

**INDIAN ASSOCIATION OF PHYSICS TEACHERS****NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE (NSEJS) 2018-2019****Total time : 120 minutes****18-11-2018****(Total Marks : 240)****[CODE JS514]****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 property 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 one is correct. Choose the correct alternative and fill the appropriate bubble, as shown.  
Q. No.  a  b  c  d
  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 1200 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.
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12. Comments or queries (if any) regarding this question paper, may be sent by email only
  13. For Certificates and awards – Please see the website



**Sol.** 
$$\text{Molarity} = \frac{\text{moles of solute}}{\text{volume of solution}}$$

$$0.5 = \frac{\text{mass of solute}}{\text{molar mass of solute} \times \text{Volume of solution}}$$

$$0.5 = \frac{240}{\text{molar mass} \times 4}$$

$$\text{Molar mass} = 120 \text{ g/mole}$$

3. 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)  $X_6Y_4$

**Ans.** [a]

**Sol.** Let the formula be  $X_aY_b$

$$\frac{10a}{10a + 20b} = \frac{60}{100} = 0.6$$

$$6a + 12b = 10a$$

$$4a - 12b = 0$$

$$4a = 12b \Rightarrow a = 3b$$

$$X_{3b}Y_b$$

$$\text{Simplest formula} = X_3Y$$

4.  $4.095 \times 10^{24}$  nitrogen atom 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

**Ans.** [c]

**Sol.** 
$$\text{Mole} = \frac{\text{Given no. of atoms}}{N_A}$$

$$= \frac{4.095 \times 10^{24}}{6.022 \times 10^{23}}$$

$$= 6.8 \text{ mole of nitrogen atom}$$

$$= 3.4 \text{ moles of nitrogen molecule}$$

5. 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

**Ans.** [c]

**Sol.** The weight of the flask containing sulphur dioxide is  $W_1$

The weight of the flask containing methane is  $W_2$

The weight of the flask containing oxygen is  $W_3$

The ratio of the weights  $W_1 : W_2 : W_3$

$$W_1 = 64$$

$$W_2 = 16$$

$$W_3 = 32$$

$$\text{So } W_1 : W_2 : W_3 \text{ is } 4 : 1 : 2$$



6. A car battery was kept for charging and after getting fully charged density of the battery acid ( $\text{H}_2\text{SO}_4$ ) was measured and found to be  $1.28 \text{ g cm}^{-3}$ . If initial molarity of battery acid was  $4.2 \text{ M}$  then mass percentage will be around \_\_\_\_ .
- (a) 28%                      (b) 30%                      (c) 32%                      (d) 34%

Ans. [c]

Sol.  $\text{density} = \frac{\text{mass}}{\text{volume}}$

$$1 \text{ litre} = 1000 \text{ cm}^3$$

$$d = 1.28 \text{ g/cm}^3 = 1280 \text{ g/L}$$

$$\text{Volume} = 1 \text{ L}$$

$$1280 = \frac{M}{1}$$

$$M = 1280 \text{ g}$$

$4.2 \text{ M}$  mass  $4.2$  moles in  $1$  litre of solution

$$1 \text{ mole} = 98 \text{ g}$$

$$\begin{aligned} 4.2 \text{ moles} &= 98 \times 4.2 \text{ g} \\ &= 411.6 \text{ g} \end{aligned}$$

Mass percentage of  $\text{H}_2\text{SO}_4$  initially

$$= \frac{4.11.6}{1.280} \times 100$$

$$= 32.15 \%$$

$$= 32 \% \text{ (approx)}$$

7.  $\text{P}^{3-}$  has a larger radius than atom of P because -
- (a) There is greater coulombic attraction between the nucleus & electrons in the  $\text{P}^{3-}$  ion  
(b) The core electrons in  $\text{P}^{3-}$  exert a weaker shielding force than those of a neutral atom  
(c) The nuclear charge is weaker in  $\text{P}^{3-}$  than it is in P  
(d) The electrons in  $\text{P}^{3-}$  have a greater coulombic repulsion than those in P atom

Ans. [d]

Sol. On adding electrons to the atom but not any protons this means that no. of electron increases with results in the greater repulsion between the electrons having like charge (same charges repel each other).

8. 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

Ans. [a]

Sol. compound formed by X and Y is an ionic compound and compound formed by W and Z is a covalent compound. Melting point of ionic compound is greater than melting point of covalent compound.

9. Sonu has  $\text{N}/2$  HCl solution and Monu has  $\text{N}/10$  HCl solution. They are asked to prepare  $2$  litres of  $\text{N}/5$  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



**Ans.** [a]

**Sol.**  $N_1V_1 + N_2V_2 = N \times V$

$$0.5 \times V_1 + 0.1 \times V_2 = 0.2 \times 2$$

$$0.5 V_1 + 0.1 V_2 = 0.4 \quad \dots(i)$$

$$V_1 + V_2 = 2 \quad \dots(ii)$$

On solving equation (i) and (ii)

$$V_1 = 0.5 \text{ L}$$

$$V_2 = 1.5 \text{ L}$$

- 10.** 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 8.60g. 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

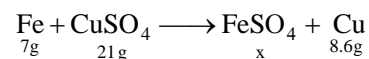
**Ans.** [a]

**Sol.** 
$$\begin{array}{ccccccc} \text{Fe} & + & \text{CuSO}_4 & \longrightarrow & \text{FeSO}_4 & + & \text{Cu} \\ 15.5\text{g} & & 21\text{g} & & ? & & 8.60\text{g} \end{array}$$

8.5 g iron remained unreacted

$\therefore$  7 g iron reacts with 21g  $\text{CuSO}_4$  to form products

Using the law of conservation of mass



$$7 + 21 = x + 8.6$$

$$x = (28 - 8.6)\text{g}$$

$$x = 19.40 \text{ g}$$

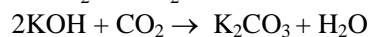
$\therefore$  19.40 g of  $\text{FeSO}_4$  is formed.

- 11.** 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  $\text{CO}_2$  required  $5\text{cm}^3$  of 0.1 M KOH. The amount of coal combusted is-

(a) 3 mg                      (b) 6 mg                      (c) 11 mg                      (d) 12 mg

**Ans.** [a]

**Sol.**  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$



2 mole required 1 mole of  $\text{CO}_2$

$$(5 \times -1) \times 10^{-3} \text{ moles of KOH} \equiv .25 \times 10^{-3} \text{ moles of CO}_2$$

$$.25 \times 10^{-3} \text{ moles of CO}_2 \equiv .25 \times 10^{-3} \text{ moles of C}$$

$$= .25 \times 10^{-3} \times 12$$

$$= 3 \times 10^{-3} \text{ g} = 3 \text{ mg}$$

- 12.** When 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                      (d) along its full length

**Ans.** [d]

**Sol.** Height of capillary rise liquid is given by  $h = 2T / (r\rho g)$ . T is surface tension, r is radius of capillary tube,  $\rho$  is density and g is acceleration due to gravity.

Since acceleration due to gravity is negligible so water will rise in capillary tube along its full length



13. A solution of pure aluminium sulphate containing 0.17g 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

Ans. [b]



from the equation, 342 g of  $\text{Al}_2(\text{SO}_4)_3$  react with 167 g of  $\text{Ba}(\text{OH})_2$  to give 699 g  $\text{BaSO}_4$  and 156 g  $\text{Al}(\text{OH})_3$ .  
 $342 \text{ g of } \text{Al}_2(\text{SO}_4)_3 = 57 \text{ g Al} + 288 \text{ g SO}_4$

therefore 0.17 g Al will require  $\frac{288}{54} \times 0.17 = 0.90 \text{ g SO}_4$

Hence, mass of  $\text{Al}_2(\text{SO}_4)_3 = 0.17 + 0.90 = 1.07$

1.07 g  $\text{Al}_2(\text{SO}_4)_3$  will give  $= \frac{699}{342} \times 1.07 = 2.18 \text{ g BaSO}_4$

similarly

1.07 g  $\text{Al}_2(\text{SO}_4)_3$  will give  $= \frac{156}{342} \times 1.07 = 0.48 \text{ g Al}(\text{OH})_3$

Therefore, total weight of the precipitate is  $2.18 + 0.48 = 2.66 \text{ g}$  (approx 2.7 g)

14. Sulphur di-oxide gas and ammonia gas were mixed in different proportions. The pair of gases containing same number of molecules at NTP is \_\_\_\_\_ .  
 (a) 1120 cm<sup>3</sup> of SO<sub>2</sub> + 0.85 g of ammonia (b) 0.25 g mole of SO<sub>2</sub> + 2240 cm<sup>3</sup> of ammonia  
 (c) 1680 cm<sup>3</sup> of SO<sub>2</sub> + 1.7 g of ammonia (d) 0.25 g mole of SO<sub>2</sub> + 0.85 g of ammonia

Ans. [a]

Sol. For SO<sub>2</sub> gas

$$1120 \text{ cm}^3 = 1.12 \text{ Lt}$$

$$\text{mole} = \frac{\text{given volume}}{22.4}$$

$$\text{mole} = \frac{1.12}{22.4} = 0.05$$

For ammonia

$$\text{mole} = \frac{\text{given mass}}{\text{molar mass}}$$

$$\text{mole} = \frac{0.85}{17} = 0.05$$

sulphur dioxide and ammonia has same no. of moles so they will have same no. of molecules.

15. 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 successful in growing daffodil ?  
 (a) Suhas (b) Bobby (c) Sandy (d) Kimi

Ans. [b]

Sol. One square meter area was given to each Suhas, Bobby, Sandy and Kimi in a garden to grow the daffodil plants. The ideal pH range of soil to grow daffodil is 6.0 to 6.5.

The current pH of soil is 4.5, now for daffodil to grow ideally we need to make it slightly basic.

$\text{Na}_3\text{PO}_4$  is a basic salt made by reaction of NaOH (strong base) and  $\text{H}_3\text{PO}_4$  (weak acid) so to increase the pH of soil we add basic salt to the soil





16. A solution (P) was prepared by dissolving 6.3g 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) 40 ppm                      (b) 10 ppm                      (c) 20 ppm                      (d) 80 ppm

Ans. [a]

Sol. Moles of oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ ) =  $\frac{6.3}{126 \times 0.1} = 0.5$

25 ml of this oxalic acid is 0.5 m than diluted 250 ml

$$M_1V_1 = M_2V_2$$

$$0.5 \times 25 = M_2 \times 250$$

$$M_2 = 0.05 \text{ M solution (Q)}$$

Neutralisation with NaOH

$$\text{E of NaOH} = \text{E of solution (Q)}$$

$$= N \times V \text{ of solution (Q)}$$

$$= M \times n \times V$$

$$= 0.05 \times 2 \times 10 = 1$$

$$\text{No. of E of NaOH} = 1 = \frac{\text{mass}}{\text{eq.mass}} = \frac{\text{mass}}{40}$$

weight of NaOH in ppm will be required to neutralize 10 ml of solution (Q) is 40 ppm

17. Which of the following is incorrect ?

(a) Chalcite-Copper                      (b) Magnetite-Iron  
(c) Calamine-Aluminium                      (d) Galena-Lead

Ans. [c]

Sol. Calamine is an ore of zinc ( $\text{ZnCO}_3$ )

18. Which of the following can improve the quality of Petrol ?

(a) n heptane                      (b) iso-octane  
(c) n hexadecane                      (d) benzene

Ans. [b]

Sol. There are many additives used to increase octane number of petrol. Most common additives are- Ferrocene, Tetraethyllead, Toluene, Isooctane etc.

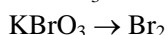
19.  $2\text{KBrO}_3 + 12\text{H}^+ + 10\text{e}^- \rightarrow \text{Br}_2 + 6\text{H}_2\text{O} + 2\text{K}^+$

From above reaction the equivalent weight of  $\text{KBrO}_3$  can be calculated as (M is molecular weight of  $\text{KBrO}_3$ )

(a) M/5                      (b) M/10                      (c) M/12                      (d) M/2

Ans. [a]

Sol.  $2\text{KBrO}_3 + 12\text{H}^+ + 10\text{e}^- \rightarrow \text{Br}_2 + 6\text{H}_2\text{O} + 2\text{K}^+$



Oxidation number of bromine in  $\text{KBrO}_3$  is = 5

Oxidation number of bromine in  $\text{Br}_2$  is = 0

changing in oxidation number = 5

$$\text{hence, equivalent weight} = \frac{M}{5}$$

where M = molecular weight of  $\text{KBrO}_3$

20. Shaila took about  $10 \text{ cm}^3$  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

Ans. [c]

Sol. Potassium hydrogen carbonate ( $\text{KHCO}_3$ ) is slightly basic in nature.

21. 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

Ans. [b]

Sol. Let for first polygon

$$\text{No. of side} = n \rightarrow \text{Red}$$

$$\therefore \text{No. of diagonal} = \frac{n(n-3)}{2} \rightarrow \text{Green}$$

& for second polygon

$$\text{No. of sides} = m \rightarrow \text{Green}$$

$$\therefore \text{No. of diagonal} = \frac{m(m-3)}{2} \rightarrow \text{Red}$$

Now

According to question

$$n + \frac{m(m-3)}{2} = 103 \quad \dots (i)$$

$$\& m + \frac{n(n-3)}{2} = 80 \quad \dots (ii)$$

$$(i) - (ii)$$

$$(n-m) + \frac{m^2 + 3m - n^2 + 3n}{2} = 23$$

$$2(n-m) + (m+n)(m-n) - 3(m-n) = 46$$

$$\Rightarrow -2(m-n) + (m+n)(m-n) - 3(m-n) = 46$$

$$\Rightarrow (m-n)(m+n-5) = 46$$

case (i)

$$(m-n)(m+n-5) = 1 \times 46$$

$$\Rightarrow m-n = 1 \& m+n-5 = 46$$

$$m+n = 46 + 5 = 51 \text{ (not in option)}$$

case (ii)

$$(m-n)(m+n-5) = 2 \times 23$$

$$\therefore m-n = 2 \& m+n-5 = 23$$

$$\Rightarrow m+n = 23 + 5 = 28$$

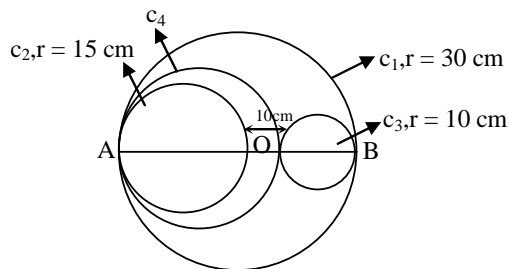
$\therefore$  Total number of sides the two polygons together have is 28

22. 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

Ans. [c]

Sol.



$$\text{diameter of } C_4 = 40 \text{ cm} \Rightarrow \text{radius} = 20 \text{ cm}$$





23. A person kept rolling a regular (six faced) die until one of the numbers appeared third time on the top. This happened in 12<sup>th</sup> 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

Ans. [c,d]

Sol. case-1

Let 6 comes 3 times

$$6 \rightarrow 3 \text{ times} \rightarrow 6 \times 3 = 18$$

$$\Rightarrow 9 \text{ no. sum} = 46 - 18 = 28$$

$$\Rightarrow 2(1 + 3 + 4 + 5) + 2 = 28$$

$$26 + 2 = 28$$

$$28 = 28$$

$\Rightarrow$  minimum times '2' comes on the top

case-2

Let 5 comes 3 times

$$5 \rightarrow 3 \text{ times} \rightarrow 5 \times 3 = 15$$

$$\Rightarrow 9 \text{ no. sum} = 46 - 15 = 31$$

$$\Rightarrow 2(2 + 3 + 4 + 6) + 1 = 31$$

$$31 = 31$$

$\Rightarrow$  minimum times '1' comes on the top

24. The value of  $\frac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}}$ , when  $x = \frac{2ab}{b^2 + 1}$  is :

- (a) a (b) b (c) x (d) 0

Ans. [b]

Sol. 
$$\frac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}} \times \frac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} - \sqrt{a-x}}$$

$$= \frac{(a+x) + (a-x) + 2\sqrt{a^2 - x^2}}{a+x - a+x}$$

$$= \frac{a + \sqrt{a^2 - x^2}}{x}$$

$$= \frac{a + \sqrt{a^2 - \frac{4a^2b^2}{(b^2 + 1)^2}}}{\frac{2ab}{b^2 + 1}}$$

$$= \frac{a(b^2 + 1) + \sqrt{a^2b^4 + a^2 - 2a^2b^2 - 4a^2b^2}}{2ab}$$

$$= \frac{a(b^2 + 1) + \sqrt{a^2b^4 + a^2 - 2a^2b^2}}{2ab}$$

$$= \frac{a(b^2 + 1) + \sqrt{a^2(b^2 - 1)^2}}{2ab}$$

$$= \frac{a(b^2 + 1) + a(b^2 - 1)}{2ab}$$

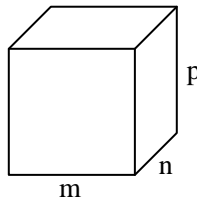
$$= \frac{b^2 + 1 + b^2 - 1}{2b} = \frac{2b^2}{2b} = b$$

25. A 5 x 5 x 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

Ans. [d]

Sol.



$$\frac{m(m+1)}{2} \times \frac{n(n+1)}{2} \times \frac{p(p+1)}{2}$$

$$\frac{5 \times 6}{2} \times \frac{5 \times 6}{2} \times \frac{5 \times 6}{2}$$

$$15 \times 15 \times 15$$

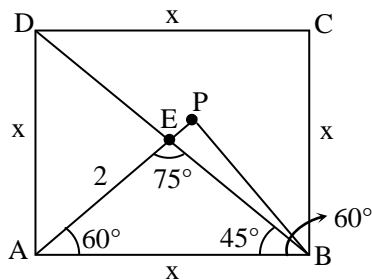
$$= 3375$$

26. 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)  $5 + 4\sqrt{3}$

Ans. [a]

Sol. Let side be 'x',  $\Delta APB$  is an equilateral  $\Delta$ ,  $\angle ABE = 45^\circ$



In  $\Delta AEB$

$$\angle EAB = 60^\circ$$

$$\angle EBA = 45^\circ$$

So, by angle sum property :

$$\angle AEB = 180^\circ - (60^\circ + 45^\circ)$$

$$= 180^\circ - 105^\circ$$

$$= 75^\circ$$

By sine law :

$$\frac{\sin 45^\circ}{2} = \frac{\sin 75^\circ}{x}$$

$$x = \left( \frac{\sin 75^\circ}{\sin 45^\circ} \right) \times 2$$

$$\text{Area of square} = x^2$$





**Sol.** Let total red & yellow ball be  $x$  &  $y$   
 total balls =  $x + y$ .  
 one red ball is removed  
 $\Rightarrow$  red ball becomes =  $x - 1$   
 Total remaining balls. =  $x + y - 1$   
 now according to question

$$\frac{1}{7}(x + y - 1) = x - 1$$

$$\Rightarrow x + y - 1 = 7x - 7$$

$$6x - y - 7 + 1 = 0$$

$$6x - y - 6 = 0$$

$$\frac{1}{6}(x + y - 1) = x$$

$$x + y - 1 = 6x$$

$$y - 1 = 5x$$

$$y - 5x = 1$$

$$y = 6x - 6$$

$$6x - 6 - 5x = 1$$

$$\boxed{x = 7}$$

$$6 \times 7 - y - 6 = 0$$

$$42 - y - 6 = 0$$

$$\boxed{y = 36}$$

$$x + y = 7 + 36$$

$$\Rightarrow 43$$

$$\therefore \text{sum of digits} = 4 + 3 = 7$$

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

(a) 2

(b) 3

(c) 4

(d) 5

**Ans.** [b]

**Sol.**  $2a(n) = a(n-2) + a(n+3)$

$$2 \times \frac{(n-2)180}{n} = \frac{(n-4)180}{n-2} + \frac{(n+1)180}{n+3}$$

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

$$\Rightarrow 2(n-2)^2(n+3) = (n-4)(n)(n+3) + (n+1)(n)(n-2)$$

$$\Rightarrow 2(n-3)(n^2-4n+4) = (n+3)(n^2-4n) + (n+1)(n^2-2n)$$

$$\Rightarrow 2(n^3-4n^2+4n+3n^2-12n+12) = (n^3-4n^2+3n^2-12n) + (n^3-2n^2+n^2-2n)$$

$$\Rightarrow 2(n^3-n^2-8n+12) = 2n^3-2n^2-14n$$

$$\Rightarrow n^3-n^2-8n+12 = n^3-n^2-7n$$

$$n = 12$$

$$\therefore \text{sum of digits} = 1 + 2 = 3$$

32. The integer closest to  $\sqrt{111\dots1 - 222\dots2}$ , where there are 2018 ones and 1009 twos, is
- (a)  $\frac{10^{1009} - 1}{3}$       (b)  $\frac{10^{1009} - 1}{9}$       (c)  $\frac{10^{2018} - 1}{3}$       (d)  $\frac{10^{2018} - 1}{9}$

Ans. [a]

Sol.

$$\sqrt{\frac{1}{9}(999\dots9) - \frac{2}{9}(999\dots9)}$$

$$\frac{1}{3}\sqrt{10^{2018} - 1 - 2(10^{1009} - 1)}$$

$$\Rightarrow \frac{1}{3}\sqrt{10^{2018} - 1 - 2 \cdot 10^{1009} + 2}$$

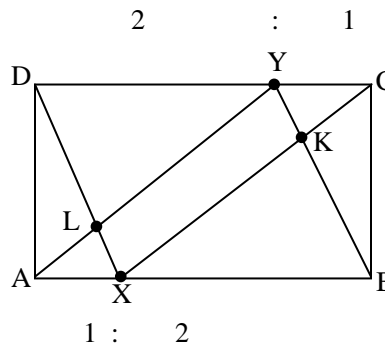
$$\Rightarrow \frac{1}{3}\sqrt{10^{2018} - 2 \cdot 10^{1009} + 1}$$

$$\Rightarrow \frac{1}{3}\sqrt{(10^{1009} - 1)^2}$$

$$\Rightarrow \frac{10^{1009} - 1}{3}$$

33. 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 & 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

Ans. [b]  
Sol.



Given  $\frac{\text{ar XKYL}}{\text{ar ABCD}} = \frac{m}{n}$

let  $AB = 3X = CD$

$\therefore AX = x$  &  $XB = 2x$

also  $YC = x$

$YD = 2x$

also  $\text{ar } \triangle ALD = \text{ar } \triangle BKC$

$\text{ar } \triangle ALX = \text{ar } \triangle CKY$

$\text{ar } \triangle DLY = \text{ar } \triangle BKX$

By symmetry

Area of rectangle =  $AB \times AD$   
 $= 3x \times AD$

also

$$\text{Area of } (\Delta ALD + \Delta LDY) = \frac{1}{2} \times 2x \times AD \quad \dots(1)$$

$$\text{Area of } (\Delta ALD + \Delta LLX) = \frac{1}{2} \times x \times AD \quad \dots(2)$$

(1-2)

$$\text{Area of } (\Delta LDY - \Delta ALX) = \frac{x}{2} \times AD \quad \dots(3)$$

Also  $\Delta LDY \sim \Delta LXA$  (By AA similarity)

$$\Rightarrow \frac{\text{area } \Delta LDY}{\text{area of } \Delta LAX} = \left(\frac{2}{1}\right)^2 = \frac{4}{1}$$

$$\text{area } \Delta LDY = 4 \text{ area } \Delta ALX \quad \dots(4)$$

from (3) & (4)

$$4(\text{ar } \Delta ALX) - \text{area } \Delta ALX = \frac{x}{2} \times AD$$

$$\Rightarrow \text{ar } \Delta ALX = \frac{x}{6} \times AD$$

$$\therefore \text{ar } \Delta LDY = \frac{4x}{6} \times AD = \frac{2x}{3} \times AD$$

$$\text{Now area of } \Delta XDC = \frac{1}{2} \times 3X \times AD$$

$$\Rightarrow \text{area of } \Delta DLY + \text{area of } \Delta YKC + \text{area (XKYL)} = \frac{3x}{2} \times AD$$

$$\Rightarrow \frac{2x}{3} AD + \frac{x}{6} AD + \text{area (XKYL)} = \frac{3x}{2} \times AD$$

$$\begin{aligned} \text{area (XKYL)} &= \frac{3x}{2} AD - \frac{2x}{3} AD - \frac{x}{6} AD \\ &= \frac{9x \times AD - 4x \times AD - x \times AD}{6} \\ &= \frac{4x}{6} AD = \frac{2x}{3} \times AD. \end{aligned}$$

$$\begin{aligned} \text{Now. } \frac{\text{area (XKYL)}}{\text{area (ABCD)}} &= \frac{\frac{2x}{3} \times AD}{3x \times AD} \\ &= \frac{2}{9} = \frac{m}{n} \end{aligned}$$

$$\Rightarrow m + n = 2 + 9 = 11$$

34. 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)  $(p - r)^2 = q^2 + r^2$

Ans. [a]







$$\left[ \frac{10^2}{9} \right] = [11.11] = 11$$

$$\left[ \frac{10^2}{10} \right] = [10] = 10$$

$$\left[ \frac{10^2}{11} \right] = [9.09] = 9$$

$$\left[ \frac{10^2}{12} \right] = [8.33] = 8$$

⇒ Total 15 distinct integer

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

- (a)  $\frac{1}{mn}$                       (b)  $\frac{1}{m} + \frac{1}{n}$                       (c) 1                      (d) 0

Ans. [c]

Sol.  $T_m = \frac{1}{n}$

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

$$T_n = \frac{1}{m}$$

$$a + (n-1)d = \frac{1}{m} \quad \dots\dots\dots(2)$$

subtract equation (1) from equation (2)

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

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

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

Put in equation (1)

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

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

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

$$T_{mn} = a + (mn - 1) d$$

$$\Rightarrow \frac{1}{mn} + (mn - 1) \frac{1}{mn}$$

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

$$\Rightarrow 1$$

37. 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

Ans. [b]

Sol. let the number 5 be in G.P. are  $\frac{a}{r^2}, \frac{a}{r}, a, ar, ar^2 \rightarrow$  In G.P.

acc to questions

$$\begin{aligned} \frac{a}{r^2} + \frac{a}{r} + a + ar + ar^2 &= 24 \\ \Rightarrow \frac{a + ar + ar^2 + ar^3 + ar^4}{r^2} &= 24 \\ \Rightarrow \frac{a(1 + r + r^2 + r^3 + r^4)}{r^2} &= 24 \quad \dots(1) \end{aligned}$$

also,

$$\begin{aligned} \text{reciprocal of no. } \frac{r^2}{a^2}, \frac{r}{a}, \frac{1}{a}, \frac{1}{ar}, \frac{1}{ar^2} \\ \Rightarrow \frac{r^2}{a} + \frac{r}{a} + \frac{1}{a} + \frac{1}{ar} + \frac{1}{ar^2} &= 6 \\ \Rightarrow \frac{r^4 + r^3 + r^2 + r + 1}{ar^2} &= 6 \\ \Rightarrow 1 + r + r^2 + r^3 + r^4 &= 6ar^2 \quad \dots(2) \end{aligned}$$

compare equation. (1) & (2)

$$\Rightarrow a(6ar^2) = 24r^2$$

$$\Rightarrow a^2 = 4$$

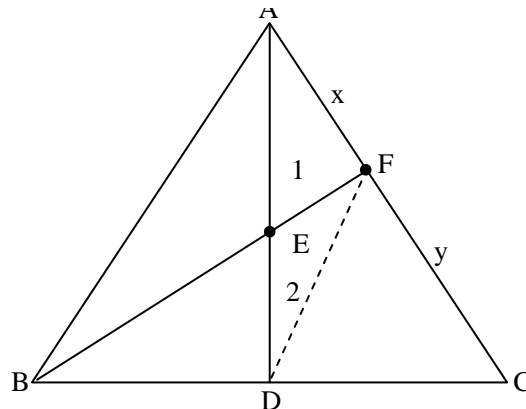
$$\Rightarrow a = 2$$

$$\begin{aligned} \therefore \text{product } \frac{a}{r^2} \times \frac{a}{r} \times a \times ar \times ar^2 \\ = a^5 = 2^5 = 32 \end{aligned}$$

38. 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 AF/FC is  
 (a) 1/6 (b) 1/5 (c) 1/4 (d) 1/3

Ans. [c]

Sol.



$$AE : ED = 1 : 2$$

$$\text{Let } AF : FC = x : y$$

Here AD is median

$$\Rightarrow BD = DC$$

$$\text{area } \triangle ABD = \text{area } \triangle ADC$$

$$\text{Now, area. } \triangle ABE = \frac{1}{3} \text{ area. } \triangle ABD = \frac{1}{3} \times \frac{1}{2} \times \text{area. } \triangle ABC$$

$$= \frac{1}{6} \text{ area } \triangle ABC \quad \dots(1)$$

$$\text{area } \triangle AEF = \frac{1}{3} \text{ area } \triangle ADF = \frac{1}{3} \times \frac{x}{(x+y)} \text{ area } \triangle ADC$$

$$= \frac{1}{3} \times \frac{x}{x+y} \times \frac{1}{2} \text{ area } \triangle ABC$$

$$= \frac{1}{6} \frac{x}{x+y} \text{ area. } \triangle ABC \quad \dots(2)$$

$$\text{area } \triangle ABF = \frac{x}{x+y} \text{ area } \triangle ABC \quad \dots(3)$$

Now

$$\text{area. } \triangle ABE + \text{area. } \triangle AEF = \text{area } \triangle ABF$$

$$\frac{1}{6} \times \text{area } \triangle ABC + \frac{1}{6} \left( \frac{x}{x+y} \right) \text{area. } \triangle ABC = \left( \frac{x}{x+y} \right) \text{area. } \triangle ABC$$

$$\Rightarrow \frac{1}{6} = \frac{5}{6} \left( \frac{x}{x+y} \right)$$

$$x + y = 5x$$

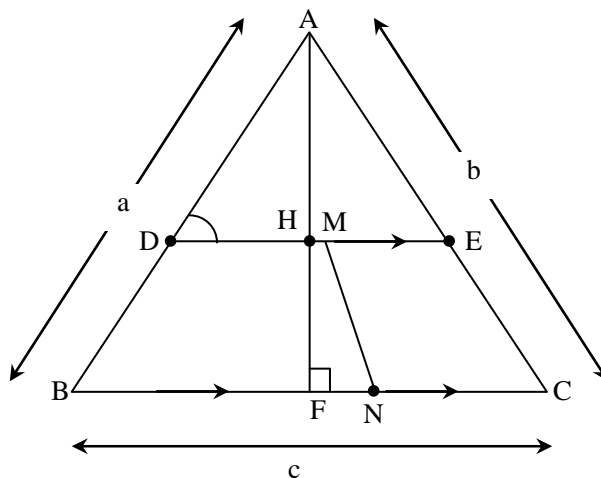
$$4x = y$$

$$\Rightarrow \frac{x}{y} = \frac{1}{4}$$

39. 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 mid points of DE and BC respectively. What is the ratio of the area of the quadrilateral BNMD to that of triangle ABC ?

- (a) 1/4 (b) 9/32 (c) 7/32 (d) 15/32

Ans. [d]  
Sol.



Let 'F' on BC such that AF perpendicular to BC

$$\frac{AD}{AB} = \frac{1}{4}$$

$$AD = a$$

$$DB = 3a$$

Let 'a' = AB, 'b' = AC and 'C' = BC

and height AF = k.

As DE || BC,

$$\Delta ADE \sim \Delta ABC$$

$$\frac{AD}{AB} = \frac{AE}{AC} = \frac{DE}{BC} = \frac{AH}{AF} = \frac{1}{4}, \quad HF = \frac{3k}{4}$$

$$\text{Area of } \Delta ABC = \frac{1}{2} \times AF \times BC$$

$$\Rightarrow \frac{1}{2} k \times C$$

$$= \frac{kC}{2}$$

$$DM \parallel BC, \text{ So quad DMNB is a trap } \Rightarrow DE = \frac{BC}{4} = \frac{C}{4}$$

$$DM = \frac{C}{4} = \frac{C}{8}$$

$$BN = \frac{BC}{2} = \frac{C}{2}$$

$$\text{Area (trap DMNB)} = \frac{1}{2} \times (DM + BN) \times HF.$$

$$\Rightarrow \frac{1}{2} \left( \frac{C}{8} + \frac{C}{2} \right) \times \frac{3k}{4}$$

$$\Rightarrow \frac{1}{2} \left( \frac{C+4C}{8} \right) \times \frac{3k}{4}$$

$$= \frac{1}{2} \times \frac{5C}{8} \times \frac{3k}{4}$$

$$\frac{\text{Area of quad BNMD}}{\text{Area of } \Delta ABC} = \frac{\frac{1}{2} \times \frac{5C \times 3k}{8 \times 4}}{\frac{1}{2} \times C \times k}$$

$$\Rightarrow \frac{15}{32}$$

40. 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

Ans. [Bonus]

Sol.  $\overline{4a1} \times \overline{25b}$

1st 2nd

$$36 = 4 \times 9$$

as 1st number cannot be divisible by 4.  
 So 25 b has to be divisible by 4.  
 So at b = 2, 6  
 252, 256 will be divisible by 4.  
 For b = '252' → also divisible by 9.  
 so a can be (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)  
 Total values of ordered pair (a,b) = 10.  
 When b = 6 '256' divisible by 4.  
 256 divisible by 4 but not by 9.  
 so, 1st number has to be divisible by 9.  
 So, possible values of a = 4 only  
 441 → divisible by 9,  
 a = 4, b = 6 \_\_\_\_\_ only 1 solutions  
 total solutions : 10 + 1 = 11

41. 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 cells belong to ?

Which of the following category do the cells belong to ?

- (a) Archaea                      (b) Plant cells                      (c) Unicellular eukaryotes                      (d) Cyanobacteria

Ans. [a]

Sol. Archae though archae doesnot contain peptidoglycans

42. 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 observation, 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

Ans. [d]

Sol. Due to above given data

43. 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

Ans. [d]

Sol. Character of acquired immunity are all the above

44. 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 hi cause ?  
 (a) Glycine max - Rhizobium (b) Cycas – Nostoc  
 (c) Casuarina– Frankia (d) Azolla-Anabaena

Ans. [d]

Sol. Azolla-Anabaena would be beneficial for employing nitrogen fixation technique

45. 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 inability 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

Ans. [d]

Sol. The correct sequence of additives in the biosynthetic pathway of X is

P → S → Q → R → T

46. 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

Ans. [c]

Sol. As 3 nitrogenous base or one codon is reduced (stopcodon), others will code for protein  $\frac{2985}{3} = 995$

47. True coelom is not present in animals of:  
 (A) Platyhelminthes (B) Annelida (C) Echinodermata (D) Arthropoda

Ans. [a]

Sol. Platyhelminthes does not have true coelom



48. 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

Ans. [b]

Sol. Golgi apparatus is responsible for formation of acrosomal vesicle.

49. 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

Ans. [c]

Sol. The charges are reversed because of more sodium ions enter the axon as compared to potassium ions leaving.

50. 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  $\alpha_2$ -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

Ans. [a]

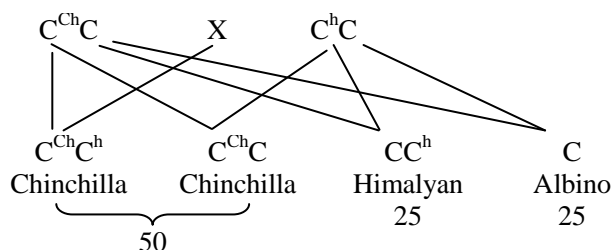
Sol. Guanfacine hydrochloride is used in case of hypertension

51. 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)  $C^{ch}C^{ch} \times C^{ch}c$  (B)  $C^{ch}C^h \times C^{ch}c$  (C)  $C^{ch}c \times C^h c$  (D)  $C^h C^h \times C^{ch} C^{ch}$

Ans. [c]

Sol.



The genotypes of the parent rabbits are  $C_C^{Ch} \times C_C^h$

- 52.

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

Ans. [b]

Sol. Bull shark is aquatic. Alpine salamander is amphibian.

53. A student recorded the data for five types of cells as given below :

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

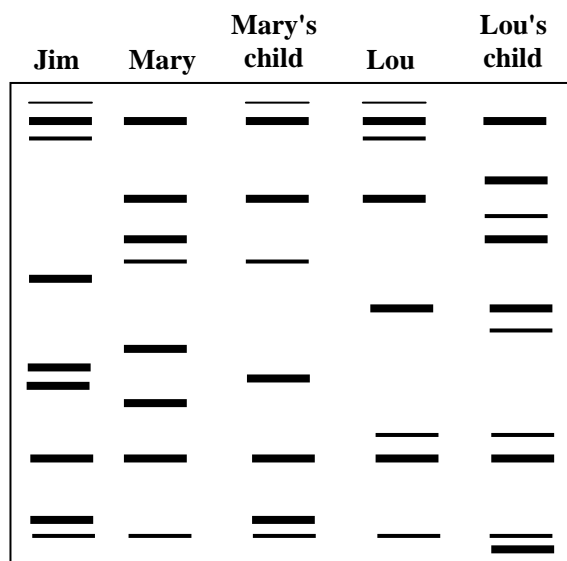
The five cell types P, Q, R, S and T are :

- (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

Ans. [a]

Sol. As per data

54.



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

Ans. [b]

Sol. Band shown in figure of both children are matching with Jim and their respective mothers

55. 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

Ans. [c]

Sol.

	A	T	G	C
Strand I	650	348	1400	X
Strand II	T	A	C	G
	650	348	1400	Y

strand I → A will be 650  
 total of strand I → 2988  
 So C = 2988 – 2398 = 590  
 Therefore G is also 590

56. 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

Ans. [a]

Sol. The correct answer is (a)

57. 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 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	
	P/A	%	P/A	%	P/A	%	P/A	%
Enzymes ↓								
X	+	50	+	50	+	100	-	-
Y	-	-	+	50	-	-	+	100

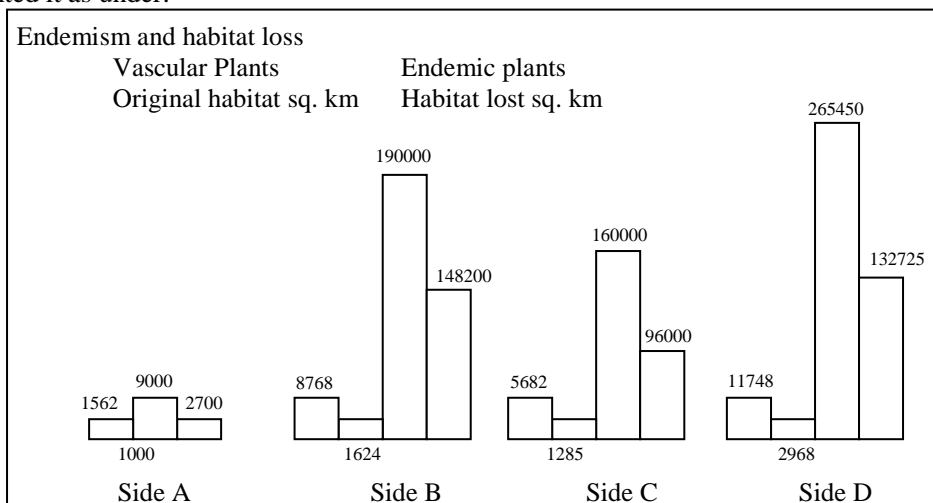
- (A) I<sup>A</sup>i, ii, I<sup>B</sup>i, I<sup>A</sup>I<sup>B</sup>      (B) I<sup>A</sup>i, I<sup>A</sup>I<sup>B</sup>, I<sup>A</sup>I<sup>A</sup>, I<sup>B</sup>I<sup>B</sup>      (C) I<sup>B</sup>i, I<sup>A</sup>I<sup>B</sup>, ii, I<sup>B</sup>i      (D) I<sup>B</sup>i, ii, I<sup>A</sup>I<sup>B</sup>, I<sup>A</sup>

Ans. [b]

Sol.

A AB AA BB  
 I i, II, II, II  
 The correct answer is (b)  
 Ramesh – 50% A  
 Ali = 50% A, 50% B  
 Sophia – 100 % A  
 Balwinder – 100 % B

58. An environment conservation group performed a survey of some diverse locations 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

Ans. [a]

Sol. Site A =  $\frac{1562}{6300} \times 100 = 24.7\%$   
 Site B =  $\frac{8768}{41800} \times 100 = 20.9\%$   
 Site C =  $\frac{5682}{64000} \times 100 = .088\%$   
 Site D =  $\frac{11748}{132625} \times 100 = 8.85\%$

59. 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

Ans. [b]

Sol. The genetically modified (GM) brinjal in India has been developed for insect resistance

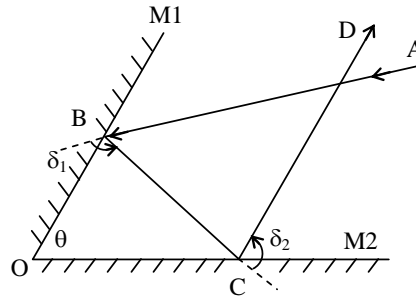
60. A bacterium has a generation time of 50 minutes. A culture containing  $10^8$  cells per mL is incubated for 300 minutes. What will be the number of cells after 300 minutes?

- (A)  $64 \times 10^3$  cells (B)  $6.4 \times 10^8$  cells (C)  $64 \times 10^9$  cells (D)  $6.4 \times 10^9$  cells

Ans. [d]

Sol.  $300 \div 50 = 6$  times multiplication  
 1 → 2 cell  
 2 → 8 cell  
 4 → 8 cell  
 8 → 16 cell  
 16 → 32 cell  
 32 → 64 cell  
 So  $64 \times 10^8 = 6.4 \times 10^9$

61. Two plane mirrors  $M_1$  &  $M_2$  have their reflecting faces inclined at  $\theta$ . 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  $\delta$  suffered by the incident ray  $AB$  is:



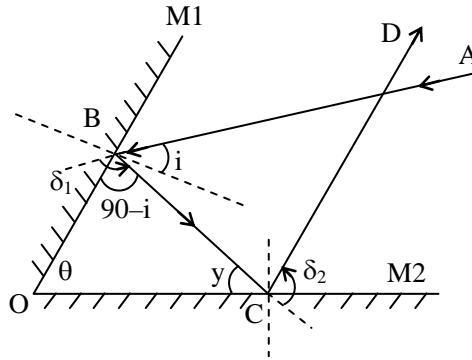
- (A)  $\delta = 90^\circ + 2\theta$       (B)  $\delta = 180^\circ + 2\theta$       (C)  $\delta = 270^\circ - 2\theta$       (D)  $\delta = 360^\circ - 2\theta$

Ans. [d]

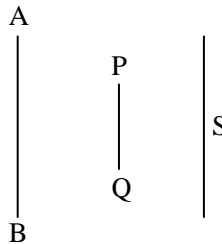
Sol.

$$\begin{aligned} \delta_1 &= 180 - 2i \\ y &= 180 - (90 - i) - \theta \\ y &= 90 - \theta + i \\ \delta_2 &= 180 - [2\theta - 2i] \\ \text{Deviation} &= \delta_1 + \delta_2 \\ &= (180 - 2i) + (180 - 2\theta - 2i) \\ &= 360 - 2\theta \end{aligned}$$

It will be of the same size



62. 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  $S$ ?



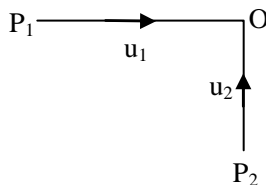
- (A) It will first increase and then decrease.  
 (B) It will first decrease and then increase.  
 (C) It will be of the same size for any position of the point source on the line  $AB$   
 (D) Umbra will increase and penumbra will decrease till central position

Ans. [c]

Sol.

It will be of the same size for any position of the point source on the line  $AB$ , Shadow size changes. When object  $PQ$  move forward or backward.

63. Two particles  $P_1$  and  $P_2$  move towards origin  $O$ , along  $X$  and  $Y$ -axes 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)  $s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)]^{1/2}$   
 (B)  $s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(bu_1 + au_2)]^{1/2}$   
 (C)  $s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 + 2t(au_1 + bu_2)]^{1/2}$   
 (D)  $s = [a^2 - b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)]^{1/2}$

Ans. [a]

Sol. Distance in time  $t$  by  $P_1$ ,  $a' = a - u_1t$   
 Distance in time  $t$  by  $P_2$ ,  $b' = b - u_2t$   
 $H^2 = P^2 + B^2$   
 $(P_1P_2)^2 = (a-u_1t)^2 + (b-u_2t)^2$   
 $(P_1P_2)^2 = a^2 + b^2 + u_1^2t^2 + u_2^2t^2 - 2u_1ta - 2u_2tb$   
 $(P_1P_2)^2 = a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(u_1a + u_2b)$   
 $P_1P_2 = s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)]^{1/2}$

64. A metal rod of length  $L$  at temperature  $T$ , when heated to temperature  $T'$ , expands to new length  $L'$ . These quantities are related as  $L' = L(1 + \alpha[T' - T])$  where  $\alpha$  is a constant for that material and called as coefficient of linear expansion. Correct SI unit of  $\alpha$  is \_\_\_\_.

- (a)  $m \cdot K^{-1}$                       (b)  $m \cdot K$                       (c)  $K^{-1}$                       (d)  $\alpha$  is a pure number

Ans. [c]

Sol.  $\Delta L = L\alpha \cdot \Delta T$   
 Unit of  $\alpha$   
 $\alpha = \frac{m}{m \cdot K}$   
 $\alpha = \frac{1}{K} = K^{-1}$

65. 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

Ans. [a]

Sol.  $\lambda_1 - \lambda_2 = 2$                       .....(1)  
 $f_2 = 1.4 f_1$   
 $f_1 = \frac{1000}{20} = 50 \text{ Hz}$   
 $f_2 = 1.4 \times 50 = 70 \text{ Hz}$   
 $v = f_1 \lambda_1$

$$v = f_2 \lambda_2$$

$$\frac{f_1}{f_2} = \frac{\lambda_2}{\lambda_1}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{f_2}{f_1} = \frac{70}{50} = \frac{7}{5}$$

$$\lambda_1 = \frac{7}{5} \lambda_2 \quad \dots\dots(2)$$

$$\frac{7}{5} \lambda_2 - \lambda_2 = 2 \quad \text{From (1) and (2)}$$

$$\lambda_2 = \frac{10}{2} = 5 \text{ cm}$$

$$v_2 = 70 \times 5 = 350 \text{ m/sec}$$

**66.** 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.

**Ans.** [b]

**Sol.**  $4m = \frac{f}{f + 25} \quad \dots\dots\dots(1)$

$$m = \frac{f}{f + 40} \quad \dots\dots\dots(2)$$

from (1) & (2)

$$4\left(\frac{f}{f + 40}\right) = \left(\frac{f}{f + 25}\right)$$

$$4f + 100 = f + 40$$

$$3f = -60$$

$$f = -20 \text{ cm}$$

**67.** 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) 4 m, bradycardia      (c) 1 m, tachycardia      (d) 1 m, tachycardia

**Ans.** [a]

**Sol.**  $T = 2\pi \sqrt{\frac{l}{g}}$

$$2 = 2\pi \sqrt{\frac{l}{9.8}}$$

$$l = 0.99 \approx 1 \text{ m.}$$

for 1 oscillations, time period is 2 second

for 60 oscillations, time period is 120 second

Pulses = 100 times (given)

In 60 sec, pulses = 55 times

1 min, pulses = 55



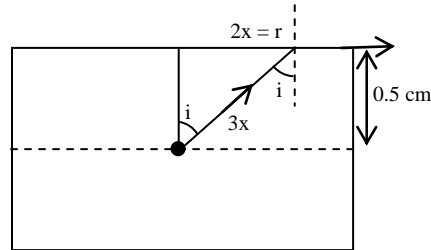
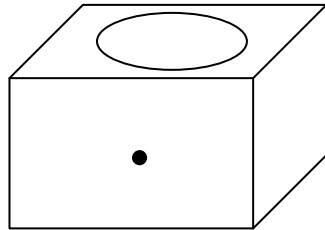


70. A glass cube of refractive index 1.5 and edge 1 cm has a tiny black spot at its center. A circular dark sheet is to be kept symmetrically on the top surface so that the central spot is not visible from the top. Minimum radius of the circular sheet should be (Given :  $\frac{1}{\sqrt{2}} = 0.707$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

- (a) 0.994 cm                      (b) 0.447 cm                      (c) 0.553 cm                      (d) 0.577 cm

Ans. [b]

Sol. refractive index of glass cube = 1.5  
refractive index of air = 1



$$(R.I)_g \sin i = (R.I)_a \sin 90$$

$$1.5 \times \sin i = 1 \times 1$$

$$\sin i = \frac{2}{3}$$

$$\sin i = \frac{P}{H} = \frac{2x}{3x}$$

$$H^2 = P^2 + B^2$$

$$(3x)^2 = (2x)^2 + (0.5)^2$$

$$9x^2 = 4x^2 + 0.25$$

$$5x^2 = 0.25$$

$$x^2 = \frac{5}{100} = \frac{1}{20}$$

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

$$\therefore r = 2x = \frac{1}{\sqrt{5}} = 0.447 \text{ cm}$$

71. A block of wood floats on water with  $\left(\frac{3}{8}\right)^{\text{th}}$  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

Ans. [b]

Sol. In water

$$\frac{\rho_0}{\rho_L} = \frac{V_i}{V} \Rightarrow \frac{\rho_0}{1} = \frac{5/8V}{V} \Rightarrow \rho_0 = \frac{5}{8}$$

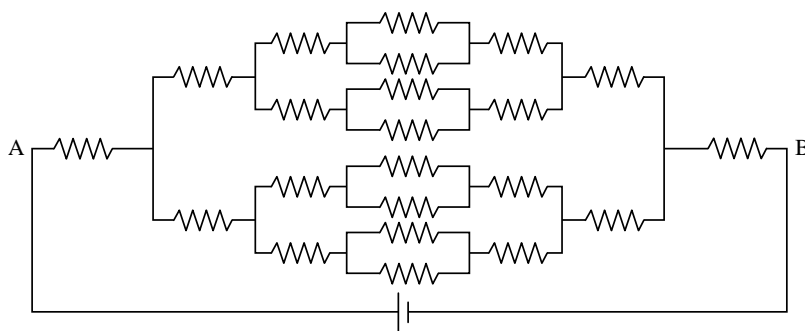
For salt solution

$$\frac{5/8}{1.12} = \frac{V_i}{V}$$

$$\text{so } \frac{V_0}{V} = 1 - \frac{V_i}{V}$$

$$\frac{V_0}{V} = 1 - \frac{5/8}{1.12} = 0.44$$

72.



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

- (a)  $4\Omega$                       (b)  $8\Omega$                       (c)  $16\Omega$                       (d)  $29\Omega$

Ans. [b]

Sol. Equivalent resistance of the circuit =  $\frac{29R}{8}$

In order to have integral value for equivalent resistance R should be  $8\Omega$ .

73. 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

Ans. [B]

Sol. force, speed, time  
 10N      100 m/s       $\frac{1}{100}$  sec

$F = m \times a$

$10 = m \times 100 \times 100 \Rightarrow m = 10^{-3}$  kg

74. Three objects of the same material coloured white, blue and black can withstand temperatures up to  $2000^\circ\text{C}$ . All these are heated to  $1500^\circ\text{C}$  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

Ans. [c]

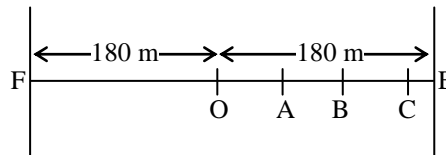
Sol. Black object will appear brightest

75. 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

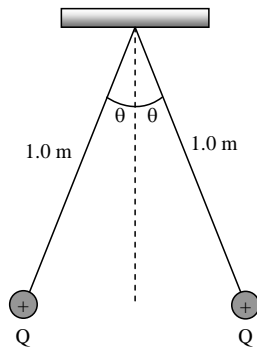
Ans. [b]

Sol.



$OA = 30t$  for car.  
 $OE + EA = 330t$  for sound  
 $180 + (180 - OA) = 330t$   
 $180 + 180 - 30t = 330t$   
 $t = 1$  sec  
 $OA = 30(1) = 30$  m.  
 For 2nd echo  
 $AB = 30t$  for car  
 $AO + OF + FO + OA + AB = 330t$  for car  
 $30 + 180 + 180 + 30 + 30t = 330t$   
 $420 = 300t$   
 $t = 1.4$   
 Next echo =  $1 + 1.4$   
 $= 2.4$  sec.

76.



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 ( $g = 3.7 \text{ m/s}^2$ ), Earth ( $g = 9.8 \text{ m/s}^2$ ) and Jupiter ( $g = 24.5 \text{ m/s}^2$ ), then angle  $2\theta$  will be \_\_\_\_\_.

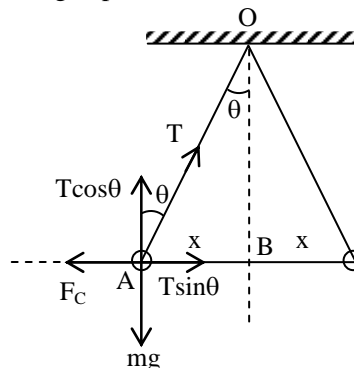
- (a) maximum on Mercury
- (b) maximum on Earth, as it has atmosphere
- (c) maximum on Jupiter
- (d) the same on any planet as Coulomb force is independent of gravity

Ans.

[a]

Sol.

$2\theta$  will be maximum when weights of charged pith balls are minimum.



$$F_C = \text{Coulomb's force} = \frac{KQ^2}{(2x)^2} = \frac{KQ^2}{4x^2}$$

In  $\Delta OAB$

$$\sin\theta = \frac{AB}{AO}$$

$$\sin\theta = \frac{x}{l}, \quad x = \sin\theta \dots\dots(1)$$

$$T\sin\theta = F_C$$

$$T\cos\theta = mg$$

$$\tan\theta = \frac{KQ^2}{4x^2 \cdot mg}$$

$$\tan\theta = \frac{KQ^2}{4\sin^2\theta \cdot mg} \quad \dots\dots\dots \text{from (1)}$$

$$\sin^2\theta \cdot \tan\theta = \frac{KQ^2}{4 \cdot mg}$$

in above equation, trigonometry function  $\sin\theta$  &  $\tan\theta$ , hence  $\theta$  increases as  $g$  decreases.

77. A beaker is completely filled with water at  $4^\circ\text{C}$ . 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.

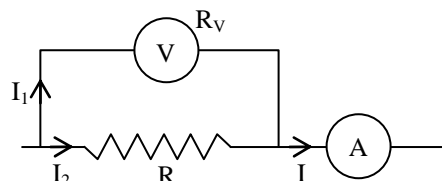
Select correct option regarding (I) and (II).

- (a) Only (I) is correct
- (b) Only (II) is correct
- (c) Both (I) and (II) are correct
- (d) Neither (I) nor (II) is correct

Ans. [c]

Sol. Water will overflow in both the cases, either the beaker is cooled or heated for some time.

78.



Refer the adjacent circuit. The voltmeter reads 117V and ammeter reads 0.13A. If the resistance of voltmeter and ammeter are  $9 \text{ k}\Omega$  and  $0.5015\Omega$  respectively, the value of  $R$  is \_\_\_\_.

- (a)  $500 \Omega$
- (b)  $1 \text{ k}\Omega$
- (c)  $1.5 \text{ k}\Omega$
- (d)  $2 \text{ k}\Omega$

Ans. [b]

Sol.

$$V = 117 \text{ volt}$$

$$I = 0.13 \text{ A}$$

$$R_v = 9000 \Omega$$

$$I = I_1 + I_2$$

$$0.13 = \frac{117}{R_v} + \frac{117}{R}$$

$$0.13 = \frac{117}{9000} + \frac{117}{R}, \quad R = 1000 \Omega$$

79. 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.

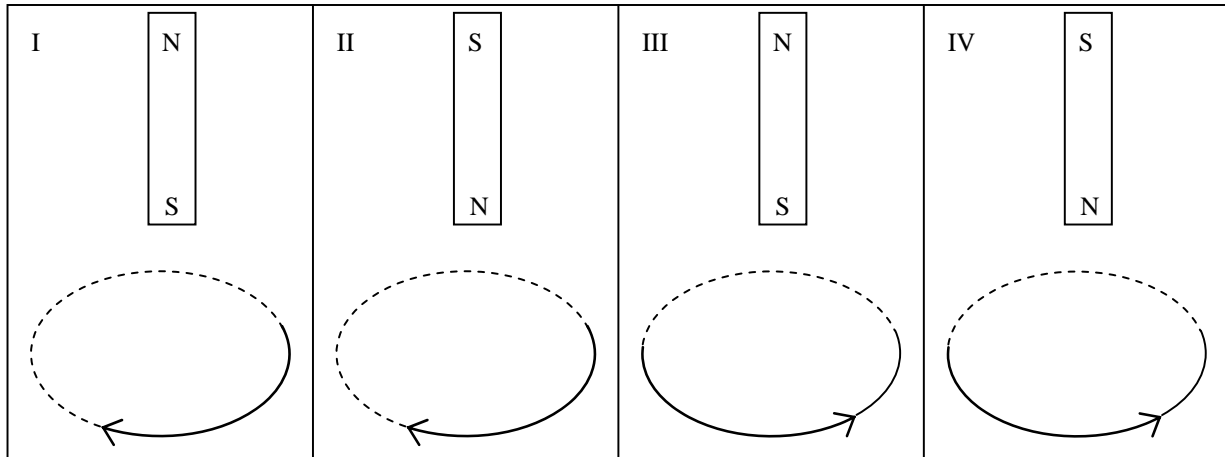
- (a) Only (I) is correct.
- (b) Only (II) is correct
- (c) Only (I) & (II) correct
- (d) All (I), (II) & (III) are correct.

**Ans.** [b]

**Sol.** Only (II) is correct

Both sphere acquired same charge and two electric lines of force never intersect to each other.

**80.** 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

**Ans.** [b]

**Sol.** In I and IV the loops will behave as south and north respectively. So, only in these two situations the magnets will experience repulsion and hence potential energy of the magnet coil interaction is maximum.