Aakash
Medical | IIT-JEE | Foundations

(Divisions of Aakash Educational Services Limited)

Regd. Office : **Aakash Tower, 8, Pusa Road, New Delhi-110005 | Ph.: 011-47623456**

Time : 120 Minutes

Answers & Solutions

for

Marks : 240

NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE (NSEJS) 2018-19

INSTRUCTIONS TO CANDIDATES - READ CAREFULLY AND STRICTLY FOLLOW EACH OF THEM

1. Use and carrying calculators of any type is strictly prohibited.

2. Use and even carrying smart watches, Phones, i-Pads or any other communication devices or any other objectionable material in examination centre is strictly prohibited.

3. Write the question paper code in your answer sheet in the appropriate space provided, otherwise your answer sheet will not be assessed.

4. On the answer sheet, make all the entries correctly, carefully in the space(s) provided, in capital letters as well as by properly darkening the appropriate bubbles using blue or black ball point pen only. Incomplete/ incorrect/ carelessly filled information may disqualify your candidature. Please take care while entering.

5. Please do not make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet. Further, do not write on the back side of the answer sheet.

6. As answer sheets are evaluated using machine, change of entry is not allowed. Even scratching or overwriting may result in a wrong score.

7. Question paper has 80 multiple choice questions. Each question has four alternatives, out of which only one is correct. Choose the correct alternative and fill the appropriate bubble, as shown:

   Q. ⓐ ⬤ ⓒ ⓓ

8. Correct answer carries 3 marks, wrong answer –1 mark (negative 1), no attempt – zero marks.

9. Rough work should be done in the space provided in the question paper only.

10. Candidates are **not permitted** to leave the examination hall before the completion of the examination schedule (i.e. before 12:00 Hrs).

11. Your answer sheet consists of two pages – original copy and candidate's copy. Do not detach them till the end of the examination. At the end of examination, submit your answer paper (original copy) to the invigilator and take away the student's copy for your further reference.

— —

12. Comments or queries (if any) regarding this question paper, may be sent by email only to iapt.nse@gmail.com till 23 : 59 Hrs. of 23 Nov. 2018. The answers to this question paper will be available at – www.iapt.org.in by 02 Dec. 2018 after 17:00 Hrs.

13. For certificates and awards – Please see the website of IAPT: www.iapt.org.in

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT

1. A tiny ball of mass m is initially at rest at height H above a cake of uniform thickness h. At some moment the particle falls freely, touches the cake surface and then penetrates in it at such a constant rate that its speed becomes zero on just reaching the ground (bottom of the cake). Speed of the ball at the instant it touches the cake surface and its retardation inside the cake are respectively

(a) $\sqrt{2gh}$ and $g\left(\dfrac{H}{h} - 1\right)$

(b) $\sqrt{2g(H-h)}$ and $g\left(\dfrac{H}{h} - 1\right)$

(c) $\sqrt{2gh}$ and $g\left(\dfrac{h}{H} - 1\right)$

(d) $\sqrt{2g(H-h)}$ and $g\left(\dfrac{h}{H} - 1\right)$

Answer (b)

Sol. $\therefore \quad v = \sqrt{2gh}$

$v = \sqrt{2g(H-h)}$

Now, $v^2 = u^2 + 2as$

$0 = \left(\sqrt{2g(H-h)}\right)^2 + 2ah$

$a = -\dfrac{2g(H-h)}{2h}$

$a = -g\left(\dfrac{H}{h} - 1\right) \quad \Rightarrow \quad |a| = g\left[\dfrac{H}{h} - 1\right]$

2. Two sound waves in air have wavelengths differing by 2 m at a certain temperature T. Their notes have musical interval 1.4. Period of the lower pitch note is 20 ms. Then, speed of sound in air at this temperature (T) is

(a) 350 m/s   (b) 342 m/s

(c) 333 m/s   (d) 330 m/s

Answer (a)

Sol. $f_1 = \dfrac{1000}{20} = 50\ Hz$

$\dfrac{f_2}{f_1} = 1.4$

$f_2 = 1.4\, f_1 = 70\ Hz$

$\lambda_1 - \lambda_2 = 2$

$\dfrac{v}{f_1} - \dfrac{v}{f_2} = 2$
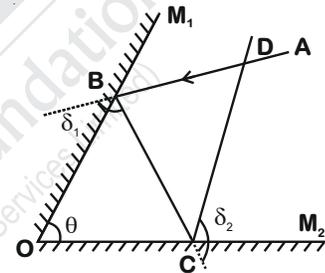
$v\left[\dfrac{1}{50} - \dfrac{1}{70}\right] = 2$

$v\left[\dfrac{70-50}{3500}\right] = 2$
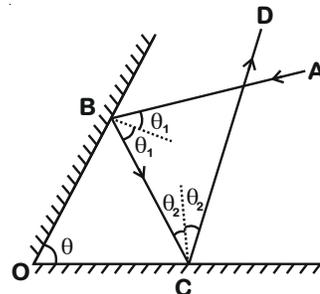
$v = \dfrac{7000}{20}$

$v = 350\ m/s$

3. Two plane mirrors M_1 & M_2 have their reflecting faces inclined at θ. Mirror M_1 receives a ray AB, reflects it at B and sends it as BC. It is now reflected by mirror M_2 along CD, as shown in the figure. Total angular deviation δ suffered by the incident ray AB is

(a) $\delta = 90° + 2\theta$ (b) $\delta = 180° + 2\theta$

(c) $\delta = 270° - 2\theta$ (d) $\delta = 360° - 2\theta$

Answer (d)

Sol.

$\delta_1 = 180 - 2\theta_1$

$\delta_2 = 180 - 2\theta_2$

Again in $\triangle OBC$

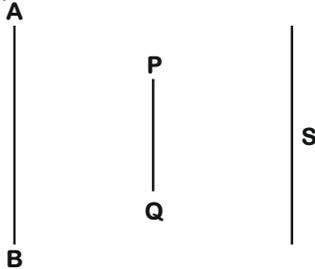$(90 - \theta_1) + (90 - \theta_2) + \theta = 180$

$\theta = \theta_1 + \theta_2$

$\delta = \delta_1 + \delta_2 = (180 - 2\theta_1) + (180 - 2\theta_2)$

$\delta = 360 - 2\,(\theta_1 + \theta_2)$

$\delta = 360 - 2\theta$

4. In the adjacent figure, line AB is parallel to screen S. A linear obstacle PQ between the two is also parallel to both. AB, PQ and screen S are coplanar. A point source is carried from A to B, along the line AB. What will happen to the size of the shadow of PQ (cast due to the point source) on the screen S?

(a) It will first increase and then decrease

(b) It will first decrease and then increase

(c) It will be of the same size for any position of the point source on the line AB

(d) Umbra will increase and penumbra will decrease till central position

Answer (c)

Sol.
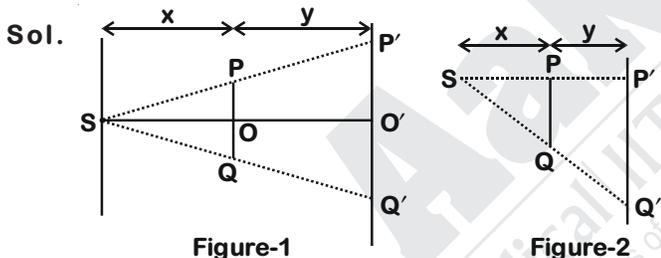
Figure-1

For figure-1

$\Delta SPQ \sim \Delta SP'Q'$

$\because \quad \dfrac{SO}{SO'} = \dfrac{PQ}{P'Q'}$

$\Rightarrow \quad P'Q' = \dfrac{SO'}{SO} \times PQ$

$P'Q' = \left(\dfrac{x+y}{x}\right)PQ$

Figure-2

For figure-2

$\Delta SPQ \sim \Delta SP'Q'$

$\because \quad \dfrac{SP}{SP'} = \dfrac{PQ}{P'Q'}$

$\Rightarrow \quad P'Q' = PQ \times \dfrac{SP'}{SP}$

$P'Q' = \left(\dfrac{x+y}{x}\right)PQ$

In every position of source, size of shadow on screen remain same.

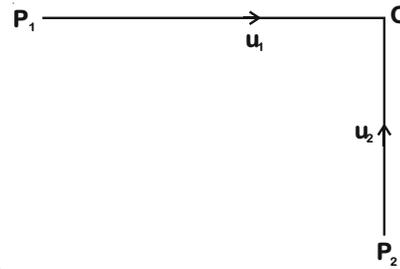5. Two particles P_1 and P_2 move towards origin O, along X and Y-axis at constant speeds u_1 and u_2 respectively as shown in the figure. At t = 0, the particles P_1 and P_2 are at distances a and b respectively from O. Then the instantaneous distance s between the two particles is given by the relation

(a) $s = \left[a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)\right]^{\frac{1}{2}}$

(b) $s = \left[a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(bu_1 + au_2)\right]^{\frac{1}{2}}$

(c) $s = \left[a^2 + b^2 + (u_1^2 + u_2^2)t^2 + 2t(au_1 + bu_2)\right]^{\frac{1}{2}}$

(d) $s = \left[a^2 - b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)\right]^{\frac{1}{2}}$

Answer (a)

Sol. Let at time (t) = t

$x_1 = a - u_1 t$

$y_1 = b - u_2 t$

$S = \sqrt{x_1^2 + y_1^2}$

$S = \sqrt{(a - u_1 t)^2 + (b - u_2 t)^2}$

$S = \left[a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)\right]^{\frac{1}{2}}$

6. An electric generator consumes some oil fuel and generates output of 25 kW. Calorific value (amount of heat released per unit mass) of the oil fuel is 17200 kcal/kg and efficiency (output to input ratio) of the generator is 0.25. Then, mass of the fuel consumed per hour and electric energy generated per ton of fuel burnt are respectively

(a) 0.5 kg, 20000 kWh

(b) 0.5 kg, 5000 kWh

(c) 5 kg, 5000 kWh

(d) 5 kg, 20000 kWh

Answer (c)

Sol. P_{out} = 25000 J/s

C.V = 17200×10^3 cal/kg

$P_{in} = m \times$ C.V.

$\dfrac{P_{out}}{P_{in}} = 0.25$

$\dfrac{17200 \times 10^3 \times m \times 4.2}{25000 \times 3600} = 0.25$

$m \approx 5$ kg

Heat generated per ton of coal

$Q_{in} = 1000 \times 17200 \times 10^3$ cal

Electricity generated

$E = Q_{in} \times \eta$

$E = 1000 \times 17200 \times 10^3 \times 4.2 \times 0.25$ J

or $E \approx 5000$ kWh

7. Image is obtained on a screen by keeping an object at 25 cm and at 40 cm in front of a concave mirror. Image in the former case is four times bigger than in the latter. Focal length of the mirror must be _____.

(a) 12 cm (b) 20 cm

(c) 24 cm (d) 36 cm

Answer (b)

Sol. $u_1 = -25$ cm

$u_2 = -40$ cm

$m_1 = 4m_2$

$\therefore \quad m = \dfrac{f}{f-u}$

$\dfrac{f}{f-(-25)} = \dfrac{4f}{f-(-40)}$

$f + 40 = 4f + 100$

$f = -20$ cm

8. A glass cube of refractive index 1.5 and edge 1 cm has a tiny black spot at its center. A circular dark sheet is to be kept symmetrically on the top surface so that the central sport is not visible from the top. Minimum radius of the circular sheet should be $\left(\text{Given: } \dfrac{1}{\sqrt{2}} = 0.707, \dfrac{1}{\sqrt{3}} = 0.577, \dfrac{1}{\sqrt{5}} = 0.447\right)$

(a) 0.994 cm (b) 0.447 cm

(c) 0.553 cm (d) 0.577 cm

Answer (b)

Sol. $\therefore \quad r = \dfrac{h}{\sqrt{\mu^2 - 1}}$

$r = \dfrac{\frac{1}{2}}{\sqrt{\left(\frac{3}{2}\right)^2 - 1}} = \dfrac{\frac{1}{2}}{\sqrt{\frac{9}{4} - 1}} = \dfrac{\frac{1}{2}}{\sqrt{\frac{5}{2}}}$

$r = \dfrac{1}{\sqrt{5}} = 0.447$

9. A metal rod of length L at temperature T, when heated to temperature T′, expands to new length L′. These quantities are related as L′ = L(1 + α[T′ – T]) where α is a constant for that material and called as coefficient of linear expansion. Correct SI unit of α is ____.

(a) m-K^{-1}

(b) m-K

(c) K^{-1}

(d) α is a pure number

Answer (c)

Sol. αT = Unitless

$\alpha = \dfrac{1}{T}$

10. A paramedical staff nurse improvises a second's pendulum (time period 2 s) by fixing one end of a string of length L to a ceiling and the other end to a heavy object of negligible size. Within 60 oscillations of this pendulum, she finds that the pulse of a wounded soldier beats 110 times. A symptom of bradycardia is pulse < 60 per minute and that of tachycardia is > 100 per minute. Then the length of the string is nearly _____ and soldier has symptoms of _____.

(a) 1 m, bradycardia (b) 4m, bradycardia

(c) 1m, tachycardia (d) 4m, tachycardia

Answer (a)

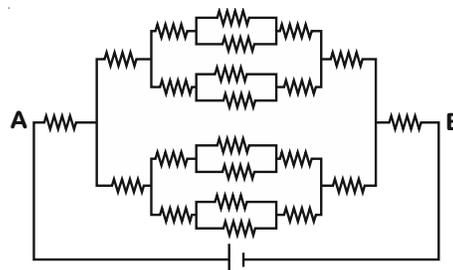**Sol.** $\therefore \quad T = 2\pi\sqrt{\dfrac{l}{g}}$

$2 = 2\pi\sqrt{\dfrac{l}{g}}$

$l = \dfrac{9}{\pi^2} = 1$ m

Number of beat per minute = $\dfrac{110}{2} = 55$
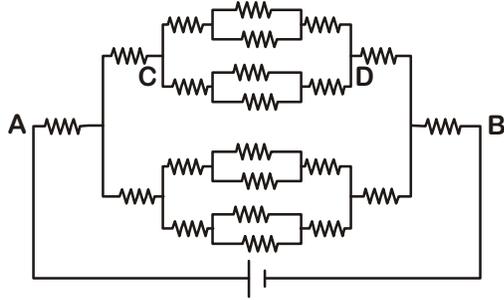
Required phenomena is bradycardia.

11.

Each resistance in the adjacent circuit is R Ω. In order to have an integral value for equivalent resistance between A & B, the minimum value of R must be

(a) 4 Ω (b) 8 Ω

(c) 16 Ω (d) 29 Ω

Answer (b)

Sol.

$$R_{eq} = \frac{29R}{8}$$

Required value of R = 8 Ω

12. A block of wood floats on water with $\left(\frac{3}{8}\right)^{th}$ of its volume above water. It is now made to float on a salt solution of relative density 1.12. The fraction of its volume that remains above the salt solution now, is nearly _____.

    (a) 0.33   (b) 0.44

    (c) 0.67   (d) 0.56

Answer (b)

Sol. Let V be the volume of wood block

$$\left(V - \frac{3V}{8}\right) \times 1000 \times g = V' \times 1.12 \times 1000 \times g$$

$$V' = \frac{5}{8} \times \frac{1000V}{1120} = 0.558 \text{ V}$$

Volume outside the liquid = (1 – 0.558)V

= 0.44 V

13. Suppose our scientific community had chosen force, speed and time as the fundamental mechanical quantities instead of length, mass and time respectively and they chose the respective units of magnitudes 10 N, 100 m/s and $\frac{1}{100}$s. Then the unit of mass in their system is equivalent to _____ in our system.

    (a) 10^3 kg   (b) 10^{-3} kg

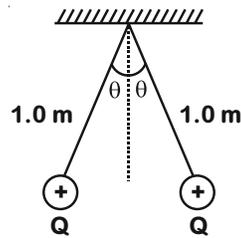   (c) 10 kg   (d) 10^{-1} kg

Answer (b)

Sol. $\therefore \quad F = ma = \frac{mdv}{dt}$

$$m = \frac{fdt}{dv}$$

$$m = \frac{(10 \text{ N})\left(\frac{1}{100}\right)}{100}$$

m = 10^{-3} kg

14.

Two equally charged identical pith balls are suspended by identical massless strings as shown in the adjacent figure. If this set up is on Mercury (g = 3.7 m/s^2), Earth (g = 9.8 m/s^2) and Jupiter (g = 24.5 m/s^2), then angle 2θ will be _____.

    (a) Maximum on Mercury

    (b) Maximum on Earth, as it has atmosphere

    (c) Maximum on Jupiter

    (d) The same on any planet as Coulomb force is independent of gravity

Answer (a)

Sol. 2θ will increase with decrease in value of 'g'.

15. Three objects of the same material coloured white, blue and black can withstand temperatures up to 2000°C. All these are heated to 1500°C and viewed in dark. Which option is correct?

    (a) White object will appear brightest

    (b) Blue object will appear brightest

    (c) Black object will appear brightest

    (d) Being at the same temperature, all will look equally bright

Answer (c)

Sol. Black colour is a good absorber as well as good emitter.

16. A car running with a velocity of 30 m/s reaches midway between two vertical parallel walls separated by 360 m, when the driver sounds the horn for a moment. Speed of sound in air is 330 m/s. After blowing horn, the first three echoes will be heard by the driver respectively at _____.

    (a) 1.2 s, 2.4 s, 3.0 s   (b) 1.0 s, 2.4 s, 3.0 s

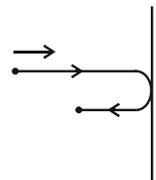   (c) 1.0 s, 2.0 s, 3.0 s   (d) 1.2 s, 2.4 s, 3.6 s

Answer (b)

Sol. $\therefore \quad$ x = 30t

For first echo,

$$\frac{180 + 180 - x_1}{330} = t_1$$

$360 - 30t_1 = 330t_1$

$$t_1 = \frac{360}{360} = 1 \text{ s}$$

For second echo,
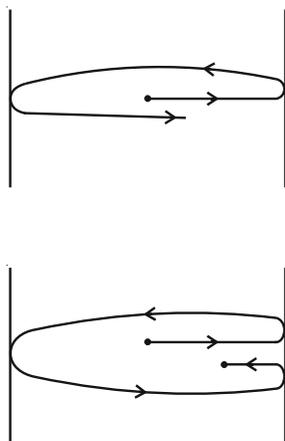
$$\frac{720 + x_2}{330} = t_2$$

$720 + 30t_2 = 330t_2$

$$t_2 = \frac{720}{300} = 2.4 \text{ s}$$

For third echo,

$$\frac{1080 - x_3}{330} = t_3$$

$1080 - 30t_3 = 330t_3$

$t_3 = 3$ s

17. Choose correct option from the following statements from electrostatics:

(I) If two copper spheres of same radii, one hollow and the other solid are charged to the same electrical potential, the solid sphere will have more charge.

(II) A charged body can attract another uncharged body.

(III) Electrical lines of force originating from like charges will exert a lateral force on each other, while those originating from opposite charges can intersect each other.

(a) Only (I) is correct

(b) Only (II) is correct

(c) Only (I) & (II) are correct

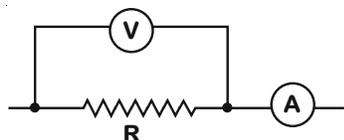(d) All (I), (II) & (III) are correct

Answer (b)

Sol. For solid and hollow conducting sphere

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

So, for same potential, charge will same on spheres of same radius

Two electric field lines can't inersect each other.

18.

Refer the adjacent circuit. The voltmeter reads 117 V and ammeter reads 0.13 A. If the resistance of voltmeter and ammeter are 9 kΩ and 0.015 kΩ respectively, the value of R is _____.

(a) 500 Ω   (b) 1 kΩ

(c) 1.5 kΩ   (d) 2 kΩ

Answer (b)

Sol. $I_V = \frac{117}{9000} = 0.013$ A

$I = I_V + I_R$

$I_R = 0.13 - 0.013$

$I_R = 0.117$

$$R = \frac{117}{0.117} = 1000\,\Omega = 1\,k\Omega$$

19. A bar magnet is allowed to fall freely from the same height towards a current carrying loop along its axis, as shown in the four situations I to IV. Arrows show direction of conventional current. Choose the situations in which the potential energy of the magnet coil interaction is maximum
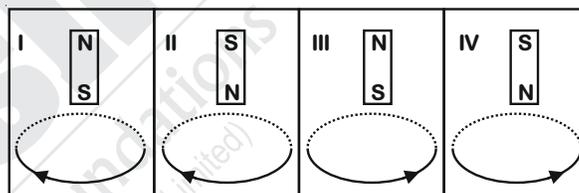
(a) I, III

(b) I, IV

(c) II, IV

(d) II, III

Answer (b)

Sol. Potential energy is maximum when interaction between coil and bar magnet is repulsive.

20. A beaker is completely filled with water at 4°C. Consider the following statements.

(I) Water will overflow if the beaker is cooled for some time.

(II) Water will overflow if the beaker is heated for some time.

Select correct option regarding (I) and (II)

(a) Only (I) is correct

(b) Only (II) is correct

(c) Both (I) and (II) are correct

(d) Neither (I) nor (II) is correct

Answer (c)

Sol. The density of water is maximum at 4°C, with increase or decrease in temperature density of water will decrease.

21. P^{3-} has a larger radius than atom of P because

    (a) There is greater coulombic attraction between the nucleus and electrons in the P^{3-} ion

    (b) The core electrons in P^{3-} exert a weaker shielding force than those of a neutral atom

    (c) The nuclear charge is weaker in P^{3-} than it is in P

    (d) The electrons in P^{3-} have a greater coulombic repulsion than those in P atom

Answer (d)

Sol. P^{3-} contains three more electrons as compared to atom of P. So the electrons in P^{3-} have a greater coulombic repulsion than those of P atom.

22. A substance is dissolved in water, forming a 0.5 molar solution. If 4.0 L of solution contains 240 g of the substance, what is the molecular mass of the substance?

    (a) 60 g/mole

    (b) 120 g/mole

    (c) 240 g/mole

    (d) 480 g/mole

Answer (b)

Sol. Molarity of solution = 0.5 M

Volume of solution = 4.0 L

Amount of substance = 240 g

Molarity of solution

$$= \frac{\text{Number of moles of solute}}{\text{Volume of solution (in litres)}}$$

$$\text{Molarity} = \frac{\text{Weight of substance}}{\text{Molecular weight} \times \text{Volume of solution}}$$

$$0.5 = \frac{240}{\text{M.Wt} \times 4}$$

$$\text{M.Wt.} = \frac{240}{0.5 \times 4} = 120 \text{ g/mole}$$

23. A car battery was kept for charging and after getting fully charged density of the battery acid (H_2SO_4) was measured and found to be 1.28 g cm^{-3}. If initial molarity of battery acid was 4.2 M then mass percentage will be around_____.

    (a) 28%

    (b) 30%

    (c) 32%

    (d) 34%

Answer (c)

Sol. Molarity of acid = 4.2 M

$$\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume of solution (in L)}}$$

$$4.2 = \frac{\text{Number of moles of solute}}{1}$$

Number of moles of solute = 4.2 moles

$$\text{Weight of solute} = \text{Number of moles} \times \text{Molecular weight}$$

$$= 4.2 \times 98$$

$$= 411.6 \text{ g}$$

Now, density of battery acid = 1.28 g/cm^3

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Mass = Density × Volume

$$= 1.28 \times 1000$$

Mass of solution = 1280 g

$$\text{Mass \% of solution} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{411.6}{1280} \times 100$$

$$= 32\%$$

24. Element "X" with atomic mass 10 was allowed to react completely with element "Y" of atomic mass 20 to form a compound. When this compound was analysed it was found that it contains 60% of X and 40% of Y by weight. The simplest formula of this compound will be _____.

(a) X_3Y
(b) X_2Y_3
(c) Y_3X
(d) X_6Y_4

Answer (a)

Sol.

Element	Percentage abundance	Given mass	Atomic mass (u)	No. of moles	Simple ratio
X	60	60 g	10	6	3
Y	40	40 g	20	2	1

The simplest formula of this compound will be = X_3Y

25. 4.095×10^{24} nitrogen atoms are filled in an enclosed gas cylinder of capacity two litre. The number of moles of nitrogen gas in the cylinder is _____.

(a) 14.7
(b) 6.8
(c) 3.4
(d) 2.9

Answer (c)

Sol. Number of moles of nitrogen gas (N_2)

$$= \frac{\text{Number of nitrogen atoms}}{N_A \times 2}$$

$$= \frac{4.095 \times 10^{24}}{6.022 \times 10^{23} \times 2} = 3.4 \text{ moles}$$

26. When a surface tension experiment with capillary tube is performed, water rises up to 0.1 m. If the experiment is carried out in space, water will rise in capillary tube _____.

(a) Up to height of 0.1 m

(b) Up to height of 0.2 m

(c) Up to height of 0.98 m

(d) Along its full length

Answer (d)

Sol. As the experiment is carried out in the space so g = 0.

Here adhesive force is much more greater than cohesive force. So water will rise in capillary along its full length.

27. Deepa was studying properties of gases. She took a flask and filled it with sulphur dioxide gas, and weighed it at temperature T and pressure P. The weight of the flask containing the gas was found to be W_1. She then flushed the flask, cleaned and filled it with methane at the same temperature and pressure. The weight of the flask containing oxygen was found to be W_2. She repeated the process with oxygen under the same conditions and found the weight to be W_3. The ratio of the weights $W_1 : W_2 : W_3$ is

(a) 2 : 1 : 4
(b) 4 : 2 : 1
(c) 4 : 1 : 2
(d) 1 : 2 : 4

Answer (c)

Sol. According to Avogadro's law, "Equal volume of all the gases under identical condition of temperature and pressure contain equal number of molecules".

According to the question

Number of moles of SO_2, $= \dfrac{W_1}{64}$

Number of moles of CH_4, $= \dfrac{W_2}{16}$

Number of moles of O_2, $= \dfrac{W_3}{32}$

Now, $\dfrac{W_1}{64} : \dfrac{W_2}{16} : \dfrac{W_3}{32}$

On comparing these

$W_1 : W_2 : W_3 = 4 : 1 : 2$

28. Four gas jars filled with sulphur dioxide gas were inverted into troughs of water by four students P, Q, R, S. The following observations and inference were reported by them.

P: Water did not enter the gas jar and sulphur dioxide is soluble in water.

Q: Water rushed into the gas jar and sulphur dioxide is soluble in water.

R: Water did not enter in the gas jar and sulphur dioxide is insoluble in water.

S: A small amount of water entered the gas jar slowly and sulphur dioxide is sparingly soluble in water.

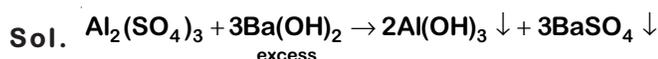Then the correct set of observations and inference is reported by,

(a) P
(b) Q
(c) R
(d) S

Answer (d)

Sol. Sulphur dioxide is sparingly soluble in water so observation of student 'S' is correct.

29. A solution of pure aluminium sulphate containing 0.170 g of aluminium ions is treated with excess of barium hydroxide solution. Total weight of the precipitate will be

   (a) 0.5 g

   (b) 2.7 g

   (c) 1.7 g

   (d) 0.54 g

Answer (b)

Sol. $Al_2(SO_4)_3 + 3Ba(OH)_2 \underset{\text{excess}}{\rightarrow} 2Al(OH)_3 \downarrow + 3BaSO_4 \downarrow$

2 moles Al^{3+} ions are present in 1 mole of $Al_2(SO_4)_3$

54 g Al^{3+} ions are present in 342 g $Al_2(SO_4)_3$

0.170 g Al^{3+} ions are present in $\frac{342}{54} \times 0.170$

$= 1.076$ g of $Al_2(SO_4)_3$

No. of moles of $Al_2(SO_4)_3 = \frac{1.076}{342}$

$= 0.00314$ mole

1 mole of $Al_2(SO_4)_3$ gives 2 moles of $Al(OH)_3$

0.00314 mole of $Al_2(SO_4)_3$ gives 0.00628 moles of $Al(OH)_3$

And 0.00628 moles of $Al(OH)_3 = 0.00628 \times 78$

$= 0.489$ g of $Al(OH)_3$

Similarly, 0.00314 moles of $Al_2(SO_4)_3$ give 0.00942 mole of $BaSO_4$

And 0.00942 mole of $BaSO_4$

$= 0.00942 \times 233.38$

$= 2.198$ g of $BaSO_4$

Total weight of precipitate ($BaSO_4 + Al(OH)_3$) $= 0.489 + 2.198$

$= 2.687$

~ 2.7 g

30. A region of one square meter area was given to each Suhas, Bobby, Sandy and Kimi in a garden. The daffodil plants grow best in the soil having a pH range of 6.0 to 6.5. If the soil has a pH 4.5, to grow daffodils, Suhas added common salt, Bobby added sodium phosphate, Sandy added aluminium sulphate and Kimi added ammonium chloride in their allotted area. Who was successful in growing daffodil?

   (a) Suhas

   (b) Bobby

   (c) Sandy

   (d) Kimi

Answer (b)

Sol. Required pH range = 6.0 to 6.5

Given pH = 4.5

Here Na_3PO_4 is the only basic salt. So, it can increase the pH to required range. Hence, Bobby was successful in growing daffodil.

31. Electrons in the last shell of X, Y, W and Z are 2, 6, 4 and 1 respectively. Which of the following statement is correct?

   (a) Melting point of compound formed by X and Y is more than that of by W and Z

   (b) Compound formed by X and Y is more volatile than that of by W and Z

   (c) Melting point of compound formed by X and Z is more than that of by W and Y

   (d) Incomplete information so inference cannot be drawn

Answer (a)

Sol. Compound formed by elements X and Y is an ionic compound whereas compound formed by elements W and Z is a covalent compound. Melting point of ionic compound is more than that of covalent compounds.

32. W g of pure coal was combusted in pure dry oxygen. The carbon dioxide gas obtained was absorbed in 0.1 M KOH solution. The complete absorption of CO_2 required 5 cm³ of 0.1 M KOH. The amount of coal combusted is

   (a) 3 mg

   (b) 6 mg

   (c) 11 mg

   (d) 12 mg

Answer (a)

Sol. $C + O_2 \longrightarrow CO_2$

$CO_2 + 2KOH \longrightarrow K_2CO_3 + H_2O$
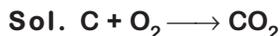
For complete absorbtion of CO_2, 5 cm^3 of 0.1 M KOH is required.

$\therefore$ Number of moles of KOH = 5 × 0.1

$\qquad\qquad\qquad$ = 0.5 milimoles

$\qquad\qquad\qquad$ = 5 × 10^{-4} moles

Now, 2 moles of KOH is needed by 1 mole of CO_2

$\therefore$ 5 × 10^{-4} moles of KOH is needed by

$$\frac{1}{2} \times 5 \times 10^{-4} = 2.5 \times 10^{-4} \text{ moles of } CO_2$$

$\because$ 1 mole of CO_2 is formed by 1 mole of coal

$\therefore$ 2.5 × 10^{-4} moles of CO_2 is formed by 2.5 × 10^{-4} moles of coal

$\therefore$ Weight of coal = Number of moles × M. Wt.

$\qquad\qquad$ = 2.5 × 10^{-4} × 12

$\qquad\qquad$ = 30 × 10^{-4} g

$\qquad\qquad$ = 3 × 10^{-3} g

$\qquad\qquad$ = 3 mg

33. Sulphur dioxide gas and ammonia gas were mixed in different proportions. The pair of gases containing same number of molecules at NTP is _____.

(a) 1120 cm^3 of SO_2 + 0.85 g of ammonia

(b) 0.25 g mole of SO_2 + 2240 cm^3 of ammonia

(c) 1680 cm^3 of SO_2 + 1.7 g of ammonia

(d) 0.25 g mole of SO_2 + 0.85 g of ammonia

Answer (a)

Sol. $\because$ 22400 mL of SO_2 = 1 mole of SO_2

$\therefore$ 1120 cm^3 = 1120 mL of SO_2

$$= \frac{1}{22400} \times 1120 = 0.05 \text{ moles of } SO_2$$

Also,

$\because$ 17 g of NH_3 = 1 mole of NH_3

$\therefore$ 0.85 g of $NH_3 = \frac{1}{17} \times 0.85 = 0.05$ moles of NH_3

(b) 0.25 g moles of SO_2 = 0.25 moles

2240 cm^3 of ammonia contains = 0.1 mole

(c) 1680 cm^3 of SO_2 contains = 0.075 moles

1.7 g of NH_3 contains = 0.1 moles

(d) 0.25 g moles of SO_2 = 0.25 moles

0.85 g of ammonia contains = 0.05 moles

$\therefore$ Option (a) is the correct answer.

34. A strip of iron with mass 15.5 g is placed in a solution containing 21.0 g copper sulphate. After some time the reaction stops. Iron strip was found to have mass 8.5 g. The mass of copper formed was found to be 8.60 g. Find the mass of ferrous sulphate formed in this reaction.

(a) 19.40 g

(b) 18.40 g

(c) 17.40 g

(d) 16.40 g

Answer (a)

Sol. $\underset{\substack{(15.5-8.5)g \\ =7g}}{Fe} + \underset{21.0\,g}{CuSO_4} \longrightarrow \underset{x\,g}{FeSO_4} + \underset{8.60g}{Cu}$

According to law of conservation of mass

Mass of reactants = Mass of products

7g + 21 g = x g + 8.60 g

x = 19.40 g

35. Sonu has N/2 HCl solution and Monu has N/10 HCl solution. They are asked to prepare 2 litres of N/5 HCl solution. What volume of two solutions be mixed?

(a) (0.5 + 1.5) litre

(b) (1.0 + 1.0) litre

(c) (0.3 + 1.7) litre

(d) (0.2 + 1.8) litre

Answer (a)

Sol. Using $\underset{\substack{\text{(Sonu's}\\\text{solution)}}}{N_1V_1} + \underset{\substack{\text{(Monu's}\\\text{solution)}}}{N_2V_2} = \underset{\substack{\text{(Final}\\\text{solution)}}}{N_3V_3}$

$$\frac{1}{2} \times x + \frac{1}{10}(2-x) = \frac{1}{5} \times 2$$

On solving, we get,

$x = 0.5$ L

$2 - x = 1.5$ L

36. A solution (P) was prepared by dissolving 6.3 g of oxalic acid in 100 ml water. 25 ml of this solution was taken and was further diluted to 250 ml to prepare solution (Q). What weight of NaOH in ppm will be required to neutralize 10 ml of solution (Q)?

    (a) 10 ppm   (b) 20 ppm

    (c) 40 ppm   (d) 80 ppm

Answer (c)

Sol. No. of moles of oxalic acid $= \dfrac{6.3}{126} = 0.05$ moles

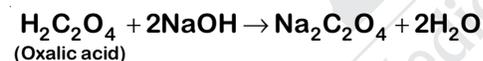Molarity of solution 'P' $= \dfrac{0.05}{100} \times 1000$

$\qquad\qquad\qquad\qquad = 0.5$ M

To find out molarity of solution 'Q'

$M_1V_1 = M_2V_2$

(P) = (Q)

$0.5 \times 25 = M_2 \times 250$

$M_2 = \dfrac{0.5 \times 25}{250} = 0.05$ M

$\underset{\text{(Oxalic acid)}}{H_2C_2O_4} + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

Here, 10 ml of 'Q' is used.

So, number of moles of 'Q' used for neutralisation $= \dfrac{10}{1000} \times 0.05$

$= 5 \times 10^{-4}$ moles

∵ 1 mole of 'Q' (oxalic acid) is needed by 2 mole of NaOH.

So, 5×10^{-4} moles of Q is needed by 10^{-3} moles of NaOH

Weight of NaOH required $= 40 \times 10^{-3}$ g

$\qquad\qquad\qquad\qquad = 40$ ppm

37. Which of the following can improve the quality of petrol?

    (a) n heptane   (b) Benzene

    (c) n hexadecane   (d) Iso-octane

Answer (d)

Sol. Iso-octane can improve the quality of petrol.

Higher the octane number, better is the quality of fuel.

38. $2KBrO_3 + 12H^+ + 10e^- \longrightarrow Br_2 + 6H_2O + 2K^+$

From above reaction the equivalent weight of $KBrO_3$ can be calculated as (M is molecular weight of $KBrO_3$)

    (a) $\dfrac{M}{5}$ (b) $\dfrac{M}{10}$

    (c) $\dfrac{M}{12}$ (d) $\dfrac{M}{2}$

Answer (a)

Sol. ∵ For 2 moles of $KBrO_3$ we require 10 electrons

∴ For 1 mole of $KBrO_3$ we require 5 electrons

Equivalent weight of $KBrO_3$

$= \dfrac{\text{Molecular weight}}{\text{Number of electron lost or gained by one mole}}$

$= \dfrac{M}{5}$

39. Shaila took about 10 cm^3 of a diluted Potassium hydrogen carbonate solution in a test tube. To this solution she added few drops of universal indicator. The colour of the solution turned :

    (a) Orange   (b) Green

    (c) Blue   (d) Yellow

Answer (c)

Sol. Potassium hydrogen carbonate ($KHCO_3$) is basic in nature because it is a salt of strong base (KOH) and weak acid (H_2CO_3). So, the colour of the solution turns blue on adding universal indicator.

40. Which of the following is incorrect?

    (a) Chalcocite - Copper

    (b) Magnetite - Iron

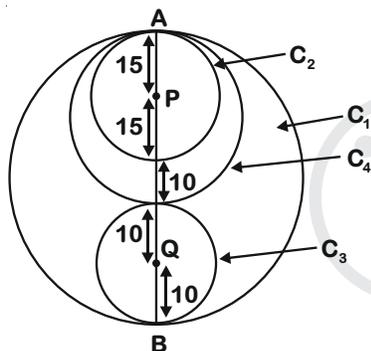   (c) Calamine - Aluminium

    (d) Galena - Lead

Answer (c)

Sol. Calamine is an ore of zinc.

41. Let AB be a diameter of a circle C_1 of radius 30 cm and with center O. Two circles C_2 and C_3 of radii 15 cm and 10 cm touch C_1 internally at A and B respectively. A fourth circle C_4 touches C_1, C_2 and C_3. What is the largest possible radius of C_4?

(a) 12 cm

(b) 15 cm

(c) 20 cm

(d) 30 cm

Answer (c)

Sol.

P and Q be the centres of circles of C_2 and C_3 respectively

Diameter of circle C_4 = 15 + 15 + 10

$\quad\quad\quad = 40$ cm

∴ Radius of circle C_4 = 20 cm

Hence, option (c) is correct

42. A 5 × 5 × 5 cube is built using unit cubes. How many different cuboids (that differ in at least one unit cube) can be formed using the same number of unit cubes?

(a) 1000

(b) 1728

(c) 2730

(d) 3375

Answer (d)

Sol. Selecting 1, 2, 3, 4 or 5 cubes at a time, taken lengthwise, breadthwise and height wise.

We got total number of cuboids =

$\quad (1 + 2 + 3 + 4 + 5)^3 = 3375$

Option - (d) is correct

43. What is the largest value of the positive integer k such that k divides $n^2(n^2 - 1)$ $(n^2 - n - 2)$ for every natural number n?

(a) 6

(b) 12

(c) 24

(d) 48

Answer (d)

Sol. On factorising $n^2(n^2 - 1)$ $(n^2 - n - 2)$

We get $(n - 2)$ $(n - 1)$ $n^2(n + 1)^2$ ...(i)

Since, $n \in N$,

If we take n = 3, 4, 5, we get 288, 2400 and 10800 respectively

HCF of (288, 2400, 10800) is 48

∴ (i) is always divisible by 6, 12, 24 and 48

∴ Required largest value = 48

Hence, option (d) is correct

44. A person kept rolling a regular (six faced) die until one of the numbers appeared third time on the top. This happened in 12th throw and the sum of all the numbers in 12 throws was 46. Which number appeared least number of times?

(a) 6   (b) 4

(c) 2   (d) 1

Answer (c) & (d)#

Sol. Clearly, till 11th throw 5 of 6 numbers would have come twice and one number only once. In 12th throw one of 5 numbers comes 3rd times.

$\Rightarrow 3x_6 + 2x_1 + 2x_2 + 2x_3 + 2x_4 + x_5 = 46$

$\Rightarrow 2(x_1 + x_2 + x_3 + x_4 + x_5 + x_6) + x_6 - x_5 = 46$...(i)

∵ $x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 21$ ...(ii)

$\quad\quad\quad [\because 1 + 2 + 3 + 4 + 5 + 6 = 21]$

$\Rightarrow x_6 - x_5 = 46 - 42$

[From equation (i) and (ii)]

$\Rightarrow x_6 - x_5 = 4$

∴ (6, 2) and (5, 1) are the possibilities

∴ $x_5 = 1$ or 2.
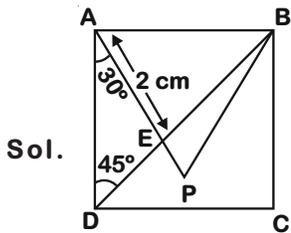
Hence, either 1 or 2 will be least.

∴ Option (c) and (d) are correct

45. In a square ABCD, a point P is inside the square such that ABP is an equilateral triangle. The segment AP cuts the diagonal BD in E. Suppose AE = 2. The area of ABCD is

(a) $4 + 2\sqrt{3}$

(b) $5 + 2\sqrt{3}$

(c) $4 + 4\sqrt{3}$

(d) $5 + 4\sqrt{3}$

Answer (a)

Sol.

$\angle AED = 105°$

Let side of square be 'a' cm

Using sine rule,

$$\frac{AD}{\sin\angle DEA} = \frac{AE}{\sin\angle ADE} = \frac{DE}{\sin\angle DAE}$$

$$\frac{AD}{\sin 105°} = \frac{2}{\sin 45°}$$

$\Rightarrow$ $\dfrac{a}{\dfrac{1+\sqrt{3}}{2\sqrt{2}}} = \dfrac{2}{\dfrac{1}{\sqrt{2}}}$

$\Rightarrow$ $a = 1 + \sqrt{3}$

$\therefore$ Area of square ABCD $= \left(1+\sqrt{3}\right)^2$

$= \left(4 + 2\sqrt{3}\right)$ sq. units

Hence, option (a) is correct

46. Let n be a positive integer not divisible by 6. Suppose n has 6 positive divisors. The number of positive divisors of 9n is

(a) 54   (b) 36

(c) 18   (d) 12

Answer (c) & (d)#

Sol. According to question, n is not divisible by 6 and number of divisors of n is 6.

$\therefore$ $9n = 3^2 \times n$

No. of positive divisors = (2 + 1)6 = 18

Let n = 147 = $7^2 \times 3^1$

$\therefore$ 9n = $7^2 \times 3^3$

No. of positive divisors = 12

Let n = 243 = 3^5

$\therefore$ 9n = 3^7

$\therefore$ Number of positive divisors = 8

and many other possibilities are there

Hence, option (c) & (d) both are correct

47. The value of $\dfrac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}}$, when $x = \dfrac{2a}{b^2+1}$

is:

(a) a   (b) b

(c) x   (d) 0

Answer (*)

Sol. $\dfrac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}} = \lambda$ (let)

$\Rightarrow \dfrac{\lambda+1}{\lambda-1} = \dfrac{\sqrt{a+x}}{-\sqrt{a-x}}$ [On applying componendo and dividendo]

Squaring both sides, we get

$\Rightarrow \dfrac{\lambda^2 + 2\lambda + 1}{\lambda^2 - 2\lambda + 1} = \dfrac{a+x}{a-x}$

Again applying componendo and dividendo, we get $\dfrac{\lambda^2 + 1}{2\lambda} = \dfrac{a}{x}$

If we have, $x = \dfrac{2ab}{b^2+1}$

$\Rightarrow \dfrac{a}{x} = \dfrac{b^2+1}{2b}$

$\Rightarrow \dfrac{\lambda^2+1}{2\lambda} = \dfrac{b^2+1}{2b}$

$\Rightarrow \lambda = b$

But we have given

$x = \dfrac{2a}{b^2+1}$, so we couldn't get the correct option.

48. Two regular polygons of different number of sides are taken. In one of them, its sides are coloured red and diagonals are coloured green, in the other, sides are coloured green and diagonals are coloured red. Suppose there are 103 red lines and 80 green lines. The total number of sides the two polygons together have is:

(a) 23   (b) 28

(c) 33   (d) 38

Answer (b)

Sol. I^{st} regular polygon has n_1 sides.

∴ n_1 = Red

$\dfrac{n_1(n_1-3)}{2} = \text{Green}$

IInd regular polygon has n_2 sides.

∴ n_2 = Green

$\dfrac{n_2(n_2-3)}{2} = \text{Red}$

∴ $n_1 + \dfrac{n_2(n_2-3)}{2} = 103$ …(i)

And $n_2 + \dfrac{n_1(n_1-3)}{2} = 80$ …(ii)

From equation (i) and (ii), we get

$\Rightarrow (n_1 - n_2) + \dfrac{1}{2}[n_2{}^2 - 3n_2 - n_1{}^2 + 3n_1] = 23$

$\Rightarrow (n_2 - n_1)\left[-1 + \dfrac{n_1 + n_2}{2} - \dfrac{3}{2}\right] = 23$

$\Rightarrow (n_2 - n_1)(n_1 + n_2 - 5) = 46$

$\Rightarrow n_2 - n_1 = 1$ or $n_2 - n_1 = 2$

$\Rightarrow n_1 + n_2 = 51$ or $n_1 + n_2 = 28$

Option (b) is true.

49. A box contains some red and some yellow balls. If one red ball is removed, one seventh of the remaining balls would be red; if one yellow ball is removed, one-sixth of the remaining balls would be red. If n denotes the total number of balls in the box, then the sum of the digits of n is

(a) 6   (b) 7

(c) 8   (d) 9

Answer (b)

Sol. Let red balls be x and yellow balls be y

$x = \dfrac{n-1}{7} + 1$

$\Rightarrow \quad x = \dfrac{n-1}{6}$

$\Rightarrow \quad \dfrac{n-1}{7} + 1 = \dfrac{n-1}{6}$

$\Rightarrow \quad 6n + 36 = 7n - 7$

$\Rightarrow \quad n = 43$

Sum of digits = 7

Hence, option (b) is correct

50. Let ABCD be a rectangle. Let X and Y be points respectively on AB and CD such that AX : XB = 1 : 2 = CY : YD. Join AY and CX; let BY intersect CX in K; let DX intersect AY in L. If m/n denotes the ratio of the area of XKYL to that of ABCD, then m + n equals

(a) 9   (b) 11

(c) 13   (d) 15

Answer (b)

Sol.

Now, In ABCD

AB = CD

AX = CY

$\Rightarrow$ AXCY is a parallelogram.

In ΔDXC

LY || XC

$\Rightarrow$ DL : DX = 2 : 3

$\Rightarrow$ ar(ΔDLY) = $\dfrac{4}{9}$ ar(ΔDCX)

$\Rightarrow$ ar(ΔYKC) = $\dfrac{1}{9}$ ar(ΔDCX)

$\Rightarrow$ ar(XLYK) = $1 - \dfrac{5}{9} = \dfrac{4}{9}$ ar(ΔDCX)

ar(ΔDCX) = $\dfrac{ar}{2}$ (ABCD)

$\Rightarrow$ ar(XLYK) = $\dfrac{4}{9} \times \dfrac{1}{2}$ ar(ABCD)

           = $\dfrac{2}{9}$ ar(ABCD)

m = 2, n = 9

$\Rightarrow$ m + n = 11

Hence, option (b) is correct

51. Let ABC be an equilateral triangle. The bisector of ∠BAC meets the circumcircle of ABC in D. Suppose DB + DC = 4. The diameter of the circumcircle of ABC is

(a) 4

(b) $3\sqrt{3}$

(c) $2\sqrt{3}$

(d) 2

Answer (a)

Sol.
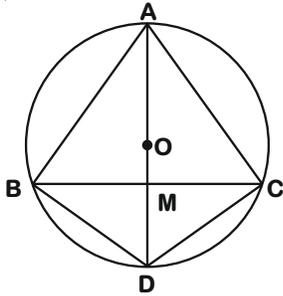
Let O be the centre of the circle and AM be the median of ∆ABC. Median of equilateral triangle overlap the diameter

∴ ∠ABD = ∠ACD = 90°

∠CBD = ∠BCD = 30°

⇒ DB = DC = 2

In ∆ABD

$$\cos 60° = \frac{BD}{AD}$$

$$\Rightarrow \frac{1}{2} = \frac{2}{AD}$$

⇒ AD = 4

Hence, option (a) is correct

52. Let T_k denote the k-th term of an arithmetic progression. Suppose there are positive integers $m \neq n$ such that $T_m = \frac{1}{n}$ and $T_n = \frac{1}{m}$. Then T_{mn} equals

(a) $\frac{1}{mn}$

(b) $\frac{1}{m} + \frac{1}{n}$

(c) 1

(d) 0

Answer (c)

Sol. $a + (m - 1)d = \frac{1}{n}$

$a + (n - 1)d = \frac{1}{m}$
_____

$(m - n)d = \frac{m-n}{mn}$

$$d = \frac{1}{mn}$$

$$\Rightarrow a + \frac{1}{n} - \frac{1}{mn} = \frac{1}{n}$$

$$\Rightarrow a = \frac{1}{mn}$$

∴ $T_{mn} = a + (mn - 1)d$

$$\Rightarrow T_{mn} = \frac{1}{mn} + 1 - \frac{1}{mn}$$
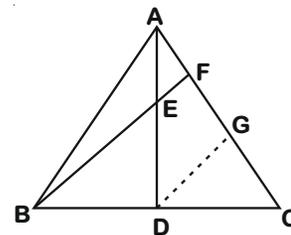
$$\Rightarrow T_{mn} = 1$$

Hence, option (c) is correct

53. In a triangle ABC, let AD be the median from A; let E be a point on AD such that AE : ED = 1 : 2; and let BE extended meets AC in F. The ratio of $\frac{AF}{FC}$ is

(a) $\frac{1}{6}$

(b) $\frac{1}{5}$

(c) $\frac{1}{4}$

(d) $\frac{1}{3}$

Answer (c)

Sol. Draw DG || BF

$$\frac{AF}{FG} = \frac{1}{2}$$

⇒ FG = 2AF   ...(i)

Since, DG || EF

$\Rightarrow \quad \dfrac{CG}{FG} = \dfrac{CD}{BD} = 1$

$\Rightarrow \quad CG = FG \qquad \qquad ...(ii)$

$FC = FG + GC$

$\Rightarrow \quad FC = 2AF + 2AF \qquad$ [From (i) and (ii)]

$\Rightarrow \quad FC = 4AF$

$\therefore \quad \dfrac{AF}{FC} = \dfrac{1}{4}$

Hence, option (c) is correct

54. If $\sin \theta$ and $\cos \theta$ are roots of the equation $px^2 + qx + r = 0$, then :

(a) $p^2 - q^2 + 2pr = 0$ (b) $(p + r)^2 = q^2 - r^2$

(c) $p^2 + q^2 - 2pr = 0$ (d) $(p - r)^2 = q^2 + r^2$

Answer (a)

Sol. $\sin\theta + \cos\theta = \dfrac{-q}{p} \qquad ...(i)$

$\sin\theta . \cos\theta = \dfrac{r}{p}$

On squaring (i), we get

$\sin^2\theta + \cos^2\theta + 2\sin\theta\cos\theta = \dfrac{q^2}{p^2}$

$\Rightarrow \quad 1 + \dfrac{2r}{p} = \dfrac{q^2}{p^2}$

$\Rightarrow \quad (p^2 - q^2 + 2rp = 0)$

Hence, option (a) is correct

55. For a regular k-sided polygon, let $\alpha(k)$ denotes its interior angle. Suppose n > 4 is such that $\alpha(n-2)$, $\alpha(n)$, $\alpha(n + 3)$ forms an arithmetic progression. The sum of digits of n is

(a) 2   (b) 3

(c) 4   (d) 5

Answer (b)

Sol. $\alpha(k) = \dfrac{(k-2)180°}{k}$

As $\alpha(n-2)$, $\alpha(n-1)$, $\alpha(n + 3)$ are in A.P.

$\dfrac{(n-4)180°}{n-2} - \dfrac{(n-2)180°}{n} = \dfrac{(n-2)180°}{n} - \dfrac{(n+1)180°}{n+3}$

$\Rightarrow \quad 1 - \dfrac{2}{n-2} - 1 + \dfrac{2}{n} = 1 - \dfrac{2}{n} - 1 + \dfrac{2}{n+3}$

$\Rightarrow \quad \dfrac{-n+n-2}{n(n-2)} = \dfrac{-n-3+n}{n(n+3)}$

$\Rightarrow \quad \dfrac{-2}{n(n-2)} = \dfrac{-3}{n(n+3)}$

$n = 12$

$\therefore$ Sum of digits = 1 + 2 = 3

Hence, option (b) is correct

56. The sum of 5 numbers in geometric progression is 24. The sum of their reciprocals is 6. The product of the terms of the geometric progression is

(a) 36   (b) 32

(c) 24   (d) 18

Answer (b)

Sol. $\dfrac{a}{r^2} + \dfrac{a}{r} + a + ar + ar^2 = 24$

$\Rightarrow \quad a\left[\dfrac{1+r+r^2+r^3+r^4}{r^2}\right] = 24$

$\Rightarrow \quad \dfrac{1+r+r^2+r^3+r^4}{r^2} = \dfrac{24}{a} \qquad .....(i)$

$\dfrac{r^2}{a} + \dfrac{r}{a} + \dfrac{1}{a} + \dfrac{1}{ar} + \dfrac{1}{ar^2} = 6$

$\Rightarrow \quad \dfrac{1}{a}\left[\dfrac{r^4+r^3+r^2+r+1}{r^2}\right] = 6 \qquad .....(ii)$

From (i) and (ii)

$\dfrac{1}{a} \times \dfrac{24}{a} = 6$

$\Rightarrow \quad a = \pm 2$

$\therefore$ Product of terms is $\dfrac{2}{r^2} \times \dfrac{2}{r} \times 2 \times 2r \times 2r^2$

$\qquad \qquad \qquad = 32$

Hence, option (b) is correct.

57. Digits a and b are such that the product $\overline{4a1} \times \overline{25b}$ is divisible by 36 (in base 10). The number of ordered pairs (a, b) is

(a) 15   (b) 8

(c) 6   (d) 4

Answer (*) No option is correct

Sol. $\overline{4a1} \times \overline{25b}$ to be divisible by 36.

If we take b = 2, then 252 is divisible by 36

So, a = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

One more possibility is there

If a = 4, b = 6

∴ Total no. of ordered pairs = 11

∴ Hence, no option is correct

58. The integer closest to $\sqrt{\overline{111...1 - 222...2}}$, where there are 2018 ones and 1009 twos, is

(a) $\dfrac{10^{1009} - 1}{3}$

(b) $\dfrac{10^{1009} - 1}{9}$

(c) $\dfrac{10^{2018} - 1}{3}$

(d) $\dfrac{10^{2018} - 1}{9}$

Answer (a)

Sol. $\sqrt{\overline{111......1 - 222......2}}$

2018 ones and 1009 twos.

$$= \sqrt{\dfrac{1}{9}[\overline{999......9} - 2(\overline{999......9})}}$$

$$= \sqrt{\dfrac{1}{9}[10^{2018} - 1 - 2(10^{1009} - 1)]}$$

$$= \sqrt{\dfrac{1}{9}[(10^{1009})^2 - 2(10)^{1009} + 1]}$$

$$= \sqrt{\left(\dfrac{10^{1009} - 1}{3}\right)^2}$$
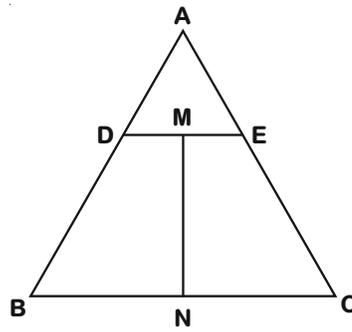
$$= \dfrac{10^{1009} - 1}{3}$$

Option (a) is correct.

59. In a triangle ABC, a point D on AB is such that AD : AB = 1 : 4 and DE is parallel to BC with E on AC. Let M and N be the midpoints of DE and BC respectively. What is the ratio of the area of the quadrilateral BNMD to that of triangle ABC ?

(a) $\dfrac{1}{4}$

(b) $\dfrac{9}{32}$

(c) $\dfrac{7}{32}$

(d) $\dfrac{15}{32}$

Answer (d)

Sol.

ΔADE ~ ΔABC

$$\dfrac{AD}{AB} = \dfrac{AE}{AC} = \dfrac{DE}{BC} = \dfrac{1}{4}$$

$$ar(BDEC) = \dfrac{15}{16}\, ar(\Delta ABC)$$

ar (BNMD) = ar(NCEM)

$$\Rightarrow ar(BNMD) = \dfrac{15}{32}\, ar(\Delta ABC)$$

Hence, option (d) is correct

60. The number of distinct integers in the collection $\left[\dfrac{10^2}{1}\right], \left[\dfrac{10^2}{2}\right], \left[\dfrac{10^2}{3}\right], ..., \left[\dfrac{10^2}{20}\right]$, where [x] denotes the largest integer not exceeding x, is

(a) 20

(b) 18

(c) 17

(d) 15

Answer (d)

Sol. [x] denotes the largest integer not exceeding x

$$\left[\dfrac{10^2}{1}\right], \left[\dfrac{10^2}{2}\right], ... \left[\dfrac{10^2}{20}\right]$$

$$= [100], [50], \left[\dfrac{100}{3}\right] .....$$

$$..... \left[\dfrac{50}{9}\right], \left[\dfrac{100}{19}\right], [5]$$

= 100, 50, 33, 25, 20, 16, 14, 12, 11, 10, 9, 8, 7, 7, 6, 6, 5, 5, 5, 5.

So, distinct integer values = 15

Hence, option (d) is correct.

61. True coelom is not present in animals of

   (a) Platyhelminthes   (b) Annelida

   (c) Echinodermata   (d) Arthropoda

Answer (a)

Sol. The body cavity lined by mesoderm is called coelom. The animals which possess coelom are annelids, echinoderms and arthropods, where as platyhelminthes are devoid of coelom. Hence, they are acoelomate.

62. The intracellular organelle that is responsible for formation of acrosomal vesicle is

   (a) Endoplasmic reticulum

   (b) Golgi apparatus

   (c) Mitochondrion

   (d) None of the above

Answer (b)

Sol. Acrosome is an organelle that develops over the anterior half of the head in the spermatozoa. This part of the sperm cell is formed by an organelle known as Golgi apparatus.

63. The genetically modified (GM) brinjal in India has been developed for

   (a) Enhancing shelf life

   (b) Insect-resistance

   (c) Drought-resistance

   (d) Enhancing mineral content

Answer (b)

Sol. The genetically modified (GM) brinjal in India, *i.e.,* Bt Brinjal has been developed which is resistance to shoot and fruit borer insects.

64. A scientist observed few cells under a microscope with following characters:

   i.   Cells divided by binary fission or fragmentation, or budding

   ii. Cells moved with the help of flagella

   iii. Ether lipids were observed in cell membranes

   iv. Peptidoglycans were noted in the cell walls

   Which of the following category do the cells belong to?

   (a) Archaea

   (b) Plant cells

   (c) Unicellular eukaryotes

   (d) Cyanobacteria

Answer (a)

Sol. Archaea are prokaryotes. They reproduce asexually by binary fission, fragmentation or by the budding process. They have ether bonds with the branching of aliphatic acids in their lipid membrane. They use flagella for motility. Their cell wall is said to be as pseudopeptidoglycan.

65. Character(s) of acquired immunity is (are)

   (a) Differentiation between self and non-self

   (b) Specificity of antigen

   (c) Retains memory

   (d) All the above

Answer (d)

Sol. Acquired immunity is the immunity that our body gains over time, similar to how an individual gains knowledge. The three important characteristics of acquired immunity are self-recognition, specificity and memory.

66. Instead of using chemical fertilizers in a paddy field, a farmer thought of employing nitrogen fixation technique. Amongst the following which would be beneficial for his cause?

   (a) *Glycine max - Rhizobium*

   (b) *Cycas - Nostoc*

   (c) *Casuarina - Frankia*

   (d) *Azolla - Anabaena*

Answer (d)

Sol. *Azolla* is a fresh water pteridophyte maintains a symbiotic relationship with nitrogen-fixing cyanobacterium *Anabaena*. *Azolla* is either incorporated into the soil before rice transplanting or grown as a dual crop along with rice.

67. An action potential in the nerve fibre is produced when positive and negative charges on outside and inside of the axon membrane are reversed because

   (a) All potassium ions leave the axon

   (b) More potassium ions enter the axon as compared to sodium ions leaving it

   (c) More sodium ions enter the axon as compared to potassium ions leaving it

   (d) All sodium ions enter the axon

Answer (c)

Sol. When a stimulus is applied to a polarised membrane, the permeability of the membrane to Na^+ ions is greatly increased at the point of stimulation.

As a result more Na⁺ ions enter the axonal membrane than leaving it, the electrical potential of the membrane changes from negative to positive. Hence, the membrane is said to be depolarised.

68. A geneticist was studying the pathway of synthesis of an amino acid 'X' in an organism. The presence (either synthesized *de novo* or externally added) of 'X' is a must for the survival of that organism. She isolated several mutants that require 'X' to grow. She tested whether each mutant would grow when different additives, P, Q, R, S and T were used. '+' indicates growth and '−' indicates the inablity to grow in the mutants tested. Find out the correct sequence of additives in the biosynthetic pathway of 'X'.

Organisms	Additives				
	P	Q	R	S	T
Wild-type	+	+	+	+	+
Mutant 1	−	−	−	−	+
Mutant 2	−	+	+	+	+
Mutant 3	−	−	+	−	+
Mutant 4	−	+	+	−	+

(a) P → Q → R → S → T

(b) P → R → S → Q → T

(c) T → P → Q → S → R

(d) P → S → Q → R → T

Answer (d)

Sol. In additive P, none of the mutants 1, 2, 3 and 4 grow.

In additive S, only mutant 2 grows.

In additive Q, only the mutants 2 and 4 grow.

In additive R, mutants 2, 3 and 4 grow.

And in additive T, all the mutants 1, 2, 3 and 4 grow.

Therefore the correct sequence of additives in the biosynthetic pathway of 'X' would be

P → S → Q → R → T

69. In a case of mammalian coat color, the principal gene identified is 'C' which codes for a tyrosinase enzyme. In case of rabbits four different phenotypes are observed *Full Color > Chinchilla > Himalayan > Albino* (in order of the expression of gene 'C' and its alleles). In a progeny obtained after crossing two rabbits, the percentages of *Chinchilla*, *Himalayan* and

Albino rabbits were 50, 25 and 25 respectively. What must have been the genotypes of the parent rabbits?

(a) $C^{ch}C^{ch}$ X $C^{ch}c$ (b) $C^{ch}C^{h}$ X $C^{ch}c$

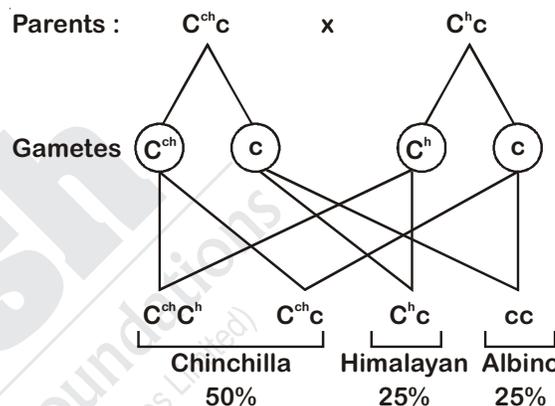(c) $C^{ch}c$ X $C^{h}c$ (d) $C^{h}C^{h}$ X $C^{ch}C^{ch}$

Answer (c)

Sol. Here :

Genotype of Full Colour - $C^{ch}C^{ch}$

Genotype of Chinchilla - $C^{ch}C^{h}$ or $C^{ch}c$

Genotype of Himalayan - $C^{h}C^{h}$ or $C^{h}c$

Genotype of Albino - cc

Parents : $C^{ch}c$ x $C^{h}c$

Gametes C^{ch} c C^{h} c

$C^{ch}C^{h}$ $C^{ch}c$ $C^{h}c$ cc

Chinchilla Himalayan Albino
50% 25% 25%

70. It was observed in a group of tadpoles of a mutant frog reared in a laboratory that their development was arrested at a particular stage. The exact tissue that was affected by the mutation is unknown. The development was then resumed and accelerated by injecting the tadpoles with the extracts prepared from various tissues of the wild type frogs. The observations of the experiment are given below.

Experiment No.	Tissue Extract	Observations
1	Anterior lobe of pituitary	Development resumed
2	Posterior lobe of pituitary	Development did not resume
3	Thyroid gland	Development resumed
4	Anterior lobe of pituitary + Thyroid gland	Development resumed
5	Anterior + posterior lobe of pituitary	Development resumed
6	Posterior lobe of pituitary + Thyroid gland	Development did not resume

From the above observations, find out the tissue that is affected by the mutation.

(a) Anterior lobe of pituitary

(b) Posterior lobe of pituitary

(c) Thyroid gland

(d) Both pituitary and thyroid gland

Answer (a)

Sol. Frog requires thyroid hormone(TH) for the further development. Anterior lobe of pituitary secretes thyroid-stimulating hormone(TSH), which stimulates the thyroid gland to produce thyroxine hormone.

Since, when the tadpole is given the extract of anterior lobe of pituitary only, its development resumed, it shows that anterior lobe of pituitary is not functioning properly but its thyroid gland is functioning.

71.

Group A	Group B
Salmon	Alpine salamander
Bullfrog	Spiny anteater
Platypus	Common toad
Bull shark	Crocodile

Identify the odd ones from each group (A and B) based on same criterion.

(a) Platypus, Alpine salamander

(b) Bull shark, Alpine salamander

(c) Bullfrog, Crocodile

(d) Platypus, Common toad

Answer (b)

Sol. **In Group A :** Salmon, Bullfrog and Platypus are oviparous, while Bull shark is viviparous.

In Group B : Spiny anteater, Common toad and Crocodile are oviparous, while some species of Alpine salamander are viviparous.

72. A patient was administered a chemical agent called Guanfacine hydrochloride after the patient showed the symptoms like shortness of breath and headache. Guanfacine hydrochloride is a known stimulant of central α_2-adrenergic receptors of the medulla regulating the sympathetic nervous system. The patient in this case must be suffering from

(a) Hypertension   (b) Hyperstimulation

(c) Hyperpolarization (d) None of the above

Answer (a)

Sol. Guanfacine is a sympatholytic drug used to treat hypertension and attention deficit hyperactivity disorder.

73. A bacterial dsDNA molecule, 2988 bp in length, was found to have the following composition
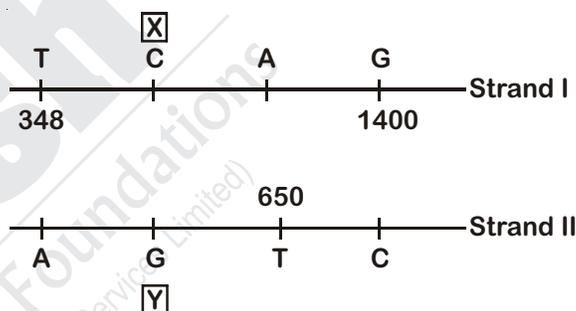
	T	C	A	G
Strand I	348	X		1400
Strand II	650			Y

The respective values of X and Y are

(a) 1400 and 590   (b) 590 and 1400

(c) 590 and 590   (d) None of the above

Answer (c)

Sol.

In strand I number of adenine(A) = Number of thymine in strand II = 650

Therefore, 'X' = 2988 – (348 + 650 + 1400)

= 2988 – 2398

= 590

Similarly, in strand II numbers of A and C will be 348 and 1400 respectively.

Therefore, Y = 2988 – (348 + 650 + 1400)

= 590

74. What would be the length of a polypeptide translated from mRNA which is encoded by 2988 bp of a bacterial gene?

(a) 989   (b) 992

(c) 995   (d) 998

Answer (c)

Sol. Three bases (called the triplet code) encode one amino acid. The total number of triplet codons in the mRNA containig 2988 bp will be 2988/3 = 996.

The terminal codon will be for stop signal which does not code for any amino acid, therefore the length of polypeptide = 996 – 1

= 995

75. A student recorded the data for five types of cells as geven below

| Character	P	Q	R	S	T
Cell wall	+	+	–	–	+
Centrioles	–	–	–	+	–
Chloroplast	–	+	–	–	–
Mitochondrion	–	+	–	+	+
Nucleus	–	+	–	+	+
Plasma membrane	+	+	–	+	+
RNA/DNA	+	+	+	+	+
Vacuoles	+	+	–	+	+

The five cell types P, Q, R, S and T are:

(a) P-Bacterium, Q-Plant, R-Virus, S-Animal, T-Fungus

(b) P-Bacterium, Q-Plant, R-Virus, S-Fungus, T-Animal

(c) P-Fungus, Q-Plant, R-Bacterium, S-Animal, T-Virus

(d) P-Plant, Q-Bacterium, R-Virus, S-Animal, T-Fungus

Answer (a)

Sol. A prokaryotic cell (Bacterium) has cell wall, plasma-membrane, genetic material (RNA/DNA) and vacuole.

Plant, animal and fungal cells are eukaryotic.

Viruses have RNA or DNA as genetic material enclosed in protein coat.

76. An environment conservation group performed a survey of some diverse location in the country and represented it as under
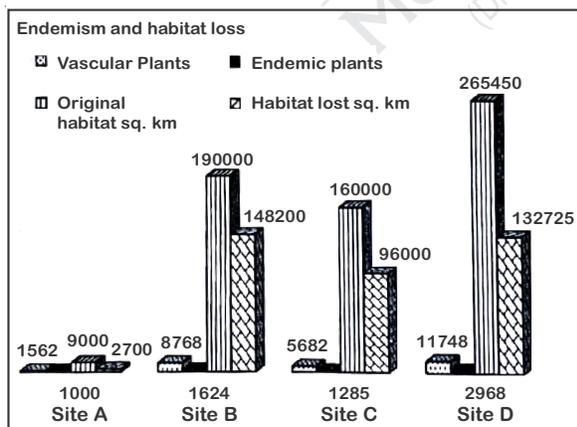
Which amongst these sites should be included as a biodiversity hotspot?

(a) Site A   (b) Site B

(c) Site C   (d) Site D

Answer (b)

Sol. To qualify as a hotspot, a region must meet two criteria:

⇒ It must contain at least 1500 species of vascular plants (>0.5% of the world's total) as endemics.

⇒ It has to have lost $\geq 70\%$ of its original native habitat.

Since, the site B and site D have more than 1500 species of vascular plants as endemics, but the habitat lost in site B is > 70% of its original native habitat. So, the site B should be included as a biodiversity hotspot.

77. A bacterium has a generation time of 50 minutes. A culture containing 10^8 cells per mL is incubated for 300 minutes. What will be the number of cells after 300 minutes?

(a) 64×10^3 cells   (b) 6.4×10^8 cells

(c) 64×10^9 cells   (d) 6.4×10^9 cells

Answer (d)

Sol. Number of generations in 300 minutes

$$= \frac{300}{50} = 6$$

Therefore, number of cells after 6th generation

$= 2^6 \times 10^8$

$= 64 \times 10^8$

$= 6.4 \times 10^9$

78. The blood grouping system is an example of 'multiple allelism'. In order to find out the gene products of various gene variants, different enzymes (codes used for the purpose of experimentation are X and Y) from four blood samples were assayed. The enzymes were quantified and the information obtained from these experiments is given in percentages in the following table. '+' indicates presence of an enzyme and '–' indicates the absence of that enzyme from the blood sample. The standard codes for dominant and recessive alleles are considered. Identify the blood groups of subjects and choose the correct option of their genotypes from given options. (In table: P means present, A means absent)

Subjects →	Ramesh		Ali		Sophia		Balwinder	
Enzymes ↓	P/A	%	P/A	%	P/A	%	P/A	%
X	+	50	+	50	+	100	–	–
Y	–	–	+	50	–	–	+	100

(a) $I^A i$, ii, $I^B i$, $I^A I^B$ (b) $I^A i$, $I^A I^B$, $I^A I^A$, $I^B I^B$

(c) $I^B i$, $I^A I^B$, ii, $I^B i$ (d) $I^B i$, ii, $I^A I^B$, $I^A i$

Answer (b)

Sol. Ramesh is heterozygous dominant for enzyme 'X', therefore, his genotype will be $I^A i$.

Ali shows codominance for both the genes as there is the synthesis of both the enzymes in equal amount, therefore his genotype will be $I^A I^B$.

Sophia and Balwinder shows homozygous dominance for X and Y respectively as there is 100% synthesis of enzymes X and Y respectively, therefore, their blood groups are $I^A I^A$ and $I^B I^B$ respectively.

79. In an experiment, a scientist discovered a darkly stained chromatin body on the periphery of nucleus of epithelial cells obtained from an eight year old boy. This is indicative of a particular syndrome. Find out the best possible chromosome combination of their parents from the options given below; which have the highest probability of producing the child under investigation. 'A' indicates autosome. 'X' and 'Y' represent the sex chromosomes.

(a) 22AA + XY, 22AA + XXX

(b) 22AA + XXY, 22AA + XXX

(c) 22AA + XY, 22AA + XX

(d) 22AA + XXY, 22AA + XX

Answer (a)

Sol. A person with 22AA + XXY genotype will be a sterile male.

The boy with darkly stained chromatin body on the periphery of nucleus of epithelial cells indicates that the boy has extra X chromosome in his cells. Therefore, the genotype of that boy is 22AA + XXY. Parents with (22AA + XY), (22AA + XX) may produce such type of boys due to non-disjunction of chromosomes during gamete formation but, highest probability of producing such a male child is when their genotype will be 22AA + XY, 22AA + XXX.

Here the female with genotype 22AA + XXX may have normal sexual development and are able to conceive children.

80. A millionaire Mr. Jim, died recently. Two women, Mary and Lou, claiming to have a child by Jim approached the police demanding a share in his wealth. Fortunately Jim's semen sample was cryopreserved. The scientists used DNA fingerprinting technique to study the three highly variable chromosome regions. The results obtained are shown in the adjoining figure:
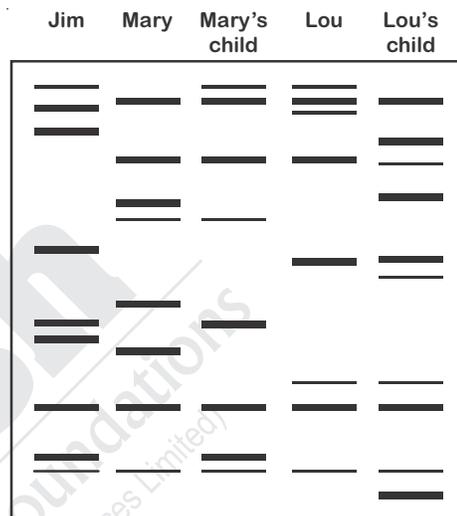
After studying the DNA profile, which of the alleged heirs are children of Jim?

(a) Mary's child

(b) Both are children of Jim

(c) Lou's child

(d) None are children of Jim

Answer (a)

Sol. DNA fingerprinting can be used for parental identification. Each child inherits one set of chromosomes from each parent.

In case of Mary's child all the DNA bands are matching either with Jim's DNA bands or with Mary's DNA bands.

In case of other child (Lou's child) some of the bands are not matching with his mother nor with Jim.