Date: 23/11/2025

Question Paper Code: 53

Max. Marks: 216

Time: 120 Minutes

Aakash
Medical | IIT-JEE | Foundations

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Answers & Solutions

For

Indian Association of Physics Teachers
National Standard Examination in Junior Science
(NSEJS-2025)

INSTRUCTIONS TO CANDIDATES

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY **PROHIBITED**.
2. On the OMR Sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
3. On the OMR Answer Sheet, use only **BLUE** or **BLACK BALL POINT PEN** for making entries and filling the bubbles.
4. There are 60 questions in the paper. Attempt All the 60 Questions.
5. Question paper has two parts. In part A-1 (Q. No. 1 to 48) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as shown.

   Q. No. 12 (a) (●) (c) (d)

   In part A-2 (Q. No. 49 to 60) each question has four alternatives out of which any number of alternative(s) (1, 2, 3 or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

   Q. No. 52 (a) (●) (c) (●)
6. Attempt all sixty questions. For **Part A-1**, each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2**, you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
7. Calculator is **not** allowed.
8. No candidate should leave the examination hall before the completion of the examination.
9. After submitting answer paper, take away the question paper & candidate's copy of the OMR for your future reference.

Attempt All Sixty Questions

A-1

OUT OF THE FOUR OPTIONS ONLY ONE IS CORRECT. BUBBLE THE CORRECT OPTION.

1. A student, intending to catch a bus on the bus stand, finds that the bus starts and accelerates away from him/her with uniform acceleration $a = 2\ ms^{-2}$ when he is 16 m far from the bus. He runs fast enough with a uniform speed so as just to catch the bus. The minimum speed with which the student must run, is

(a) $2.0\ ms^{-1}$ (b) $4.0\ ms^{-1}$

(c) $8.0\ ms^{-1}$ (d) $16.0\ ms^{-1}$

Answer (c)

Sol. Distance covered by student = vt …(i)

Distance covered by bus $= 16 + \frac{1}{2} \times 2 \times t^2$ …(ii)

From equation (i) and (ii)

$vt = 16 + t^2$

For minimum

$$v = \frac{16}{t} + t$$

$$\frac{dv}{dt} = \frac{-16}{t^2} + 1$$

$t^2 = 16$

$t = 4$ s

$$v_{min} = \frac{16}{4} + 4 = 8 \text{ m/s}$$

2. A block of mass 2.0 kg is suspended from the ceiling by a massless string. The string is taut bearing a definite tension when the block is stationary. Suddenly, the string breaks and the block start falling freely. The difference in the tension in string just before and after it breaks is

(a) 9.8 N (b) 19.6 N

(c) 4.9 N (d) zero

Answer (b)

Sol. Before string breaks

$T = 2 \times 9.8 = 19.6$ N

After string breaks

$T = 0$

$\therefore \quad \Delta T = 19.6 - 0 = 19.6$ N

3. Having been paddled continuously on a horizontal road, the speed of a bicycle is increasing, the force of friction exerted by the ground on the wheels is

(a) in the backward direction on both the wheels

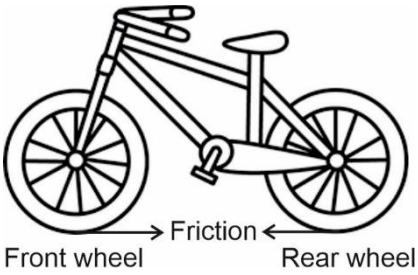
(b) in the forward direction on both the wheels

(c) in the forward direction on the front wheel and in backward direction on the rear wheel

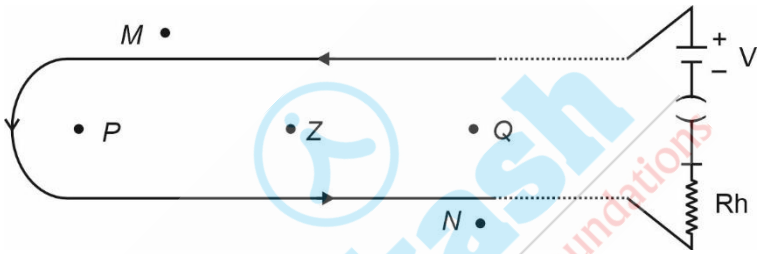
(d) in the backward direction on the front wheel and in forward direction on the rear wheel

Answer (d)

Sol.



4. A current i = 2 amp is established through the long straight conductors which are the arms of a hairpin like structure placed in the plane of paper as shown in the figure. Knowing that a current carrying conductor produces magnetic field represented by the lines of force, analyze the situations described



The correct option is

(a) The magnetic field at point P is directed outward, normal to the plane of paper

(b) The magnetic field at point Q is directed inward, normal to the plane of paper

(c) The magnetic field at point Z is directed normal to the line PQ in the plane of paper

(d) No magnetic field is produced outside the hair pin that is at points M & N

Answer (a)

Sol. The magnetic field at points P, Q and Z is directed outward, normal to the plane of paper.

The magnetic field at points M and N is directed inward, normal to the plane of paper.

5. A certain water pump rated 500 watt lifts water from ground level to a height h = 10 meter at a rate of 240 kg/minute. Ignoring the kinetic energy gained by water, the efficiency of water pump is

(a) 74.8% (b) 78.4%

(c) 84.7% (d) 87.4%

Answer (b)

Sol. $P_{output} = \frac{mgh}{t}$

$= \frac{240 \times 9.8 \times 10}{60}$

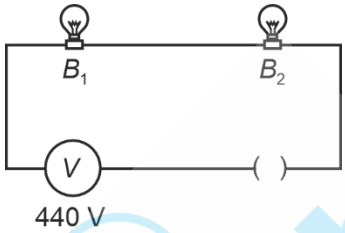
= 392 W

Efficiency $= \frac{P_{output}}{P_{input}} \times 100$

$= \frac{392}{500} \times 100$

= 78.4%

6. Two filament bulbs B_1 (100 W, 220 V) and B_2 (60 W, 220 V) are connected in series with a 440 V supply voltage source as shown. When switched on, the bulb



(a) B_1 will fuse: B_2 will not fuse

(b) B_1 will not fuse: B_2 will fuse

(c) B_1 and B_2 both will fuse at the same instant

(d) B_1 and B_2 both will not fuse

Answer (b)

Sol. $I_1 = \frac{P_1}{V_1} = \frac{100}{220}$

$I_1 = \frac{5}{11}$ A

$I_2 = \frac{P_2}{V_2} = \frac{60}{220} = \frac{3}{11}$ A

$R_1 = \frac{V^2}{P_1} = \frac{220 \times 220}{100}$

R_1 = 484 Ω

$R_2 = \frac{V^2}{P_2} = \frac{220 \times 220}{60}$

$$R_2 = \frac{4840}{6}\Omega = \frac{2420}{3}\Omega$$

$R_{net} = R_1 + R_2$

$$= 484 + \frac{2420}{3}\Omega$$

$$R_{net} = \frac{3872}{3}\Omega$$

$$\text{Total current}(I) = \frac{V}{R_{net}}$$

$$= \frac{440 \times 3}{3872} \approx 0.34 \text{ A}$$

$V_1 = I \times R_1 = 0.34 \times 484 = 164.5$ V

$V_2 = 440 - 164.5 = 275.4$ V

$\therefore$ B_1 will not fuse: B_2 will fuse

7. An electric kettle consists of two filaments F_1 and F_2 of different resistances R_1 and R_2 respectively, connected in parallel with separate switches. With a certain fixed amount of water in the kettle pot to prepare the tea, when only F_1 is switched on, it takes 4 minute to boil the water. When F_1 and F_2 both are switched on simultaneously, it takes 3 minute to boil the same amount of water up to the same temperature. The time taken to boil the same amount of water when only F_2 is switched on (assume that entire heat radiated by filaments is used in boiling the water starting from the same room temperature in each case) is

(a) 7.0 min (b) 8.4 min

(c) 9.6 min (d) 12.0 min

Answer (d)

Sol. $P = \frac{E}{t}$

$$P \propto \frac{1}{t} \quad ...(1)$$

$$\therefore \quad t_1 : t_2 : t_3 = \frac{1}{P_1} : \frac{1}{P_2} : \frac{1}{P_3}$$

Also,

$$P = \frac{V^2}{R}$$

$$\therefore \quad P \propto \frac{1}{R} \quad ...(2)$$

From (1) and (2)

$t \propto R$

$\therefore \quad 4 : 3 : t = R_1 : R_2 : R_3$

$$\frac{4}{3} = \frac{R_1}{R_1 R_2}(R_1 + R_2)$$

$$\frac{R_1}{R_2} = \frac{1}{3}$$

Also,

$$\frac{4}{t} = \frac{R_1}{R_2}$$

$$\therefore \quad \frac{4}{t} = \frac{1}{3}$$

$\Rightarrow \quad t = 12$ min.

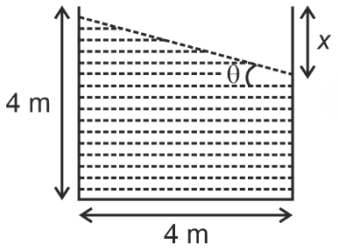
8. The volume of water, spilled out of a completely filled cubic container of side 4 m when the container has been accelerated horizontally with 1.96 m/s^2, is

(a) 0 (b) 12.8 m^3

(c) 6.4 m^3 (d) 3.2 m^3

Answer (c)

Sol.



$$\tan\theta = \frac{a}{g} = \frac{1.96}{9.8} = 0.2$$

$$x = a\tan\theta = 4 \times 0.2 = 0.8 \text{ m}$$

Spilled volume $= \frac{1}{2} \times a^2 \times x$

$$= \frac{1}{2} \times (4)^2 \times 0.8 = 6.4 \text{ m}^3$$

9. Two athletes, *A* and *B*, run in the ground on an oval track of length *L* (say) at 8.0 m/s and 6.0 m/s respectively in the same direction starting from same initial point. How many laps (rounds) will the athlete A complete on the track before overtaking athlete *B* for the first time?

(a) 2 (b) 3

(c) 4 (d) 5

Answer (c)

Sol. Speed of athelete *A* = 8 m/s

Speed of athelete *B* = 6 m/s

Relative speed V_{rel} = 8 – 6 = 2 m/s

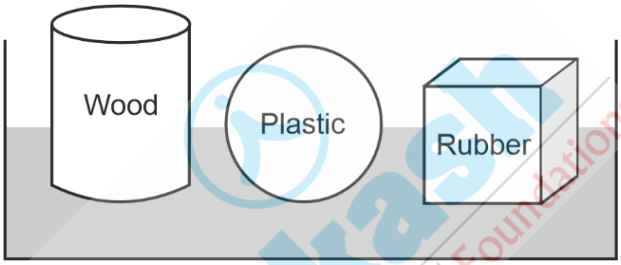
Time taken for first overlap $= \frac{L}{V_{rel}} = \frac{L}{2}$

Distance covered by athelete *A* $= 8 \times \frac{L}{2} = 4L$

Athelet *A* will complete 4 laps before overtaking athelete *B*

10. A wooden solid cylinder (density 0.80 kg/m^3), a plastic ball (density 0.90 kg/m^3) and a rubber cube (density 0.95 kg/m^3) all of equal mass *M* float partly immersed in a trough containing water (density 1.00 kg/m^3) as shown below (ignore any tilt during floatation)

You may conclude that



(a) The buoyant force is largest on the wooden cylinder

(b) The buoyant force is largest on the Plastic ball

(c) The buoyant force is largest on the rubber cube

(d) The buoyant force is equal on all the three

Answer (d)

Sol. All three bodies have equal mass *M* when floating, the buoyant force equals the weight of the body.

11. A stone is thrown vertically down into a well, the splash is heard after a time t_1. If the stone is thrown vertically up with the same speed from the same point, the splash is heard after a time t_2. The common initial speed (u) of the stone in both the cases is given by (the time taken by the splash sound to reach the observer is ignored)

(a) $u = g(t_2 - t_1)$ (b) $u = g(t_2 + t_1)$

(c) $u = \frac{1}{2}g(t_2 + t_1)$ (d) $u = \frac{1}{2}g(t_2 - t_1)$

Answer (d)

Sol. When stone is thrown down

$$h = ut_1 + \frac{1}{2}gt_1^2 \qquad ...(i)$$

When stone is thrown upward

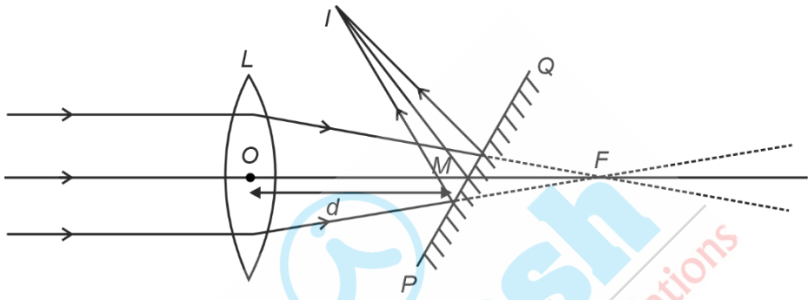
$$h = -ut_2 + \frac{1}{2}gt_2^2 \qquad ...(ii)$$

On solving equation (i) and (ii)

$$u(t_1 + t_2) = \frac{1}{2}g\left(t_2^2 - t_1^2\right)$$

$$\Rightarrow \quad u = \frac{1}{2}g(t_2 - t_1)$$

12. A beam of light is incident parallel to principal axis on a convex lens (L) of focal length f = 20 cm. A plane mirror PQ (See figure), inclined at 60° with the principal axis, is placed a distance 'd' behind the lens so as to form a real image I of the distant object at a distance 'd' from the optical center of the lens as shown in the figure. The value of 'd' is

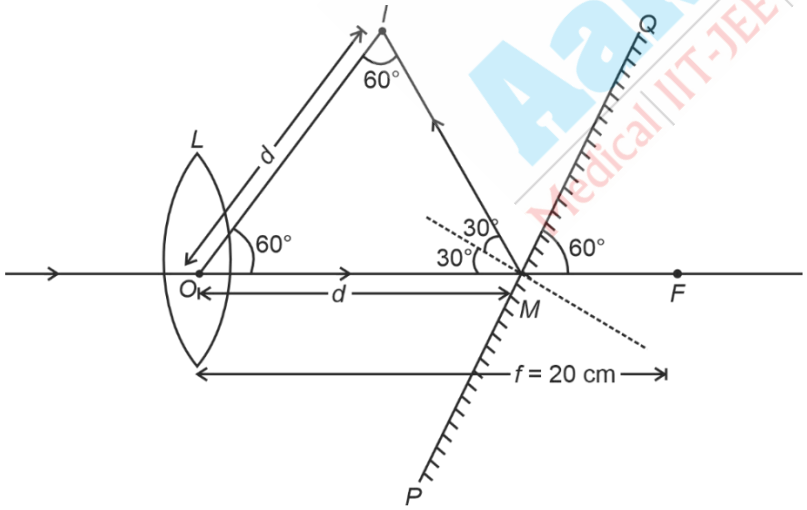


(a) 5 cm (b) 10 cm

(c) 15 cm (d) 20 cm

Answer (b)

Sol.



Since, a plane mirror reflection does not change the convergence or divergence of the beam, it only changes direction. So, the beam that returns to the lens has exactly the same convergence it had at the mirror.

$\therefore \quad f_{eff} = \frac{f}{2} = \frac{20}{2} = 10$ cm

This f_{eff} is equal to d i.e., d = 10 cm

13. A 80 kg man skating with a speed of 10 m/s on a smooth horizontal surface collides with a 20 kg skater at rest, as a result the two cling to each other. What percentage of initial kinetic energy of skaters is lost during the collision? (Ignore any friction)

(a) 12%

(b) 18%

(c) 20%

(d) 25%

Answer (c)

Sol. $80 \times 10 + 20 \times 0 = (80 + 20) \times v$

$\Rightarrow \quad v = 8$ m/s

$k_i = \frac{1}{2} \times 80 \times (10)^2 + \frac{1}{2} \times 20 \times (0)^2$

$= 4000$ J

$k_f = \frac{1}{2} \times (20 + 80) \times (8)^2$

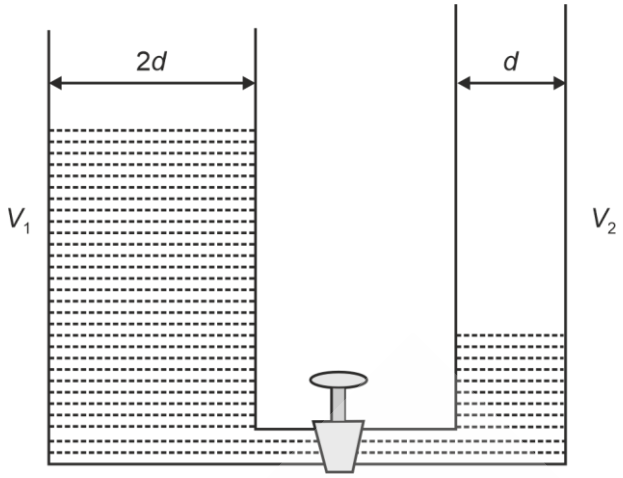
$= 3200$ J

Percentage loss $= \frac{k_i - k_f}{k_i} \times 100$

$= \frac{4000 - 3200}{4000} \times 100$

$= 20\%$

14. Two cylindrical vessels V_1 and V_2 are placed on the same horizontal level. Each vessel contains the same liquid of density ρ. Initially the vessels are not connected (valve closed). The height of liquid in vessel V_1 is h_1 and that in vessel V_2 is h_2. The diameter of vessels V_1 and V_2 are $2d$ and d respectively. When vessels are interconnected (valve opened) at the bottom, the height h of liquid in each vessel (neglecting the volume of liquid in connecting tube) will be



(a) $\frac{2h_1 + h_2}{3}$

(b) $\frac{4h_1 + h_2}{5}$

(c) $\frac{h_1 + h_2}{2}$

(d) $\frac{h_1 + 2h_2}{4}$

Answer (b)

Sol. $\rho \times g \times (h_1 - x) = \rho \times g \times (h_2 + 4x) = \rho g h$

$\Rightarrow \quad h_1 - x = h_2 + 4x$

$\Rightarrow \quad 5x = h_1 - h_2$

$\Rightarrow \quad x = \frac{h_1 - h_2}{5}$

Now,

$$h = h_1 - x = h_1 - \left(\frac{h_1 - h_2}{5}\right)$$

$$= \frac{4h_1 + h_2}{5}$$

15. Two vertical object pins are located on the principal axis of a thin lens at distances of x_1 = 9.0 cm and x_2 = 18.0 cm from the lens on the two sides of the lens. The images of the two pins formed by the lens are at the same position (overlap). The focal length and the nature of the lens are

(a) 15 cm, convex (b) 12 cm, convex

(c) 15 cm, concave (d) 12 cm, concave

Answer (b)

Sol. $u_1 = -18$ cm, $v_1 = x$ cm

$u_2 = -9$ cm, $v_2 = -x$ cm

Now,

$$\frac{1}{f} = \frac{1}{v_1} - \frac{1}{u_1} = \frac{1}{x} + \frac{1}{18} \quad \ldots(i)$$

Again,

$$\frac{1}{f} = \frac{1}{v_2} - \frac{1}{u_2} = -\frac{1}{x} + \frac{1}{9} \quad \ldots(ii)$$

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

$$\frac{1}{x} + \frac{1}{18} = -\frac{1}{x} + \frac{1}{9}$$

$\Rightarrow$ $x = 36$ cm

$\therefore$ $\frac{1}{f} = \frac{1}{36} + \frac{1}{18} = \frac{1+2}{36}$

$\Rightarrow$ $f = 12$ cm and lens is convex

16. A steam boat goes across a lake up to a distance of 1200 meter and comes back. There is a uniform wind blowing with velocity v so as to help the onward journey and to impede the journey back. If the uniform speed of launch of the boat is 5 ms^{-1} and total time taken by the boat in going and coming back is 500 s, the velocity v of the wind blow is

(a) 0.6 ms^{-1} (b) 0.8 ms^{-1}

(c) 1.0 ms^{-1} (d) 1.2 ms^{-1}

Answer (c)

Sol. $\frac{1200}{5+v} + \frac{1200}{5-v} = 500$

$$12\left(\frac{1}{5+v} + \frac{1}{5-v}\right) = 5$$

$12 \times 10 = 5(25 - v^2)$

$\Rightarrow$ $v^2 = 1$

$\therefore$ $v = 1$ m/s

17. Which National Park derives its name from the abundance of red silk cotton trees?
(a) Keoladeo (b) Simlipal
(c) Sunderban (d) Kaziranga

Answer (b)

Sol. The name Simlipal National Park in Odisha is derived from the abundance of the Red Silk Cotton Trees.

18. Some algae live as endophytes in sea-weeds. Which of the following alga is endophytic to the aquatic fern, *Azolla*?
(a) *Sarcodia* (b) *Anabaena*
(c) *Nostoc* (d) *Chondrus*

Answer (b)

Sol. The aquatic fern *Azolla* forms a symbiotic relationship with the nitrogen-fixing cyanobacterium *Anabaena azollae*. *Anabaena* lives inside the cavities of the fern's leaves, acting as an endophyte and provides nitrogen to the plant.

19. St. Anthony's Fire disease is caused by consumption of infected grains of rye. Which of the following is responsible for this disease?
(a) *Candida* (b) *Aspergillus*
(c) *Russula* (d) *Claviceps*

Answer (d)

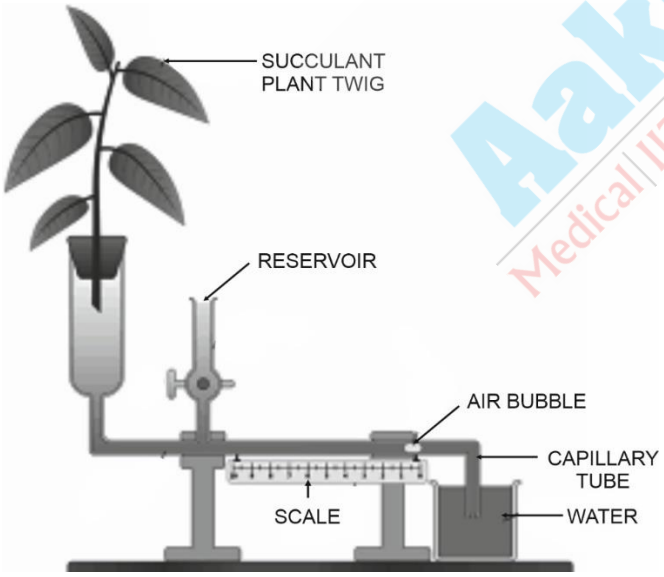
Sol. St. Anthony's Fire (or Ergotism) is caused by consuming rye or other grains infected with the fungus *Claviceps purpurea*. The fungus produces ergot alkaloids, which are toxic.

20. Which of the following is often referred to as the Old Man of the Jungle?
(a) Orangutan (b) Gibbon
(c) Gorilla (d) Chimpanzee

Answer (a)

Sol. Orangutan is often referred to as the old man of the jungle.

21. In the following experimental set-up, a twig of a succulent plant (*Crassula*) was inserted in the glass tube. The apparatus was kept in sun light for 6 hours. The inserted bubble will:



(a) Move very fast to show high rate of transpiration

(b) Move slowly to show lower rate of transpiration

(c) Not move at all

(d) Move according to temperature of water

Answer (b)

Sol. Succulent plants like *Crassula* are adapted to dry environment and have a thick cuticle and sunken stomata to reduce water loss through transpiration. The experiment uses a potometer to measure the rate of water uptake because the plant has a very low rate of transpiration, so inserted bubble will move slowly.

22. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R). Choose the correct option from the codes given below,

Assertion (A): Each of the two strands of the original DNA molecule serves as a template for the synthesis of a new complementary strand. The result is two DNA molecules, each composed of one old (parental) strand and one new (daughter) strand.

Reason (R): During replication, the original DNA molecule is broken into fragments and each fragment is replicated. The newly synthesized DNA fragments and the original fragments are then interspersed resulting in both strands of the daughter DNA containing a mix of old (parental) and new (daughter) DNA segments.

Code:

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) R is true but A is false

Answer (c)

Sol. DNA replication is a semi-conservative process where each strand of the original DNA molecule acts as a template for a new complementary strand. This results in two DNA molecules, each containing one parental and one daughter strand.

The original DNA molecule is not broken into fragments and interspersed with newly synthesized fragments.

23. Who among the following is the launching leader of the Human Genome Project?

(a) Alec Jeffreys

(b) Francis Collins

(c) Craig Venter

(d) John Sulston and Bob Waterston

Answer (b)

Sol. Francis Collins is the launching leader of the Human Genome Project.

24. Make the correct matches of the items M, N, O and P with (i) – (iv):

[M] International Day of Forests	(i) 22, May
[N] International Day for Biological Diversity	(ii) 29, July
[O] World Nature Conservation Day	(iii) 21, March
[P] International Tiger Day	(iv) 28, July

Choose the option showing correct matches:

(a) M-(ii), N-(iii), O-(i), P-(iv)

(b) M-(iv), N-(iii), O-(ii), P-(i)

(c) M-(iii), N-(i), O-(iv), P-(ii)

(d) M-(i), N-(iii), O-(ii), P-(iv)

Answer (c)

Sol.

[M] International Day of Forests	(iii) 21, March
[N] International Day for Biological Diversity	(i) 22, May
[O] World Nature Conservation Day	(iv) 28, July
[P] International Tiger Day	(ii) 29, July

25. Singly or in combination with other nucleotides, which of the following produce co-enzymes for oxidation-reduction reactions?

(a) Vitamin B2 and B5

(b) Vitamin B1 and B3

(c) Vitamin B2 and B6

(d) Vitamin B7 and B9

Answer (a)

Sol. Vitamin B_2 is a precursor to the co-enzymes FAD and FMN.

Vitamin B_5 is a component of coenzyme A(CoA) that acts as an acyl-group carrier, playing a central role in oxidation-reduction reactions.

26. Match the characteristics (V-Z) listed in Column I with the Groups (i-v) listed under Column II:

CHARACTERISTICS	GROUPS
(V) Presence of gelatinous mesogloea.	(i) Nematoda
(W) Presence of syncytial epidermis.	(ii) Platyhelminthes
(X) Presence of parapodia.	(iii) Cnidaria
(Y) Presence of parenchymatous tissue.	(iv) Mollusca
(Z) Presence of Radula.	(v) Annelida

Choose the option showing the correct matches:

(a) V-iii, W-i, X-v, Y-ii & Z-iv
(b) V-iv, W-iii, X-ii, Y-i & Z-v
(c) V-i, W-ii, X-iv, Y-v & Z-iii
(d) V-v, W-iv, X-iii, Y-ii & Z-i

Answer (a)

Sol.

Characteristics	Groups
(V) Presence of gelatinous mesogloea.	(iii) Cnidaria
(W) Presence of syncytial epidermis.	(i) Nematoda
(X) Presence of parapodia.	(v) Annelida
(Y) Presence of parenchymatous tissue.	(ii) Platyhelminthes
(Z) Presence of Radula.	(iv) Mollusca

27. In the animal Kingdom some examples of structures (internal or external) with similar name and function are found in distantly related animals. This is a fascinating example of convergent evolution. Choose the correct option exhibiting such similarity by possessing an organ called 'CROP';

(a) *Taenia*, Prawn and Toad
(b) Earthworm, *Nereis* and *Balanoglossus*
(c) Leech, Cockroach and Bird
(d) *Ascaris*, Crab and Fish

Answer (c)

Sol. Leech, cockroach and birds exhibit such similarity by possessing an organ called 'CROP'.

28. Which of the following is not only the most abundant biopolymer on earth but a Nitrogenous Polysaccharide, too?

(a) Inulin
(b) Hyaluronic Acid
(c) Chitin
(d) Trehalose

Answer (c)

Sol. Chitin is a nitrogen-containing polysaccharide and one of the most abundant biopolymers on Earth.

29. The mathematical relationship called 'Fibonacci Series' is commonly observed in the arrangement of:

(a) Stipules on twig
(b) Leaves
(c) Stamens
(d) Flowers in an inflorescence

Answer (b)

Sol. The Fibonacci series is most commonly seen in leaf arrangement on the stem.

30. Santalin, Red Brasilin and Haematoxylin dyes are naturally found in:

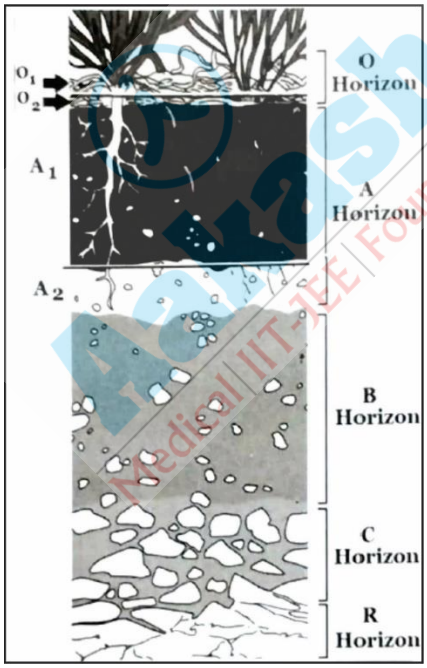
(a) Alburnum
(b) Rhytidome
(c) Duramen
(d) Phelloderm

Answer (c)

Sol. Santalin, red brasilin and haematoxylin are natural dyes obtained from the heartwood of trees.

Heartwood is called duramen, which contains coloured substances (tannins, dyes, resins).

31. Although, profiles of different types of soil differ markedly with respect to their physico-chemical and biological properties; the following diagram shows a typical hypothetical soil profile with its 5 principal horizons [O to R].



Study the given diagram. The characteristics [Q to U] related to various horizons and the names of horizons [i to v] are tabulated below :

CHARACTERISTICS	HORIZONS
(Q) Solum	(i) O2
(R) Podsolic Zone	(ii) A1
(S) Fairly decomposed matter –'Duff'	(iii) A + B
(T) Melanized Region	(iv) A
(U) Zone of Eluviation	(v) A2

Make the correct matches of the characteristics [Q to U] with the horizons [i to v] and choose the correct option:

(a) Q-i, R-iv, S-v, T-iii, U-ii (b) Q-v, R-ii, S-iv, T-iii, U-i

(c) Q-iii, R-v, S-i, T-ii, U-iv (d) Q-ii, R-iv, S-iii, T-i, U-v

Answer (c)

Sol. Duff = partially decomposed organic matter, found in the O2 horizon.

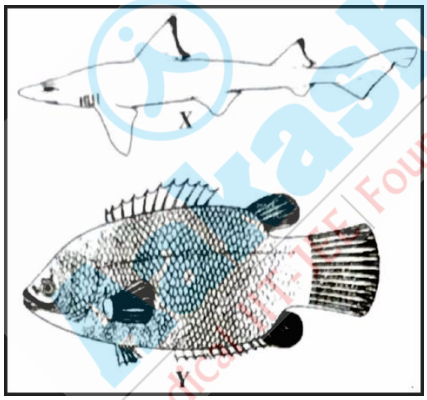
Melanized region = dark, humus-rich A1 horizon.

Zone of eluviation = A2 (A horizon) where minerals are leached out.

Solum = true soil, includes horizons A + B.

Podsolic zone = strongly leached A2 layer.

32. Identify the animals X and Y:



Choose the correct option showing their diagnostic characteristics of scales:

(a) X-Ctenoid Scale; Y-Cycloid Scale (b) X-Placoid Scale; Y-Ctenoid Scale

(c) X-Ganoid Scale; Y-Cosmoid Scale (d) X-Elasmoid Scale; Y-Placoid Scale

Answer (b)

Sol. Animal **X** is a shark, which belongs to the class Chondrichthyes (cartilaginous fish). Sharks have placoid scales, which are structurally similar to teeth. Animal **Y** is a bony fish, likely a climbing perch, which belongs to the class Osteichthyes. Bony fishes typically have cycloid or ctenoid scales. The fish shown has ctenoid scales, characterized by small, tooth-like projections (ctenii) on the posterior edge.

33. A mixture of hydrogen and chlorine kept in a closed flask at a constant temperature was irradiated with scattered light. After a certain time the chlorine content decreased by 20% compared with that of the starting mixture and the resulting mixture had the composition as follows: 60 volume % of chlorine, 10 volume % of hydrogen and 30 volume % of hydrogen chloride. Determine the composition of the initial gaseous mixture

(a) Cl_2 = 60%, H_2 = 40%
(b) H_2 = 60%, Cl_2 = 40%
(c) Cl_2 = 45%, H_2 = 55%
(d) H_2 = 25%, Cl_2 = 75%

Answer (d)

Sol. $H_2 + Cl_2 \longrightarrow 2HCl$

At t = 0 a b

At t = t a – x b – x 2x

Given that Cl_2 content decreases by 20%

$\Rightarrow$ x = 20% of b

$= \frac{20b}{100} = \frac{b}{5}$

Resulting mixture

Total volume = a – x + b – x + 2x.

= a + b

Volume % of Cl_2 = $\frac{b-x}{a+b} \times 100 = 60$

or $\frac{b-x}{a+b} = \frac{6}{10}$ …(i)

Volume % of H_2 = $\frac{a-x}{a+b} = \frac{1}{10}$ …(ii)

Volume % of HCl = $\frac{2x}{a+b} = \frac{3}{10}$ …(iii)

On solving (i) (after putting $x = \frac{b}{5}$), we get

b = 3a

$\therefore$ Volume of Cl_2 must be three times the volume of H_2.

34. A research scholar requires 50 mL aqueous $NaNO_3$ solution containing 70.0 mg Na^+ per mL. The amount of $NaNO_3$ required is

(a) 0.350 g
(b) 0.161 g
(c) 29.75 g
(d) 12.93 g

Answer (d)

Sol. Mass of Na^+ per mL = 70 mg

Moles of Na^+ per mL = $\frac{70\times10^{-3}}{23} = 3.043\times10^{-3}$

Moles of Na^+ in 50 mL = $3.043 \times 10^{-3} \times 50$

$= 0.1522$

Moles of Na^+ = Moles of $NaNO_3$

Hence moles of $NaNO_3$ = 0.1522

$\therefore$ Mass of $NaNO_3$ = (0.1522×85) g

= 12.937 g

35. A sample of crystalline soda (A) with a mass of 1.287 g was allowed to react with an excess of hydrochloric acid and 100.8 mL of a gas was liberated (measured at STP). How many molecules of water in relation to one molecule of Na_2CO_3 are contained in the sample of soda?

(Relative atomic masses are: Na = 23; H = 1; C = 12; 0 = 16)

(a) 5 (b) 6

(c) 4 (d) 10

Answer (d)

Sol. Let 'A' be $Na_2CO_3.xH_2O$

m(A) = 1.287 g

$n(CO_2) = \frac{PV}{RT}$ = 0.0045 mol = n(A)

$M(A) = \frac{1.287\text{ g}}{0.0045\text{ mol}} = 2.86\text{ g mol}^{-1}$

$M(A) = M(Na_2CO_3) + xM(H_2O)$

$x = \frac{M(A) - M(Na_2CO_3)}{M(H_2O)}$

$= \frac{(286-106)\text{ g mol}^{-1}}{18\text{ g mol}^{-1}}$

= 10

36. Which of the following ammonium salt, release SO_3 gas on thermal decomposition:

(I) $(NH_4)_2SO_4 \xrightarrow{\Delta}$

(II) $(NH_4)_2S_2O_8 \xrightarrow{\Delta}$

(a) I only (b) II only

(c) Both (I) and (II) (d) None of these

Answer (d)

Sol. Both compounds will not release SO_3 gas.

37. Which of the following group contains solid compounds at 10°C?

(a) H_2O, NH_3, CH_4 (b) F_2, Cl_2, Br_2

(c) SO_3, I_2, NaCl (d) Si, S_8, CH_3COCH_3

Answer (c)

Sol. I_2, NaCl and SO_3 all are solid at room temperature.

38. How many 1°-amine are possible for $C_5H_{13}N$?

(a) 6 (b) 7

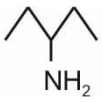
(c) 8 (d) 6

Answer (c)

Sol. Possible 1° amines for $C_5H_{13}N$

(i)  1-pentanamine

(ii)  2-pentanamine

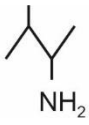
(iii)  3-pentanamine

(iv)  2-methyl-1-butanamine

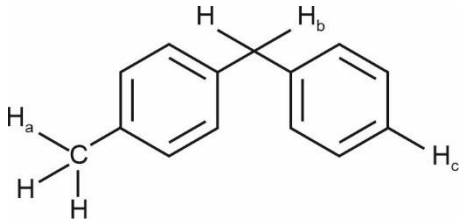
(v)  3-methyl-1-butanamine

(vi)  2-methyl-2-butanamine

(vii)  2,2-dimethyl-1-propanamine

(viii)  3-methyl-2-butanamine

39. For the compound given below, the correct increasing order of C – H bond strength is



(a) $C - H_a > C - H_b > C - H_c$ (b) $C - H_a > C - H_c > C - H_b$

(c) $C - H_b > C - H_a > C - H_c$ (d) $C - H_c > C - H_a > C - H_b$

Answer (d)

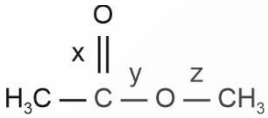
Sol. Bond strength gets weaker when the resulting radical is stabilized.

- Benzylic $C - H_b$ gives a resonance – stabilised radical i.e., weakest $C - H_b$.
- Aromatic (sp^2) $C - H_c$ bond is quite strong i.e., strongest $C - H_c$.

So, the increasing order of bond strength is

$C - H_b < C - H_a < C - H_c$.

40. Consider the C – O bonds x, y and z present in the compound given below



The increasing order of C – O bond length is

(a) x = y = z (b) x < y < z

(c) x < z < y (d) y < x < z

Answer (b)

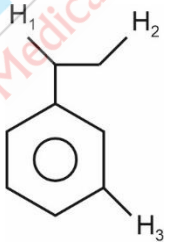
Sol. x < y < z

C = O (x) ⇒ Highest bond order or shortest bond length.

C – O (y) ⇒ Normal C – O single bond so intermediate bond length.

C – O (z) ⇒ Longest bond length.

41. The correct order of the bond energy of different C – H bonds in the given compound is



(a) $C - H_1 > C - H_2 > C - H_3$ (b) $C - H_2 > C - H_1 > C - H_3$

(c) $C - H_3 > C - H_2 > C - H_1$ (d) $C - H_3 > C - H_1 > C - H_2$

Answer (c)

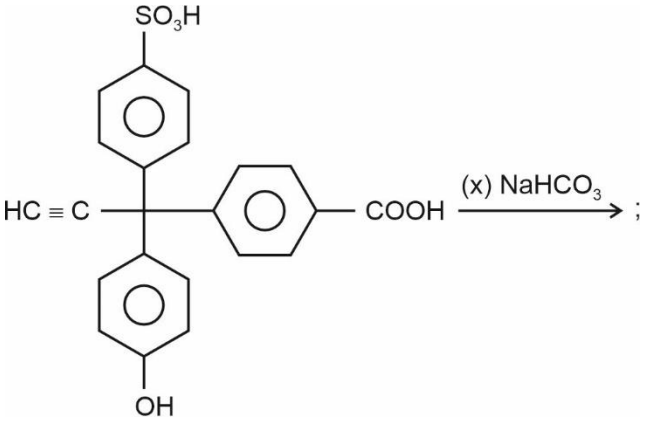
Sol. Bond energy increases when the resulting radical is less stable.

- Removing H_1 gives the most stabilized radical as it is benzylic and more substituted.

Therefore C – H_1 bond is weakest.

- Aromatic (sp^2) C – H_3 bond is quite strong therefore C – H_3 bond is strongest.

42. The total number of moles of $NaHCO_3$ consumed during the given reaction is x.



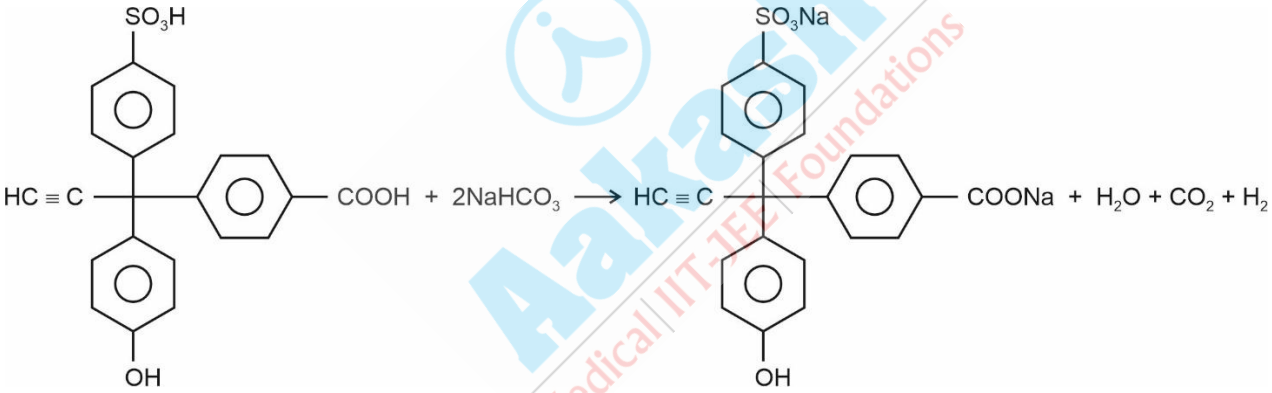
The value of x is

(a) 1 (b) 2

(c) 3 (d) 4

Answer (b)

Sol.



Both sulphonic acid and carboxylic acid react with $NaHCO_3$.

43. If 1 mL of water contains 20 drops, the number of water molecules, in each drop of water, is (A is Avogadro number)

(a) $\frac{0.5}{18}$ A (b) 0.05 A

(c) 0.5 A (d) $\frac{0.05}{18}$ A

Answer (d)

Sol. Given that 1 mL of water contains 20 drops

Since the density of water is approximately 1 g/mL,

$\therefore$ 1 mL of water has a mass of 1 gram

$$\text{Mass of one drop} = \frac{1\text{ g}}{20\text{ drops}} = 0.05\text{ g}$$

Now, 18 g of water contains = A molecules

$$\therefore \quad 0.05\text{ g of water contains} = \frac{A}{18} \times 0.05 \text{ molecules}$$

$$= \frac{0.05}{18} A$$

44. In which of the below given sets, all types of bonds (ionic, covalent and coordinate) are present in all the molecules?

(a) HCN, HNO_3, O_3

(b) $KNO_3, HNO_3, CuSO_4.5H_2O$

(c) $NH_4Cl, KNO_3, CuSO_4.5H_2O$

(d) Both (b) and (c)

Answer (c)

Sol. NH_4Cl

Ionic : $NH_4^+ - Cl^-$

Covalent : N–H bonds

Coordinate : $NH_3 + H^+ \longrightarrow NH_4^+$ Dative bond

KNO_3

Ionic : $K^+ - NO_3^-$

Covalent : N – O bonds in nitrate ion

Coordinate : In resonant structure, N $\rightarrow$ O Dative bond

$CuSO_4.5H_2O$

Ionic : $Cu^{2+} - SO_4^{2-}$

Covalent : S – O bonds in sulphate ion

Coordinate : Cu^{2+} bonds with water molecule.

45. Which of the following C–H bonds has lowest bond dissociation energy?

(a) 3°C–H bond (b) 2°C–H bond

(c) 1°C–H bond (d) All have same bond dissociation energy

Answer (a)

Sol. 3° carbon radicals are the most stable, hence having lowest bond dissociation energy.

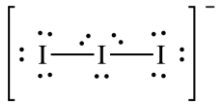
46. The total number of lone pair of electron in I_3^- is

(a) 2 (b) 3

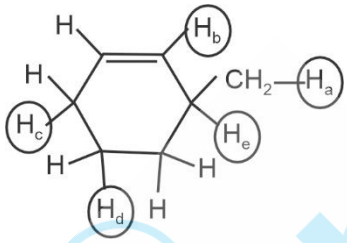
(c) 6 (d) 9

Answer (d)

Sol.



47. The correct order of abstraction of hydrogen from the below given compound when treated with halogen is



(a) e > b > c > a > d (b) b > e = c > a > d

(c) e > c > d > a > b (d) b > c > e > d > a

Answer (c)

Sol.
- H_e is on the carbon adjacent to the double bond i.e. forms and allylic radical and highly resonance stabilized (CH_3 is also attached)
- H_c is on the allylic position which will also stabilised by resonance
- In case of H_b, radical on the doubly bonded carbon is least stable
- H_a is on primary carbon whereas H_d is on secondary carbon.

$\therefore$ e > c > d > a > b

48. Which of the following will form foam in water containing Ca^{2+} and Mg^{2+} ions?

(a) Ba-stearate (b) Na-palmitate

(c) Potassium n-dodecyl benzene sulphonate (d) All of these

Answer (c)

Sol. Detergents will form foam with hard water.

$\Rightarrow$ Ba-stearate and Na-palmitate are soaps.

$\Rightarrow$ Potassium n-dodecyl benzene sulphonate is detergent.

A-2

ANY NUMBER OF OPTIONS (4, 3, 2 or 1) MAY BE CORRECT
MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED AND NO INCORRECT.

49. A trolley of mass 240 kg is initially at rest on the frictionless horizontal straight rails lying in east-west direction. The length of the trolley is 20 meter. A man of mass 60 kg is standing at the eastern end of the trolley. The man starts moving on the trolley from eastern end towards west with velocity 1.0 m/s relative to the trolley. Assume the displacement and the velocity in eastward direction to be positive.

Choose the correct option.

(a) The velocity of man relative to ground is $-1\ ms^{-1}$

(b) The recoil velocity of the trolley relative to ground is $+ 0.2\ ms^{-1}$

(c) The man reaches from one end of trolley to other end in time $t = 20$ s

(d) Displacement of trolley over the ground when the man reaches the other end of trolley is + 4.0 m.

Answer (b, c, d)

Sol. Let v and V be the velocity of man and trolley relative to the ground respectively

$V_{mt} = v - V$

$-1 = v - V$

$\Rightarrow \quad v = V - 1$

Applying conservation of momentum

$M \times V + m \times v = 0$

$240V + 60(V - 1) = 0$

$240V + 60V = 60$

$\Rightarrow \quad V = +0.2$ m/s

The recoil velocity of the trolley relative to the ground is +0.2 m/s

The velocity of man w.r.t. ground is

$v = V - 1 = 0.2 - 1 = -0.8$ m/s

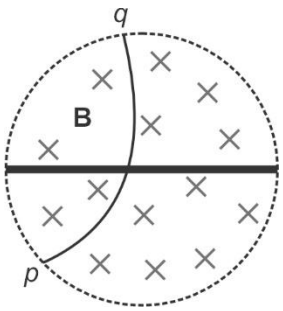
Time taken by the man to move from one end of the trolley to the other is

$$t = \frac{L}{|V_{mt}|} = \frac{20}{1} = 20 \text{ s}$$

The displacement of the trolley $X = V \times t$

$= 0.2 \times 20 = +4$ m/s

50. In an experiment performed using a cloud chamber (a device that can show the tracks of subatomic particle) the nature of a particle can be analysed. Under the influence of a strong perpendicular magnetic field **B** directed into the plane of paper, a particle track like the one shown beside as *p q* was obtained. The track shown may depict



(a) a proton (charge + e) moving from point *p* to *q*

(b) an alpha particle (charge + 2e) moving from point *p* to *q*

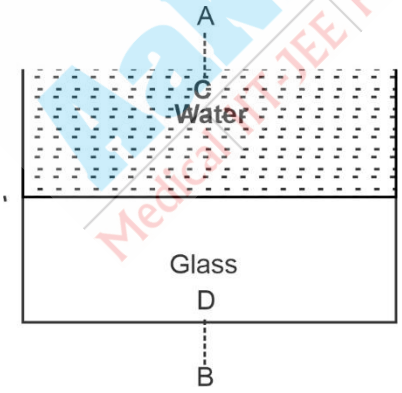
(c) an electron (charge – e) moving from point *q* to *p*

(d) a neutron (charge zero) moving from point *p* to *q*

Answer (a, b, c)

Sol. Use Fleming's left hand rule

51. A homogeneous column of water $\left({}_a\mu_w = \frac{4}{3}\right)$ of height 8.0 cm fills the space above a 9.0 cm thick glass $\left({}_a\mu_g = \frac{3}{2}\right)$ slab. Observers A and B are in air just outside the top and the bottom whereas the observers C and D are inside just below the top and above the bottom. The total thickness of glass plus water observed by these observers are



(a) Observer A measures it as 12.0 cm

(b) Observer B measures it as 12.0 cm

(c) Observer C measures it as 16.0 cm

(d) Observer D measures it as 18.0 cm

Answer (a, b, c, d)

Sol. For observer A

Total Thickness of glass plus water $= \frac{d}{\mu_1} + \frac{d}{\mu_2}$

$= \frac{8\times 3}{4} + \frac{9\times 2}{3}$

= 12 cm

For observer B

Total thickness of glass plus water $= \frac{8\times 3}{4} + \frac{9\times 2}{3}$

= 12 cm

For observer C

Total thickness of glass plus water $= 8 + \frac{9\times 2}{3} \times \frac{4}{3}$

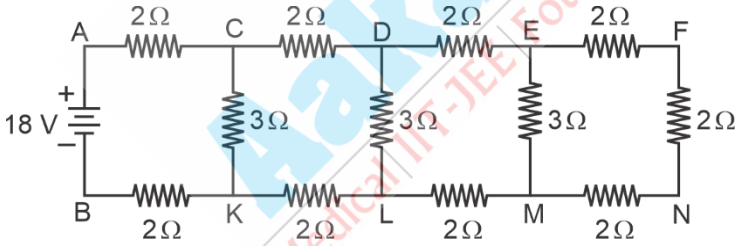
= 16 cm

For observer D

Total thickness of glass plus water $= 9 + \frac{8\times 3}{2} \times \frac{3}{4}$

= 18 cm

52. Several resistances of 2 Ω and 3 Ω are used to form a typical electric network as shown in the figure below. A dc supply of emf 18 volt and negligible internal resistance has been connected between points A and B.



Choose the correct option(s)

(a) Total resistance between A and B is 6 Ω

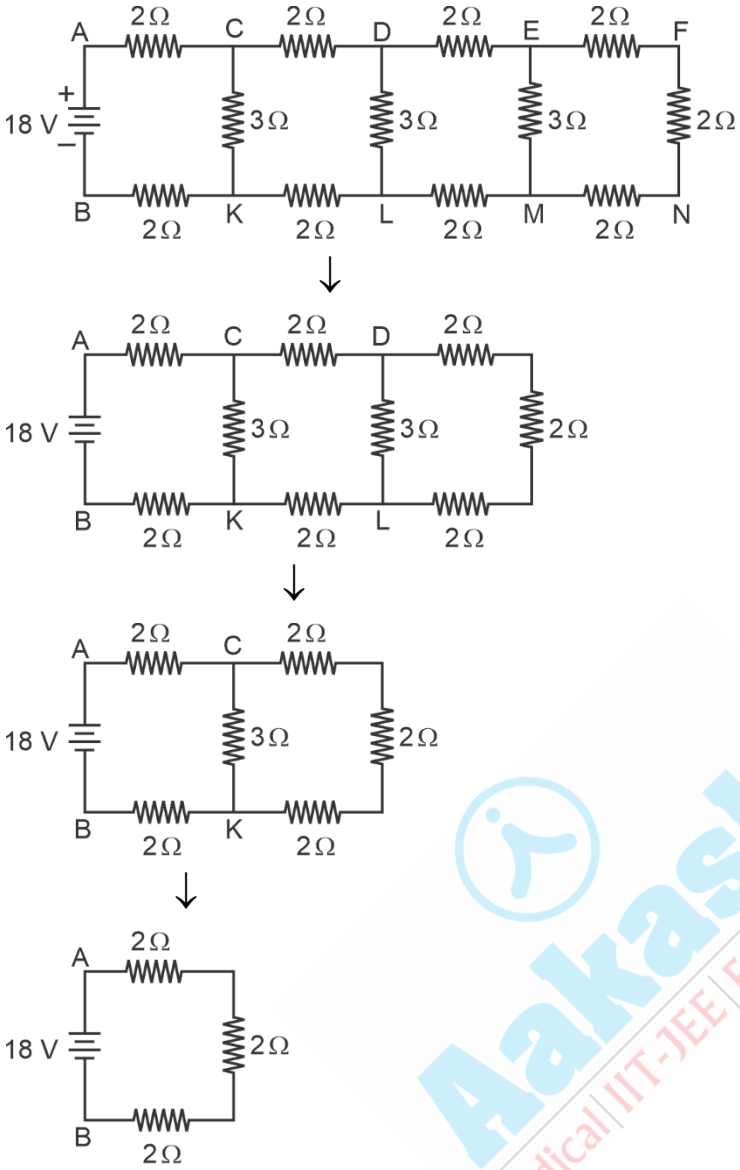
(b) The power consumed in the network is 60 W

(c) The current through resistance of 2 Ω on the branch AC is 3 A

(d) The current through resistance of 3 Ω in the branch CK is 2 A

Answer (a, c, d)

Sol. (a)



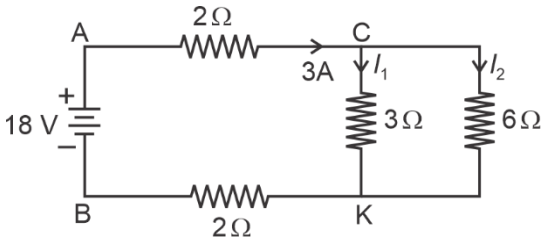
$R_{AB} = 2 + 2 + 2 = 6\ \Omega$

(b) $P = \dfrac{V^2}{R_{eq}} = \dfrac{(18)^2}{6} = 54\ \text{W}$

(c) $I_{AC} = I_{eq} = \dfrac{V}{R_{eq}}$

$I_{AC} = \dfrac{18}{6} = 3\ \text{A}$

(d)



$$I_1 = \left(\frac{6}{3+6}\right) \times 3 = 2 \text{ A}$$

53. Fine structure of striated muscle fibres has been elucidated with the help of electron microscope. Study the following statements and choose the **incorrect** ones:

(a) The dark and light bands of myofibrils have been respectively, named as 'A' [Anisotropic under polarized light] and 'I' [Isotropic under polarized light] bonds.

(b) The 'A' bonds contain about 120Å thick and 18Å long actin filaments.

(c) Each 'I' band is divided into two equal halves by a thin, fibrous and transverse zig-zag partition called 'Z' band.

(d) The major middle lighter region of 'A' band is called 'M' zone.

Answer (b, d)

Sol. A band contains thick myosin filaments, instead of thick and long actin filaments.

The values for myosin filament thickness is 120Å to 140Å and actin filament length is 1000Å.

The lighter middle region of the A band is the H zone.

54. The autonomic nervous system is divided into two parts- [A] Sympathetic and [B] Parasympathetic. Some effects of these systems are given below, respectively. Choose the correct option(s)

(a) Pupil constricts; Glycogen converted into glucose

(b) Salivation decreases; Bladder constricts

(c) Adrenaline released; Glucose converted into glycogen

(d) Bronchii constrict; Gastric activity stimulated

Answer (b, c)

Sol. Pupil dilation is a sympathetic effect and glycogen conversion to glucose is also sympathetic effect. So, it is an incorrect pair.

$\Rightarrow$ Sympathetic causes bronchodilation and parasympathetic stimulates gastric activity. So, the pair is incorrect.

Hence, the correct answer is (b), (c).

55. Study the following statements regarding Haemophilia and choose the incorrect option(s).

(a) It follows criss-cross pattern of inheritance

(b) It is a Y-linked dominant trait

(c) It is common in women but rare in man

(d) It is also called royal disease

Answer (b, c)

Sol. Haemophilia is an X-linked recessive bleeding disorder. Since males have only one X chromosome, they much more likely to have the disorder if they inherit the mutated gene, while females with two X chromosomes usually only become carriers.

56. Which of the following trees does/do not show cheiropterophily?

(a) Sausage tree (b) Kadamb

(c) Coral tree (d) Silk Cotton

Answer (b, c)

Sol. $\Rightarrow$ Sausage tree are the classic cheiropterophilous tree and silk cotton tree gets pollinated by fruit bats.

$\Rightarrow$ Kadamb gets pollinated by insects (bees or butterflies).

$\Rightarrow$ Coral tree gets pollinated by birds.

57. The pair(s) of elements which has/have equal number of electrons in the outer most shell is/are

(a) Na, Sr (b) Se, Te

(c) Mn, Fe (d) As, Bi

Answer (b, c, d)

Sol. $Na(Z=11)=[Ne]3s^1$

$Sr(Z=38)=[Kr]5s^2$

$Se(Z=34)=[Ar]3d^{10},\ 4s^2 4p^4$

$Te(Z=52)=[Kr]4d^{10},\ 5s^2 5p^4$

$Mn(Z=25)=[Ar]3d^5,\ 4s^2$

$Fe(Z=26)=[Ar]3d^6,\ 4s^2$

$As(Z=33)=[Ar]3d^{10},\ 4s^2 4p^3$

$Bi(Z=83)=[Xe]4f^{14},\ 5d^{10},\ 6s^2 6p^3$

58. The correct statement(s) is/are

(a) pH of 10^{-8} NaOH is 8

(b) pH of 10^{-8} HCl is < 7

(c) Aqueous solution of $FeCl_3$ is acidic

(d) NaH_2PO_2 will react with NaOH to form Na_2HPO_2

Answer (b, c)

Sol. (a) Total $[OH^-] = 10^{-8} + 10^{-7}$ (from H_2O)

$= 1.1 \times 10^{-7}$

$pOH = -\log [OH^-]$

$= -\log (1.1 \times 10^{-7})$

$= 6.96$

$pH = 14 - pOH$

$= 14 - 6.96$

$= 7.04$

(b) Total $[H^+] = 10^{-8} + 10^{-7}$ (from H_2O)

$= 1.1 \times 10^{-7}$

$pH = -\log [H^+]$

$= -\log (1.1 \times 10^{-7})$

$= 6.96$

(c) $FeCl_3$ is a salt formed from weak base, $Fe(OH)_3$ and a strong acid, HCl. Therefore, $FeCl_3$ is acidic.

(d) NaH_2PO_2 has no acidic protons. Therefore, it will not react with NaOH to form Na_2HPO_2.

59. Considering the H-spectrum series, select the correctly matched pair(s).

(a) Balmer: $n_2 > 2$

(b) Pfund: $\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{n^2}\right]$

(c) Humphery: $n_1 > 6$

(d) Paschen: IR region

Answer (a, d)

Sol. (a) Balmer series : e^- de-excites from $n_2 > 2$ to $n_1 = 2$

(b) For Pfund series $n_2 \rightarrow n_1 = 5$

So, $\frac{1}{\lambda} = R \cdot (1)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\frac{1}{\lambda} = R\left[\frac{1}{5^2} - \frac{1}{n_2^2}\right]$

(c) For Humphery series : e^- de-excites

From $n_2 > 6$ to $n_1 = 6$

(d) For H-atom

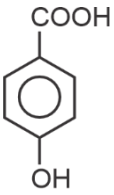
Lyman series → UV Region

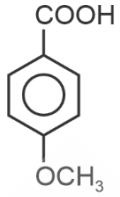
Balmer series → Visible Region

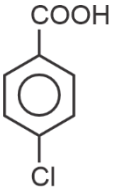
Paschen series → IR Region

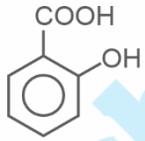
Brakett series → IR Region

60. Which of the following acids are stronger than benzoic acid?

(a) 

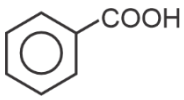
(b) 

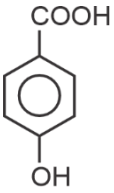
(c) 

(d) 

Answer (c, d)

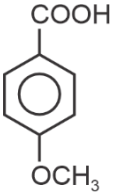
Sol. Benzoic acid



(a) 

– OH – Electron donating group

∴ Decreases acidity

(b) 

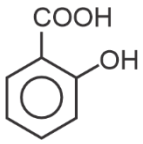
– OCH_3 – Electron donating group

∴ Decreases acidity

(c) 

– Cl – Electron withdrawing group

$\therefore$ Increases acidity

(d) 

$\rightarrow$ Although – OH is electron donating group, but,

here, the intramolecular H-bond stabilises the conjugate base

$\therefore$ Increases acidity

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