

**INDIAN ASSOCIATION OF PHYSICS TEACHERS**  
**NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE (NSEJS) 2018 – 19**  
**Question Paper Code: JS514**  
**Held on: November 18, 2018**

**ANSWER KEYS**

1.	<b>b</b>	2.	<b>b</b>	3.	<b>a</b>	4.	<b>c</b>
5.	<b>c</b>	6.	<b>c</b>	7.	<b>d</b>	8.	<b>a</b>
9.	<b>a</b>	10.	<b>a</b>	11.	<b>a</b>	12.	<b>d</b>
13.	<b>b</b>	14.	<b>a</b>	15.	<b>b</b>	16.	<b>c</b>
17.	<b>c</b>	18.	<b>d</b>	19.	<b>a</b>	20.	<b>c</b>
21.	<b>b</b>	22.	<b>c</b>	23.	<b>c or d</b>	24.	<b>b</b>
25.	<b>d</b>	26.	<b>a</b>	27.	<b>d</b>	28.	<b>c or d or (*)</b>
29.	<b>a</b>	30.	<b>b</b>	31.	<b>b</b>	32.	<b>a</b>
33.	<b>b</b>	34.	<b>a</b>	35.	<b>d</b>	36.	<b>c</b>
37.	<b>b</b>	38.	<b>c</b>	39.	<b>d</b>	40.	<b>(*)</b>
41.	<b>a</b>	42.	<b>a</b>	43.	<b>d</b>	44.	<b>d</b>
45.	<b>d</b>	46.	<b>c</b>	47.	<b>a</b>	48.	<b>b</b>
49.	<b>c</b>	50.	<b>a</b>	51.	<b>c</b>	52.	<b>b</b>
53.	<b>a</b>	54.	<b>a</b>	55.	<b>c</b>	56.	<b>a</b>
57.	<b>b</b>	58.	<b>b</b>	59.	<b>b</b>	60.	<b>d</b>
61.	<b>d</b>	62.	<b>c</b>	63.	<b>a</b>	64.	<b>c</b>
65.	<b>a</b>	66.	<b>b</b>	67.	<b>a</b>	68.	<b>b</b>
69.	<b>c</b>	70.	<b>b</b>	71.	<b>b</b>	72.	<b>b</b>
73.	<b>b</b>	74.	<b>c</b>	75.	<b>b</b>	76.	<b>a</b>
77.	<b>c</b>	78.	<b>b</b>	79.	<b>b</b>	80.	<b>B</b>

28. (\*) Possible answers are : 8, 10, 12 and 18.

40. (\*) Correct answer is 11

## SOLUTIONS

1. 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 |

1. b

1. Correct set of observations is Q

i.e. water rushed into the gas jar and sulphur dioxide is soluble in water.

2. 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 |

2. b

2. 
$$\text{Molarity} = \frac{\text{Mass}}{\text{Molar mass} \times \text{Volume(L)}}$$

$$0.5 = \frac{240}{M \times 4}$$

$$M = 120 \text{ g/Mole}$$

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) $X_6Y_4$ |

3. a

3.  $X = \frac{60}{10} = 6$        $Y = \frac{40}{20} = 2$



4.  $4.095 \times 10^{24}$  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 |

4. c

4. Given no. of nitrogen atoms =  $4.095 \times 10^{24}$

$$\text{No. of nitrogen molecules} = \frac{4.095 \times 10^{24}}{2}$$

$$\text{No. of moles of nitrogen gas in the cylinder} = \frac{4.095 \times 10^{24}}{2 \times 6.022 \times 10^{23}} = 3.4 \text{ moles}$$

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 to be  $W_3$ .

The ratio of the weight  $W_1:W_2:W_3$  is

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

5.

c  
Number of moles of sulphur dioxide gas =  $\frac{W_1}{64}$

Number of moles of methane gas =  $\frac{W_2}{16}$

Number of moles of oxygen gas =  $\frac{W_3}{32}$

According to Avogadro hypothesis, Equal volumes of all gases under similar conditions of temperature and pressure contains equal no. of molecules and hence equal number of moles.

$$\frac{W_1}{W_2} = \frac{64}{16} = \frac{4}{1}$$

$$\frac{W_2}{W_3} = \frac{16}{32} = \frac{1}{2}$$

∴ Ratio of weights  $W_1 : W_2 : W_3$  is 4 : 1 : 2

6. 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  $1.28 \text{ g cm}^{-3}$ . If initial molarity of battery acid was 4.2

M then mass percentage will be around \_\_\_\_\_.

- (a) 28% (b) 30%  
(c) 32% (d) 34%

6.

c  
Molarity =  $\frac{x \times \text{density} \times 10}{\text{Molecular mass of solute}}$

$$4.2 = \frac{x \times 1.28 \times 10}{98}$$

$$X = 32.15\% \approx 32\%$$

7.  $P^{3-}$  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.

7.

d  
The electron in  $P^{3-}$  have a greater coulombic repulsion than those in P-atom. This is the reason that  $P^{3-}$  has a larger radius than that of its parent atom.

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.

8.

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

9. 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
9. a
9. Let volume of Sonu HCl solution be x L  
 So, volume of Monu HCl solution be (2 - x)L  
 $\therefore M_1V_1 + M_2V_2 = M_R \times (\text{Total volume})$   
 $\frac{1}{2} \times x + \frac{1}{10} (2 - x) = \frac{1}{5} \times 2$   
 $x = 0.5$   
 Volume of two solutions mixed will be (0.5 + 1.5) litre
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 8.60 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
10. a
10. 
$$\text{Fe} + \text{CuSO}_4 \longrightarrow \text{FeSO}_4 + \text{Cu}$$
  
 Given: 15.5 g 21.0 g 8.60 g  
 Unreacted mass of iron = 8.5 g  
 Mass of ferrous sulphate formed in this reaction = 19.4 g
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 CO<sub>2</sub> required 5 cm<sup>3</sup> of 0.1 M KOH. The amount of coal combusted is  
 (a) 3 mg (b) 6 mg (c) 11 mg (d) 12 mg
11. a
11. 
$$\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$$
  

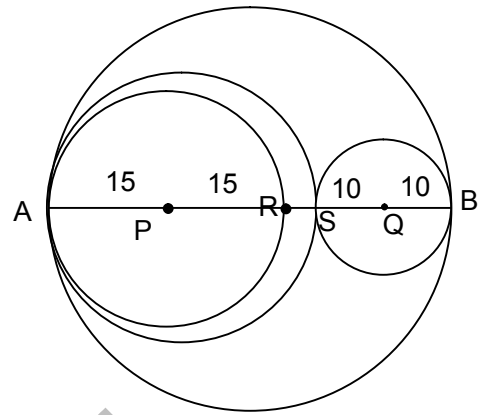
$$\text{CO}_2 + 2\text{KOH} \longrightarrow \text{K}_2\text{CO}_3 + \text{H}_2\text{O}$$
  
 2 moles of KOH give 1 mole of CO<sub>2</sub>  
 So, 0.0005 moles of KOH will give 0.00025 moles of CO<sub>2</sub> i.e. Mass of carbon = 0.00025 × 12 = 0.003 g  
 $\therefore$  Amount of coal combusted is 3 mg
12. When a surface tension experiment with capillary tube is performed, water rises up to 0.1m. If the experiment is carried out in space, water will rise in capillary tube \_\_\_\_\_.  
 (a) up to height of 0.1m (b) up to height of 0.2 m  
 (c) up to height of 0.8 m (d) along its full length
12. d
12. Height of capillary rise liquid is given by  

$$h = \frac{2T}{\rho r g}$$
  
 (T = surface tension, r = radius of capillary tube,  $\rho$  = density, g = acceleration due to gravity)  
 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 along its full length. As when experiment is carried out in space, acceleration due to gravity (g) will be negligibly small.
13. 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
13. b



18. d
18. Iso-octane can improve the quality of petrol.
19.  $2\text{KBrO}_3 + 12\text{H}^+ + 10\text{e}^- \longrightarrow \text{Br}_2 + 6\text{H}_2\text{O} + 2\text{K}^+$   
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)  $M/2$
19. a
19. Equivalent weight of  $\text{KBrO}_3 = \frac{\text{Molecular mass}}{n - \text{factor}} = \frac{M}{5}$
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
20. c
20. Colour of the solution turned blue
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
21. b
21. First polygon has sides = m, and another = n  
In first polygon number of diagonals =  $\frac{m(m-3)}{2}$   
In second polygon number of diagonal =  $\frac{n(n-3)}{2}$   
 $m + \frac{n(n-3)}{2} = 103 \Rightarrow 2m + n^2 - 3n = 206$   
 $n + \frac{m(m-3)}{2} = 80 \Rightarrow 2n + m^2 - 3m = 160$   
equation (i) – (ii)  
 $2(m-n) + n^2 - m^2 - 3n + 3m = 46$   
 $n^2 - m^2 - 5n + 5m = 46$   
 $(n-m)(n+m-5) = 46$   
Different possible case  $1 \times 46 = 46$   
 $2 \times 23 = 46$   
Considering,  $n - m = 2$   
 $n + m - 5 = 23$   
So,  $n = 15$  and  $m = 13$   
 $m + n = 28$
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
22. c

22. AB = 60 cm  
As is clear from the figure, RS = 10 cm  
Therefore,  
AS = 40 cm  
So, the required radius is 20 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

23. c or d

23. There can be two cases:

	Thrice	Twice	Once
Case 1 →	6	5, 4, 3, 1	2
Case 2 →	5	6, 4, 3, 2	1

So, answer will be option C or option D

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

24. b

$$\frac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}} = k$$

$$\frac{k+1}{k-1} = \frac{2\sqrt{a+x}}{-2\sqrt{a-x}}$$

$$\left(\frac{k+1}{k-1}\right)^2 = \frac{a+x}{a-x}$$

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

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

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

$$b(k^2 + 1) = k(b^2 + 1)$$

$$kb(k-b) - 1(k-b) = 0, k = \frac{1}{b} \text{ or } b$$

25. A  $5 \times 5 \times 5$  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

25. d

25. Total number of cuboids =  $({}^6C_2)^3$   
 $= 15^3 = 3375$

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

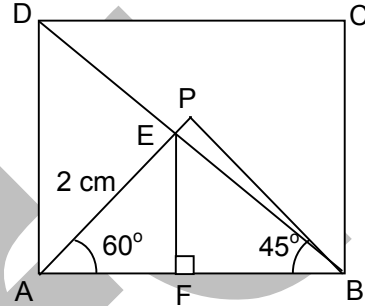
- (a)  $4 + 2\sqrt{3}$                       (b)  $5 + 2\sqrt{3}$                       (c)  $4 + 4\sqrt{3}$                       (d)  $5 + 4\sqrt{3}$

26. a

26. In  $\triangle EFA$ ,  $AF = 1$  and  $FB = EF = \sqrt{3}$

Side of square =  $\sqrt{3} + 1$

area =  $4 + 2\sqrt{3}$



27. 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

27. d

27.  $n^2(n^2 - 1)(n^2 - n - 2) = n^2(n - 1)(n + 1)(n + 1)(n - 2)$

Since  $(n - 2)(n - 1)n(n + 1)$  is divisible by  $4!$  and either n or  $n + 1$  is even.

So,  $n^2(n^2 - 1)(n^2 - n - 2)$  is divisible by 48.

28. 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

28. c or d or (\*)

28. If n has 6 positive divisors then n can be of form  $n = x^2y$  or  $n = z^5$

Case 1:

$9n = 3^2x^2y$

If  $x \neq 3, y \neq 3$ , number of factors = 18

If  $x \neq 3, x \neq 2, y = 3$ , number of factors = 12

If  $y \neq 3, y \neq 2, x = 3$ , number of factors = 10

Case 2:

$9n = 3^2z^5$

If  $z \neq 3$ , number of factors = 18

If  $z = 3$ , number of factors = 8

So possible answers are : 8, 10, 12 and 18.

29. Let ABC be an equilateral triangle. The bisector of  $\angle BAC$  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

29. a



29.  $DB + DC = 4$   
 $\therefore DB = DC = 2$  [DB and DC subtend equal angles]

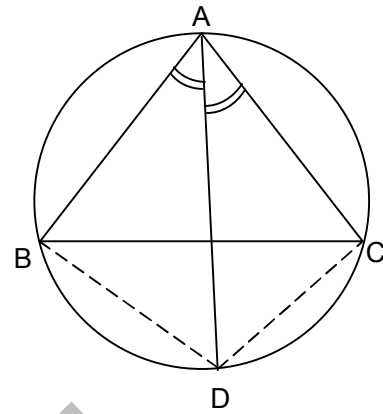
$$\angle BAD = 30^\circ$$

As  $\triangle ABC$  is equilateral, AD is the perpendicular bisector of BC.

$\therefore$  AD is the diameter.

In  $\triangle ABD$ ,

$$AD = \frac{BD}{\sin 30^\circ} = \frac{2}{\frac{1}{2}} = 4$$



30. 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

30. b

30. Red balls =  $x$ , yellow balls =  $y$

$$\therefore n = x + y$$

$$\text{According to the question, } \frac{1}{7}(x + y - 1) = x - 1$$

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

$$\Rightarrow 6x - y - 6 = 0 \quad \text{(i)}$$

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

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

$$\Rightarrow 5x - y + 1 = 0 \quad \text{(ii)}$$

$$\text{equation (i) - (ii) } \Rightarrow x = 7$$

$$\therefore y = 36$$

$$\therefore n = x + y = 43$$

$$\therefore \text{Sum of digits of } n = 7$$

31. 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

31. b

$$31. \alpha(k) = \frac{180(k-2)}{k}$$

$$\alpha(n-2) = \frac{180(n-4)}{n-2}$$

$$\alpha(n) = \frac{180(n-2)}{n}$$

$$\alpha(n+3) = \frac{180(n+1)}{n+3}$$

According to the question

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

$$\frac{n+1}{n+3} + \frac{n-4}{n-2} - \frac{2n-4}{n} = 0$$

$$\Rightarrow n = 12$$

$\therefore$  Sum of digits of  $n = 3$

32. The integer closet 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)  $\frac{10^{2018} - 1}{9}$

32. a

$$x = \sqrt{\underbrace{(1111\dots11)}_{2018 \text{ times}} - 2 \underbrace{(111\dots111)}_{1009 \text{ times}}}$$

$$\begin{aligned} x &= \sqrt{10^{1009} \times \underbrace{(1111\dots11)}_{1009 \text{ times}} - \underbrace{(1111\dots111)}_{1009 \text{ times}}} \\ &= \sqrt{(10^{1009} - 1) \underbrace{(111\dots111)}_{1009 \text{ times}}} \\ &= (10^{1009} - 1) \times (10^{1008} + 10^{1007} + \dots + 10 + 1) \\ &= \sqrt{\frac{(10^{1009} - 1)^2}{9}} = \frac{10^{1009} - 1}{3} \end{aligned}$$

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 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

33. b

33. Let area of rectangle ABCD is 'a'

$$\text{Then ar(DXC)} = \frac{a}{2}$$

Now,  $\triangle DLY \sim \triangle XLA$

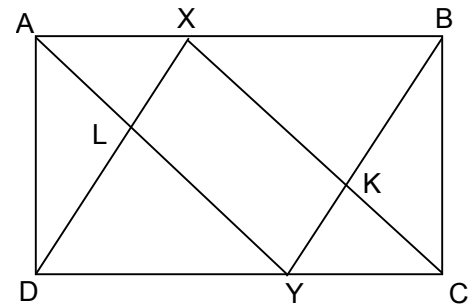
$$\Rightarrow \frac{AL}{LY} = \frac{XL}{LD} = \frac{1}{2}$$

$$\text{Now ar(ADY)} = \frac{a}{3} \Rightarrow \text{ar(DLY)} = \frac{2a}{9}$$

$$\text{Now } \frac{\text{ar(ALX)}}{\text{ar(DLY)}} = \frac{1}{4} \Rightarrow \text{ar(ALX)} = \frac{a}{18}$$

Now,

$$\text{ar(XKYL)} = \frac{a}{2} - \frac{2a}{9} - \frac{a}{18} = \frac{2a}{9} \Rightarrow \frac{m}{n} = \frac{2}{9} \Rightarrow m+n=11$$



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

34. a

$$\sin \theta + \cos \theta = \frac{-q}{p}$$

$$\sin \theta \cos \theta = \frac{r}{p}$$

$$\sin^2 \theta + \cos^2 \theta = 1$$

$$(\sin \theta + \cos \theta)^2 - 2 \sin \theta \cos \theta = 1$$

$$\frac{q^2}{p^2} - \frac{2r}{p} = 1$$

$$q^2 - 2pr = p^2$$

$$p^2 - q^2 + 2pr = 0$$

35. The number of distinct integers in the collection  $\left[ \frac{10^2}{1} \right], \left[ \frac{10^2}{2} \right], \left[ \frac{10^2}{3} \right], \dots, \left[ \frac{10^2}{20} \right]$ , where  $[x]$  denotes the largest integer not exceeding  $x$ , is
- (a) 20 (b) 18  
(c) 17 (d) 15

35. d

$$\begin{aligned} \left[ \frac{10^2}{1} \right] &= 100, & \left[ \frac{10^2}{2} \right] &= 50, & \left[ \frac{10^2}{3} \right] &= 33, & \left[ \frac{10^2}{4} \right] &= 25, \\ \left[ \frac{10^2}{5} \right] &= 20, & \left[ \frac{10^2}{6} \right] &= 16, & \left[ \frac{10^2}{7} \right] &= 14, & \left[ \frac{10^2}{8} \right] &= 12, \\ \left[ \frac{10^2}{9} \right] &= 11, & \left[ \frac{10^2}{10} \right] &= 10, & \left[ \frac{10^2}{11} \right] &= 9, & \left[ \frac{10^2}{12} \right] &= 8, \\ \left[ \frac{10^2}{13} \right] &= \left[ \frac{10^2}{14} \right] = 7, & \left[ \frac{10^2}{15} \right] &= \left[ \frac{10^2}{16} \right] = 6, & \left[ \frac{10^2}{17} \right] &= \left[ \frac{10^2}{18} \right] = \left[ \frac{10^2}{19} \right] = \left[ \frac{10^2}{20} \right] = 5 \end{aligned}$$

So, 15 distinct integers.

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

36. c

36. Let first term be  $a$  and common difference be  $d$

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

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

Subtracting (ii) from (i), we get,

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

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

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

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

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

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

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

$$= 1$$

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

37. b

37. Let the numbers be  $\frac{a}{r^2}, \frac{a}{r}, a, ar, ar^2$

$$\text{Sum} \Rightarrow \frac{a}{r^2} + \frac{a}{r} + a + ar + ar^2 = 24$$

$$a \left( \frac{1}{r^2} + \frac{1}{r} + 1 + r + r^2 \right) = 24 \text{ -----(i)}$$

$$\text{Sum of reciprocals} \Rightarrow \frac{r^2}{a} + \frac{r}{a} + \frac{1}{a} + \frac{1}{ar} + \frac{1}{ar^2} = 6$$

$$\frac{1}{a} \left[ r^2 + r + 1 + \frac{1}{r} + \frac{1}{r^2} \right] = 6 \text{ -----(ii)}$$

Dividing (i) by (ii), we get

$$a^2 = 4$$

$$a = 2$$

$$\therefore \text{Product of the terms} = a^5 = 2^5 = 32$$

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

38. c

38. Construct  $DX \parallel BF$

$$\frac{AE}{ED} = \frac{1}{2}$$

$$\Rightarrow \frac{AF}{FX} = \frac{1}{2} \text{ -----(i)}$$

[by Basic proportionality theorem]

In  $\triangle CFB$ ,

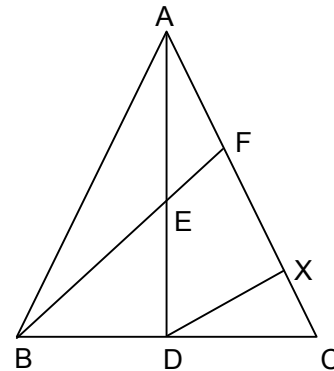
$$\frac{BD}{DC} = \frac{1}{1}$$

$$\Rightarrow \frac{FX}{XC} = \frac{1}{1} \text{ [By basic proportionality theorem]}$$

$$\Rightarrow \frac{FX}{FC} = \frac{1}{2} \text{ -----(ii)}$$

Multiplying (i) and (ii), we get,

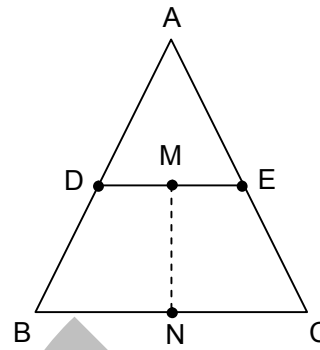
$$\frac{AF}{FC} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$



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

39. d

39.  $\frac{AD}{AB} = \frac{1}{4}$   
 and  $\triangle ADE \sim \triangle ABC$   
 $\Rightarrow \frac{\text{ar}(\triangle ADE)}{\text{ar}(\triangle ABC)} = \frac{1}{16}$   
 Now,  $\frac{\text{ar}(\text{quad DECB})}{\text{ar}(\triangle ABC)} = \frac{15}{16}$  .....(i)  
 Also,  $\frac{\text{ar}(\text{quad BNMD})}{\text{ar}(\text{quad DECB})} = \frac{1}{2}$  .....(ii)  
 Multiplying (i) and (ii), we get,  
 $\frac{\text{ar}(\text{quad BNMD})}{\text{ar}(\triangle ABC)} = \frac{15}{32}$



40. Digit 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  
 40. (\*)  
 40. Factor pairs of 36 : (1, 36), (2, 18), (3, 12), (4, 9), (6, 6)  
 Out of this both numbers cannot be both even or both odd, as  $4a1$  is odd  $\Rightarrow 25b$  is even.  
 So, we will consider (1, 36), (3, 12) and (4, 9)  
 Case : 1  
 $4a1 \rightarrow$  divisible by 9,  $25b \rightarrow$  divisible by 4  
 $a \rightarrow 4$   $b \rightarrow 2, 6$   
 Case : 2  
 $4a1 \rightarrow$  divisible by 3,  $25b$  divisible by 12  
 $a \rightarrow 1, 4, 7$   $b \rightarrow 2$   
 Case : 3  
 $4a1 \rightarrow$  divisibly by,  $25b$  divisible by 36  
 $a \rightarrow 0, 1, 2, \dots, 9$   $b \rightarrow 2$   
 $\therefore$  Total Number of pairs are =  $2 + 3 + 10 = 15$  but some pairs are repeating.  
 So, the distinct pairs are (0,2), (1,2), (2,2), (3,2), (4,2), (5,2), (6,2), (7,2), (8,2), (9,2), (4,6)  
 Number of distinct pairs = 11, which is not there in options.

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 cell walls  
 Which of the following category do the cells belong to?  
 (a) Archaea (b) Plant cells  
 (c) Unicellular eukaryotes (d) Cyanobacteria  
 41. a  
 41. All the mention characteristics belongs to Archaea bacteria.  
 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 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

42.

a

42.

The exact tissue that was affected by mutation is Anterior Lobe of pituitary.

43.

Character(s) of acquired immunity is (are):

- (a) differentiation between self and non-self (b) specificity of antigen  
(c) retains memory (d) all of the above

43.

d

43.

Characters of acquired immunity are differentiation between self and non-self, specificity of antigen and retains memory.

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 his cause?

- (a) Glycine max – Rhizobium (b) Cycas – Nostoc  
(c) Casuarina – Frankia (d) Azolla – Anabaena

44.

d

44.

Azolla – Anabaena are beneficial for paddy field.

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 required '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

45.

d

45.

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

46.

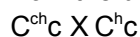
c

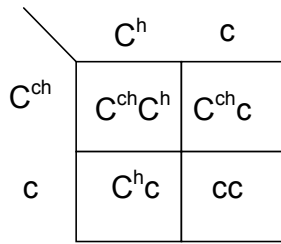
46.

According to Genetic code, Codon is triplet.  
Number of bp = 2988  
Therefore, 2988/3 = 996

1 stop codon is present so  $996 - 1 = 995$ . Hence, the length of polypeptide translated from mRNA is 995.

47. True coelom is not present in animals of  
(a) Platyhelminthes (b) Annelida  
(c) Echinodermata (d) Arthropoda
47. a
47. True coelom is not present in animals of phylum Platyhelminthes.
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
48. b
48. The intracellular organelle that is responsible for formation of acrosomal vesicle is Golgi apparatus.
49. An action potential in the nerve fibre is produced when positive and negative charges on outside and inside of the axon membrane are reserved 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
49. c
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 more sodium ions enter the axon as compared to potassium ions leaving it.
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
50. a
50. This patient is suffering from 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)  $C^{ch}C^{ch} \times C^{ch}c$   
(c)  $C^{ch}c \times C^{ch}c$  (d)  $C^{ch}C^{ch} \times C^{ch}C^{ch}$
51. c
51. The genotypes of coat colour in Rabbit  
(a) Chinchilla  $\rightarrow C^{ch}$   
(b) Himalayan  $\rightarrow C^h$   
(c) Albino  $\rightarrow c$   
Therefore, if the percentage of Chinchilla is 50%, Himalayan is 25% and Albino is 25% then the genotypes of parent rabbit obtain from the below mention punnet square.





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  
(c) Bullfrog, Crocodile

- (b) Bull shark, Alpine salamander  
(d) Platypus, Common toad

52.

b

52.

Both Bull shark and Alpine salamander are viviparous.

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	+	+	-	+	+
RNS / 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

53.

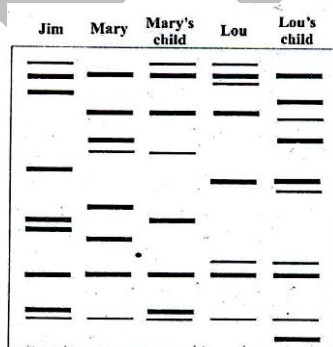
a

53.

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

P – Bacterium, Q – Plant, R – Virus, S – Animal, T – Fungus

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 NDA fingerprinting technique to study the three highly variable chromosome regions. The results obtained that shown in the adjoining figure.

After studying the DNA profile, which of the alleged heirs are children of Jim?

- (a) Mary's child  
(c) Lou's child
- (b) both are children of Jim  
(d) none are children of Jim

54.

a

54.

After studying the DNA profile, Mary's child considered as child of Jim.



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
55. c
55. Chargaff's Rule state that DNA helices contain equal molar ratios of A to T and C to G. This is because DNA found as double stranded helix in which A and T and G and C bases pair complementarily.

	T	C	A	G
Strand I	348	590 (X)	650	1400
Strand II	650	1400	348	590 (Y)

According to Chargaff's rule X and Y both are 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 chromosome.

- (a) 22AA + XY, 22AA + XXX (b) 22AA + XXY, 22AA + XXX  
 (c) 22aa + XY, 22AA + XX (d) 22AA + XXY, 22AA + XX

56. a
56. Best possible combination of parent is 22AA + XY, 22AA + XXX

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 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)

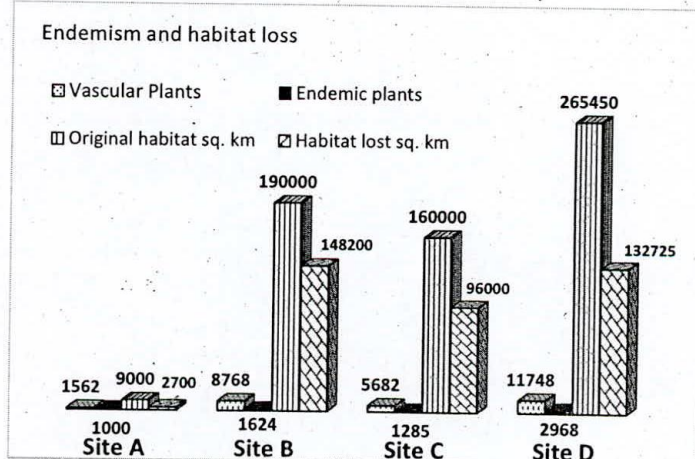
Subjects→	Ramesh		Ali		Sophia		Balwinder	
Enzymes↓	P / A	%	P / A	%	P / A	%	P / A	%
X	+	50	+	50	+	100	-	-
Y	-	-	+	50	-	-	+	100

- (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)  $I^B i$ ,  $ii$ ,  $I^A I^B$ ,  $I^A i$

57. b
57. The blood group of subjects are as follows:

- (a) Ramesh →  $I^A i$   
 (b) Ali →  $I^A I^B$   
 (c) Sophia →  $I^A I^A$   
 (d) Balwinder →  $I^B I^B$

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
58. b  
58. Site B (as high number of endemics species) should be included as biodiversity hotspots.

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

59. b

59. 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

60. d

60. 
$$N = \frac{\text{Total time for division}}{\text{Time taken for one division}}$$

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

$$F = i \times 2^n$$

F = Final number of bacteria

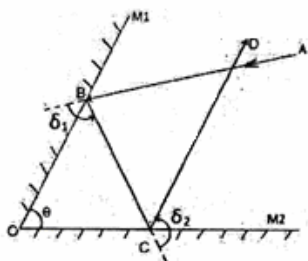
i = initial number of bacteria

n = number of generations

$$F = 10^8 \times 2^6$$

The number of cells after 300 minutes will be =  $6.4 \times 10^9$

61.

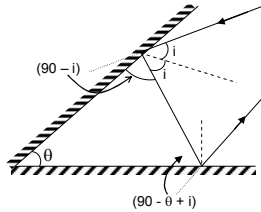


Two plane mirror  $M_1$  or  $M_2$  have their reflecting faces inclined at  $\theta$ . Mirror  $M_1$  receives a ray AB, reflects it at B and sends it a BC. It is now, reflected by mirror  $M_2$  along CD, as shown in the figure. Total angular deviation  $\delta$  suffered by the incident ray AB is:

- (a)  $\delta = 90^\circ + 2\theta$   
 (c)  $\delta = 270^\circ - 2\theta$

- (b)  $\delta = 180^\circ + 2\theta$   
 (d)  $\delta = 360^\circ - 2\theta$

61.  
61.



$$\begin{aligned} \delta_1 &= 2(90 - i) + 2(90 - \theta + i) \\ &= 180 - 2i + 180 - 2\theta + 2i \\ &= 360 - 2\theta \end{aligned}$$

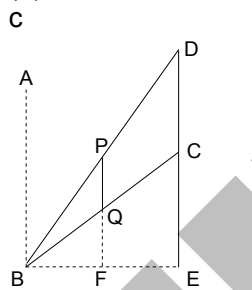
62.



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

62.  
62.



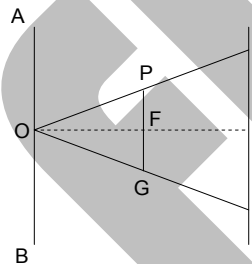
By similarity of  $\triangle BFQ$  &  $\triangle BFC$

$$\frac{BF}{BE} = \frac{QF}{CE}$$

By similarity of  $\triangle BDE$  &  $\triangle BPF$

$$\frac{BF}{BE} = \frac{PF}{DE} = \frac{PQ + QF}{DC + CE} = \frac{PQ}{DC}$$

$$\therefore \frac{\text{Distance between line AB \& obstacle}}{\text{Distance between AB \& screen}} = \frac{\text{Size of obstacle}}{\text{Size of shadow}}$$

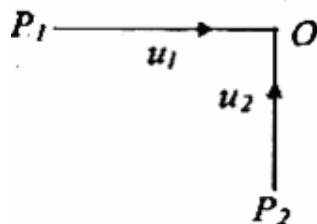


By similarity of  $\triangle ODE$  &  $\triangle OPF$

$$\frac{OF}{OE} = \frac{PF}{DE}$$

$$\frac{\text{Distance between line AB \& obstacle}}{\text{Distance between AB \& screen}} = \frac{\frac{1}{2} \text{ size of obstacle}}{\frac{1}{2} \text{ size of shadow}}$$

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:

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

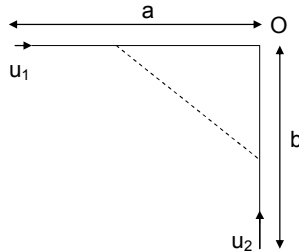
$$(b) s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(bu_1 + au_2)]^{1/2}$$

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

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

63.

a



After time  $t$  positions of particles will become  $(a - u_1t)$  &  $(b - u_2t)$

$$\begin{aligned} \text{Instantaneous distance} &= \sqrt{(a - u_1t)^2 + (b - u_2t)^2} \\ &= [a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2(bu_2 + au_1)t]^{1/2} \end{aligned}$$

64.

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

(a)  $m - K^{-1}$

(b)  $m - K$

(c)  $K^{-1}$

(d)  $\alpha$  is a pure number

64.

c

64.

SI unit of  $\alpha$  is  $K^{-1}$ .

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

65.

a

65.

$$\text{Musical interval} = \frac{(\text{frequency})_1}{(\text{frequency})_2}$$

$$\left[ f_2 = \frac{1}{20 \times 10^{-3}} \text{ Hz} = 50 \text{ Hz} \right]$$

$$1.4 = \frac{f_1}{50} \Rightarrow f_1 = 1.4 \times 50$$

Two wavelengths are  $(\lambda)$  &  $(\lambda + 2)$

Speed will remain same  $v = \lambda f$

$$\Rightarrow \lambda \cdot (1.4 \times 50) = (\lambda + 2) \times 50$$

$$\Rightarrow 70\lambda = 50\lambda + 100$$

$$20\lambda = 100$$

$$\lambda = 5\text{m}$$

$$v = 5 \times 1.4 \times 50 = 350 \text{ m/s}$$

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

66.

b

66.

Say focal length of mirror =  $f$

Object distances  $u_1 = 25$  ;  $u_2 = 40$

$$\text{Using } m = \frac{f}{f - u}$$

$$\frac{m_1}{m_2} = 4 = \frac{f - u_2}{f - u_1}$$

$$3f = 4u_1 - u_2$$

$$= 100 - 40 \quad ; \quad f = 20$$

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) 4 m, tachycardia

67. a

67. Time taken in 60 oscillations of second's Pendulum = 120 s = 2 min.

In 2 min pulse beats 110 times

So, pulse frequency = 55 per minute.

$$T = 2\pi\sqrt{\frac{L}{g}} \quad ; \quad L = \frac{T^2}{4\pi^2} \cdot g \text{ putting values}$$

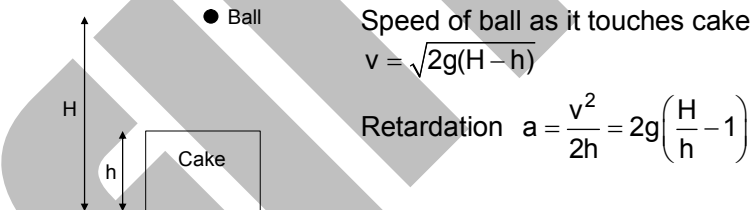
$$L \cong 1 \text{ m.}$$

68. 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  $g\left(\frac{H}{h} - 1\right)$   
(b)  $\sqrt{2g(H-h)}$  and  $g\left(\frac{H}{h} - 1\right)$   
(c)  $\sqrt{2gh}$  and  $g\left(\frac{h}{H} - 1\right)$   
(d)  $\sqrt{2g(H-h)}$  and  $g\left(\frac{h}{H} - 1\right)$

68. b

68.



69. An electric generator consumes some oil fuel and generates output of 25 kW. Calorific value (amount of heat released per unit mass) of 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 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

69. c

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

$$\text{Input} = \frac{25 \text{ kW}}{0.25} = 10^5 \text{ J/s} = 3600 \times 10^5 \text{ J/hour}$$

17200 × 4184 J of heat is released on burning 1 kg

$$3600 \times 10^5 \text{ J of heat is released on burning} = \frac{3600 \times 10^5}{17200 \times 4184} = 5 \text{ kg.}$$

On burning 5 kg fuel energy generated = 25 kWh

On burning 10<sup>3</sup> kg fuel energy generated = 5000 kWh.

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:  $\left(\frac{1}{\sqrt{2}} = 0.707, \frac{1}{\sqrt{3}} = 0.577, \frac{1}{\sqrt{5}} = 0.447\right)$ )

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

70. b

$$R = \frac{h}{\sqrt{n^2 - 1}} = \frac{\frac{1}{2}}{\sqrt{(1.5)^2 - 1}} = 0.447$$

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

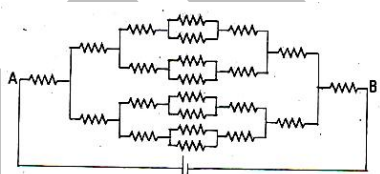
71. b

$$\left(1 - \frac{V_{\text{out}}}{V}\right) = \frac{\rho_{\text{solid}}}{\rho_{\text{liq}}}$$

$$\frac{5}{8} = \frac{\rho_b}{1} \Rightarrow \rho_b = \frac{5}{8}$$

$$\frac{V_{\text{out}}}{V} = 1 - \frac{\rho_b}{1.12} = 1 - 0.56 = 0.44$$

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)  $29 \Omega$

72. b

$$\text{Req. of ckt} = \frac{29R}{8} \Omega$$

For Req. to be integer  $R = 8\Omega$ .

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)  $10^3 \text{ kg}$  (b)  $10^{-3} \text{ kg}$   
(c) 10 kg (d)  $10^{-1} \text{ kg}$

73. b

$$m = \frac{F \times t}{v} \Rightarrow 1\text{kg} = \frac{1\text{N} \times 1\text{s}}{1\text{m/s}}$$

In new system

$$m = \frac{10\text{N} \times \frac{1}{100} \text{s}}{100 \text{ m/s}} = 10^{-3} \frac{\text{N} \times \text{s}}{\text{m/s}} = 10^{-3} \text{ kg}$$

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

74. c

74. Good absorber is good emitter.

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

- (a)  $1.2 \text{ s}$ ,  $2.4 \text{ s}$ ,  $3.0 \text{ s}$
- (b)  $1.0 \text{ s}$ ,  $2.4 \text{ s}$ ,  $3.0 \text{ s}$
- (c)  $1.0 \text{ s}$ ,  $2.0 \text{ s}$ ,  $3.0 \text{ s}$
- (d)  $1.2 \text{ s}$ ,  $2.4 \text{ s}$ ,  $3.6 \text{ s}$

75. b

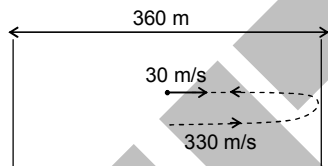
75.

Sound reflected from first wall

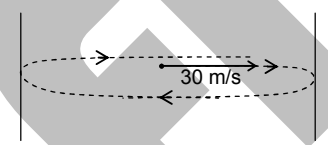
Say 1<sup>st</sup> echo is heard after time  $t_1$

$$30t_1 + 330t_1 = 360$$

$$t_1 = 1 \text{ sec.}$$



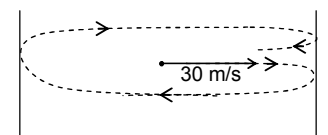
First wave when reflected from second wall will reach observer after time  $t_4$ .



$$330t_4 = 720 + 30t_4$$

$$t_4 = 2.4 \text{ sec}$$

The third echo will be heard when this ray will strike to the first wall again and come back to the observer in time  $t_5$ .



$$330t_5 + 30t_5 = 1080$$

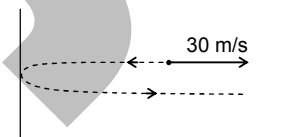
$$t_5 = 3 \text{ sec}$$

Sound reflected from second wall

Say sound reaches from second wall after time

$$330 \times t_2 = 360 + 30 \times t_2$$

$$\Rightarrow t_2 = 1.2 \text{ sec}$$

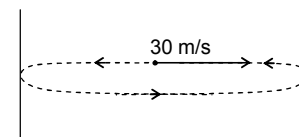


Second sound wave reaches after reflection in time  $t_3$

$$330 \times t_3 + 30 \times t_3 = 720$$

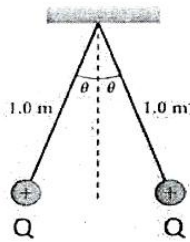
$$360 t_3 = 720$$

$$t_3 = 2\text{s}$$



The time is less than time of persistence of sound. So, they will not produce echo.

76.

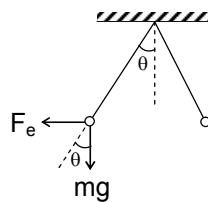


Two equally charged identical pith balls are suspended by identical massless strings as shown in the adjacent figure. If this set up is on Mercury ( $g = 3.7 \text{ m/s}^2$ ), Earth ( $g = 9.8 \text{ m/s}^2$ ) and Jupiter ( $g = 24.5 \text{ m/s}^2$ ), then angle  $2\theta$  will be \_\_\_\_\_

- (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

76.

a



$$\tan \theta = \frac{F_e}{mg}$$

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

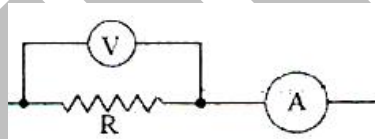
77.

c

77.

Water has maximum density at  $4^\circ \text{C}$ .

78.



Refer the adjacent circuit. The voltmeter reads  $117 \text{ V}$  and ammeter reads  $0.13 \text{ A}$ . If the resistance of voltmeter and ammeter are  $9 \text{ k}\Omega$  and  $0.015 \Omega$  respectively, the value of  $R$  is \_\_\_\_\_

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

78.

b

78.

$$V = 117 \text{ V} ; \quad I = 0.13 \text{ A}$$

$$R_{eq} = \frac{117}{0.13} = 900 = \frac{R \times R_V}{R + R_V}$$

$$R_V = 9 \times 10^3 \Omega \text{ using the value}$$

$$R = 10^3 \Omega.$$

79.

Choose correct option from the following statements from electrostatics:

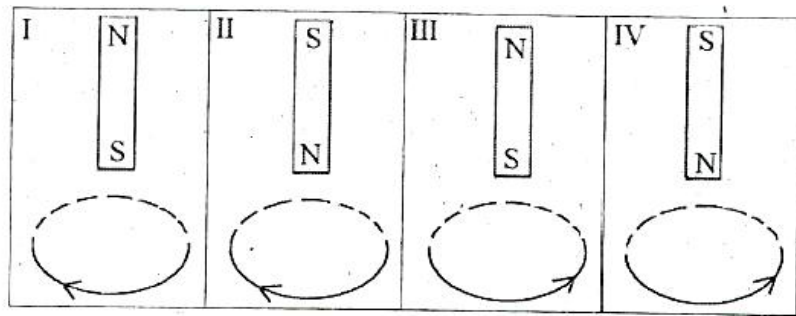
- (I) If two copper spheres of same radii, one hollow and the other solid are charged to the same electrical potential, the solid sphere will have more charges
- (II) A charged body can attract another uncharged body.
- (III) Electrical lines of force originating from like charges will exert a lateral 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) and (II) are correct      (d) All (I), (II) and (III) are correct
79. b
79. (i) Both spheres will have same charge.  
 (ii) is true  
 (iii) Electric line of force never intersect.

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
80. b
80. In 1<sup>st</sup> and 4<sup>th</sup> case system is experiencing repulsion hence potential energy is maximum.