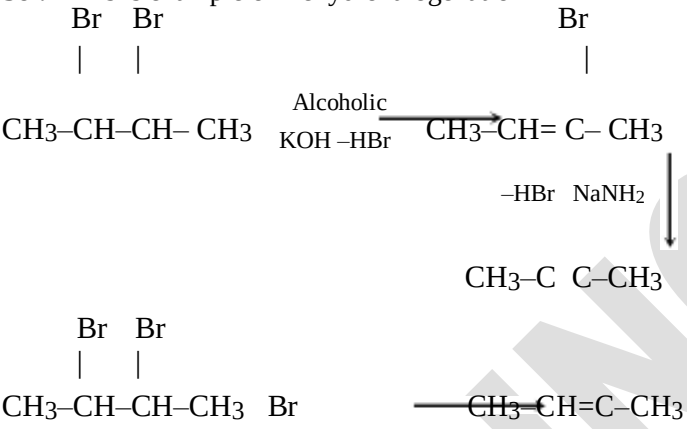
72. 2,3-dibromobutane can be converted to 2-butyne in two-step reaction using

(A) (i) HCl and (ii) NaH (B) (i) alcoholic KOH and (ii) $NaNH_2$

(C) (i) Na and (ii) NaOH (D) (i) Br_2 and (ii) NaH

Ans. [B]

Sol. This is example of Dehydrohalogenation



73. Given

$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$ $\Delta H = -198.9$ kJ/mol

$O_3(g)g)$ $\Delta H = -142.3$ kJ/mol

$O_2(g)g$ $\Delta H = +495.0$ kJ/mol

The entalpy change (ΔH) for the following reaction is

NO (g) + O (g)g

(A) –304.1 kJ/mol (B) +304.1 kJ/mol (C) -403.1 kJ/mol (D) +403.1 kJ/mol

Ans. [A]

Sol. $NO \; O_3 \; NO_2 \; O_2 \quad H \quad 198.9$ KJ / mole

$O_3 \quad \frac{3}{2} O_2(g) \quad H \quad 142.3$ KJ / mole

$O_2 \quad 2O_2(g) \quad H \quad 495.0$ KJ / mole

H of NO O(g) $NO_2(g)$

For this i ii $\frac{iii}{2}$

$= -198.9 - (-142.3) - \frac{495}{2}$

$= -304.1$ KJ / mole

74. A 1.85 g sample of an arsenic-containing pesticide was chemically converted to AsO_4^{3-} (atomic mass of As = 74.9) and titrated with Pb^{2+} to form $Pb_3(AsO_4)_2$. If 20 mL of 0.1 M Pb^{2+} is required to reach the equivalence point, the mass percentages of arsenic in the pesticide sample is closest to

(A) 8.1 (B) 2.3 (C) 5.4 (D) 3.6

Ans. **[C]**

Sol. $3Pb^{2} \quad 2ASO^{3}_{4} \quad Pb_3(AsO_4)_2$

$n = M \times V \qquad n \quad \frac{2}{3} 2\ 10^{3}$

$= 0.1 \quad \frac{20}{1000} = 0.00133$

$= 2 \times 10^{-3}$

$AS \quad ASO_{34} \quad 0.00133$

$W_{AS} = 0.00133 \times 74.9 = 0.0996$

$\%\ \text{of AS} \quad \frac{0.0996}{1.85} 100 \quad 5.4\ \%$

75. When traded with conc. HCl_2 MnO_2 yields gas (X) which further reacts with $Ca(OH_2)$ to generate a white solid (Y) reacts with dil. HCl to produce the same gas X. the solid Y is

(A) CaO (B) $CaCl_2$ (C) Ca(OCl)Cl (D) $CaCO_3$

Ans. **[C]**

Sol. $MnO_2 \quad \underset{\text{conc.}}{HCl} \quad Cl_2\ (g)\ (x)$

$Ca(OH)_2 \quad Cl_2 \quad CaOCl_2\ (y)$

$CaOCl_2 \quad dilHCl \quad \underset{(X)}{Cl_2} \quad CaCl_2 \quad H_2O$

BIOLOGY

76. The atmospheric pressure is 760 mm Hg at the sea level. Which of the following ranges is nearest to the partial pressure of CO_2 in mm Hg?

(A) 0.30–0.31 (B) 0.60–0.61 (C) 3.0–3.1 (D) 6.0–6.1

Ans. **[A]**

Sol. P_{CO_2} = 0.30 - 0.31 mm Hg in Air

77. A breeder crossed a pure bred tall plant having white flowers to a pure bred short plant having blue flowers. He obtained 202 F_1 progeny and found that they are all tall having white flowers. Upon selfing these F_1 plants, he obtained a progeny of 2160 plants. Approximately, how many of these are likely to be short and having blue flowers?

(A) 1215 (B) 405 (C) 540 (D) 135

Ans. **[D]**

Sol. TTWW × ttww

TtWw x TtWw (202 plants)

2160 plants – (Total) in F_2

Tw 3

according to ratio of dihybrid cross.

tw 1

The total number of short and blue flowered plants is –

$\frac{1}{16}$ 2130 = $\frac{1080}{8}$ = 135

78. Match the different types of heart given in column A with organisms given in the column B. Choose the correct combination.

Column A	**Column B**
P. Neurogenic heart	i. Human
Q. Bronchial heart	ii. King crab
R. Pulmonary heart	iii. Shark

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

Ans. [A]

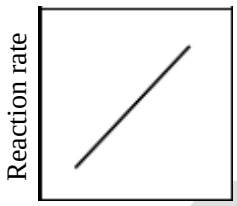
Sol. – Neurogenic Heart King crab [Arthropod]

– Bronchial Heart Shark [Single circulation]

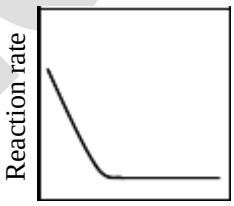
– Pulmonary Heart Human

79. Given below are the four schematics that describe the dependence of the rate of an enzymatic reaction on temperature. Which of the following combinations is true for thermophilic and psychrophilic organisms?

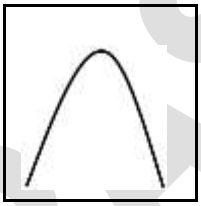
P.



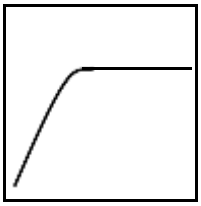
Q



R



S.



(A) P and P (B) P and S (C) P and R (D) R and R

Ans. [D]

Sol. Being mostly proteinaceous enzymes are liable to temperature. Thermophiles are living at very high temperature while psychrophiles live in the range of –20°C to +10°C. In either case rising temperature will first raise the rate of reaction but if temperature is still raised continuously enzyme get denatured hence reaction rate decreases.

80. Match the enzymes in Group I with the reactions in Group II. Select the correct combination.

Group I	Group II
P. Hydrolase	i. Inter-conversion of optical isomers
Q. Lyase	ii. Oxidation and reduction of two substrates
R. Isomerase	iii. Joining of two compounds
S. Ligase	iv. Removal of a chemical group from a substrate
	v. Transfer of a chemical group from one substrate to another

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

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

Ans. **[B]**

Sol. (i) Hydrolase catalyses hydrolysis of ester, ether, peptide, glycosidic, C–C, C-halide or P–N bonds

(ii) Lyase catalyses removal of groups other than hydrolysis

(iii) Isomerase catalyses interconversion of optical, geometric or positional isomers.

(iv) Ligase catalyses linking together of two compounds