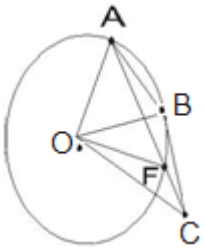
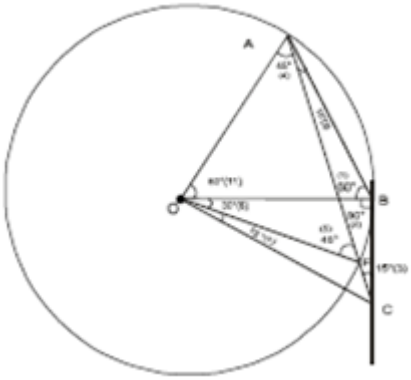
1. On the circle with centre O, points A, B are such that OA = AB. A point C is located on the tangent at B to the circle such that A and C are on the opposite sides of the line OB and AB = BC. The line segment AC intersects the circle again at F. Then the ratio ∠BOF: ∠BOC is equal to:



- **A.** 1:2
- **B.** 2:3
- **C.** 3:4
- **D.** 4:5

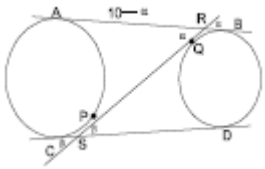


1. Δ AOB is equilateral (∠ AOB = ∠OAB = ∠OBA = 60°)
2. Δ OBC is right angled isosceles (∠OBC = 90°)
3. Δ ABC is isosceles (∠BAC = ∠BCA = 15°)
4. ∠ OAC = 60° - ∠CAB = 45°
5. Δ AOF is right angled isosceles (∠ AOF = 90°,∠ OFA = 45°)
6. ∠ BOF = 90° - ∠ AOB = 30°
7. Δ OBC is right angled isosceles (∠BOC = 45°)

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

2. 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 at R and CD at S. If AB = 10, then RS is

- **A.** 8
- **B.** 9
- **C.** 10
- **D.** 11



Let RB be α and PS be β

$\therefore$ RP = RA = 10- α $\Rightarrow$ RS = 10 - α + β ..... (1)

Also SQ = SD = 10 - β $\Rightarrow$ *RS* = 10 - β + α .....(2)

(1) and (2) $\Rightarrow$ α = β , Hence RS = 10

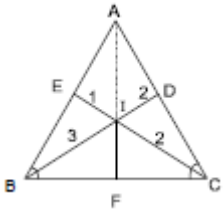
3. The angle bisectors BD and CE of a triangle ABC are divided by the incentre I in the ratio of 3 : 2 and 2 :1 respectively. Then the ratio in which I divide the angle bisector through A is.

A. 3:1

B. 11:4

C. 6:5

D. 7:4



$\therefore \frac{AI}{IF} = \frac{b+c}{a} \quad .....(1)$

$\because \frac{BI}{ID} = \frac{a+c}{b} = \frac{3}{2} \quad (2)$

$\because \frac{CI}{IE} = \frac{a+b}{c} = \frac{2}{1}$

$\Rightarrow a + b = 2c \quad (3)$

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

$\Rightarrow 2a + a + b = 3b \quad using(3)$

$\Rightarrow 3a = 2b$

$\Rightarrow b = \frac{3}{2}a \quad ....(4)$

Now~again~(3)$\Rightarrow 2c = a + b$

$2c = a + \frac{3}{2}a$

$\Rightarrow c = \frac{5}{4}a$

Hence $\frac{AI}{IF} = \frac{b+c}{a} = \frac{\frac{3}{2}a + \frac{5}{4}a}{a} = \frac{11}{4}$

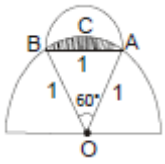
4. A semi-circle of diameter 1 unit sits at the top of a semi-circle of diameter 2 units. The shaded region inside the smaller semi-circle but outside the larger semi-circle is called a lune. The area of the lune is.

A. $\frac{\pi}{6}-\frac{\sqrt{3}}{4}$

B. $\frac{\sqrt{3}}{4}-\frac{\pi}{24}$

C. $\frac{\sqrt{3}}{4}-\frac{\pi}{12}$

D. $\frac{\sqrt{3}}{4}-\frac{\pi}{8}$



area of sector OACB = $\frac{r^2}{2}\theta=\frac{1}{2}.\frac{\pi}{3}=\frac{\pi}{6}$

area of shaded region = $\frac{\pi}{6}$- area of ΔOAB

$\frac{\pi}{6}-\frac{\sqrt{3}}{4}$

Hence area of line = Area of semi-circle - area of shaded region

$\frac{1}{2}\pi\left(\frac{1}{2}\right)^2-\left(\frac{\pi}{6}-\frac{\sqrt{3}}{4}\right)$

$=\frac{\sqrt{3}}{4}+\frac{\pi}{8}-\frac{\pi}{6}$

$=\frac{\sqrt{3}}{4}-\frac{\pi}{24}$

5. In a quadrilateral ABCD, which is not a trapezium, it is known that $\angle DAB = \angle ABC = 60^0$. Moreover, $\angle CAB = \angle CBD$. Then,

- **A.** AB = BC + CD
- **B.** AB = AD + CD
- **C.** AB = BC +AD
- **D.** AB = AC + AD

AB = AC + AD

6. Let $p(x) = x^2 - 5x + a$ and $q(x) = x^2 - 3x + b$, where a and b are positive integers. Suppose hof(p(x),q(x)) = x – 1 and k(x) = 1cm (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

$\therefore HCF = x - 1$

$\Rightarrow p(x) = x^2 - 5x + a$

$= x^2 - 5x + 4$

$= (x - 1)(x - 4)$ ..... (1)

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

$= (x - 1)(x - 2)$ .....(2)

$\Rightarrow k(x) = (x - 1)(x - 2)(x - 4)$

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

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

Hence sum of roots = 7

7. 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

$x \to ab$ or $x = 10a + b$

$y \to ba$ or $y = 10b + a$

Now $x^2 - y^2 = (10a + b)^2 - (10b + a)^2$

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

$= 3^2 \times 11(a + b)(a - b)$ ------ (1)

According of Q

$(a + b)(a - b) = 11 and a - b = 1$

$\Rightarrow a + b = 11 and a - b = 1$

$\Rightarrow a = 6, b = 5$

Hence

$x = 65$

$y = 56$

and $m = 33$

$\Rightarrow x + y + m = 154$

8. 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.** -2
- **D.** -4

$\frac{1^3+2^3....+(2n)^3}{1^2+2^2+...n^2} = \left(\frac{2n(2n+1)^2}{2}\right)^2 \frac{6}{n(n+1)(2n+1)}$

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

$= \frac{12n^2+6n}{n+1} = \frac{12(n^2+1)+6(n+1)+6}{n+1}$

$= 12n - 6 + \frac{6}{n+1}$

If the given terms are an integers, then $\frac{6}{n+1}$ must be an integer

$\Rightarrow n = 1, 2, 5$

$Sum = 8$

9. Let R be the set of all real numbers and let f be a function R to R such that that $f(x)+\left(x+\frac{1}{2}\right)f(1-x)=1$ for all x ϵ R.Then 2f(0)+3f(1)is equal to

- **A.** 2
- **B.** 0
- **C.** -2
- **D.** -4

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

But $x=0$

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

$\Rightarrow 2f(0)+f(1)=2$ ..... (2)

Put $x=1$ in (1)

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

$\Rightarrow 2f(1)+3f(0)=2$ ..... (3)

Solving (2) & (3) we have

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

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

10. 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

r be a root $\Rightarrow r^2$ + 2r + 6 = 0 .....(1)

now (r+2) (r+3) (r+4) (r+5)

= (r^2 + 5r +6) (r^2+ 9r + 20)

= (3r) (7r + 14) using (i)

= 21 (r^2+ 2r)

= -126 using (i)

11. 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 contain.
- ✗ **D.** Paper is a poor conductor of heat.

Water is an excellent conductor of heat and absorbs or uses the flames energy to evaporate. Because the paper cup cannot become appreciably hotter than the water it contains, the cup will not ignite until the water has all turned to steam and risen away.

12. A box when dropped from a certain height reaches the ground with a speed v. When it skids 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 $\frac{v}{3}$. The coefficient of sliding friction between the box and the plane is (acceleration due to gravity is $10ms^{-2}$)

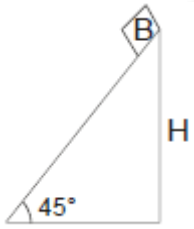
- **A.** $\frac{8}{9}$
- **B.** $\frac{1}{9}$
- **C.** $\frac{2}{3}$
- **D.** $\frac{1}{3}$

Case-1

$v = \sqrt{2gh}$

Case-2

$\Delta U + \Delta k = W_f$

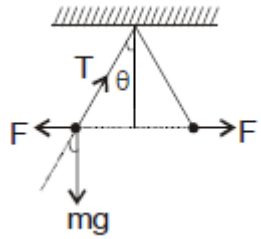


$-mgh + \frac{1}{2}m\left(\frac{2gh}{9}\right) = -\mu mgh$

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

13. 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. Charges 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.** $q_2\, m_1 = q_1\, m_2$



$\tan\theta = \frac{F}{mg}(F \to same)$

$\tan\ \theta\ \propto \frac{1}{m}$

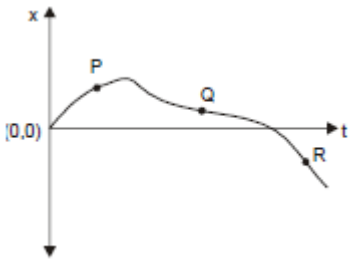
$\therefore m_1 = m_2$

14. 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 buoyant force due to air will be absent.

No buoyant force acts in vacuum.

15. In the following displacement (x) vs. time (t) graph, at which point is the object's speed increasing?



- **A.** R only
- **B.** P only
- **C.** Q and R only
- **D.** P, Q and R

|slope| is increasing at point R

16. 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 $0 \leq a < j$ for j= 2,4,5,6,7.

The sum $a_2 + a_3 + a_4 + a_5 + a_6 + a_7$ is

- **A.** 8
- **B.** 9
- **C.** 10
- **D.** 11

$\frac{5}{7} = \frac{2520a_2 + 840a_3 + 210a_4 + 42a_5 + 7a_6 + a_7}{7!}$

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

Let $a_2 = a_3 = a_4 = 1 \quad a_5 = 0 \; a_6 = 4 \; a_7 = 2$

17. 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.** $2 \leq a \leq 6$

✗ **B.** $8 \leq a \leq 12$

✓ **C.** $14 \leq a \leq 20$

✗ **D.** $22 \leq a \leq 30$

Let the house numbers be $\alpha, \alpha+2, \alpha+4, \alpha+6, \alpha+8, \alpha+10 \ldots\ldots$

$\alpha + 10 = a \Rightarrow \alpha = a - 10$ .....(1)

House no. will be (+)

$\Rightarrow \alpha = a - 10 > 0$

$\Rightarrow \alpha = a - 10 > 0$

$\Rightarrow \alpha > 10$

$\Rightarrow \alpha \geq 12$ as a is each too..... (2)

$Now, S_n = \frac{n}{2}[2\alpha + (n+1)d]$

$170 = \frac{n}{2}[2\alpha + (n+1)2]$

$= n\alpha + (n+1))$

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

$= n(a - 11 + n)$

$\Rightarrow n^2 + n(a-11) - 170 = 0$

$\Rightarrow n = \frac{(11-a) \pm \sqrt{(a-11)^2 + 680}}{2} \ldots\ldots (3)$

$\because n \geq 6$

$\Rightarrow \frac{(11-a) \pm \sqrt{(a-11)^2 + 680}}{2} \geq 6$

$\Rightarrow a \leq \frac{800}{24} \ldots\ldots\ldots (4)$

From (2) and (4) $\Rightarrow 12 \leq a \leq 32$

Now checking through (3) for a = 12, 14...

we have a = 18, n = 10 and S_n = 170

18. 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

N = ab ab ab

1< a $\leq$ 9 0 < b $\leq$ 9 a, b ϵ I

N = $10^5a + 10^4b + 10^3a + 10^2b + 10a + b$

$= (10^4 + 10^2 + 1)(10a + b)$

$= (10^2 + 10 + 1)(10^2 - 10 + 1)(10a + b)$

$= 3 \times 37 \times 13 \times 7(10a + b)$ ..... (1)

then 10a + b = P1 $\times$ P2 p1,p2 ϵ prime and 10 $\leq$ 10a + b $\leq$ 99

a	b	10a + b
1	0	10 = 2 $\times$ 5
2	2	22 = 2 $\times$ 11
3	4	34 = 2 $\times$ 17
3	8	38 = 2 $\times$ 19
4	6	46 = 2 $\times$ 23
5	5	55 = 5 $\times$ 11
5	8	58 = 2 $\times$ 29
6	2	62 = 2 $\times$ 31
7	4	74 = 2 $\times$ 37
8	2	82 = 2 $\times$ 41
8	5	85 = 5 $\times$ 17
9	4	94 = 2 $\times$ 47
9	5	95 = 5 $\times$ 19

19. 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 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

Year Population

2010 ---------39

2011 --------- 60

2012 --------- x

2013 ---------- 123

According to Q

x - 39 = k (60) & 63 = kx

$\Rightarrow$ x – 39= $\frac{63}{x}.60$

$\Rightarrow x^2$ - 39x - (60)(63) = 0

x = 84 & - 40

20. 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 in increase 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

Let total seats = 100 on first day,

Ticket price = 200

Seats full = 60%

$= \frac{60}{100} \times = 60$

$\therefore$ Revenue = 60 $\times$ 200

R_1 = 12000

On second day

Tricked price = 200 - 20% of 200

$= 200 - \frac{20}{100} \times 200$

= 200 - 40 = 160

Seats full 60 + 50% of 60

$= 60 + \frac{50}{100} \times 60$

= 60 + 30 = 90

Revenue = 160 $\times$ 90

R_2 = 14400

% Increase is Revenue = $\frac{R_2 - R_1}{R_1} \times 100$

$\frac{14400 - 12000}{12000} \times 100$

$= \frac{2400}{1200} \times 100$

$= 20\%$

21. Consider the following statements

1. All isotopes of an element have the same number of neutrons.
2. Only one isotope of an element can be stable and non-radioactive.
3. All elements can have isotopes.
4. 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 (iii) only
- ✘ **C.** (i), (ii) and (iii) only
- ✘ **D.** (i), (iii) and (iv) only

1. Isotopes have different number of neutrons.

2. More than one isotopes of an element can be stable. For example: Chlorine

3. All the elements can have isotopes.

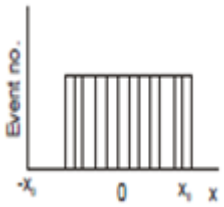
4. All the isotopes show combustion reaction with Oxygen-16.

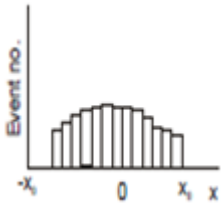
22. In 1911, the physicist Ernest Rutherford discovered that atoms have a tiny, dense nucleus by shooting positively charged particles at a very thin gold foil. A key physical property which led Rutherford to use gold was

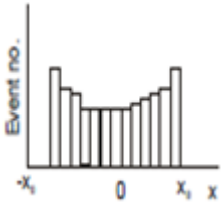
- ✘ **A.** Electrically conducting
- ✔ **B.** Highly malleable
- ✘ **C.** Shiny
- ✘ **D.** Non-reactive

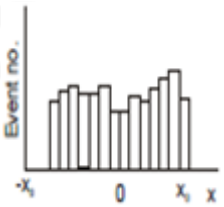
Gold, being highly malleable, could be made into extremely thin sheets.

23. A large number of random snapshots 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.** 

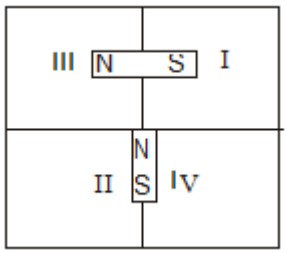
✓ **C.** 

✗ **D.** 

In SHM particle comes 2 times at every position in 1 oscillation, so actual histogram may be option (A)

But since at it random snapshots so it should be option (C)

2 4. 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

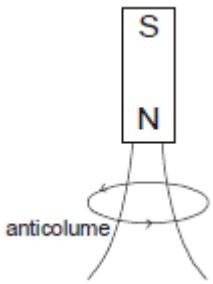
- **A.** Zone I
- **B.** Zone II
- **C.** Zone III
- **D.** Zone IV

The neutral point is located in zone II.

25. 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

Using Lenz's law, we know that upper face first becomes North Pole and then South Pole.



26. Two equal charges of magnitude Q each are placed at a distance d apart. Their electrostatic energy is E. A third charge $-\frac{Q}{2}$ is brought midway between these two charges. The electrostatic energy of the system is now

- ✗ **A.** -2E
- ✓ **B.** -E
- ✗ **C.** 0
- ✗ **D.** E

$$\mu_i = \frac{KQ^2}{d} = E$$

$$\mu_f = \frac{KQ^2}{d} + \frac{K(-Q)^2}{d} + \frac{K(-Q)^2}{d}$$

$$= -\frac{KQ^2}{d} = -E$$

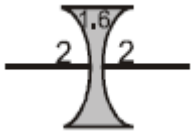
27. A charged particle, initially at rest at O, when released follows a trajectory as shown. Such a trajectory is possible in the presence of

- ✔ **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

In a magnetic field of constant magnitude and varying direction (option B), it will not move. While in an electric field of of constant magnitude and constant direction (Option C) or in electric and magnetic fields of constant magnitudes and constant directions which are parallel to each other (Option D), path will be a straight line.

28. 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



$\frac{1}{F} = \left(\frac{1.6}{2} - 1\right)\left(\frac{1}{-0.2} - \frac{1}{0.2}\right)$

$= \frac{0.4}{2} \times \frac{1}{0.1}$

F = 0.5

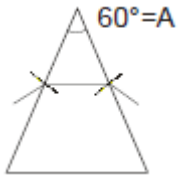
It will behave as a converging lens.

29. 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.** $i > 60^\circ$

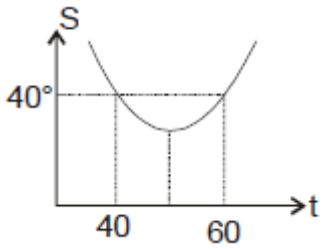
For min deviation

i = e



$r_1 = r_2 = \frac{A}{2}$

$\therefore r_1 = r_2 = 30^\circ$



For minimum deviation i should lie between 40° to 50°.

30. 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 a single block.
- **D.** Crush the ice.

Crushing the ice will speed up the cooling process.

31. Ammonia is NOT produced in the reaction of

- **A.** NH_4Cl with KOH
- **B.** AIN with water
- **C.** NH_4Cl with $NaNO_2$
- **D.** NH_4Cl with Ca $(OH)_2$

$NH_4Cl + NaNO_2 \longrightarrow NaCl + N_2 + 2H_2O$

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

- **A.** $2\sqrt{2}$
- **B.** $\frac{6}{\sqrt{2}}$
- **C.** 8
- **D.** 6

average speed$\propto \frac{1}{\sqrt{M}}$

$\frac{V_{He}}{V_{O_2}} = \sqrt{\frac{32}{4}} = \sqrt{\frac{M_{0_2}}{M_{He}}}$

$= \sqrt{8} = 2\sqrt{2}$

33. The pH of 0.1M aqueous solutions 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.** $NaCl < NH_4Cl < CH_3COONa$

NH_4Cl $\rightarrow$acidic Salt (PH<7)

NaCl $\rightarrow$Neutral Salt (PH = 7)

CH_3COONa $\rightarrow$Basic salt (PH>7)

34. The diamagnetic species is

- **A.** NO
- **B.** No_2
- **C.** O_2
- **D.** CO_2

Diamagnetic species are the substance which contains no unpaired electrons and thus is not attracted to a magnetic field. CO_2 is diamagnetic because all of the electrons in CO_2 are paired.

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

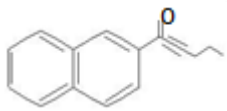
- **A.** 108 pm
- **B.** 81 pm
- **C.** 27 pm
- **D.** 13 pm

$r_n = \frac{R_H n^2}{Z}$

$r_{He+} = \frac{53n^2}{Z}$

$= \frac{53 \times 1^2}{2} = 27$ approx

36. The number of C-C sigma bonds in the compound



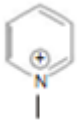
- **A.** 16
- **B.** 17
- **C.** 18
- **D.** 11

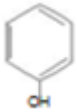
The number of C-C sigma bonds in the compound are 16.

37. The species that exhibits the highest R_f value in a thin layer chromatogram using a non polar solvent on a silica gel is

A. 

B. 

C. 

D. 

Nonpolar substance will have high R_f value as solvent is nonpolar therefore option (A) will have high R_f value as it has low dipole moment.

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

A. 1.12 L

B. 8.96L

C. 2.24 L

D. 4.48L

C(s) +O_2 (g)$\longrightarrow$(g) CO_2(g)

moles = 1mole 1mole 1mole

weight = 12gm 32gm 44gm

12gm of C require $\rightarrow$1mole of O_2

$\therefore$ 2.4gm of C will require $\rightarrow \frac{1}{12} \times 2.4$ mole of O_2

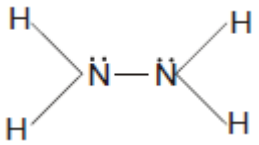
volume of $\frac{2.4}{12}$mole O_2 at STP $= \frac{22.4 \times 2.4}{12}$litre

4.48 litre

39. The numbers of lone pairs and bond pairs in hydrazine are, respectively

- **A.** 2 and 4
- **B.** 2 and 6
- **C.** 2 and 5
- **D.** 1 and 5

HYDRAZINE N_2H_4



LP=2

BP=5

40. The isoelectronic pair is

- **A.** CO, N_2
- **B.** O_2, NO
- **C.** C_2, HF
- **D.** F_2, HCL

CO & N_2 are isoelectronic

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

- **A.** Prolactin
- **B.** Glucagon
- **C.** Luteinizing hormone
- **D.** Epinephrine

Glucagon is secreted from alpha cell of pancreas

42. In human brain two hemispheres are connected by bundle of fibers which is known as:

- **A.** Medulla oblongata
- **B.** Cerebrum
- **C.** Cerebellum
- **D.** Corpus callosum

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

43. Athletes are often trained at high altitude because:

- **A.** Training at high altitude increase 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

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

44. 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

Producers consume 20 percent of their gross productivity in respiration. The herbivores consume about 30 percent of assimilated energy in respiration. The carnivores consume about 60 percent of assimilated energy in respiration.

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

- **A.** Community
- **B.** Population
- **C.** Species
- **D.** Biome

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

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

- **A.** O,F, and Ne
- **B.** F, O and Ne
- **C.** Ne, F and O
- **D.** F, Ne and O

As we move from left to right in period ionisaton energy increases.

47. Of the following reactions

(i) A $\rightleftharpoons$ B ΔD G^0 = 250 kJ mol^{-1}

(ii) D $\rightleftharpoons$ E Δ D G^0 = -100 kJ mol^{-1}

(iii) F $\rightleftharpoons$ G Δ D G^0 = -150 kJ mol^{-1}

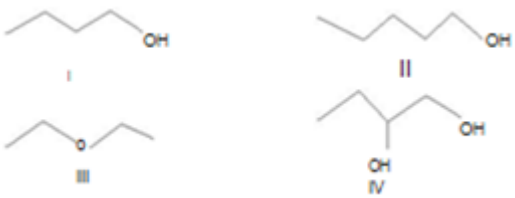
(iv) M $\rightleftharpoons$ N Δ D G^0 = 150 kJ mol^{-1}

the reaction with the largest equilibrium constant is

- **A.** I
- **B.** II
- **C.** III
- **D.** IV

$\Delta G^0 = -RT\ In\ K_{eq}$

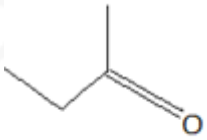
48. Among the compounds I-IV, the compound having the lowest boiling point is

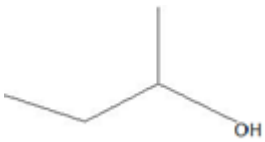


- **A.** I
- **B.** II
- **C.** III
- **D.** IV

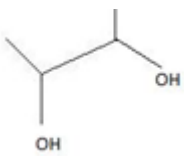
I,II & IV compound form H -bond III do not form H-Bond

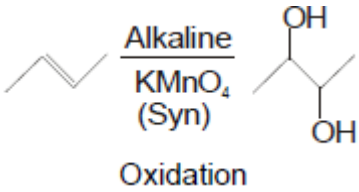
49. The major product of the reaction of 2-butene with alkaline $KMnO_4$ solution is

- **A.** 

- **B.** 

- **C.** 

- **D.** 



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

A. 2

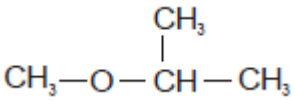
B. 3

C. 4

D. 5

$CH_3 - O - CH_2 - CH_2 - CH_3$

$CH_3 - CH_2 - O - CH_2 - CH_3$



51. 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

Antivenom injection act as antibodies against snake poison.

So, using antivenom injection develops artificial acquired passive immunity.

52. Human mature red blood cells (RBCs) do NOT contain:

- **A.** Iron
- **B.** Cytoplasm
- **C.** Mitochondria
- **D.** Haemoglobin

Mature RBCs lack

(i) Nucleus

(ii) Mitochondria

(iii) Endoplasmic Reticulum

53. 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

In photosynthesis,

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

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

54. A reflex action does NOT involve:

- **A.** Neurons
- **B.** Brain
- **C.** Spinal cord
- **D.** Muscle fiber

A reflex action does not involve brain.

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

55. 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

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

56. 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

Auditory cranial nerve has two branches

(i) Vestibular nerve : for equilibrium

(ii) Cochlear nerve : for hearing

57. Both gout and kidney stone formation is caused by:

- **A.** Calcium oxalate
- **B.** Uric acid
- **C.** Creatinine
- **D.** Potassium chloride

Gout is caused by deposition of uric acid in joints.

Composition of kidney stone → Calcium oxalate, Calcium phosphate, Uric acid, Xanthine & Indigo calculi.

58. 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

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

59. 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

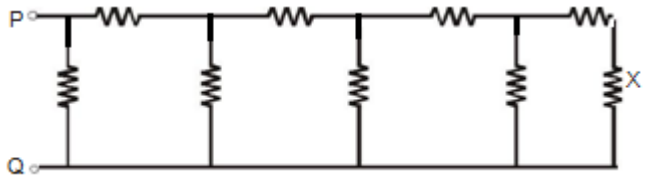
Both smooth muscle (unstriated muscle) and cardiac muscle are functionally involuntary.

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

- **A.** Sclerenchyma
- **B.** Parenchyma
- **C.** Chlorenchyma
- **D.** Collenchyma

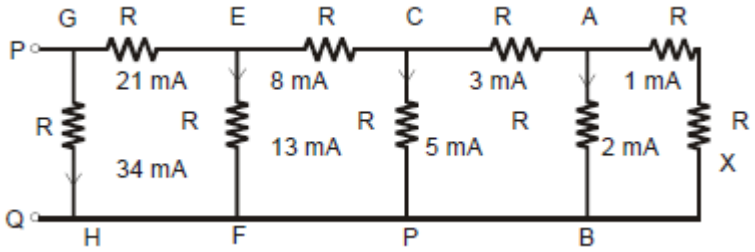
The stalk of plant leaf (petiole) is reinforced by collenchyma.

61. Consider the circuit shown below where all resistors are of 1 k Ω



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

- **A.** 21V
- **B.** 68V
- **C.** 55V
- **D.** 34V



Using KCL

At point A

Current is 3mA

At point C

Current is 8 mA

At point E

Current is 21 mA

At point G

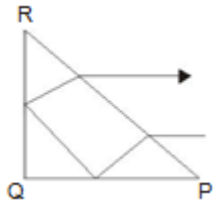
Current through GH is

34ma

$\therefore V_{PQ} = V_{GH} = i\ R_{GH}$

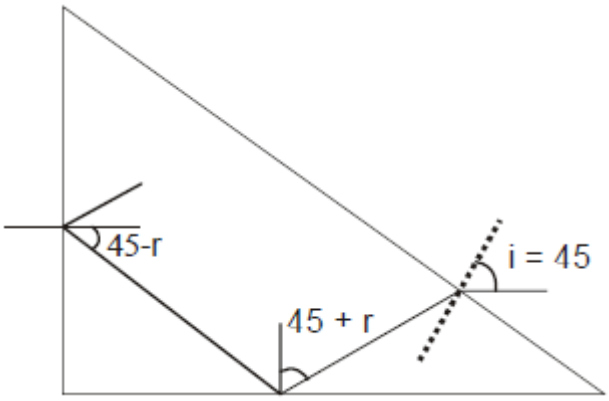
= 34 V

62. 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 faces 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.** $\sqrt{2} < \mu < \sqrt{5}$
- **D.** $\mu < \sqrt{2}$



45 + r > C

Also 45 - r > C

90 > C

$\mu > \sqrt{2}$

63. An aluminium piece of mass 50g initially at $300^\circ C$ is dipped quickly and taken out of 1kg of water, initially at $30^\circ C$. If the temperature of the aluminium piece be $160 \circ C$, what is the temperature of the water then (Specific heat capacities of aluminium and water are 900 $JKg^{-1}K^{-1}$ and 4200 $Jkg^{-1}k^{-1}$, respectively)

- **A.** $165^\circ C$
- **B.** $45^\circ C$
- **C.** $31.5^\circ C$
- **D.** $28.5^\circ C$

Heat lost = heat gas

0.05 $\times$ 900 $\times$ (300 - 160) = 1 $\times$ 4200 $\times$ (T - 30)

T = 31.5°

64. 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 kgm^{-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 μ m = 10^{-6} m)

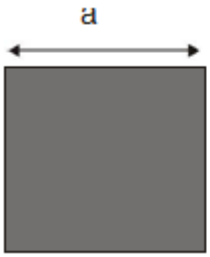
- **A.** 0.50 μm
- **B.** 1.50 μm
- **C.** 7.00 μm
- **D.** 3.50 μm

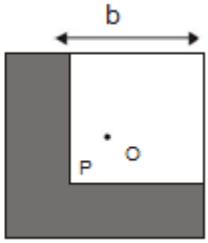
$Weight = F_0$

$4\pi r^2 t\rho_{\ w}g + \frac{4}{3}\pi r^3 \rho_{\ Ne}g =$

$\frac{4}{3}\pi r^3 \rho_{\ air}g \therefore t = 3.5um$

65. A uniform square wooden sheet of side a has its centre 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 and 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. $\frac{a}{b}=\frac{(\sqrt{5}-1)}{2}$

B. $\frac{a}{b}=\frac{(\sqrt{5}+1)}{2}$

C. $\frac{a}{b}=\frac{(\sqrt{3}-1)}{1}$

D. $\frac{a}{b}=\frac{(\sqrt{3}+1)}{2}$

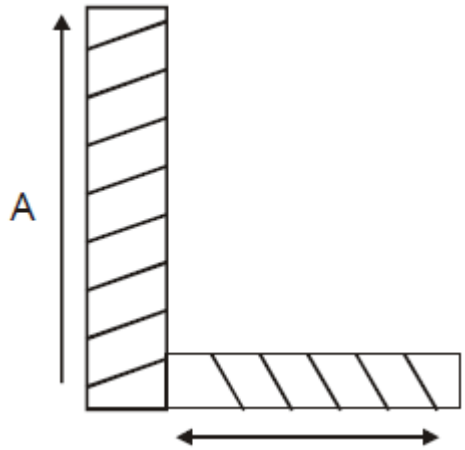
Finally com at p

$x_{am}=\frac{A_1X_1+A_2X_2}{A_1+A_2}$

$(a-b)=\frac{a(a-b\frac{(a-b)}{2})+b(a-b)(a-b+\frac{b}{a})}{a(a-b)+(a-b)b}$

$\therefore\left(\frac{a}{b}\right)^2-\left(\frac{a}{b}\right)-1=0$

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



66. The number of all 3-digit numbers abc (in base10) 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

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

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

$2 \times 3 \times 5 \rightarrow (a, b, c) \Rightarrow (1, 2, 3) \Rightarrow 6$

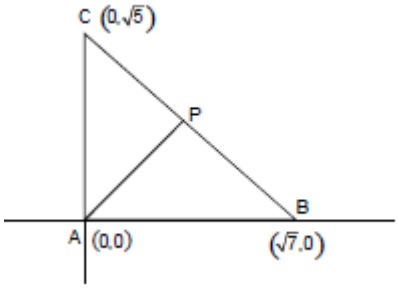
$1 \times 6 \times 5 \rightarrow (a, b, c) \Rightarrow (0, 5, 4) \Rightarrow 4$

$1 \times 3 \times 10 \rightarrow (a, b, 1) \Rightarrow (0, 2, 9) \Rightarrow 4$

14

67. 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



Equation of line AB is

$\frac{x}{\sqrt{7}} + \frac{y}{\sqrt{5}} = 1$

Let $P\left[a, \sqrt{5}(1 - \frac{a}{\sqrt{7}})\right]$

On solving $16(PA)^2 = 9(PB)^2$

$p\left[\frac{\sqrt{7}}{3}, \frac{2\sqrt{5}}{3}\right]$

$Let\ BP : PC = \lambda : 1$
$then\ \lambda = 2$
$BP : PC = 2 : 1$

68. 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

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

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

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

$\frac{(a-1)-x+x+1}{(x-1)[(a-1)-x]} = 2 - a$

$\therefore a \neq 2$ [for a = 2 equation have infinitely many solution]

∴ (x - 1)[(a - 1) - x] = -1

(x - 1)[x - (a - 1)] = 1

x^2 - ax + (a - 2) = 0

D > 0

∴ equation have 2 real roots so

a can be 1, 3, 4..... 2014

Answer is 2013

69. 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.** $\frac{1948}{\sqrt{2^{1947}}}$

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

$\sum_{n=0}^{1947} \frac{1}{2^n+\sqrt{2^{1947}}}=\frac{974}{\sqrt{2^{1947}}}=\frac{487}{\sqrt{2^{1945}}}$

70. 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.** q2 < 2r always
- **B.** q2 = 2r always
- **C.** q2 > 2r always
- **D.** q2 - 2r can take both positive and negative value

$a+b+c=0, a, b, c\ \epsilon R \neq 0$

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

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

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

$r=q^2-2[(ab+bc+ca)^2-2abc(a+b+c)]$

$r=q^2-2(q^2/4)$

$r=q^2/2$

71. 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

Ganga is more polluted than Kaveri. Lower DO [Dissolved Oxygen] indicates more polluted water. In this case DO of Ganga is 2% which is less than DO of Kaveri which is 10%.

72. 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

Phenyl Ketonuria is an autosomal recessive disorder with mutation in gene for enzyme phenylalanine hydroxylase (PAH), rendering it non functional.
Phenylalanine $\xrightarrow{PAH}$ Tyrosine
Such person cannot metabolise the above reaction leading to accumulation of phenylalanine. So, are given food low in (Phe) and supplemented with (tyr).

73. Two semi-permeable bags containing 2% sucrose 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 remain unchanged both

Sucrose is a disaccharide [Glucose + Fructose]
It is non-reducing and non-osmotic sugar so, there will be no change in concentration of sucrose.

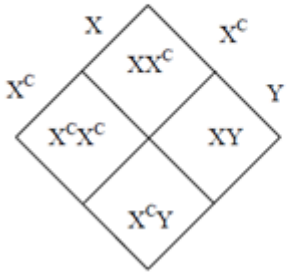
74. A woman heterozygous for color blindness marries a color blind man. What will be the ratios of carrier daughters, color blind daughters, normal sons and color blind sons in F1 generation?

- **A.** 1:2:2:1
- **B.** 2:1:1:2
- **C.** 1:1:1:1
- **D.** 1:1:2:2

Color blindness is X-linked recessive disorder

XX^c X X^cY

Heterozygous women Color blind man



Ratio

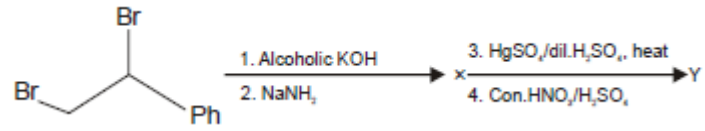
	Genotype	F_1 *ratio*
Carrier daughter	XX^C	1
Color blind daughter	X^CX^C	1
Normal son	XY	1
Color blind son	X^CY	1

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

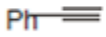
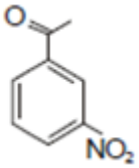
- **A.** Cytoplasm and Endoplasmic reticulum
- **B.** Mitochondria and Golgi complex
- **C.** Mitochondria and Cytoplasm
- **D.** Mitochondria only

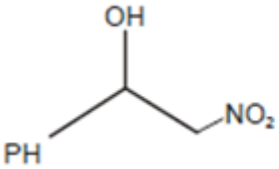
Respiratory Reactions
Glycolysis $\rightarrow$ Cytoplasm
Kreb cycle and ETS $\rightarrow$ Mitochondria

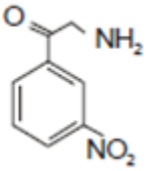
76. In the following reaction sequence

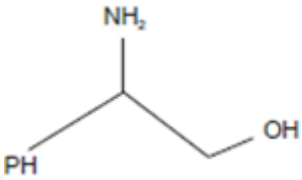


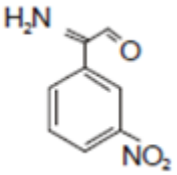
X and Y are, respectively

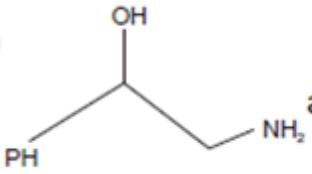
A.  and 

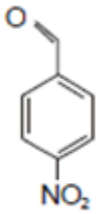
B. 

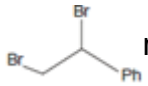
and 

C. 

and 

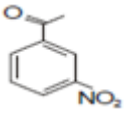
D. 

and 

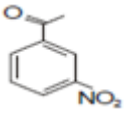


reacts with $NaNH_3$ in the presence of alcoholic KOH to form

. Again

reacts with $HgSO_4$ in the presence of conc HNO_3 to form 

. So Xand Y are

and 

respectively.

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

A.

B. 

C. 

D. 

$CaO + C \rightarrow CaC_2 + CO_2$
$CaC_2 + H_2O \rightarrow HC \equiv CH + Ca(OH)_2$
$3HC \equiv CH \frac{Red\ Hot}{Fe}$

78. 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

1.125L of H_2 produced by 0.1 equivalent of metal

1.85L a of H_2 will be produced by $= \frac{0.1 \times 1.85}{1.125}$ equivalents

∴No of gram equivalent of metal

$= \frac{2}{\text{Equivalent weight}} = \frac{2}{x}$

$\therefore \frac{0.1}{1.125} \times 1.85 = \frac{2}{x}$

X=12.16

79. The ammonia evolved from 2g 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

$2NH_2 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$

10ml

2ml

millimole of $H_2SO_4 = \frac{\text{mmol of } NH_3}{2} = 20$

Mmol NH_3=mmol of N=40

$= \frac{40 \times 14}{1000} = \frac{560}{1000} = 0.56g$

W_n

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

80. 10 moles of a mixture of hydrogen and oxygen gases at a pressure of 1 atm at 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

$2H_2(g) + O_2(g) \longrightarrow 2H_2O$ (l)

0.2 mole 0.1 mole 0.2 mole

moles of gas remaining = 9.7 at constant (T) & (V)

$\frac{n_1}{n_2} = \frac{p_1}{p_2}$

$\frac{10}{9.7} = \frac{1}{p_2}$ & $p_2 = 0.97$