CAREER POINT

KVPY QUESTION PAPER-2014 (STREAM SA)

Part – I

One - Mark Questions

Date : 02 / 11 / 2014

MATHEMATICS

1. Let r be a root of the equation $x^2 + 2x + 6 = 0$. The value of $(r + 2)(r + 3)(r + 4)(r + 5)$ is equal to-

(A) 51 (B) – 51 (C) –126 (D) 126

Ans. **[C]**

Sol. r is root, therefore $r^2 + 2r + 6 = 0$

$(r + 2)(r + 3)(r + 4)(r + 5) = (r^2 + 2r + 6 + 3r)(r^2 + 4r + 5r + 20)$

$= (3r)(7r + 14)$

$= 21(r^2 + 2r) = 21(-6) = -126$

2. Let R be the set of all real numbers and let f be a function from R to R such that

$$f(x) + \left(x + \frac{1}{2}\right) f(1 - x) = 1,$$

for all $x \in R$. Then $2f(0) + 3f(1)$ is equal to-

(A) 2 (B) 0 (C) – 2 (D) – 4

Ans. **[C]**

Sol. $f(x) + \left(x + \frac{1}{2}\right) f(1 - x) = 1$

$$f(1 - x) + \left(1 - x + \frac{1}{2}\right) f(1 - (1 - x)) = 1$$

$$f(1 - x) + \left(\frac{3}{2} - x\right) f(x) = 1$$

$$\frac{1 - f(x)}{x + \frac{1}{2}} + \left(\frac{3}{2} - x\right) f(x) = 1$$

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

$$f(x)\left(x - x^2 - \frac{1}{4}\right) = x - \frac{1}{2}$$

$f(x)\,(4x - 4x^2 - 1) = 4x - 2$

$$f(x) = \frac{-2+4x}{4x-4x^2-1}$$

$$2f(0) + 3f(1) = 2\left(\frac{-2+0}{0-0-1}\right)+3\left(\frac{-2+4}{4-4-1}\right)$$

$$= +4 + \frac{3(+2)}{-1} = +4-6 = -2$$

Alternate

Put $x = 0$

$$f(0) + \frac{1}{2}f(1) = 1 \Rightarrow 2f(0) + f(1) = 2$$

put $x = 1$

$$f(1) + \frac{3}{2}f(0) = 1 \Rightarrow 2f(1) + 3f(0) = 2$$

solving above $f(0) = 2$ and $f(1) = -2$

$\therefore \quad 2f(0) + 3f(1) = 4 - 6 = -2$

3. The sum of all positive integers n for which

$$\frac{1^3+2^3+...+(2n)^3}{1^2+2^2+...+n^2}$$

is also an integer is

(A) 8 (B) 9 (C) 15 (D) Infinite

Ans. **[A]**

Sol. $$\frac{\left(\frac{2n(2n+1)}{2}\right)^2}{\frac{n(n+1)(2n+1)}{6}} = \frac{6n^2(2n+1)^2}{n(n+1)(2n+1)}$$

$$= \frac{6n(2n+1)}{(n+1)} = \frac{6n(n+1+n)}{n+1}$$

$$= 6n + \frac{6n^2}{n+1} = 6n + 6(n-1) + \frac{6}{n+1} = \text{Integer}$$

The values of 'n' which are satisfying are n = 1, 2, 5 only for being integer

$\therefore$ sum = 1 + 2 + 5 = 8

4. Let x and y be two 2-digit numbers such that y is obtained by reversing the digits of x. Suppose they also satisfy $x^2 - y^2 = m^2$ for some positive integer m. The value of x + y + m is-

(A) 88 (B) 112 (C) 144 (D) 154

Ans. **[D]**

Sol. $x = ab = 10a + b$

$y = ba = 10b + a \qquad 1 \le a, b \le 9$

$x^2 - y^2 = m^2$

$100a^2 + b^2 + 20ab - (100b^2 + a^2 + 20ab) = m^2$

$99(a^2 - b^2) = m^2$

$9 \times 11 \times (a - b)(a + b) = m^2$

m is integer so $a = 6$ {Note: $a - b \neq 9$ (think why ?)}

$b = 5$

$m^2 = 9 \times 11 \times 1 \times 11 \Rightarrow m = 3 \times 11$

$x + y + m = 10a + b + 10b + a + 33$

$= 11(a + b) + 33 = 11(11) + 33 = 121 + 33 = 154$

5. Let $p(x) = x^2 - 5x + a$ and $q(x) = x^2 - 3x + b$, where a and b are positive integers. Suppose hcf (p(x), q(x)) = x – 1 and k(x) = lcm(p(x), q(x)). 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. $p(x) = x^2 - 5x + a$, $q(x) = x^2 - 3x + b$ { where, $a, b \in N$}

hcf (p(x), q(x)) = x – 1

so x – 1 is root of both p(x) & q(x)

$p(1) = 1 - 5 + a = 0 \Rightarrow a = 4$

$q(1) = 1 - 3 + b = 0 \Rightarrow b = 2$

$p(x) = x^2 - 5x + 4 = (x - 1)(x - 4)$

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

$k(x) = \text{lcm}(p(x), q(x)) = (x - 1)(x - 2)(x - 4)$

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

$= (x - 1)[1 + x^2 - 6x + 8]$

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

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

roots 1, 3, 3

Sum of roots = 1 + 3 + 3 = 7

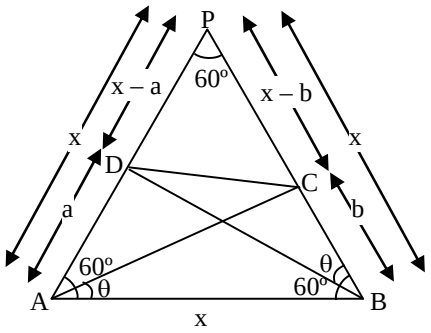
6. In a quadrilateral ABCD, which is not a trapezium, it is known that $\angle DAB = \angle ABC = 60^o$. Moreover, $\angle CAB = \angle CBD$. Then-

(A) AB = BC + CD (B) AB = AD + CD

(C) AB = BC + AD (D) AB = AC + AD

Ans. **[C]**

Sol. **Construction:** complete the equilateral ΔAPB

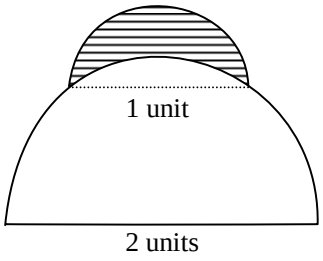


$\Delta ABC \sim \Delta BPD$

$\therefore \dfrac{x-a}{x} = \dfrac{b}{x} \Rightarrow x = a + b$

AB = AD + BC

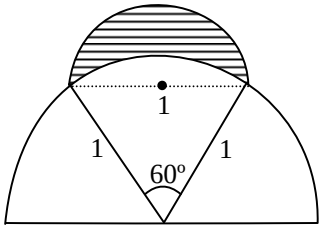
7. A semi-circle of diameter 1 unit sits at the top of a semi-circle of diameter 2 units. The shaded region inside the smaller semi-circle but outside the larger semi-circle is called a *lune*. The area of the lune is-



(A) $\dfrac{\pi}{6} - \dfrac{\sqrt{3}}{4}$ (B) $\dfrac{\sqrt{3}}{4} - \dfrac{\pi}{24}$ (C) $\dfrac{\sqrt{3}}{4} - \dfrac{\pi}{12}$ (D) $\dfrac{\sqrt{3}}{4} - \dfrac{\pi}{8}$

Ans. **[B]**

Sol.



Required area $= \dfrac{\pi\left(\frac{1}{2}\right)^2}{2} - \left(\dfrac{60^o}{360^o}\times\pi(1)^2 - \dfrac{\sqrt{3}}{4}\times 1^2\right)$

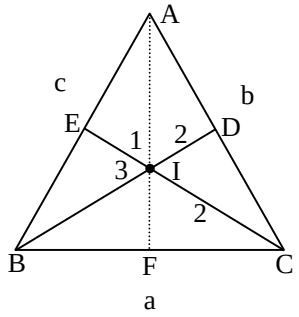
$= \dfrac{\pi}{8} - \left(\dfrac{\pi}{6} - \dfrac{\sqrt{3}}{4}\right) = \dfrac{\sqrt{3}}{4} - \dfrac{\pi}{24}$

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

(A) 3 : 1 (B) 11 : 4 (C) 6 : 5 (D) 7 : 4

Ans. **[B]**

Sol.



I divides AF

b + c : a

I divides BD

c + a : b

I divides CE in

a + b : c

$\dfrac{c+a}{b} = \dfrac{3}{2}$; $\dfrac{a+b}{c} = \dfrac{2}{1}$

$2c + 2a = 3b \Rightarrow a + b = 2c$

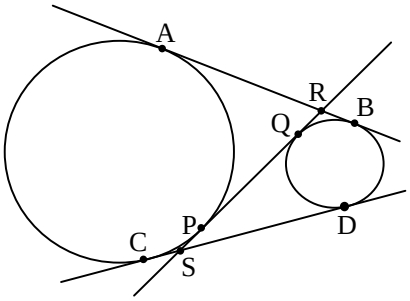
$\Rightarrow a + b + 2a = 3b$ | $a + \dfrac{3a}{2} = 2c$

$\Rightarrow 3a = 2b$ | $\dfrac{5}{2}a = 2c$

$\Rightarrow b = \dfrac{3a}{2}$ | $c = \dfrac{5}{4}a$

Now $\dfrac{b+c}{a} = \dfrac{\frac{3a}{2} + \frac{5a}{4}}{a} = \dfrac{6+5}{4} = \dfrac{11}{4}$

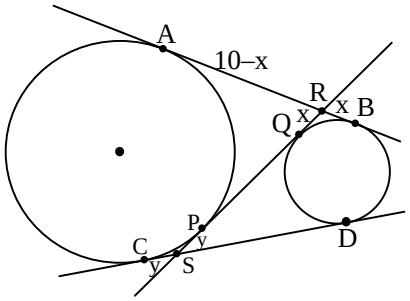
9. Suppose S_1 and S_2 are two unequal circles; AB and CD are the direct common tangents to these circles. A transverse common tangent PQ cuts AB in R and CD in S. If AB = 10, then RS is-



(A) 8 (B) 9 (C) 10 (D) 11

Ans. **[C]**

Sol.



AR = PR = 10 – x

PQ = 10 – 2x

AB = CD = 10

CD = CS + SD = y + SD

= y + SP + PQ

10 = y + y + 10 – 2x

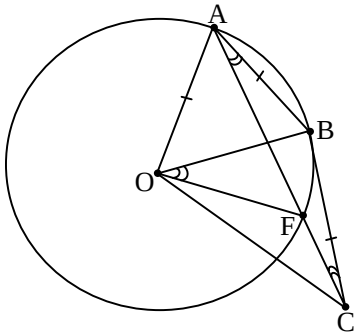
$\Rightarrow$ y = x

Now RS = SP + PQ + QR

= y + 10 – 2x + x

= 10 + y – x = 10

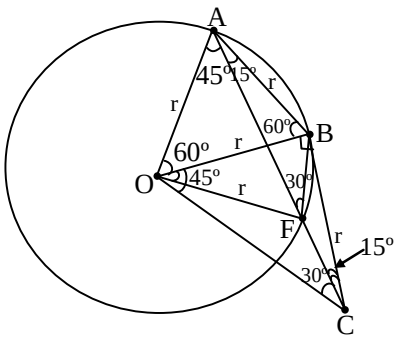
10. On the circle with center O, points A, B are such that OA = AB. A point C is located on the tangent at B to the circle such that A and C are on the opposite sides of the line OB and AB = BC. The line segment AC intersects the circle again at F. Then the ratio $\angle BOF : \angle BOC$ is equal to-



(A) 1 : 2 (B) 2 : 3 (C) 3 : 4 (D) 4 : 5

Ans. **[B]**

Sol.



$\therefore$ ΔOAB should be equilateral

Now $\angle OBC = 90^\circ$ & $AB = BC$

$\Rightarrow \angle BAC = \angle BCA = 15^\circ$

$\therefore \angle BOF = 30^\circ$ & $\angle BOC = 45^\circ$ $\{\Delta OBC$ is right isosceles$\}$

$\therefore \dfrac{\angle BOF}{\angle BOC} = \dfrac{30^\circ}{45^\circ} = \dfrac{2}{3}$ $\{\angle BOF = 2\angle BAF\}$

11. In a cinema hall, the charge per person is Rs. 200. On the first day, only 60% of the seats were filled. The owner decided to reduce the price by 20% and there was an increases of 50% in the number of spectators on the next day. The percentage increase in the revenue on the second day was-

(A) 50 (B) 40 (C) 30 (D) 20

Ans. **[D]**

Sol. Let total seats = 100

Revenue collected first days = 200 × 60 = 12000 Rs

Revenue collected second day = 90 × 160 = 14400

$\therefore$ % increase = $\dfrac{2400}{12000} \times 100 = 20\%$

12. 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. Year wise distribution

2010 $\Rightarrow$ 39

2011 $\Rightarrow$ 60

2012 $\Rightarrow$ x

2013 $\Rightarrow$ 123

Let proportionality constant is 'k'

$\therefore$ according to the question

$(123 - 60) \propto x \Rightarrow 123 - 60 = kx$

$\Rightarrow 63 = kx$ …(1)

and $(x - 39) \propto 60 \Rightarrow x - 39 = 60k$ …(2)

solving (1) & (2)

$x^2 - 39x = 60 \times 63$

$\Rightarrow x = 84;\ D = 129$

13. The number of 6-digit numbers of the form *ababab* (in base 10) each of which is a product of exactly 6 distinct primes is-

(A) 8 (B) 10 (C) 13 (D) 15

Ans. **[C]**

Sol. $100000 \le ababab < 1000000$

$\le 10^5a + 10^4b + 10^3a + 100b + 10a + b < 1000000$

$\le a(10^5 + 10^3 + 10) + b(10^4 + 10^2 + 1) \le 1000000$

$100000 \le (10^4 + 10^2 + 1)(10a + b) < 1000000$

$100000 \le 10101(ab) < 1000000$

$9.9 \le ab < 99$

'ab' number can be obtained as product of ordered pairs

(2, 5); (2, 11); (2, 17); (2, 19); (2, 23); (2, 29); (2, 31); (2, 41); (2, 43); (2, 47); (5, 11); (5, 17); (5, 19)

Total numbers = 13

14. The houses on one side of a road are numbered using consecutive even numbers. The sum of the numbers of all the houses in that row is 170. If there are at least 6 houses in that row and a is the number of the sixth house, then-

(A) $2 \le a \le 6$ (B) $8 \le a \le 12$ (C) $14 \le a \le 20$ (D) $22 \le a \le 30$

Ans. **[C]**

Sol. Let maximum house is 'n' ; sum of first 'n' even natural numbers = $n^2 + n$

Let first 'm' even natural numbers are left in numbering the houses.

$(n^2 + n) - (m^2 + m) = 170$

$\Rightarrow n^2 - m^2 + n - m = 170$

$\Rightarrow (n - m)(n + m + 1) = 170$

$n - m = 10 \Rightarrow n - m = 10$

$n + m + 1 = 17 \Rightarrow n + m = 16$

$n = 13;\ m = 3$

$n \le 13$

If first term is $a - 10$ then sixth = a

$$\frac{n}{2}[2(a - 10) + 2(n - 1)] = 170$$

$\Rightarrow n[a + n - 11] = 170$

$$\Rightarrow a = \frac{170}{n} + 11 - n$$

$\therefore$ n = 10 (only will make 'a' integer)

$\Rightarrow a = 17 + 11 - 10 = 18$

15. Suppose $a_2, a_3, a_4, a_5, a_6, a_7$ are integers such that

$$\frac{5}{7} = \frac{a_2}{2!} + \frac{a_3}{3!} + \frac{a_4}{4!} + \frac{a_5}{5!} + \frac{a_6}{6!} + \frac{a_7}{7!},$$

where $0 \le a_j < j$ for j = 2, 3, 4, 5, 6, 7. The sum $a_2 + a_3 + a_4 + a_5 + a_6 + a_7$ is-

(A) 8 (B) 9 (C) 10 (D) 11

Ans. **[B]**

Sol. $5 \times 6! = 2520a_2 + 840a_3 + 210a_4 + 42a_5 + 7a_6 + a_7$

$\because 3600 = 2520a_2 + 840a_3 + 210a_4 + 42a_5 + 7a_6 + a_7$

Now $a_j \in I$ {from 2 to 7}

so above equation is true if

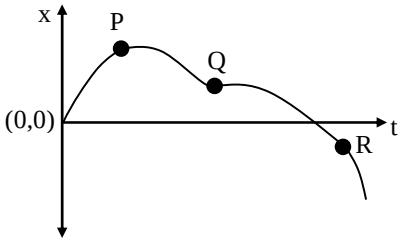
$a_2 = a_3 = a_4 = 1$

$a_5 = 0$

$a_6 = 4,\ a_7 = 2$

PHYSICS

16. In the following displacement (x) vs time (t) graph at which among the P, Q and R is the object's speed increasing ?



(A) R only (B) P only

(C) Q and R only (D) P, Q, R

Ans. **[A]**

Sol. Magnitude of slope is increasing at point R. Magnitude of slope of displacement-time graph represents speed

17. A box, when hung from a spring balance shows a reading of 50 kg. If the same box is hung from the same spring balance inside an evacuated chamber, the reading on the scale will be

(A) 50 kg because the mass of the box remains unchanged.

(B) 50 kg because the effect of the absence of the atmosphere will be identical on the box and the spring balance.

(C) less than 50 kg because the weight of the column of air on the box will be absent.

(D) more than 50 kg because the atmosphere buoyancy force will be absent.

Ans. **[D]**

Sol. In an evacuated chamber, in absence of air, buoyancy force due to air on box is absent.

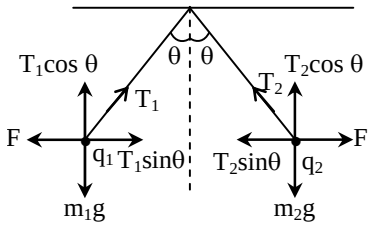
18. Two positively charged spheres of masses m_1, and m_2 are suspended from a common point at the ceiling by identical insulating massless strings of length ℓ. Charged on the two spheres are q_1 and q_2, respectively. At equilibrium both strings make the same angle θ with the vertical. Then

(A) $q_1 m_1 = q_2 m_2$ (B) $m_1 = m_2$

(C) $m_1 = m_2 \sin\theta$ (D) $q_2 m_1 = q_1 m_2$

Ans. **[B]**

Sol.



for equilibrium of m_1

$T_1 \cos\theta = m_1 g$

$T_1 \sin\theta = F$

$\tan\theta = \dfrac{F}{m_1 g}$ ...(1)

For equilibrium of m_2

$T_2 \cos\theta = m_2 g$

$T_2 \sin\theta = F$

$\tan\theta = \dfrac{F}{m_1 g}$ ...(2)

from (1) & (2)

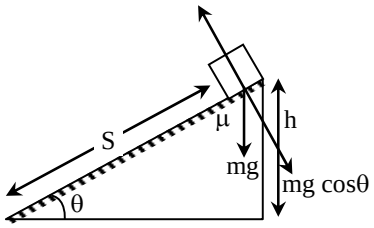
$m_1 = m_2$

19. A box when dropped from a certain height reaches the ground with a speed v. When it slides from rest from the same height down a rough inclined plane inclined at an angle 45° to the horizontal, it reaches the ground with a speed v/3. The coefficient of sliding friction between the box and the plane is (acceleration due to gravity is 10 ms^{-2})

(A) $\dfrac{8}{9}$ (B) $\dfrac{1}{9}$ (C) $\dfrac{2}{3}$ (D) $\dfrac{1}{3}$

Ans. **[A]**

Sol.



When box is dropped from a height h, then speed at ground is v, therefore using mechanical energy conservation

$mgh = \dfrac{1}{2} mv^2$ …(i)

when body slides on rough inclined plane, friction force will also act $f = \mu N = \mu\, mg \cos\theta$

Applying work-energy theorem

$mgh - fs = \dfrac{1}{2} m\left(\dfrac{v}{3}\right)^2 - 0$

$mgh - f.\ \dfrac{h}{\sin\theta} = \dfrac{1}{2}\ m\ \left(\dfrac{v}{3}\right)^2$

$\left(\sin\theta = \dfrac{h}{s}\right)$

$mgh - \mu mg\cos\theta \times \frac{h}{\sin\theta} = \frac{1}{2}\frac{mv^2}{9}$ …(ii)

from equation (i) & (ii)

$mgh\,[1 - \mu\cot\theta] = \left(\frac{1}{9}\right) mgh$

putting $\theta = 45^\circ$, $\cot\theta = 1$

$1 - \mu = \frac{1}{9}$

$\Rightarrow \mu = \frac{8}{9}$

20. A thin paper cup filled with water does not catch fire when placed over a flame. This is because

(A) the water cuts off oxygen supply to the paper cup.

(B) water is an excellent conductor of heat.

(C) the paper cup does not become appreciably hotter than the water it contains.

(D) paper is a poor conductor of heat.

Ans. **[C]**

Sol. specific heat of water is very high

$\therefore$ It temperature rises by small amount.

21. Ice is used in a cooler in order to cool its contents. Which of the following will speed up the cooling process ?

(A) Wrap the ice in a metal foil.

(B) Drain the water from the cooler periodically.

(C) Put the ice as single block.

(D) Crush the ice.

Ans. **[D]**

Sol. Surface area of Ice get increases by crushing and cooling due to ice occur due to convection process which is proportional to area.

22. The angle of a prism is 60°. When light is incident at an angle of 60°on the prism, the angle of emergence is 40°. The angle of incidence i for which the light ray will deviate the least is such that

(A) $i < 40^\circ$ (B) $40^\circ < i < 50^\circ$ (C) $50^\circ < i < 60^\circ$ (D) $i > 60^\circ$

Ans. **[B]**

23. A concave lens made of material of refractive index 1.6 is immersed in a medium of refractive index 2.0 The two surfaces of the concave lens have the same radius of curvature 0.2 m. The lens will behave as a

(A) divergent lens of focal length 0.4 m.

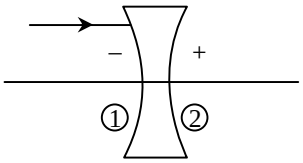
(B) divergent lens of focal length 0.5 m.

(C) convergent lens of focal length 0.4 m.

(D) convergent lens of focal length 0.5 m.

Ans. **[D]**

Sol.



$$\frac{1}{f} = \frac{n_1 - n_2}{n_1}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$R_1 = -0.2$; $R_2 = 0.2$

$n_2 = 1.6$; $n_1 = 2.0$

$$\frac{1}{f} = \left[\frac{1.6-2}{2}\right]\left[\frac{1}{-0.2} - \frac{1}{0.2}\right]$$

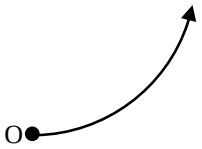
$$\Rightarrow \frac{(-0.4)}{2} \times \frac{2}{(-0.2)}$$

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

$f = 0.5$ metre

Converging lens as f is positive.

24. A charged particle initially at rest at O, when released follows a trajectory as shown. Such a trajectory is possible in the presence of



(A) electric field of constant magnitude and varying direction.

(B) magnetic field of constant magnitude and varying direction

(C) electric field of constant magnitude and constant direction.

(D) electric and magnetic fields of constant magnitudes and constant directions which are parallel to each other

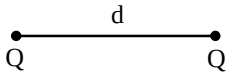
Ans. **[A]**

25. Two equal charges of magnitude Q each are placed at a distance d apart. Their electrostatic energy is E. A third charge – Q/2 is brought midway between these two charges. The electrostatic energy of the system is now

(A) – 2E (B) –E (C) 0 (D) E

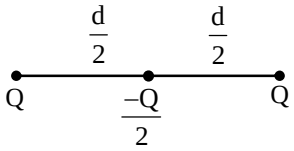
Ans. **[B]**

Sol.



Energy $E = \frac{kQ \times Q}{d} = \frac{kQ^2}{d}$ ….(1)

Third charge is put between them



Energy of system $= \frac{kQ \times Q}{d} + \frac{kQ}{\frac{d}{2}}\left(\frac{-Q}{2}\right) + \frac{kQ}{\frac{d}{2}}\left(\frac{-Q}{2}\right)$

$= \frac{kQ^2}{d} + \left(\frac{-kQ^2}{d}\right) + \left(\frac{-kQ^2}{d}\right)$

$= -\frac{kQ^2}{d}$

From (1)

Energy of system = – E

26. A bar magnet falls with its north pole pointing down through the axis of a copper ring. When viewed from above, the current in the ring will be

(A) clockwise while the magnet is above the plane of the ring, and counter clockwise while below the plane of the ring.

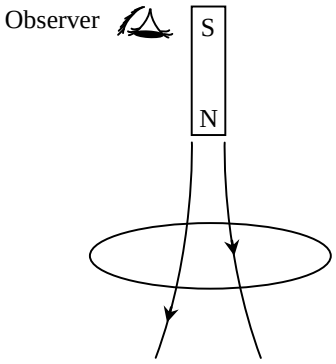
(B) counter clockwise throughout.

(C) counter clockwise while the magnet is above the plane of the ring, and clockwise while below the plane of the ring.

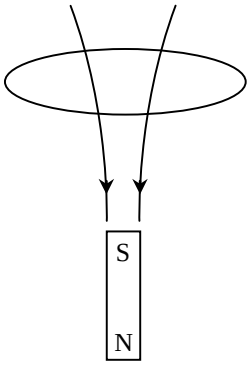
(D) clockwise throughout.

Ans. **[C]**

Sol.

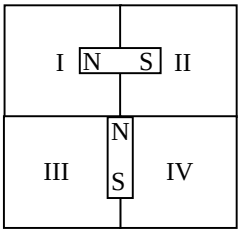


Magnet is approaching sing due to which downward flux through ring is increasing. According to lenz law induced current is anticlockwise or counter clockwise.



When magnet is below the plane of ring and moving away from ring flux in downward decreasing due to which induced current is clockwise.

27. Two identical bar magnets are held perpendicular to each other with a certain separation, as shown below. The area around the magnets is divided into four zones.



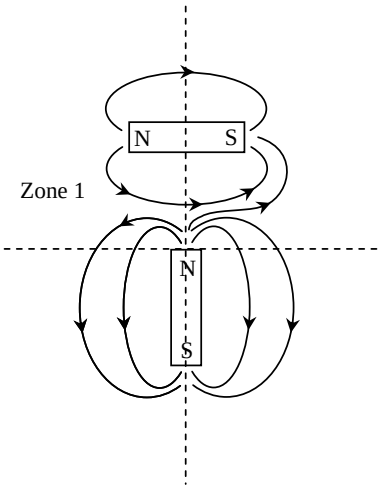
Given that there is a neutral point it is located in

(A) Zone I (B) Zone II

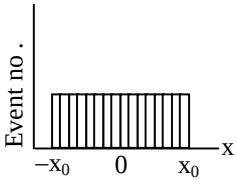
(C) Zone III (D) Zone IV

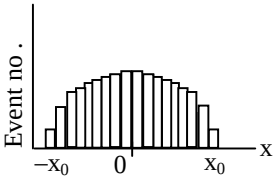
Ans. [A]

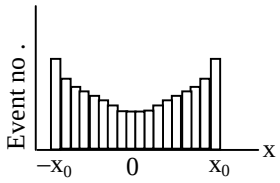
Sol. Magnetic filed lines are in opposite direction in zone 1 so Neutral point is located in zone 1.

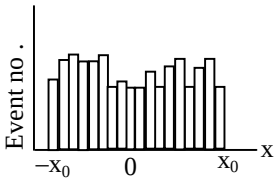


28. A large number of random snap shots using a camera are taken of a particle in simple harmonic motion between $x = -x_0$ and $x = +x_0$ with origin $x = 0$ as the mean position . A histogram of the total number of times the particle is recorded about a given position (Event no.) would most closely resemble

(A) 

(B) 

(C) 

(D) 

Ans. **[C]**

Sol. Speed of particle doing SHM decrease as it go away from mean position. Time during which particle remain in extreme position will be longer.

29. In 1911, the physical Ernest Rutherford discovered that atoms have a tiny , dense nucleus by shooting positively charged particles at a very thin gold foil. A key physical property which led Rutherford to use gold was that it was

(A) electrically conducting (B) highly malleable

(C) shiny (D) non-reactive

Ans. **[B]**

Sol. Very thin foil can be made only of highly malleable material.

30. Consider the following statements :

(I) All isotopes of an elements have the same number of neutrons.

(II) only one isotope of an element can be stable and non-radioactive .

(III) All elements have isotopes.

(IV) All isotopes of Carbon can form chemical compounds with Oxygen -16

The correct option regarding an isotope is

(A) (III) and (IV) only.

(B) (II), (III) and (IV) only.

(C) (I), (II) and (III) only

(D) (I) (III) and (IV) only

Ans. **[A]**

Sol. All elements have isotopes. All isotopes of carbon can form chemical compounds with oxygen-16.

31. The isoelectronic pairs is :

(A) CO, N_2 (B) O_2, NO (C) C_2, HF (D) F_2, HCl

Ans. **[A]**

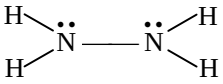
Sol. CO and N_2 are isoelectronic because both have 14 electrons.

32. The numbers of lone pair and bond pairs in hydrazine are, respectively :

(A) 2 and 4 (B) 2 and 6 (C) 2 and 5 (D) 1 and 5

Ans. **[C]**

Sol.



2 lone pair on nitrogen

4 N–H bond pair

1 N–N bond pair

33. The volume of oxygen at STP required to burn 2.4 g of carbon completely is :

(A) 1.12 L (B) 8.96 L (C) 2.24 L (D) 4.48 L

Ans. **[D]**

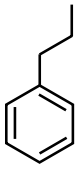
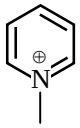
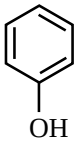
Sol. $C + O_2 \longrightarrow CO_2$

$\frac{2.4}{12}$ = 0.2 mole of carbon

$\therefore$ 0.2 mole of C need 0.2 mole of O_2

So vol. of 0.2 mole O_2 at STP = 0.2 × 22.4 = 4.48 L

34. The species that exhibits the highest R_f value in a thin layer chromatogram using a nonpolar solvent on a silica gel plate is :

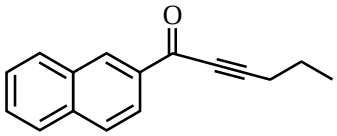
(A)  (B)  (C)  (D) 

Ans. **[A]**

Sol. The most often used stationary phase silica gel and alumina are polar material. Consequently the least polar compound will have the highest R_f value.

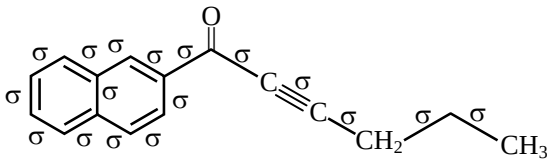
Option (A) is least polar among other options so It's R_f value will be maximum.

35. The number of C–C sigma bonds in the compound



(A) 16 (B) 17 (C) 18 (D) 11

Ans. **[B]**

Sol. 

17, C – C sigma bond present in this structure.

36. If the radius of the hydrogen atom is 53 pm, the radius of the He^+ ion is closest to :

(A) 108 pm (B) 81 pm (C) 27 pm (D) 13 pm

Ans. **[C]**

Sol. $r_{He^{\oplus}} = r_H \times \frac{n^2}{Z}$

$r_{He^+} = 53 \times \frac{1}{2} = 26.5\,\text{pm}$ It is closest to 27 pm.

37. The diamagnetic species is :

(A) NO (B) NO_2 (C) O_2 (D) CO_2

Ans. **[D]**

Sol. Species having unpaired electron are paramagnetic & without unpaired are diamagnetic

$:\dot{N} = O$ 1 unpaired electron O_2 2 unpaired $\bar{e}$ (MOT)

 = O 1 unpaired electron CO_2 no unpaired electron

38. The pH of 0.1 M aqueous solution of NaCl, CH_3COONa and NH_4Cl will follow the order :

(A) $NaCl < CH_3COONa < NH_4Cl$ (B) $NH_4Cl < NaCl < CH_3COONa$

(C) $NH_4Cl < CH_3COONa < NaCl$ (D) $NaCl < NH_4Cl < CH_3COONa$

Ans. **[B]**

Sol. Order of pH

less than 7	pH = 7	more than 7
NH_4Cl <	NaCl <	CH_3COONa
Salt of strong acid + weak base	Salt of strong acid + strong base	Salt of strong base + weak acid

39. At room temperature, the average speed of Helium is higher than that of Oxygen by a factor of :

(A) $2\sqrt{2}$ (B) $6/\sqrt{2}$ (C) 8 (D) 6

Ans. **[A]**

Sol. Average speed $(r_{avg}) = \sqrt{\frac{8RT}{\pi M}}$

$$\frac{r_{He}}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{He}}}$$

$$\frac{r_{He}}{r_{O_2}} = \sqrt{\frac{32}{4}} = 2\sqrt{2}$$

$$r_{He} = r_{O_2} 2\sqrt{2}$$

40. Ammonia is **NOT** produced in the reaction of :

(A) NH_4Cl with KOH (B) AlN with water

(C) NH_4Cl with $NaNO_2$ (D) NH_4Cl with $Ca(OH)_2$

Ans. **[C]**

Sol.
$NH_4Cl + KOH \longrightarrow KCl + NH_3 + H_2O$
$AlN + 3H - OH \longrightarrow NH_3 + Al(OH)_3$
$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2NH_3 + H_2O$] Acid base reaction
$NH_4Cl + NaNO_2 \longrightarrow NaCl + NH_4NO_2$] Double decomposition reaction

41. The number of isomers which are ethers and having the molecular formula $C_4H_{10}O$, is :

(A) 2 (B) 3 (C) 4 (D) 5

Ans. **[B]**

Sol. $C_4H_{10}O$

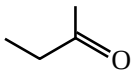
3 Ether isomers

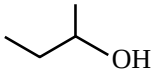
$CH_3 - CH_2 - CH_2 - O - CH_3$

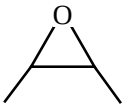
$CH_3 - CH(CH_3) - O - CH_3$

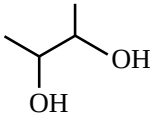
$CH_3 - CH_2 - O - CH_2 - CH_3$

42. The major product of the reaction of 2-butene with alkaline $KMnO_4$ solution is :

(A) 

(B) 

(C) 

(D) 

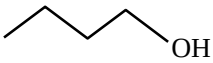
Ans. **[D]**

Sol. $CH_3 - CH = CH - CH_3$

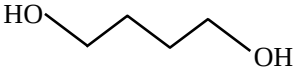
↓ Alkaline $KMnO_4$ (Baeyer's reagent)
Syn Addition

$CH_3 - CH(OH) - CH(OH) - CH_3$ Syndiol

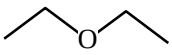
43. Among the compounds I-IV, the compound having the lowest boiling point is :



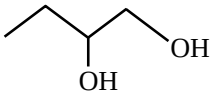
(I)



(II)



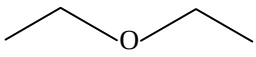
(III)



(IV)

(A) I (B) II (C) III (D) IV

Ans. **[C]**

Sol. Alcohol forms hydrogen bonding so their boiling point is higher. Ether can not form H bond so its boiling point is lowest ∴  Have lowest boiling point.

44. Of the following reactions

(i) $A \rightleftharpoons B$, $\Delta G° = 250 \text{ kJ mol}^{-1}$

(ii) $D \rightleftharpoons E$, $\Delta G° = -100 \text{ kJ mol}^{-1}$

(iii) $F \rightleftharpoons G$, $\Delta G° = -150 \text{ kJ mol}^{-1}$

(iv) $M \rightleftharpoons N$, $\Delta G° = 150 \text{ kJ mol}^{-1}$

the reaction with the largest equilibrium constant is

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

Ans. **[C]**

Sol. $\Delta G° = -2.303\, RT \log_{10} K$

$$\log K = -\frac{\Delta G°}{2.303\, RT}$$

So lower value of $\Delta G°$ higher will be log K

$F \rightleftharpoons G$, $\Delta G° = -150 \text{ kJ mol}^{-1}$ (lowest)

45. The first ionization enthalpies for three elements are 1314, 1680 and 2080 kJ mol^{-1}, respectively. The correct sequence of the element is :

(A) O, F and Ne (B) F, O and Ne

(C) Ne, F and O (D) F, Ne and O

Ans. **[A]**

Sol. First ionisation enthalpies for three elements are 1314, 1680, 2080. These are in increasing order so elements should be O, F, Ne

46. Individuals of one kind occupying a particular geographic area at a given time are called

(A) community (B) population

(C) species (D) biome

Ans. **[B]**

Sol. Population is a group of individual belonging to same sps. (one kind) occupying a particular geographic area in a given time.

47. What fraction of the assimilated energy is used in respiration by the herbivores?

(A) ~10 percent (B) ~60 percent

(C) ~30 percent (D) ~80 percent

Ans. **[C]**

48. Athletes are often trained at high altitude because

(A) training at high altitude increases muscle mass

(B) training at high altitude increases the number of red blood cells

(C) there is less chance of an injury at high altitude

(D) athletes sweat less at high altitude

Ans. **[B]**

Sol. At high altitude less dense [O_2 deficient] air is present. So RBCs count is increased.

49. In human brain, two cerebral hemispheres are connected by a bundle of fibers which is known as

(A) Medulla oblongata (B) cerebrum (C) cerebellum (D) corpus callosum

Ans. **[D]**

Sol. Corpus callosum is nervous band attaches both cerebral hemispheres of mammals.

50. Which one of the following hormones is produced by the pancreas?

(A) Prolactin (B) Glucagon

(C) Leutinizing hormone (D) Epinephrine

Ans. **[B]**

Sol. Glucagon is secreted from alpha cell of pancrease

51. The stalk of a plant leaf is derived from which one of the following types of plant tissue?

(A) Sclerenchyma (B) Parenchyma (C) Chlorenchyma (D) Collenchyma

Ans. **[D]**

Sol. The stalk of plant leaf (petiole) is reinforced by collenchyma.

52. Which of the following muscle types **CANNOT** be used voluntarily?

(A) Both striated and smooth (B) Both cardiac and striated

(C) Both smooth and cardiac (D) Cardiac, striated and smooth

Ans. **[C]**

Sol. Both smooth muscle (unstriated muscle) and cardiac muscle are functionally involuntary.

53. The pulmonary artery carries

(A) deoxygenated blood to the lungs (B) oxygenated blood to the brain

(C) oxygenated blood to the lungs (D) deoxygenated blood to the kidney

Ans. **[A]**

Sol. Pulmonary artery arises from left ventricle & carry deoxygenated blood to the lungs.

54. Both gout and kidney stone formation is caused by

(A) calcium oxalate (B) uric acid (C) creatinine (D) potassium chloride

Ans. **[B]**

Sol. $\Rightarrow$ Gout is caused by deposition of uric acid in joints

$\Rightarrow$ Composition of kidney stone $\rightarrow$ Calcium oxalate, Calcium phosphate, uric acid, Xanthine & Indigo calculi.

55. The auditory nerve gets its input from which of the following?

(A) The sense cells of the cochlea (B) Vibration of the last ossicle

(C) Eustachian tube (D) Vibration of the tympanic membrane

Ans. **[A]**

Sol. Auditory cranial nerve has two branches

(i) Vestibular nerve : for equilibrium.

(ii) Cochlear nerve : for hearing.

56. Which of the following *organelles* contain circular DNA?

(A) Peroxisomes and Mitochondria (B) Mitochondria and Golgi complex

(C) Chloroplasts and Lysosomes (D) Mitochondria and Chloroplast

Ans. **[D]**

Sol. Mitochondria and chloroplast have endo-symbiotic origin (prokaryotic type). So, have ds circular DNA as that of prokaryotes

57. A reflex action does **NOT** involve

(A) neurons (B) brain (C) spinal cord (D) muscle fiber

Ans. **[B]**

Sol. A reflex action does not involve brain

Note : Only cranial reflex completed by medulla oblongata (which is a small part of brain)

58. Which one of the following options is true in photosynthesis?

(A) CO_2 is oxidized and H_2O is reduced (B) H_2O is oxidized and CO_2 is reduced

(C) Both CO_2 and H_2O are reduced (D) Both CO_2 and H_2O are oxidized

Ans. **[B]**

Sol. In photosynthesis

Light Reaction $\rightarrow$ Photolysis of water (H_2O is oxidised)

Dark Reaction $\rightarrow$ CO_2 is reduced for sugar formation

59. Human mature red blood cells (RBCs) do **NOT** contain

(A) Iron (B) Cytoplasm (C) Mitochondria (D) Haemoglobin

Ans. **[C]**

Sol. Mature R.B.Cs. lacks : (1) Nucleus
(2) Mitochondria
(3) Endoplasmic Recticutum

60. A person was saved from poisonous snake bite by antivenom injection. Which of the following immunity explains this form of protection?

(A) Naturally acquired active immunity (B) Artificially acquired active immunity

(C) Naturally acquired passive immunity (D) Artificially acquired passive immunity

Ans. **[D]**

Sol. Antivenom injection have performed antibodies against snake poison.
So, using antivenom injection is develops artificial aquired passive immunity.

Part – II
Two - Mark Questions

MATHEMATICS

61. 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. $a + b + c = 0$

$q = a^2 + b^2 + c^2$; $r = a^4 + b^4 + c^4$

$q^2 - 2r = (a^2 + b^2 + c^2)^2 - 2(a^4 + b^4 + c^4)$

$= 2a^2b^2 + 2b^2c^2 + 2a^2c^2 - a^4 - b^4 - c^4$

$= 2a^2c^2 + 2b^2c^2 - (a^2 - b^2)^2 - c^4$

$= 2c^2(a^2 + b^2) - c^2(a - b)^2 - c^4$

$= c^2[2a^2 + 2b^2 - (a - b)^2 - c^2]$

$= c^2[2ab + a^2 + b^2 - c^2]$

$= c^2[(a + b)^2 - c^2]$

$= 0$

62. The value of

$$\sum_{n=0}^{1947} \frac{1}{2^n + \sqrt{2^{1947}}}$$

is equal to

(A) $\frac{487}{\sqrt{2^{1945}}}$ (B) $\frac{1946}{\sqrt{2^{1947}}}$ (C) $\frac{1947}{\sqrt{2^{1947}}}$ (D) $\frac{1948}{\sqrt{2^{1947}}}$

Ans. **[A]**

Sol. $\sum_{n=0}^{1947} \frac{1}{2^n + \sqrt{2^{1947}}}$ Total terms = 1948

$T_1 = \frac{1}{1 + \sqrt{2^{1947}}}$

$T_{1948} = \frac{1}{2^{1947} + \sqrt{2^{1947}}}$

$T_1 + T_{1948} = \frac{1}{\sqrt{2^{1947}}}$

Similarly, $T_2 + T_{1947} = \frac{1}{\sqrt{2^{1947}}} = T_3 + T_{1946}$ = and so on……

Total $\frac{1948}{2}$ = 974 pairs

$\therefore$ Sum = $\frac{974}{\sqrt{2^{1947}}} = \frac{974}{\sqrt{4 \times 2^{1945}}} = \frac{487}{\sqrt{2^{1945}}}$

63. The number of integers *a* in the interval [1, 2014] for which the system of equations

$$x + y = a, \ \frac{x^2}{x-1} + \frac{y^2}{y-1} = 4$$

has finitely many solutions is-

(A) 0 (B) 1007 (C) 2013 (D) 2014

Ans. **[C]**

Sol. $x + y = a; \ \frac{x^2}{x-1} + \frac{y^2}{y-1} = 4$

$a \in [1, 2014]$

$$x + 1 + \frac{1}{x-1} + y + 1 + \frac{1}{y-1} = 4$$

$$(x-1)+\frac{1}{(x-1)}+(y-1)+\frac{1}{(y-1)}=0$$

$$(a-2)+\frac{1}{(x-1)}+\frac{1}{(y-1)}=0$$

$$(a-2)+\frac{(a-2)}{(x-1)(y-1)}=0$$

$$(a-2)\left[1+\frac{1}{xy+1-a}\right]=0$$

$a \neq 2$ [for a = 2 infinitely many solutions]

$xy + 1 - a + 1 = 0$

$x(a - x) - a + 2 = 0$

$\Rightarrow \quad x^2 + ax - (2 - a) = 0$

$D = a^2 + 4(2 - a) = a^2 - 4a + 8$

always +ve

there two real solutions.

$a \neq 2$ and $a \in [1, 2014]$

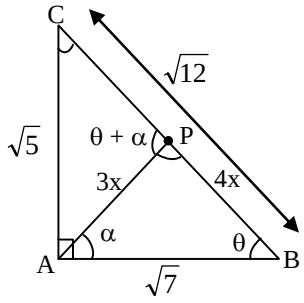
Total 2014 – 1 = 2013 values

64. In a triangle ABC with $\angle A = 90^\circ$, P is a point on BC such that PA : PB = 3 : 4. If AB = $\sqrt{7}$ and AC = $\sqrt{5}$ then BP : PC is-

(A) 2 : 1 (B) 4 : 3 (C) 4 : 5 (D) 8 : 7

Ans. **[A]**

Sol.



$\tan\theta = \frac{\sqrt{5}}{\sqrt{7}}$; $\sin\theta = \frac{\sqrt{5}}{\sqrt{12}}$; $\cos\theta = \frac{\sqrt{7}}{\sqrt{12}}$

In ΔAPB using sine rule

$$\frac{3x}{\sin\theta} = \frac{4x}{\sin\alpha} = \frac{\sqrt{7}}{\sin(180^\circ-(\theta+\alpha))}$$

$$\sin\alpha = \frac{4}{3}\sin\theta = \frac{4}{3}\times\frac{\sqrt{5}}{\sqrt{12}} = \frac{2\sqrt{5}}{3\sqrt{3}} = \frac{\sqrt{20}}{\sqrt{27}}$$

$$\Rightarrow \cos\alpha = \frac{\sqrt{7}}{\sqrt{27}}$$

$$\& \quad 3x\sin(\theta+\alpha) = \sqrt{7}\sin\theta$$

$$\Rightarrow 3x(\cos\alpha + \cot\theta\sin\alpha) = \sqrt{7}$$

$$\Rightarrow 3x\left(\frac{\sqrt{7}}{\sqrt{27}} + \frac{\sqrt{7}}{\sqrt{5}}\frac{\sqrt{20}}{\sqrt{27}}\right) = \sqrt{7}$$

$$\Rightarrow 3x\times\frac{1}{\sqrt{3}} = 1$$

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

$$\therefore \frac{BP}{PC} = \frac{4x}{\sqrt{12}-4x} = \frac{1}{\frac{2\sqrt{3}}{4/\sqrt{3}}-1} = \frac{4}{6-4} = \frac{2}{1}$$

65. The number of all 3-digit numbers abc (in base 10) for which

$(a \times b \times c) + (a \times b) + (b \times c) + (c \times a) + a + b + c = 29$ is

(A) 6 (B) 10 (C) 14 (D) 18

Ans. **[C]**

Sol. $abc + ab + bc + ca + a + b + c = 29$

$\Rightarrow abc + ab + bc + ca + a + b + c + 1 = 30$

$\Rightarrow (a+1)(b+1)(c+1) = 30$

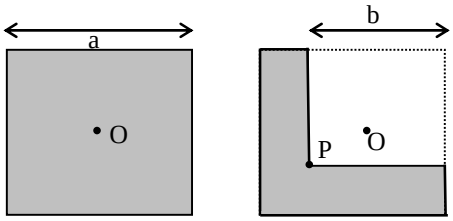
Product can be $2 \times 3 \times 5$ $\Rightarrow$ digits are 1, 2, 4 so possible number = 3! = 6

Product can be $1 \times 5 \times 6$ $\Rightarrow$ digits are 0, 4, 5 so possible number = $2 \times 2!$ = 4

Product can be $1 \times 3 \times 10$ $\Rightarrow$ digits are 0, 2, 9 so possible number = $2 \times 2!$ = 4

Total numbers = 14

66. A uniform square wooden sheet of side a has its center of mass located at point O as shown in the figure on the left. A square portion of side b of this sheet is cut out to produce as L-shaped sheet as shown in the figure on the right.



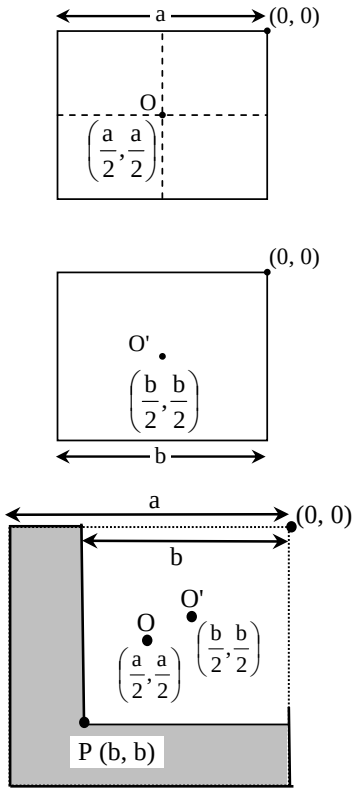
The centre of mass of the L-shaped sheet lies at the point P (in the diagram) when

(A) a/b = $(\sqrt{5}-1)/2$ (B) a/b = $(\sqrt{5}+1)/2$

(C) a/b = $(\sqrt{3}-1)/2$ (D) a/b = $(\sqrt{3}+1)/2$

Ans. **[B]**

Sol.



$$X_{cm} = \frac{m_1x_1 - m_2x_2}{m_1 - m_2}$$

m_1 is the mass of square wooden sheet of side a & m_2 is the mass of removed square portion of side b.

x-coordinate of C.O.M. of remaining L-shaped sheet. λ is areal mass density $\Rightarrow m_1 = \lambda a^2$, $m_2 = \lambda b^2$

$$X_{cm} = \frac{\lambda(a^2)\left(\frac{a}{2}\right) - \lambda(b^2)\left(\frac{b}{2}\right)}{\lambda a^2 - \lambda b^2}$$

$$X_{cm} = \frac{1}{2}\left(\frac{a^3 - b^3}{a^2 - b^2}\right)$$

similarly $Y_{cm} = \frac{1}{2}\left[\frac{a^3 - b^3}{a^2 - b^2}\right]$

centre of mass lies on point P (b, b)

$\Rightarrow X_{cm} = b$ & $Y_{cm} = b$

$$\frac{1}{2}\left[\frac{a^2 + b^2 + ab}{a + b}\right] = b$$

$a^2 + b^2 + ab = 2ab + 2b^2$

$a^2 = ab + b^2$

$$\left(\frac{a}{b}\right)^2 = \left(\frac{a}{b}\right) + 1$$

Let $x = \frac{a}{b}$

$x^2 - x - 1 = 0$

$$x = \frac{1 \pm \sqrt{1+4}}{2}$$

$$x = \frac{\sqrt{5}+1}{2}$$

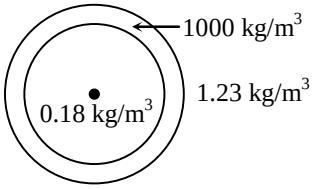
$$\frac{a}{b} = \frac{\sqrt{5}+1}{2}$$

67. A machine is blowing spherical soap bubbles of different radii filled with helium gas. It is found that if the bubbles have a radius smaller than 1 cm, then they sink to the floor in still air. Larger bubbles float in the air . Assume that the thickness of the soap film in all bubbles is uniform and equal. Assume that the density of soap solution is same as that of water (= 1000 kg m^{-3}) The density of helium inside the bubbles and air are 0.18 kg m^{-3} and 1.23 kg m^{-3}, respectively. Then the thickness of the soap film of the bubbles is (note 1 μm = 10^{-6} m)

(A) 0.50 μm (B) 1.50 μm (C) 7.00 μm (D) 3.50 μm

Ans. **[D]**

Sol.



Let X is thickness of soap film for equilibrium.

Gravity force = buoyancy force

$$\frac{4}{3}\pi(10^{-2})^3 \times 0.18 + 4\pi(10^{-2})^2 (x)(1000) = \frac{4}{3}\pi(10^{-2})^3 (1.23)$$

$$\Rightarrow \quad 4\pi(10^{-2})(x)(1000) = \frac{4}{3}\pi(10^{-6})(1.08)$$

$(10^5)\, x = 0.36$

$x = 0.36 \times 10^{-5}$

$x = 3.6 \times 10^{-6}$ m

68. An aluminum piece of mass 50 g initially at 300 °C is dipped quickly and taken out of 1 kg of water , initially at 30° C. if the temperature of the aluminum piece immediately after being taken out of the water is found to be 160°C, what is the temperature of the water then ? (specific heat capacities of aluminum and water are 900 $Jkg^{-1}\,K^{-1}$ and 4200 Jkg^{-1}, respectively.)

(A) 165°C (B) 45°C (C) 31.5°C (D) 28.5°C

Ans. **[C]**

Sol. Calorimetry principle

Heat lost = Heat gain

Heat loss by aluminum = Heat gain by water

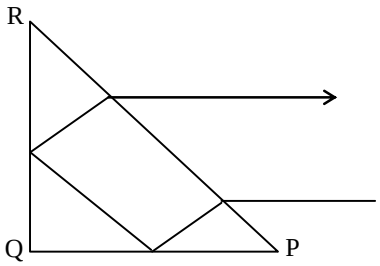
$50 \times 10^{-3} \times 900 \times (300 - 160) = 1 \times 4200 \times (T - 30)$

$6300 = 4200\,(T - 30)$

$1.5 = T - 30$

$T = 31.5^{\circ}C$

69. A ray of light incident parallel to the base PQ of an isosceles right-angled triangular prism PQR suffers two successive total internal reflections at the face PQ and QR before emerging reversed in direction as shown.

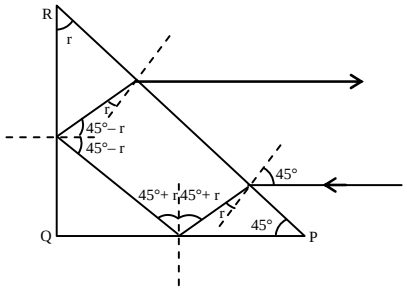


If the refractive index of the material of the prism is μ, then

(A) $\mu > \sqrt{5}$ (B) $\sqrt{3} < \mu < \sqrt{5}$ (C) $\sqrt{2} < \mu < \sqrt{3}$ (D) $\mu < \sqrt{2}$

Ans. **[A]**

Sol.



$45 + r > \theta_c$ ……. (1)

$45 - r > \theta_c$ ……. (2)

$90^o > 2\theta_c$

$45^o > \theta_c$ ……. (3)

$\sin 45^o > \sin \theta_c$

$$\frac{1}{\sqrt{2}} > \frac{1}{\mu}$$

$$\boxed{\mu > \sqrt{2}}$$

taking equation 2 only

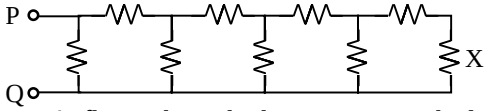
$45 - \theta_c > r$, $\sin(45 - \theta_c) > \sin r$

$$\frac{1}{\sqrt{2}} \cos\theta_c - \frac{1}{\sqrt{2}} \sin\theta_c > \frac{\sin 45}{\mu}$$

$$\frac{\sqrt{u^2 - 1}}{\mu} - \frac{1}{\mu} > \frac{1}{\mu}, \quad \sqrt{\mu^2 - 1} > 2, \quad \boxed{\mu > \sqrt{5}}$$

$\therefore$ Ans. is $\mu > \sqrt{5}$ as this is common solution

70. Consider the circuit shown below where all resistors are of 1kΩ.

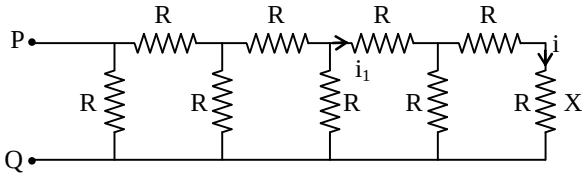


If a current of magnitude 1 mA flows through the resistor marked X, what is the potential difference measured between points P and Q?

(A) 21 V (B) 68 V (C) 55 V (D) 34 V

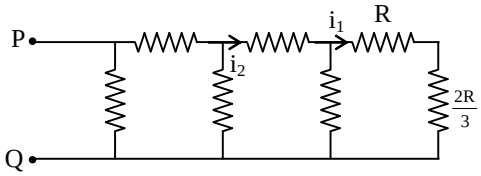
Ans. **[D]**

Sol. $R = 1k\Omega, \quad i = 1mA = 1 \times 10^{-3}$ A



$$i = \frac{i_1 \times R}{3R} = \frac{i_1}{3}$$

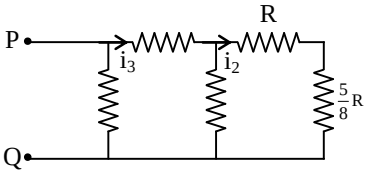
$\therefore \quad i_1 = 3i$



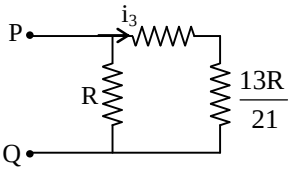
$$i_1 = i_2 \times \frac{3}{8}$$

$$i_2 = \frac{8}{3} i_1$$

$$\Rightarrow \quad \frac{8}{3} \times 3i = 8i$$



$$i_2 = i_3 \times \frac{8}{21}$$



$$i_3 = \frac{21}{8} i_2 = \frac{21}{8} \times 8i = 21i$$

$$V_p - V_Q = i_3 \times \left[R + \frac{13R}{21} \right]$$

$$\Rightarrow \quad 21i \times \frac{34\,R}{21}$$

$$\Rightarrow \quad 34\ iR$$

$$\Rightarrow \quad 34 \times 1 \times 10^{-3} \times 1 \times 10^{3} = 34 \text{ volt}$$

71. 10 moles of a mixture of hydrogen and oxygen gases at a pressure of 1 atm at a constant volume and temperature, react to form 3.6 g of liquid water. The pressure of the resulting mixture will be closest to :

(A) 1.07 atm (B) 0.97 atm (C) 1.02 atm (D) 0.92 atm

Ans. **[B]**

Sol.

	$2H_2$	+	O_2	$\longrightarrow$	$2H_2O$
Initially	x mol		$(10 - x)$ mol		0
After reaction	x–a		$\left(10 - x - \frac{a}{2}\right)$		a

As per problem ;

$a = \frac{3.6}{18} = 0.2$

$\therefore$ Resulting mole of gases in the mixture = $x - 0.2 + 10 - x - \frac{0.2}{2} = 10 - 0.3 = 9.7$

$\therefore$ from relation

$\frac{P_1}{n_1} = \frac{P_2}{n_2}$

$\frac{1}{10} = \frac{P_2}{9.7}$

$P_2 = 0.97$ atm.

72. The ammonia evolved from 2 g of a compound in Kjeldahl's estimation of nitrogen neutralizes 10 mL of 2 M H_2SO_4 solution. The weight percentage of nitrogen in the compound is :

(A) 28 (B) 14 (C) 56 (D) 7

Ans. **[A]**

Sol. $W_{NH_3} = \frac{17 \times 4 \times 10}{1000}$ g

and $W_N = \frac{14}{17} \times \frac{17 \times 4 \times 10}{1000}$ g = 0.56 g

& % N = $\frac{0.56}{2} \times 100 = 28\%$

$2\,NH_3 + H_2SO_4 \longrightarrow (NH_4)_2\,SO_4$

Eq. of H_2SO_4 = Eq. of NH_3

Eq. of $NH_3 = 10 \times 2 \times 2 \times 10^{-3}$

= No. of mole of ammonia ($n_{factor} = 1$)

73. Complete reaction of 2.0 g of calcium (at wt. = 40) with excess HCl produces 1.125 L of H_2 gas. Complete reaction of the same quantity of another metal ''M'' with excess HCl produces 1.85 L of H_2 gas under identical conditions. The equivalent weight of ''M'' is closest to :

(A) 23 (B) 9 (C) 7 (D) 12

Ans. **[D]**

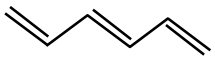
Sol. $\frac{(eq)_{Ca}}{(eq)_{M}} = \frac{(eq)_{H_2,released}}{(eq)_{H_2,released}}$

$$\frac{\left(\frac{2}{20}\right)}{\left(\frac{2}{x}\right)} = \frac{\frac{1.125}{(eq.vol.)_{H_2}}}{\frac{1.85}{(eq.vol.)_{H_2}}} \quad \{\because \text{ eq wt of } M = x\}$$

$$\therefore \quad \frac{x}{20} = \frac{1.125}{1.85}$$

$$x = \frac{1.125}{1.85} \times 20 \approx 12$$

74. A compound X formed after heating coke with lime reacts with water to give Y which on passing over red-hot iron at 873 K produces Z. The compound Z is :

(A)  (B)  (C)  (D) 

Ans. **[A]**

Sol. $CaO + C \xrightarrow{\Delta} CaC_2$
(Calcium carbide)

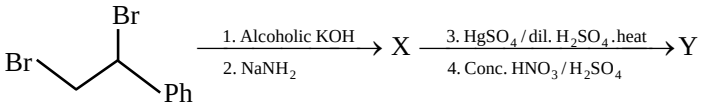
$\downarrow$ H_2O, Hydrolysis

$Ca(OH)_2 + CH \equiv CH$
(Acetylene)

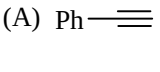
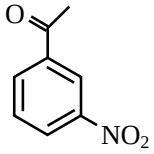
$\downarrow$ Red hot iron (Trimerisation)

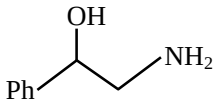
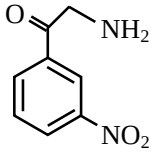
Benzene

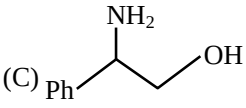
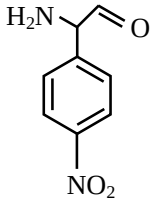
75. In the following reaction sequence

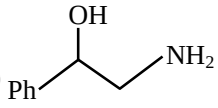
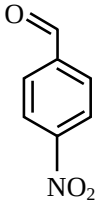


X and Y are, respectively

(A)  and 

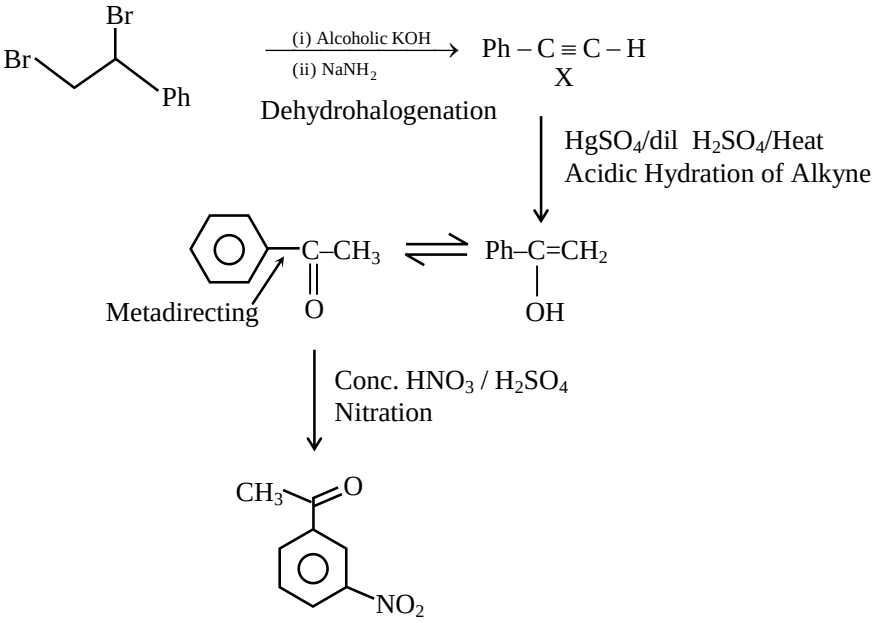
(B)  and 

(C)  and 

(D)  and 

Ans. **[A]**

Sol.



76. In which of the following cellular compartment(s) do respiratory reactions occur?

(A) Cytoplasm and endoplasmic reticulum (B) Mitochondria and Golgi complex

(C) Mitochondria and cytoplasm (D) Mitochondria only

Ans. **[C]**

Sol. Respiratory Reactions

Glycolysis → Cytoplasm

Kreb cycle and ETS → Mitochondria

77. A woman heterozygous for color blindness marries a color blind man. What would be the ratios of carrier daughters, color blind daughters, normal sons and color blind sons in the F1 generation?

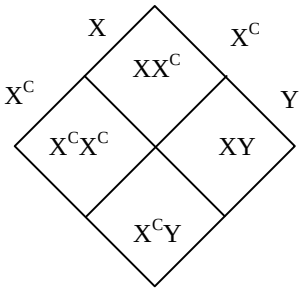
(A) 1:2:2:1 (B) 2:1:1:2 (C) 1:1:1:1 (D) 1:1:2:2

Ans. **[C]**

Sol. Color blindness is X-linked recessive disorder

XX^C X X^CY

Heterozygous women Color blind man



Ratio :

	Genotype	**F_1 ratio**
Carrier daughter	XX^C	1
Color blind daughter	X^CX^C	1
Normal son	XY	1
Color blind son	X^CY	1

78. Two semi-permeable bags containing 2% sucrose are placed in two beakers, 'P' containing water and 'Q' containing 10% sucrose. Which one of the following outcomes is true?

(A) Bag in 'P' becomes flaccid due to exosmosis

(B)Bag in 'P' becomes turgid due to endosmosis

(C) Bag in 'Q' becomes turgid due to endosmosis

(D) Concentration of sucrose remains unchanged in both

Ans. **[B]**

79. Children suffering from phenylketonuria are given food low in phenylalanine and supplemented with tyrosine. This is because they

(A) are unable to utilize phenylalanine

(B) do not require phenylalanine

(C) have increased tyrosine anabolism

(D) have increased tyrosine catabolism

Ans. **[A]**

Sol. Phenyl Ketonuria is an autosomal recessive disorder with mutation in gene for enzyme phenyl alanine hydroxylase (PAH), rendering it non functional

$$\text{Phenyl alanine} \xrightarrow[X]{\text{PAH}} \text{Tyrosine}$$

→ Such person cannot metabolise the above reaction leading to accumulation of Phenyl alanine. So, are given food low in (Phe) and supplemented with (tyr).

80. Two bottles were half filled with water from Ganga ('P') and Kaveri ('Q') and kept under identical airtight conditions for 5 days. The oxygen was determined to be 2% in bottle ('P') and 10% in bottle ('Q'). What could be the cause of this difference?

(A) Ganga is more polluted than Kaveri (B) Both the rivers are equally polluted

(C) Kaveri is more polluted than Ganga (D) Kaveri has more minerals than Ganga

Ans. **[A]**

Sol. Ganga is more polluted than Kaveri

→ lower DO [Dissolved Oxygen] indicates polluted water

DO
- 2% → Ganga water (P)
- 10% → Kaveri water (Q)