

Examination Time
10.00 to 12.00 Hrs.



Question Paper Code

JS511

INDIAN ASSOCIATION OF PHYSICS TEACHERS
NATIONAL STANDARD EXAMINATION IN JUNIOR SCIENCE (NSEJS)

NSEJS : Test Paper - 2018

Instructions to candidates - Read carefully and strictly follow each of them

1. Use and carrying calculators of any type is strictly prohibited.
2. Use and even carrying smart watches, phones, i-pads or any other communication devices or any other objectionable material in examination centre is strictly prohibited.
3. Write the question paper code in your answer sheet in the appropriate space provided, otherwise your answer sheet will not be assessed.
4. On the answer sheet, make all the entries correctly, carefully in the space(s) provided, in capital letters as well as by properly darkening the appropriate bubbles using blue or black ball point pen only. Incomplete/ incorrect / carelessly filled information may disqualify your candidature. Please take care while entering.
5. Please do not make any mark other than filling the appropriate bubbles properly in the space provided on the answer sheet. Further, do not write on the back side of the answer sheet.
6. As answer sheets are evaluated using machine, change of entry is not allowed. Even scratching or overwriting may result in a wrong score.
7. Question paper has 80 multiple choice questions. Each question has four alternatives, out of which only one is correct. Choose the correct alternative and fill the appropriate bubble, as shown:

Q. a b c d

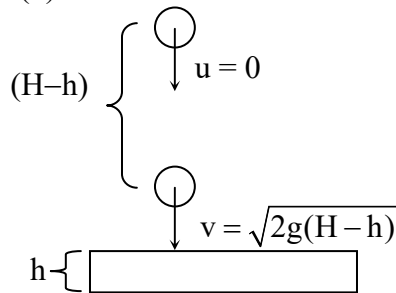
8. Correct answer carries 3 marks, wrong answer -1 mark (negative 1), no attempt - zero marks.
9. Rough work should be done in the space provided in the question paper only.
10. Candidates are not permitted to leave the examination hall before the completion of the examination schedule (i.e. before 1200 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.
12. Comments or queries (if any) regarding this question paper, may be sent by email only to iapt.nse@gmail.com till 2359 Hrs. of 23 Nov. 2018. The answers to this question paper will be available at - www.iapt.org.in by 02 Dec. 2018 after 1700 Hrs.
13. For certificates and awards - Please see the website of IAPT: www.iapt.org.in

QUESTIONS AND SOLUTIONS

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

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

1. (b)



$$v^2 = u^2 - 2as \quad \text{Here, } v = 0, u = \sqrt{2g(H-h)}$$

$$a = \frac{2g(H-h)}{2h} = g\left(\frac{H}{h}-1\right)$$

2. Two sound waves in air have wavelength 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) 333m/s (d) 330 m/s

2. (a)

$$\text{Given, } \lambda_1 - \lambda_2 = 2$$

$$v = f\lambda$$

$$f_1 = \frac{1}{T} = \frac{1}{20 \times 10^{-3}} = \frac{1000}{20} = 50 \text{ Hz}$$

$$\frac{f_2}{f_1} = 1.4 \Rightarrow f_2 = 1.4 \times 50 = 70 \text{ Hz}$$

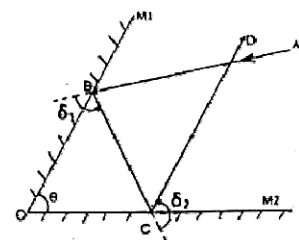
$$\lambda_1 - \lambda_2 = 2$$

$$\frac{v}{f_1} - \frac{v}{f_2} = 2$$

$$\frac{v}{50} - \frac{v}{70} = 2 \Rightarrow v = 350 \text{ m/s}$$

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

- (a) $\delta = 90^\circ + 2\theta$ (b) $\delta = 180^\circ + 2\theta$
 (c) $\delta = 270^\circ - 2\theta$ (d) $\delta = 360^\circ - 2\theta$



3. (d)

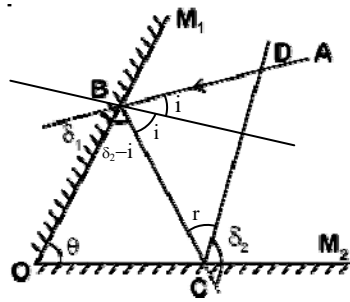
$$\frac{\pi}{2} - r + \frac{\pi}{2} - i + \theta = \pi$$

$$i + r = \theta$$

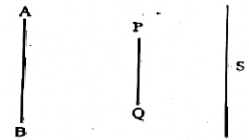
$$\delta_1 = \pi - 2i$$

$$\delta_2 = \pi - 2r$$

$$\delta = \delta_1 + \delta_2 = 2\pi - 2(i + r) = 2\pi - 2\theta$$



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



- (a) It will first increase and then decrease.
- (b) It will first decrease and then increase.
- (c) It will be of the same size for any position of the point source on the line AB.
- (d) Umbra will increase and penumbra will decrease till central position.

4. (c)

ΔSPQ and $\Delta SP'Q'$ are similar

$$\frac{PQ}{P'Q'} = \frac{x}{x+y}$$

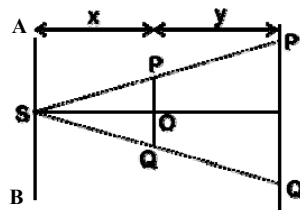
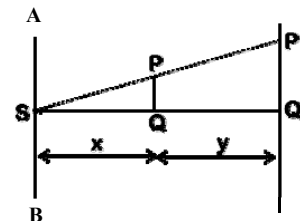
$$P'Q' = \left(\frac{x+y}{x}\right)PQ$$

When at midpoint

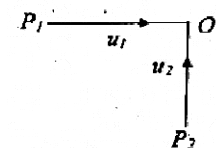
$$\frac{PQ}{P'Q'} = \frac{x}{x+y}$$

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

\Rightarrow No change.



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

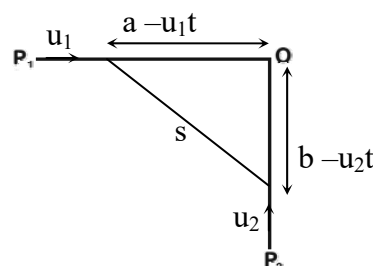
(c) $s = [a^2 + b^2 + (u_1^2 + u_2^2)t^2 + 2t(au_1 + bu_2)]^{1/2}$

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

5. (a)

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

$$= \sqrt{a^2 + b^2 + (u_1^2 + u_2^2)t^2 - 2t(au_1 + bu_2)}$$



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

- (a) 0.5 kg, 20000 kWh (b) 0.5 kg, 5000 kWh
(c) 5 kg, 5000 kWh (d) 5 kg, 20000 kWh

6. (c)

$$P_{\text{out}} = 25 \text{ kW} = 25 \times 10^3 \text{ W}$$

$$P_{\text{in}} = \frac{m \times 17200 \times 10^3 \times 4.2}{3600} \text{ W}, \quad (\text{where } m = \text{mass of fuel})$$

Consumed/hour

$$\eta = 0.25 = \frac{P_{\text{out}}}{P_{\text{in}}}$$

$$\frac{1}{4} = \frac{25 \times 10^3 \times 3600}{m \times 17200 \times 10^3 \times 4.2}$$

$$m \times 17200 \times 10^3 \times 4.2 = 4 \times 25 \times 10^3 \times 3600$$

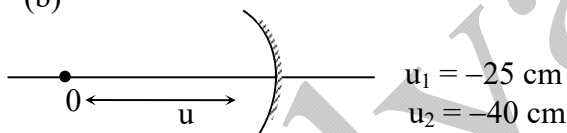
$$m = \frac{3600}{172 \times 4.2} \cong 5 \text{ kg/hr}$$

$$\begin{aligned} \text{Electric energy} &= 10^3 \times 17200 \times 10^3 \times 4.2 \times 0.25 \text{ J} \\ &= 5 \times 3600 \times 10^6 \text{ J} \\ &= 5 \times 10^3 \text{ kWh} = 5000 \text{ kWh} \end{aligned}$$

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

- (a) 12 cm (b) 20 cm (c) 24 cm (d) 36 cm

7. (b)



$$V = \frac{uf}{u-f}$$

$$m = -\frac{V}{u} = \frac{f}{f-u}$$

$$m_1 = 4m_2$$

$$\frac{-f}{-f+25} = \frac{4 \times (-f)}{-f+40}$$

$$\Rightarrow \frac{f}{f-25} = \frac{4f}{f-40}$$

$$f-40 = 4f-100$$

$$3f = 60 \Rightarrow f = 20$$

8. A glass cube of refractive index 1.5 and edge 1 cm has a tiny black spot at its center. A circular dark sheet is to be kept symmetrically on the top surface so that the central spot is not visible from the top. Minimum radius of the circular sheet should be

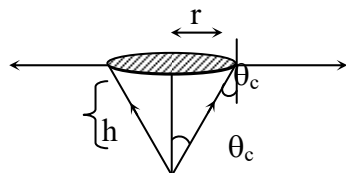
$$\left(\text{Given: } \frac{1}{\sqrt{2}} = 0.707, \frac{1}{\sqrt{3}} = 0.577, \frac{1}{\sqrt{5}} = 0.447 \right)$$

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

8. (b)

$$h = \frac{1}{2} \text{ cm}$$

$$\mu = \frac{3}{2}$$



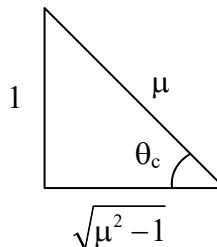
Using Snell's law

$$\mu \sin \theta_c = 1 \times 1$$

$$\sin \theta_c = \frac{1}{\mu}$$

$$\tan \theta_c = \frac{1}{\sqrt{\mu^2 - 1}} = \frac{r}{h}$$

$$r = \frac{h}{\sqrt{\mu^2 - 1}} = \frac{0.5}{\sqrt{\frac{9}{4} - 1}} = \frac{0.5 \times 2}{\sqrt{5}} = \frac{1}{\sqrt{5}} = 0.447$$



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

(a) m-K^{-1}

(b) m-K

(c) K^{-1}

(D) α is a pure number

9. (c)

$$L' = L[1 + \alpha(T' - T)]$$

$$\frac{L' - L}{L} = \alpha(T' - T)$$

$$\alpha = \frac{L' - L}{L(T' - T)} = \frac{\Delta L}{L\Delta T}$$

$$[\alpha] = \frac{[\Delta L]}{[\Delta T]} = \left[\frac{1}{T} \right] \Rightarrow \text{SI unit} = \text{K}^{-1}$$

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

(a) 1 m, bradycardia

(b) 4 m, bradycardia

(c) 1 m, tachycardia

(d) 4 m, tachycardia

10. (a)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$2 = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow \sqrt{\frac{\ell}{g}} = \frac{1}{\pi}$$

$$\ell = \frac{g}{\pi^2} \approx \frac{9.8}{9.8} \approx 1\text{m}$$

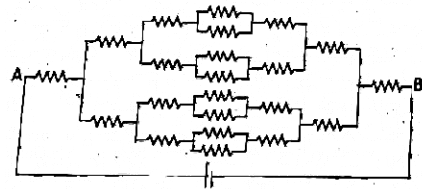
No. of beats/min

$$= \frac{110}{60 \times 2} \times 60 = 55 < 60 \text{ beats/min}$$

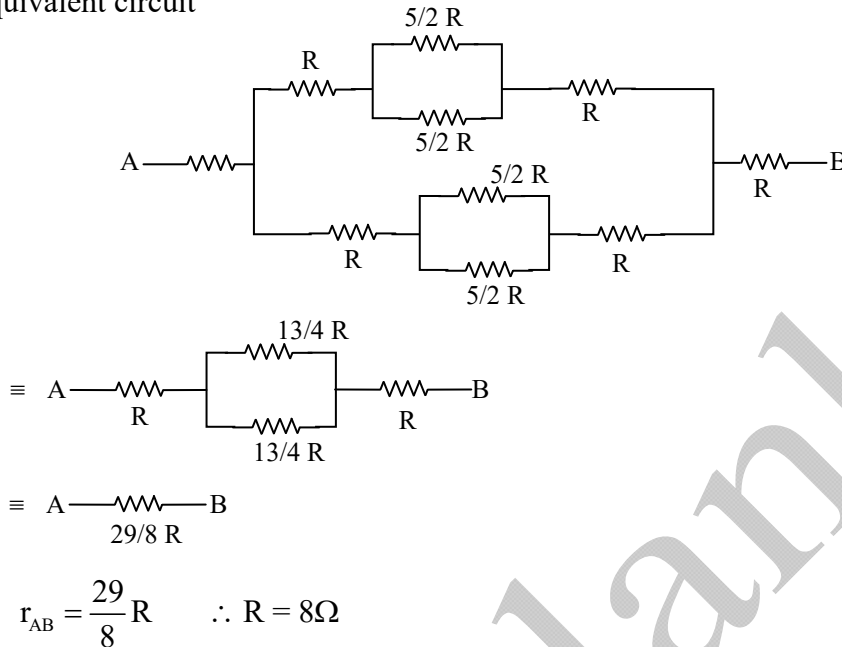
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11. Each resistance in the adjacent circuit is $R\Omega$. In order to have an integral value for equivalent resistance between A & B, the minimum value of R must be:

- (a) 4Ω (b) 8Ω
 (c) 16Ω (d) 29Ω



11. (b)
 Equivalent circuit



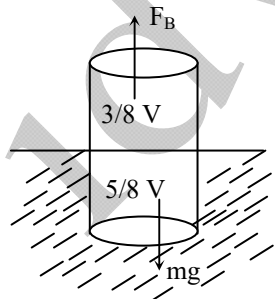
12. A block of wood floats on water with $\left(\frac{3}{8}\right)^{\text{th}}$ of its volume above water. It is now made to float on a salt solution of relative density 1.12. The fraction of its volume that remains above the salt solution now, is nearly

- (a) 0.33 (b) 0.44 (c) 0.67 (d) 0.56

12. (b)

$$F_B = mg$$

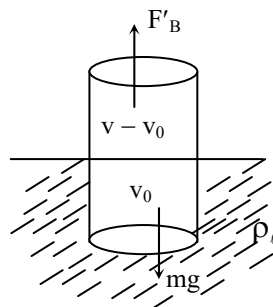
$$\frac{5}{8} v \rho_w g = mg$$



$$v_0 \times \rho_\ell g = mg = \frac{5}{8} v \rho_w g$$

$$\frac{v_0}{v} = \frac{5}{8} \times \frac{\rho_w}{\rho_\ell} = \frac{5}{8} \times \frac{1}{1.12} = 0.558$$

$$\therefore \text{Fraction of volume outside} = 1 - 0.558 = 1 - 0.56 = 0.44$$



13. Suppose our scientific community had chosen force, speed and time as the fundamental mechanical quantities instead of length, mass and time respectively and they chose the respective units of magnitudes 10N, 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

13. (b)

$$[m] = [F]^x [v]^y [T]^z = [MLT^{-2}]^x [LT^{-1}]^y [T]^z$$

$$[M] = [M^x L^{x+y} T^{-2x-y+z}]$$

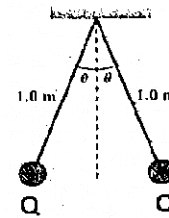
$$x = 1 \quad x + y = 0 \quad \Rightarrow y = -1$$

$$-2x - y + z = 0$$

$$-2 + 1 + z = 0 \Rightarrow z = 1$$

$$[m] = [F]^1 [v]^{-1} [T]^1 = \left[\frac{FT}{v} \right] \Rightarrow m = \frac{10 \times \frac{1}{100}}{100} = 10^{-3} \text{ kg}$$

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



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

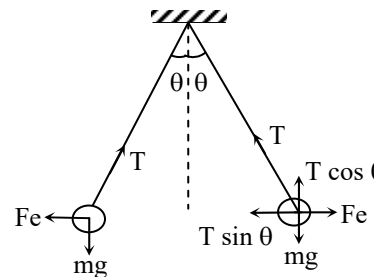
14. (a)

$$T \cos \theta = mg$$

$$T \sin \theta = F_e$$

$$\tan \theta = \frac{F_e}{mg} \Rightarrow \tan \theta \propto \frac{1}{g}$$

$$\Rightarrow \theta \propto \frac{1}{g} \text{ [Since } \theta = \text{ very small, } \tan \theta \approx \theta \text{]}$$



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

- (a) White object will appear brightest
 (b) Blue object will appear brightest
 (c) Black object will appear brightest
 (d) Being at the same temperature, all will look equally bright

15. (c)

A very good absorber is also a very good emitter, so black object will appear brightest.

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

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

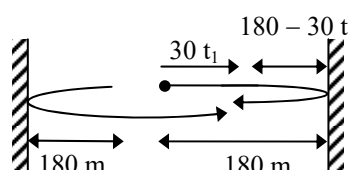
16. no option is correct

For 1st echo

$$180 + 180 - 30 t_1 = 330 t_1$$

$$360 t_1 = 360$$

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

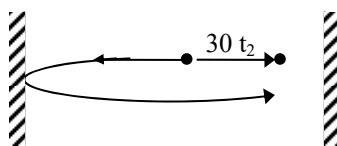


For 2nd echo

$$180 + 180 + 30 t_2 = 330 t_2$$

$$360 = 300 t_2$$

$$t_2 = \frac{360}{300} = \frac{18}{15} = 1.2 \text{ sec}$$

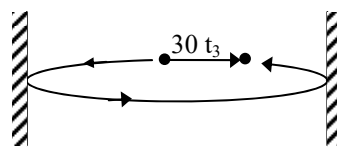


For 3rd echo

$$3 \times 180 + (180 - 30 t_3) = 330 t_3$$

$$720 = 360 t_3$$

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

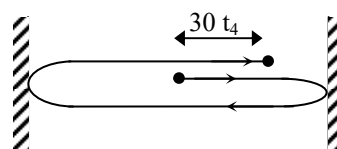


For 4th echo

$$4 \times 180 + 30 t_4 = 330 t_4$$

$$4 \times 180 = 300 t_4$$

$$t_4 = \frac{4 \times 180}{300} = 2.4 \text{ sec}$$



So actual answer should be 1 sec, 1.2 sec & 2 sec.

⇒ None of given option is correct.

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

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

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

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

(a) Only (I) is correct

(b) Only (II) is correct

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

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

17. (b)

Since conductor can have charge on outer surface only, so (I) is wrong.

Electric field lines can never intersect, so (III) is wrong.

A charged body can attract another uncharged body because of method of induction.

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

(a) 500 Ω

(b) 1 kΩ

(c) 1.5 kΩ

(d) 2 kΩ

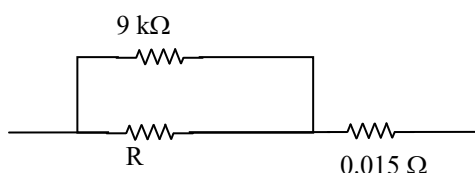
18. (b)

$$I_v = \frac{117}{9 \times 10^3} = 0.013 \text{ A}$$

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

$$\Rightarrow I_R = 0.117 \text{ A}$$

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



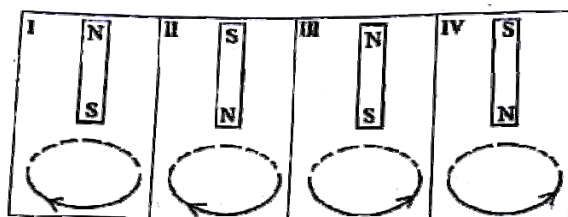
19. A bar magnet is allowed to fall freely from the same height towards a current carrying loop along its axis, as shown in the four situations I to IV. Arrows show direction of conventional current. Choose the situations in which the potential energy of the magnet coil interaction is maximum :

(a) I, III

(b) I, IV

(c) II, IV

(d) II, III



19. (b)

Any small coil is equivalent to a bar magnet. If you curl along direction of current thumb will show direction of North Pole. So in (I) & (IV) it will be repulsive.

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

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

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

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

(a) Only (I) is correct

(b) Only (II) is correct

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

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

20. (c)

Density of water at 4°C is maximum. So when temperature is increased or decreased density will decrease so volume will increase. So overflow will take place.

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

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

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

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

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

21. (d)

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

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

(a) 60 g/mole

(b) 120 g/mole

(c) 240 g/mole

(d) 480 g/mole

22. (b)

Molarity of solution = 0.5 M

Volume of solution = 4.0 L

Amount of substance = 240 g

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

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

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

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

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

(a) 28%

(b) 30%

(c) 32%

(d) 34%

23. (c)

Molarity of acid = 4.2 M

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

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

Number of moles of solute = 4.2 moles

Weight of solute = Number of moles \times Molecular weight = $4.2 \times 98 = 411.6 \text{ g}$

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

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

$$\therefore \text{Mass} = \text{Density} \times \text{Volume} = 1.28 \frac{\text{g}}{\text{cm}^3} \times 10^3 \text{ cm}^3$$

$$\therefore \text{Mass of solution} = 1280 \text{ g}$$

$$\text{Mass \% of solution} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100 = \frac{411.6}{1280} \times 100 = 32\%$$

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

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

24. (a)

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

The simplest formula of this compound will be = X_3Y

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

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

25. (c)

Number of moles of nitrogen gas (N_2)

$$= \frac{\text{Number of nitrogen atoms}}{N_A \times 2} = \frac{4.095 \times 10^{24}}{6.022 \times 10^{23} \times 2} = 3.4 \text{ moles}$$

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

- (a) up to height of 0.1 m (b) up to height of 0.2 m
(c) up to height of 0.98 m (d) along its full length

26. (d)

As the experiment is carried out in the space, $\therefore g = 0$.

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

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

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

27. (c)

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

According to the given data :

$$\text{Number of moles of } SO_2 = \frac{W_1}{64}$$

$$\text{Number of moles of CH}_4 = \frac{W_2}{16}$$

$$\text{Number of moles of O}_2 = \frac{W_3}{32}$$

$$\therefore \frac{W_1}{64} : \frac{W_2}{16} : \frac{W_3}{32}$$

$$\text{i.e. } W_1 : W_2 : W_3 = 4 : 1 : 2$$

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

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

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

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

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

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

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

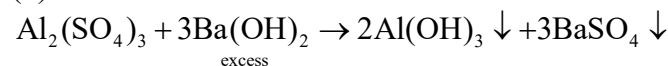
28. (d)

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

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

(a) 0.5g (b) 2.7g (c) 1.7g (d) 0.54g

29. (b)



excess

2 moles Al^{3+} ions are present in 1 mole of $\text{Al}_2(\text{SO}_4)_3$

54 g Al^{3+} ions are present in 342 g $\text{Al}_2(\text{SO}_4)_3$

0.170 g Al^{3+} ions are present in $\frac{342}{54} \times 0.170 = 1.076$ g of $\text{Al}_2(\text{SO}_4)_3$

No. of moles of $\text{Al}_2(\text{SO}_4)_3 = \frac{1.076}{342} = 0.00314$ moles

1 mole of $\text{Al}_2(\text{SO}_4)_3$ gives 2 moles of $\text{Al}(\text{OH})_3$

0.00314 moles of $\text{Al}_2(\text{SO}_4)_3$ gives 0.00628 moles of $\text{Al}(\text{OH})_3$

And 0.00628 moles of $\text{Al}(\text{OH})_3 = 0.00628 \times 78 = 0.489$ g of $\text{Al}(\text{OH})_3$

Similarly, 0.00314 moles of $\text{Al}_2(\text{SO}_4)_3$ gives 0.00942 moles of BaSO_4

And 0.00942 moles of $\text{BaSO}_4 = 0.00942 \times 233.38$

$$= 2.198 \text{ g of BaSO}_4$$

\therefore Total weight of the precipitate [$\text{BaSO}_4 + \text{Al}(\text{OH})_3$]

$$= 0.489 + 2.198 = 2.687 \sim 2.7 \text{ g}$$

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

(a) Suhas (b) Bobby (c) Sandy (d) Kimi

30. (b)

Required pH range = 6.0 to 6.5

Given pH = 4.5

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

(12) VIDYALANKAR : NSEJS-2018 : Question Paper & Solution

- 31.** Electrons in the last shell of X, Y, W and Z are 2, 6, 4 and 1 respectively. Which of the following statement is correct?
(a) Melting point of compound formed by X and Y is more than that formed by W and Z
(b) Compound formed by X and Y is more volatile than that formed by W and Z
(c) Melting point of compound formed by X and Z is more than that formed by W and Y
(d) Insufficient data for correct analysis

31. (a)
Compound formed by elements X and Y is an ionic compound whereas compound formed by elements W and Z is a covalent compound. Melting point of ionic compound is reasonably higher than that of covalent compounds.

- 32.** W g of pure coal was combusted in pure dry oxygen. The carbon dioxide gas obtained was absorbed in 0.1M KOH solution. The complete absorption of CO₂ required 5 cm³ of 0.1M KOH. The amount of coal combusted would be :
(a) 3mg (b) 6mg (c) 11mg (d) 12mg

32. (a)
 $C + O_2 \rightarrow CO_2$
 $CO_2 + 2KOH \rightarrow K_2CO_3 + H_2O$
For complete absorption of CO₂, 5 cm³ of 0.1 M KOH is required.

$$\begin{aligned}\therefore \text{Number of moles of KOH} &= 5 \times 0.1 \\ &= 0.5 \text{ millimoles} \\ &= 5 \times 10^{-4} \text{ moles}\end{aligned}$$

Now, 2 moles of KOH is needed by 1 mole of CO₂

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

$$\frac{1}{2} \times 5 \times 10^{-4} = 2.5 \times 10^{-4} \text{ moles of CO}_2$$

\therefore 1 mole of CO₂ is formed by 1 mole of coal

$$\therefore 2.5 \times 10^{-4} \text{ moles of CO}_2 \text{ is formed by } 2.5 \times 10^{-4} \text{ moles of coal}$$

$$\begin{aligned}\therefore \text{Weight of coal} &= \text{Number of moles} \times \text{M. W.} \\ &= 2.5 \times 10^{-4} \times 12 = 30 \times 10^{-4} \text{ g} = 3 \times 10^{-3} \text{ g} = 3 \text{ mg}\end{aligned}$$

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

- (a) 1120 cm³ of SO₂ + 0.85 g of ammonia (b) 0.25g mole of SO₂ + 2240 cm³ of ammonia
(c) 1680 cm³ of SO₂ + 1.7 g of ammonia (d) 0.25 g mole of SO₂ + 0.85 g of ammonia

33. (a)
 \therefore 22400 mL of SO₂ = 1 mole of SO₂
 \therefore 1120 cm³ = 1120 mL of SO₂
 $= \frac{1}{22400} \times 1120 = 0.05 \text{ moles of SO}_2$

Also,

$$\therefore 17 \text{ g of NH}_3 = 1 \text{ mole of NH}_3$$

$$\therefore 0.85 \text{ g of NH}_3 = \frac{1}{17} \times 0.85 = 0.05 \text{ moles of NH}_3$$

(b) 0.25 g moles of SO₂ = 0.25 moles
2240 cm³ of ammonia contains = 0.1 mole

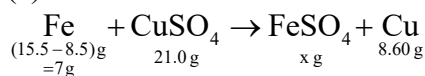
(c) 1680 cm³ of SO₂ contains = 0.075 moles
1.7 g of NH₃ contains = 0.1 moles

(d) 0.25 g moles of SO₂ = 0.25 moles
0.85 g of ammonia contains = 0.05 moles

\therefore Option (a) is the correct answer.

34. A strip of iron with mass 15.5 g is placed in a solution containing 21.0 g copper sulphate. After some time the reaction stops. Iron strip was found to have mass 8.5 g. The mass of copper formed was found to be 8.60g. Then the mass of ferrous sulphate formed in this reaction will be :
 (a) 19.40 g (b) 18.40 g (c) 17.40 g (d) 16.40 g

34. (a)



According to law of conservation of mass

Mass of reactants = Mass of products

$$7\text{g} + 21\text{g} = x\text{g} + 8.60\text{g}$$

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

35. Sonu has N/2 HCl solution and Monu has N/10 HCl solution. They are asked to prepare 2 litres of N/5 HCl solution. Then the volumes of two solutions mixed should be :
 (a) (0.5+1.5) litre (b) (1.0 + 1.0) litre (c) (0.3+1.7) litre (d) (0.2+1.8) litre

35. (a)

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

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

On solving, we get,

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

$$\therefore (2-x) = 1.5\text{ L}$$

i.e. 0.5 L of Sonu's solution + 1.5 L of Monu's solution

36. A solution (P) was prepared by dissolving 6.3 g of oxalic dihydrate acid in 100 mL water. 25 mL of this solution was taken and was further diluted to 250 mL to prepare solution (Q). Then the weight of NaOH in ppm required to neutralize 10 ml of solution (Q) will be :
 (a) 10 ppm (b) 20 ppm (c) 40 ppm (d) 80 ppm

36. (c)

$$\text{No. of moles of oxalic acid dihydrate} = \frac{6.3}{126} = 0.05\text{ moles}$$

$$\text{Molarity of solution 'P'} = \frac{0.05}{100} \times 1000 = 0.5\text{ M}$$

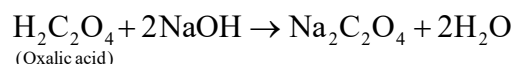
To find out : Molarity of solution 'Q'

Soln Soln
 (P) (Q)

$$M_1V_1 = M_2V_2$$

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

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



Here, 10 ml of 'Q' is used.

$$\therefore \text{Number of moles of 'Q' used for neutralization} = \frac{10}{1000} \times 0.05$$

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

\therefore 1 mole of 'Q' (oxalic acid) needs 2 moles of NaOH,

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

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

$$= 40\text{ ppm}$$

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

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

37. (d)

Iso-octane can improve the quality of petrol. Higher the octane number, better is the quality of fuel.

38. $2\text{KBrO}_3 + 12\text{H}^+ + 10\text{e}^- \rightarrow \text{Br}_2 + 6\text{H}_2\text{O} + 2\text{K}^+$

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

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

38. (a)

\therefore For 2 moles of KBrO_3 we require 10 electrons.

\therefore For 1 mole of KBrO_3 we require 5 electrons.

\therefore Equivalent weight of KBrO_3

$$= \frac{\text{molecular weight}}{\text{Number of electron lost or gained by one mole}} = \frac{M}{5}$$

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

- (a) orange (b) green (c) blue (d) yellow

39. (c)

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

40. Which of the following is incorrect?

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

40. (c)

Calamine is an ore of zinc.

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

- (a) 12 cm (b) 15 cm (c) 20 cm (d) 30 cm

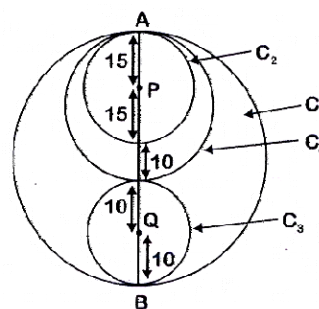
41. (C)

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

$$\text{Diameter of circle } C_4 = 15 + 15 + 10 \\ = 40 \text{ cm}$$

\therefore Radius of circle $C_4 = 20 \text{ cm}$

Hence, option (C) is correct.



42. 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

Let side of square be 'a' cm

Using sine rule,

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

$$\frac{AD}{\sin 105^\circ} = \frac{2}{\sin 45^\circ} \dots\dots\dots [\sin 105^\circ = \sin (60^\circ + 45^\circ)]$$

$$\Rightarrow \frac{a}{\left(\frac{1+\sqrt{3}}{2\sqrt{2}}\right)} = \frac{2}{\left(\frac{1}{\sqrt{2}}\right)} \Rightarrow \frac{2\sqrt{2}a}{\sqrt{3}+1} = \frac{2\sqrt{2}}{1} \Rightarrow a = 1 + \sqrt{3}$$

∴ Area of square ABCD = $(1 + \sqrt{3})^2 = (4 + 2\sqrt{3})$ sq. units

Hence, option (A) is correct.

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

- (a) 54 (b) 36 (c) 18 (d) 12

46. (C), (D)

According to data given, n is not divisible by 6 and number of divisors of n is 6.

Also, $9n = 3^2 \times n$

Number of positive divisors = $(2 + 1) 6 = 18$

We will take example

Let $n = 363 = 11^2 \times 3^1$

∴ $9n = 11^2 \times 3^3$

Number of positive divisors = $(2 + 1) (3 + 1) = 12$

Let $n = 32 = 2^5$

∴ $9n = 2^5 \times 3^2$

∴ Number of positive divisors = $(5 + 1) (2 + 1) = 18$ and many other possibilities are there.

Hence option (C) and (D) both are correct.

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

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

47. (*) All options wrong

$$\text{Let } \frac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}} = \lambda$$

$$\Rightarrow \frac{\lambda+1}{\lambda-1} = \frac{\sqrt{a+x}}{-\sqrt{a-x}} \quad (\text{on applying componendo and dividendo})$$

Squaring both sides, we get

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

Again applying componendo and dividendo,

$$\text{We get } \frac{\lambda^2 + 1}{2\lambda} = \frac{a}{x} \Rightarrow \frac{\lambda^2 + 1}{2\lambda} = \frac{a}{\left(\frac{2a}{b^2+1}\right)} = \frac{b^2+1}{2} \quad \dots\dots\dots [\text{Substituting given value of } x]$$

$$\therefore \frac{\lambda^2 + 1}{\lambda} = b^2 + 1 \Rightarrow \text{No option matches}$$

Note :

In this code JS 511, there is a mistake in value of x given. In other codes, value of x is given as

$$x = \frac{2ab}{b^2 + 1}$$

$$\text{Then, } \frac{\lambda^2 + 1}{2\lambda} = \frac{a}{\left(\frac{2ab}{b^2 + 1}\right)} = \frac{b^2 + 1}{2b} \Rightarrow \lambda = b$$

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

- (a) 23 (b) 28 (c) 33 (d) 38

48. (B)

Let Ist regular polygon has n_1 sides.

$$\therefore n_1 = \text{Red}$$

We know that Number of diagonals of n sides polygon = $\frac{n(n-3)}{2}$

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

Let IInd regular polygon has n_2 sides.

$$\therefore n_2 = \text{Green}$$

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

$$\therefore n_1 + \frac{n_2(n_2-3)}{2} = 103 \quad \dots\dots\dots \text{(i)}$$

$$\text{And } n_2 + \frac{n_1(n_1-3)}{2} = 80 \quad \dots\dots\dots \text{(ii)}$$

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

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

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

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

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

Since $46 = 1 \times 46 = 2 \times 23$, we write

$$\text{(i) If } (n_2 - n_1) = 1 \Rightarrow n_1 + n_2 - 5 = 46 \Rightarrow n_1 + n_2 = 51$$

$$\text{(ii) If } (n_2 - n_1) = 2 \Rightarrow n_1 + n_2 - 5 = 23 \Rightarrow n_1 + n_2 = 28$$

Hence total number of sides can be 51 or 28.

Hence option (B) is correct.

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

- (a) 6 (b) 7 (c) 8 (d) 9

49. (B)

Let red balls be x and yellow balls be y and it is given that $x + y = n$.

When one red ball is removed, we get

$$x = \frac{n-1}{7} + 1 \quad \dots\dots (i)$$

When one yellow ball is removed, we get

$$x = \frac{n-1}{6} \quad \dots\dots (ii)$$

From (i) and (ii),

$$\frac{n-1}{7} + 1 = \frac{n-1}{6}$$

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

$$\Rightarrow n = 43$$

Sum of digits = 7

Hence, option (B) is correct.

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

- (a) 9 (b) 11 (c) 13 (d) 15

50. (B)

In ABCD, we have

AB = CD and AX = CY

\Rightarrow AXCY is parallelogram

Here $\Delta DLY \sim \Delta DXC$

$$\therefore \frac{DY}{DC} = \frac{DL}{DX} = \frac{LY}{XC}$$

From given data, we know that

$$\frac{DY}{DC} = \frac{2}{3} \Rightarrow \frac{DL}{DX} = \frac{2}{3} \text{ and } \frac{LY}{XC} = \frac{2}{3}$$

$$\Rightarrow \text{ar}(\Delta DLY) = \frac{4}{9} \text{ar}(\Delta DCX)$$

Also $\Delta CKY \sim \Delta CXD$

$$\therefore \frac{CK}{CX} = \frac{KY}{XD} = \frac{CY}{CD}$$

From given data, we know that

$$\frac{CY}{CD} = \frac{1}{3} \Rightarrow \frac{CK}{CX} = \frac{1}{3} \text{ and } \frac{KY}{XD} = \frac{1}{3}$$

$$\Rightarrow \text{ar}(\Delta YKC) = \frac{1}{9} \text{ar}(\Delta DCX)$$

$$\Rightarrow \text{ar}(XLYK) = 1 - \frac{5}{9} = \frac{4}{9} \text{ar}(\Delta DCX)$$

$$\text{ar}(\Delta DCX) = \frac{\text{ar}}{2}(\text{ABCD})$$

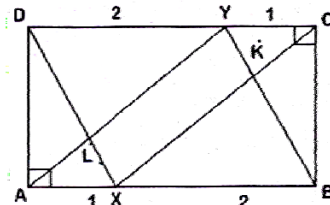
$$\Rightarrow \text{ar}(XLYK) = \frac{4}{9} \times \frac{1}{2} \text{ar}(\text{ABCD})$$

$$= \frac{2}{9} \text{ar}(\text{ABCD})$$

$$m = 2, n = 9$$

$$\Rightarrow m + n = 11$$

Hence, option (B) is correct.



51. 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

51. (A)

Let O be the centre of the circle and AM be the median of $\triangle ABC$. Median of equilateral triangle overlaps the diameter.

$\therefore \angle ABD = \angle ACD = 90^\circ$ [Angles in semi-circle]
 $\angle CBD = \angle BCD = 30^\circ$ [$\because \angle ABC = \angle ACB = 60^\circ$]

$\Rightarrow DB = DC = 2$

We know that $\angle BAC = 60^\circ$ and AD is angle bisector.

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

In $\triangle ABD$

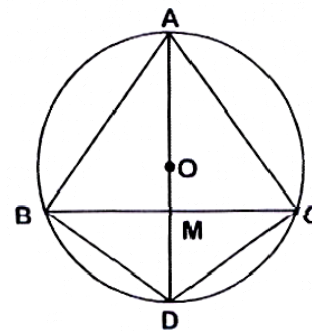
$\angle ADB = 180^\circ - (90^\circ + 30^\circ) = 60^\circ$

$\cos 60^\circ = \frac{BD}{AD}$

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

$\Rightarrow AD = 4$

Hence option (A) is correct.



52. Let T_k denote the k-th term of an arithmetic progression. Suppose there are positive integers m

$\neq n$ such that $T_m = \frac{1}{n}$ and $T_n = \frac{1}{m}$. Then T_{mn} equals

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

52. (C)

We have, $a + (m - 1)d = \frac{1}{n}$ (i) and

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

Subtracting above equations, we get

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

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

Substituting value of d in eq. (i), we get

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

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

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

$\Rightarrow T_{mn} = \frac{1}{mn} + (mn - 1)\left(\frac{1}{mn}\right) = \frac{1}{mn} + 1 - \frac{1}{mn}$

$\Rightarrow T_{mn} = 1$

Hence, option (C) is correct.

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

- (a) $\frac{1}{6}$ (b) $\frac{1}{5}$ (c) $\frac{1}{4}$ (d) $\frac{1}{3}$

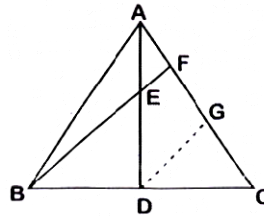
53. (C)

Draw $DG \parallel BF$

$\Delta AFE \sim \Delta AGD$

$$\therefore \frac{AE}{ED} = \frac{AF}{FG} = \frac{1}{2}$$

$$\Rightarrow FG = 2AF \quad \dots\dots\dots (i)$$



Since $DG \parallel EF$

$$\Rightarrow \frac{CG}{FG} = \frac{CD}{BD} = 1 \quad \dots\dots\dots [\because D \text{ is mid-point of } BC]$$

$$\Rightarrow CG = FG \quad \dots\dots\dots (ii)$$

$$FC = FG + GC$$

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

$$\Rightarrow FC = 4AF$$

$$\therefore \frac{AF}{FC} = \frac{1}{4}$$

Hence, option (C) is correct.

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

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

54. (A)

$$\sin \theta + \cos \theta = -\frac{q}{p} \quad \dots\dots\dots (i)$$

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

On squaring (i), we get

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

$$\Rightarrow 1 + \frac{2r}{p} = \frac{q^2}{p^2} \Rightarrow (p^2 - q^2 + 2rp = 0)$$

Hence, option (A) is correct.

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

- (a) 2 (b) 3 (c) 4 (d) 5

55. (B)

We know that sum of interior angles of n sides polygon = $(n - 2) 180^\circ$

$$\therefore \alpha(k) = \frac{(k - 2)180^\circ}{k}$$

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

$$\frac{(n - 2 - 2)180^\circ}{n - 2}, \frac{(n - 2)180^\circ}{n}, \frac{(n + 3 - 2)180^\circ}{n + 3} \text{ are in A.P.}$$

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

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

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

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

$$n = 12$$

∴ Sum of digits = 1 + 2 = 3
Hence, option (B) is correct.

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

- (a) 36 (b) 32 (c) 24 (d) 18

56. (B)

We have, $\frac{a}{r^2} + \frac{a}{r} + a + ar + ar^2 = 24 \Rightarrow \frac{a + ar + ar^2 + ar^3 + ar^4}{r^2} = 24$

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

$$\Rightarrow \frac{1+r+r^2+r^3+r^4}{r^2} = \frac{24}{a} \quad \dots\dots\dots (i)$$

As per condition given, we write

$$\frac{r^2}{a} + \frac{r}{a} + \frac{1}{a} + \frac{1}{ar} + \frac{1}{ar^2} = 6 \Rightarrow \frac{r^4 + r^3 + r^2 + r + 1}{ar^2} = 6$$

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

From (i) and (ii)

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

$$\therefore a = \pm 2$$

$$\therefore \text{Product of term is } \frac{2}{r^2} \times \frac{2}{r} \times 2 \times 2r \times 2r^2 = 32$$

Hence, option (B) is correct.

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

- (a) 15 (b) 8 (c) 6 (d) 4

57. (*) All options wrong

$\overline{4a_1} \times \overline{25b}$ should be divisible by 36.

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

So, a = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 ⇒ 10 pairs are possible.

One more possibility is there

$$\text{If } a = 4, b = 6$$

$$\therefore \text{Total number of ordered pairs} = 11$$

∴ Hence, no option is correct.

58. 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) $\frac{10^{2018} - 1}{9}$

58. (A)

$$\begin{aligned} & \sqrt{111\dots1 - 222\dots2} \\ & \text{2018 ones and 1009 twos.} \\ & = \sqrt{\frac{1}{9} \left[\underbrace{(999\dots9)}_{\text{2018 times}} - 2 \underbrace{(999\dots9)}_{\text{1009 times}} \right]} \end{aligned}$$

We calculate, (999.....2018 times) and 2 (999.....1009 times) as follows.

$$\begin{aligned} & \text{999.....2018 times} \\ & = (9 \times 10^0) + (9 \times 10^1) + (9 \times 10^2) + \dots + (9 \times 10^{2017}) \\ & = 9 [1 + 10 + 10^2 + \dots + 10^{2018}] \\ & = 9 \left[\frac{1(10^{2018} - 1)}{10 - 1} \right] = 10^{2018} - 1 \end{aligned}$$

Similarly,

$$\begin{aligned} & 2 (999.....1009 \text{ times}) \\ & = 2 [9 (1 + 10 + 10^2 + \dots + 10^{1008})] \\ & = 2 \left[9 \left(\frac{10^{1009} - 1}{9} \right) \right] = 2(10^{1009} - 1) \end{aligned}$$

Hence given expression becomes

$$\begin{aligned} & = \sqrt{\frac{1}{9} [10^{2018} - 1 - 2(10^{1009} - 1)]} = \sqrt{\frac{1}{9} [(10^{1009})^2 - 2(10^{1009} + 1)]} \\ & = \sqrt{\left(\frac{10^{1009} - 1}{3} \right)^2} = \frac{10^{1009} - 1}{3} \end{aligned}$$

Option (A) is correct.

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

- (a) $\frac{1}{4}$ (b) $\frac{9}{32}$ (c) $\frac{7}{32}$ (d) $\frac{15}{32}$

59. (D)

$\Delta ADE \sim \Delta ABC$

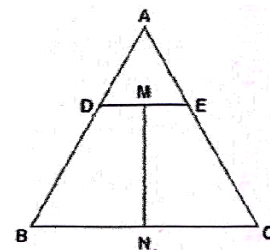
$$\frac{AD}{AB} = \frac{AE}{AC} = \frac{DE}{BC} = \frac{1}{4}$$

$$\text{ar}(\Delta ADE) = \frac{1}{2} \times DE \times h \quad \dots\dots [h \text{ is height of } \Delta ADE]$$

$$= \frac{1}{2} \times \frac{BC}{4} \times \frac{H}{4} \quad \dots\dots [H \text{ is height of } \Delta ABC]$$

$$= \frac{1}{16} \times \left(\frac{1}{2} \times BC \times H \right) = \frac{1}{16} \text{ar}(\Delta ABC)$$

$$\text{ar}(BDEC) = \frac{15}{16} \text{ar}(\Delta ABC)$$



$$\text{ar (BNMD)} = \text{ar (NCEM)}$$

$$\Rightarrow \text{ar (BNMD)} = \frac{15}{32} \text{ar}(\Delta ABC)$$

Hence, option (D) is correct.

60. 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

60. (D)

$[x]$ denotes the largest integer not exceeding x

$$\left[\frac{10^2}{1}\right], \left[\frac{10^2}{2}\right], \dots, \left[\frac{10^2}{20}\right]$$

$$= [100], [50], \left[\frac{100}{3}\right], \dots, \left[\frac{50}{9}\right], \left[\frac{100}{19}\right], [5]$$

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

So, distinct integer values = 15

Hence, option (D) is correct.

61. True coelom is not present animals of:

(a) Platyhelminthes (b) Annelida (c) Echinodermata (d) Arthropoda

61. (a)

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

(a) endoplasmic reticulum (b) Golgi apparatus
 (c) mitochondrion (d) none of the above

62. (b)

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

(a) enhancing shelf life (b) insect-resistance
 (c) drought-resistance (d) enhancing mineral content

63. (b)

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

- i. Cells divided by binary fission or fragmentation, or budding
- ii. Cells moved with the help of flagella'
- iii. Ether lipids were observed in cell membranes
- iv. Peptidoglycans were noted in the cell walls

Which of the following category do the cells belong to?

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

64. (a)

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

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

65. (d)

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

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

66. (d)

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

- (a) all potassium ions leave the axon
(b) more potassium ions enter the axon as compared to sodium ions leaving it
(c) more sodium ions enter the axon as compared to potassium ions leaving it
(d) all sodium ions enter the axon

67. (c)

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

68. (d)

69. In a case of mammalian coat color, the principal gene identified is 'C' which codes for a tyrosinase enzyme. In case of rabbits four different phenotypes are observed Full Color>Chinchilla>Himalayan>Albino (in order of the expression of gene 'C' and its alleles). In a progeny obtained after crossing two rabbits, the percentages of Chinchilla, Himalayan and Albino rabbits were 50, 25 and 25 respectively. What must have been the genotypes of the parent rabbits?

- (a) $C^{ch}C^{ch} \times C^{ch}c$ (b) $C^{ch}C^{ch} \times C^{ch}c$ (c) $C^{ch}c \times C^{h}c$ (d) $C^{h}C^{h} \times C^{ch}C^{ch}$

69. (c)

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

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

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

- (a) Anterior lobe of pituitary (b) Posterior lobe of pituitary
(c) Thyroid gland (d) Both pituitary and thyroid gland

70. (a)

71.

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

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

- (a) Platypus, Alpine Salamander (b) Bull shark, Alpine salamander
(c) Bullfrog, Crocodile (d) Platypus, Common toad

71. (b)

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

- (a) Hypertension (b) Hyperstimulation
(c) Hyperpolarization (d) None of the above

72. (a)

73. A bacterial dsDNA molecule, 2988 bp in length, was found to have the following composition:

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

The respective values of X and Y are:

- (a) 1400 and 590 (b) 590 and 1400 (c) 590 and 590 (d) None of these

73. (c)

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

- (a) 989 (b) 992 (c) 995 (d) 998

74. (c)

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

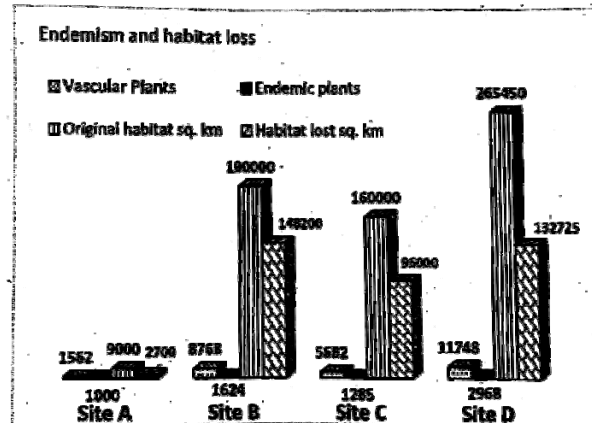
Character	P	Q	R	S	T
Cell wall	+	+	-	-	+
Centrioles	-	-	-	+	-
Chloroplast	-	+	-	-	-
Mitochondrion	-	+	-	+	+
Nucleus	-	+	-	+	+
Plasma membrane	+	+	-	+	+
RNA / DNA	+	+	+	+	+
Vacuoles	+	+	-	+	+

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

75. (a)

76. 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

76. (b)

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

- (a) 64×10^3 cells (b) 6.4×10^8 cells (c) 64×10^9 cells (d) 6.4×10^9 cells

77. (d)

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

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

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

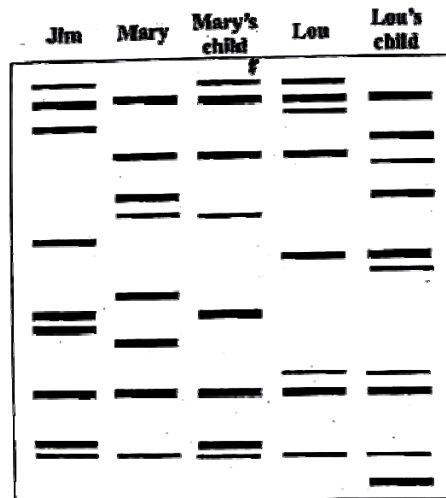
78. (b)

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

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

79. (a)

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



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

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

80. (a)

