B.K. Birla Centre For Education

Date: 13-12-2025 PRE BOARD EXAMINATION-II **Duration**: 3 Hrs

Class: X Science **Total Marks** : 80

Instructions to the Students

- Write only question numbers clearly outside the margin (1, 2, 3.i, 5.b, 4.c.ii, etc.).
- Do not write questions or any titles. (For ex. - Do not write **II. Answer the following**).
- After every answer, give a one-line space.
- For Multiple choice Questions - Both Option and Answer should be written.
- This question paper consists of 3 sections: Section A - Biology, Section B - Chemistry and Section C - Physics.
- All questions are compulsory. However, an internal choice is provided in some questions. A student is expected to attempt only one of these questions.
- Bullet points & Sub-points should be written inside the margin.
- Do not fold / staple the paper.

Section A

1. Why is leaf fall considered a method of excretion in plants? [1]

a) Leaves store oxygen that plants don't need
b) Leaves store water for future use
c) Waste products are stored in leaves, which are then shed
d) Leaves block sunlight needed for photosynthesis

Answer 🔑

c) Waste products are stored in leaves, which are then shed (1)

2. A stomata closes when: [1]

A) It needs Carbon dioxide for photosynthesis
B) It does not need Carbon dioxide for photosynthesis
C) Water flows out of the guard cells
D) Water flows into the guard cells

a) A only.
b) A and C.
c) B and C.
d) B and D

Answer 🔑

c) B and C. (1)

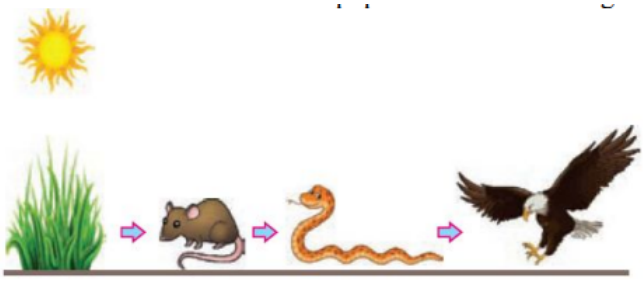
3. Why do arteries have thicker walls than veins? [1]

a) They carry oxygenated blood
b) They have to withstand high pressure from the heart
c) They contain valves to prevent backflow
d) They transport nutrients only

Answer 🔑

b) They have to withstand high pressure from the heart (1)

4. Which of these statements would be correct if the population of snakes is greatly increased? [1]



a) Population of green plants will decrease.
b) Population of mice will decrease.
c) Population of hawk will decrease
d) Both (a) and (c)

Answer 🔑

b) Population of mice will decrease. (1)

5. The incorrect statement about ozone is [1]
a) It is a deadly poisonous gas.
b) It shields the surface of the earth from UV radiation from sun.
c) It is used as a refrigerant and in fire-extinguishers.
d) It is formed by combining oxygen molecule with free oxygen atom.

Answer 🔑

c) It is used as a refrigerant and in fire-extinguishers. (1)

6. **Statement 1:**Roots absorb minerals like nitrogen and phosphorus from the soil. [1]
Statement 2: Energy needs of plants are high because they are constantly moving.
a) Both Statements 1 and 2 are true
b) Both Statements 1 and 2 are false
c) Statement 1 is true and Statement 2 is false
d) Statement 1 is false and Statement 2 is true

Answer 🔑

c) Statement 1 is true and Statement 2 is false (1)

7. Why is the spinal cord protected by the vertebral column? [1]
a) It controls voluntary actions.
b) It needs protection from mechanical injury.
c) It supports muscle movement.
d) It stores neurotransmitters.

Answer 🔑

b) It needs protection from mechanical injury. (1)

8. **Assertion (A):** A geneticist crossed two pea plants and got 50% tall and 50% short progeny. [1]
Reason(R): One plant was heterozygous tall and the other one was short.
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 correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer 🔑

a) Both (A) and (R) are true and (R) is the correct explanation of (A) (1)

9. **Assertion (A):** Plastics decompose quickly in the environment because bacteria produce enzymes that break them down efficiently. [1]

Reason (R): Non-biodegradable substances resist breakdown by biological processes and persist for a long time in the environment, causing pollution.

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 correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer 🔑

d) (A) is wrong but (R) is correct (1)

10. **Give reason:** We do not have to think consciously to breathe, digest food, or make our heart beat. [2]

Answer 🔑

These actions are involuntary and are controlled by the medulla in the hind-brain. (1)

The medulla regulates vital functions such as breathing, heartbeat, salivation, and blood pressure automatically, without requiring conscious thought. (1)

11.A. Why is it important for mammals and birds to have a four-chambered heart, whereas amphibians can survive with a three-chambered heart? [2]

Answer 🔑

Mammals and birds are warm-blooded and need a constant body temperature, which requires a high metabolic rate and efficient oxygen delivery. A four-chambered heart ensures complete separation of oxygenated and deoxygenated blood, allowing maximum oxygen supply to tissues. (1)

Amphibians are cold-blooded; their body temperature fluctuates with the environment, so they have lower oxygen demands and can tolerate some mixing of blood in a three-chambered heart. (1)

(OR)

11.B. Riya's father is suffering from kidney failure and is in urgent need of a transplant. Riya offers to donate one of her kidneys. Based on your understanding of organ donation, explain whether this is possible and under what conditions it can be done. [2]

Answer 🔑

Yes, this is possible because a kidney is one of the organs that can be donated by a living person. (1)

The donation can be done with proper medical evaluation and consent from both Riya and her family, ensuring that it is safe for both the donor and the recipient. (1)

12. Define biomagnification and explain why pesticides accumulate in higher amounts in humans compared to plants. [2]

Answer

The progressive accumulation of non-degradable chemicals, like pesticides, at successive trophic levels of a food chain. (1)

Humans are at the top of the food chain, so they consume organisms from all lower trophic levels, leading to the maximum concentration of these chemicals in their bodies. Since the chemicals are not easily degradable, they get concentrated in humans more than in plants. (1)

13. Define a reflex arc. Why have reflex arcs evolved in animals? Trace the sequence of events, which occur, when you suddenly touch a hot object. [3]

Answer

A shortest pathway taken by a nerve impulse. (1)

It has evolved to protect the organism from any injury. (1)

stimulus——---> receptor—->sensory neuron ——-> spinal reflex ——--> relay or interneuron——-----> motor neuron——-->effector ——--> response (1)

Stimulus- heat, receptor- thermoreceptor , effector—-> hand muscle response - pull the hand (1)

14. The gene combination of purple flowered pea plants is denoted as (WW) and that of white flowered pea plants as (ww), when these two plants are crossed F_1 generation is obtained. [3]

i) List two observations made by Mendel in F_1 generation plants.

ii) Give the (a) percentage white flowered plants and (b) ratio of the gene combinations WW, Ww and ww in F_2 generation.

iii) Write one difference between dominant and recessive trait.

Answer

i)

All plants were purple flowered (0.5)

Only dominant parental trait was observed (0.5)

No mixed coloured flowers were observed (0.5)

No white flowered plants were observed (0.5)

ii)

a) 25% (0.5)

b) 1 WW : 2 Ww : 1 ww (0.5)

iii)

Dominant Trait: A trait that can express itself in the presence of its unexpressed contrasting trait (0.5)

Recessive Trait: A trait that remains unexpressed in the presence of its contrasting form. (0.5)

15. The human alimentary canal is a long, specialized tube where food is mechanically and chemically digested. Enzymes like salivary amylase, pepsin, and pancreatic enzymes break

down complex food molecules into simpler forms, which are then absorbed through villi in the small intestine. The process is aided by bile for fat digestion and regulated by muscular movements and sphincters to ensure proper digestion.

15.A. Why is food first made alkaline in the small intestine before digestion by pancreatic enzymes? [1]

Answer ⊶

Pancreatic enzymes work best in an alkaline medium, so the acidic food from the stomach is neutralized by bile to allow proper digestion. (1)

15.B. A person has a weak anal sphincter. What problem might they face? [1]

Answer ⊶

They may face difficulty controlling the exit of waste, leading to involuntary leakage or incontinence. (1)

15.C. A student has a condition where their small intestine cannot absorb nutrients efficiently. Which structural feature of the small intestine is likely affected, and why? [2]

Answer ⊶

The villi of the small intestine are likely affected. Villi increase the surface area for absorption, so if they are damaged or reduced, nutrient absorption becomes inefficient. (2)

(OR)

15.D. If bile secretion is blocked, how will fat digestion be affected, and why? [2]

Answer ⊶

Fat digestion will be inefficient because bile salts emulsify large fat globules into smaller ones, increasing the surface area for lipase action. Without bile, lipase cannot act effectively on fats. (2)

16. Puneet wanted to grow banana plants

16.A.i. Based on your knowledge on plant reproduction should he opt for seeds or any alternate method of reproduction. Justify your answer. [2]

Answer ⊶

Puneet should not choose seeds as banana plants have lost the capacity to produce seeds. Most cultivated banana plants are seedless and sterile, so they cannot reproduce sexually by seeds. (1)

He should go for vegetative propagation of banana (by stem cutting). This method ensures that new banana plants are genetically identical to the parent and maintain the same desirable qualities (1)

16.A.ii. Offsprings of a banana plant usually show very little variation. What causes variation and are variations good or bad? Justify. [3]

Answer

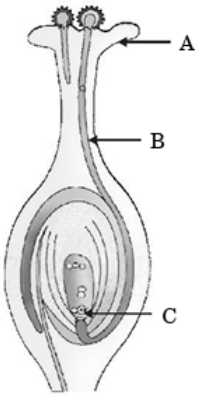
Cause of variation: Variations are mainly caused by sexual reproduction (due to recombination of genes) and sometimes by mutations in DNA. (1)

Variation is good as it can help a population tide over unfavourable conditions by survival of some variants. (1)

Bananas reproduce asexually (by vegetative propagation), so the offspring are genetically identical to the parent plant, showing very little variation. (1)

(OR)

16.B.i. Identify A, B and C in the diagram given below and write one function of each. [3]



Answer

A – Stigma: Receives pollen and provides suitable environment for its germination (1)

B –Pollen tube: Carries males germ cells (gametes) to the female gamete situated in the ovary (1)

C – Egg Cell (Female germ cell): Fuses with male gamete and forms zygote. (1)

16.B.ii. Compare the processes of Pollination and germination [2]

Answer

Pollination

The process in which the pollen grains from stamen are transferred to the stigma of pistil. (0.5)

External agents like air, water or an animal are required. (0.5)

After pollination the pollen tube is produced which contains male germ cell. (0.5)

Germination

It is the process in which a tiny seed gives rise to a future plant in the form of radicle and plumule (0.5)

Generally, it takes place in the soil under appropriate conditions. (0.5)

After germination the plumule (future stem) and radicle (future root) are developed. (0.5)

Section B

17. **Statement 1:** Skeletal chemical equations show reactants and products but are not necessarily balanced. [1]

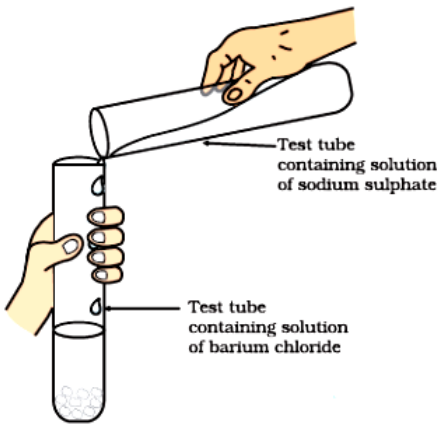
Statement 2: The number of atoms on the reactant side can be different from the products side in a balanced chemical equation.

a) Both Statements 1 and 2 are true
b) Both Statements 1 and 2 are false
c) Statement 1 is true and Statement 2 is false
d) Statement 1 is false and Statement 2 is true

Answer

c) Statement 1 is true and Statement 2 is false (1)

18. [1]



Identify the product which represents the solid state in the above reaction.

a) Barium chloride b) Barium sulphate c) Sodium chloride d) Sodium sulphate

Answer

b) Barium sulphate (1)

19. Which one of the following can be used as an acid-base indicator by a blind student? [1]

a) Turmeric b) Litmus c) Vanilla essence d) Methyl orange

Answer

c) Vanilla essence (1)

20. In the chlor-alkali process, which gas is released at the anode? [1]

a) Hydrogen b) Chlorine c) Oxygen d) Nitrogen

Answer 🔑

b) Chlorine (1)

21. Wires in homes are coated with polyvinyl chloride (PVC) or rubber-like materials. This coating ensures that: [1]

a) The wires do not rust over time.
b) The wires can carry more current.
c) The wires become more flexible.
d) The wires are safe to touch and prevent electric shocks.

Answer 🔑

d) The wires are safe to touch and prevent electric shocks. (1)

22. Which of the following statements about metal oxides and their reactions is correct? [1]

a) All metal oxides are soluble in water and produce acids.
b) Aluminium oxide reacts with both acids and bases, so it is amphoteric.
c) Sodium oxide is insoluble in water and does not form an alkali.
d) Copper and gold react vigorously with oxygen at room temperature.

Answer 🔑

b) Aluminium oxide reacts with both acids and bases, so it is amphoteric. (1)

23. A student is given three metals: sodium, iron, and copper. She keeps all three in separate containers under identical conditions for one week. [1]

After a week:

i) Sodium reacts vigorously and forms a new compound.

ii) Iron shows rust formation.

iii) Copper remains mostly unchanged.

Which of the following conclusions can be correctly drawn?

a) All metals react at the same rate with air.
b) Copper is sonorous and therefore does not react.
c) Iron does not react with air, only with water.
d) Reactivity of metals depends on their position in the reactivity series.

Answer 🔑

d) Reactivity of metals depends on their position in the reactivity series. (1)

24. **Assertion (A):** Burning of natural gas (methane) is an endothermic process. [1]

Reason (R): Methane reacts with oxygen to form carbon dioxide and water, releasing heat energy.

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 correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer 🔑

d) (A) is wrong but (R) is correct (1)

25. Cinnabar is an ore of a metal 'X'. When this ore is heated in air, it is first converted into oxide of 'X' (XO) and then reduced to metal 'X' on further heating. [2]
Identify metal X and write chemical equations for the reactions that occur in the above processes.

Answer
Metal X

'X' is Mercury. (1)

Reaction involved in its extractions are:

$$2HgS + 3O_2 \xrightarrow{\Delta} 2HgO + 2SO_2$$ (0.5)

$$2HgO \xrightarrow{\Delta} 2Hg + O_2$$ (0.5)

26. The domes of many building in Europe are made of copper. These domes now appear greenish in colour. [3]
(i) Why do the domes appear greenish though copper is orange-red in colour?
(ii) In your opinion, should the copper domes be replaced by iron domes to overcome the problem of change of colour of copper domes?
(iii) Domes used to be made from thin sheets of metals. Why did the ancient architects use copper to make domes?

Answer

(i) Copper gets oxidised/corroded to basic copper carbonate and basic copper sulfate which is greenish in colour. (1)

II) No, iron will rust and the reddish layer of rust will come off exposing iron to air, the dome will not be stable. (1)

III) Copper is a highly malleable metal (1)

27.A. A student dipped an iron nail in copper sulphate solution and left it for a day. [3]
i) What observation is recorded?
ii) Write the balanced equation.
iii) Identify the reaction type and justify.

Answer

1) i) Blue solution fades, reddish-brown deposit on nail (1)

2) ii) Fe (s) + $CuSO_4$ (aq) → $FeSO_4$ (aq) + Cu (s) (1)

3) iii) Displacement reaction – Iron is more reactive and replaces copper from the solution (1)

(OR)

27.B. Balance the following chemical equations and identify the type of chemical reaction [3]

.(a) $TiCl_4$ (l) + Mg(s) → Ti(s) + $MgCl_2$ (s)

(b) HgO(s) —— (Heat) → Hg(l) + O_2(g)

(c) Na(s) + S(s) —— (Fuse) → Na_2S(s)

Answer ⇦

$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$ (0.5)

Displacement reactions. (0.5)

$2HgO \rightarrow 2Hg + O_2$ (0.5)

Thermal decomposition reaction. (0.5)

$2Na + S \rightarrow Na_2S$ (0.5)

Combination reaction. (0.5)

28. At a hospital, doctors use a white powder which, when mixed with water, sets into a hard solid mass to support fractured bones. This substance is obtained by carefully heating gypsum at 373 K.

28.A. Write its chemical name and chemical formula. [1]

Answer ⇦

Chemical name: Calcium sulphate hemihydrate (0.5)

Chemical formula: $CaSO_4 \cdot ½H_2O$ or $CaSO_4 \cdot H_2O$ (as commonly written) (0.5)

28.B. Explain why this substance must be stored in a moisture-proof container. [1]

Answer ⇦

Plaster of Paris readily absorbs moisture from the atmosphere and reacts with it to form the hard solid mass gypsum. To prevent unwanted setting, POP must be stored in a moisture-proof container. (1)

28.C. Write the balanced chemical equation for the preparation of this substance from gypsum. [2]

Answer ⇦

$$CaSO_4 \cdot 2H_2O(s) \xrightarrow{373K} CaSO_4 \cdot \frac{1}{2} H_2O(s) + \frac{3}{2} H_2O(g)$$ (2)

(OR)

28.D. Write the balanced chemical equation for the reaction that occurs when this powder is mixed with water. [2]

Answer ⇦

$$CaSO_4 \cdot \frac{1}{2} H_2O(s) + \frac{3}{2} H_2O(l) \rightarrow CaSO_4 \cdot 2H_2O(s)$$ (2)

29.A. Alkanes, Alkenes, and Alkynes are the three main classes of aliphatic hydrocarbons. [5]

i) What is meant by a homologous series? List any two characteristics of the members of such a series.

ii) Write the general formula for alkanes and alkynes.

iii) Explain why alkanes generally burn with a clean flame while alkenes and alkynes burn with a sooty flame.

Answer

i) A homologous series is a group of organic compounds having the same functional group and similar chemical properties, in which successive members differ by a $–CH_2–$ (methylene) group. (1)

All members can be represented by a single general formula / any relevant point (0.5)

Each successive member differes from the next by -Ch2 group / any relevant point (0.5)

ii) Alkanes: Cn H2n + 2 (0.5)

Alkynes: CnH2n-2 (0.5)

iii) Alkanes have a higher hydrogen-to-carbon ratio, meaning they contain more hydrogen and less carbon. → On burning, they undergo complete combustion, producing carbon dioxide and water, giving a clean (non-sooty) flame. (1)

Alkenes and Alkynes have higher carbon content and less hydrogen. → On burning, they undergo incomplete combustion, leading to the formation of unburnt carbon particles (soot), producing a sooty (yellow) flame. (1)

(OR)

29.B. i) What are soaps? Write the structure of a soap molecule. [5]

ii) Explain the cleansing action of soap with the help of a labelled diagram.

iii) Why do soaps not work well in hard water? How can we overcome this problem?

Answer ⊶

i) Soaps are sodium or potassium salts of long chain carboxylic acids. (1)

Soap molecule consists of a hydrophobic(water repelling)end and a hydrophilic (water loving)end. (1)

Diagram 1, 2 (1)

Answer ⊶

ii) Most dirt is oily in nature, oil does not dissolve in water. The ionic-end (hydrophilic) of soap interacts with water while the carbon chain(hydrophobic) interacts with oil. The soap molecules reacts with dirt, thus form structures called micelles. This forms an emulsion in water. The soap micelle thus helps in pulling out the dirt in water and we can wash our clothes clean (1)

iii) Hard water contains salts of Ca and Mg, which reacts with soap to form scum (an insoluble substance) and no foam is formed (1)

By using detergents as cleaning agents, removing hardness of water. (1)

Section C

30. An object is placed at a distance of 30 cm from the pole of a concave mirror. If its real and inverted image is formed at 60 cm in front of the mirror, the focal length of the mirror is : [1]

a) -15 cm b) - 20 cm c) + 20 cm d) + 15 cm

Answer ⊶

b) - 20 cm (1)

31. The value of 1 KWh is _____ joules. [1]

a) 36000 b) 3.6×10^6

c) 6.3×10^6 d) 3.6×10^5

Answer ⊶

b) 3.6×10^6 (1)

32. **Assertion (A):** The current is different in different components of a circuit. [1]

Reason (R): Different components offer different resistances to the flow of electric current; good conductors have low resistance, resistors have moderate resistance, and insulators have very high resistance.

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 correct but (R) is wrong
d) (A) is wrong but (R) is correct

Answer 🔑

a) Both (A) and (R) are true and (R) is the correct explanation of (A) (1)

33. Why do stars appear to twinkle, while planets do not, even though both are visible in the night sky? [2]

Answer 🔑

Stars appear to twinkle because they are very far from the Earth and behave like point sources of light. As their light passes through the turbulent atmosphere, it undergoes continuous refraction due to varying air densities. (1)

Planets, on the other hand, are closer to Earth and appear as extended sources of light. The variations in atmospheric refraction average out over their larger apparent size, so their brightness appears steady, and they do not twinkle. (1)

34.A. If refractive index of water is 1.33, then determine the speed of light in this medium, if the speed of light in vacuum is given by 3×10^8 ms^{-1} [2]

Answer 🔑

Since refractive index of water can be given by μw = Speed of light in vacuum /Speed of light in water (1)

$\Rightarrow 1.33 = 3 \times 10^8$ /Speed of light in water (1)

Speed of light in water = $\frac{3 \times 108}{1.33}$ (1)

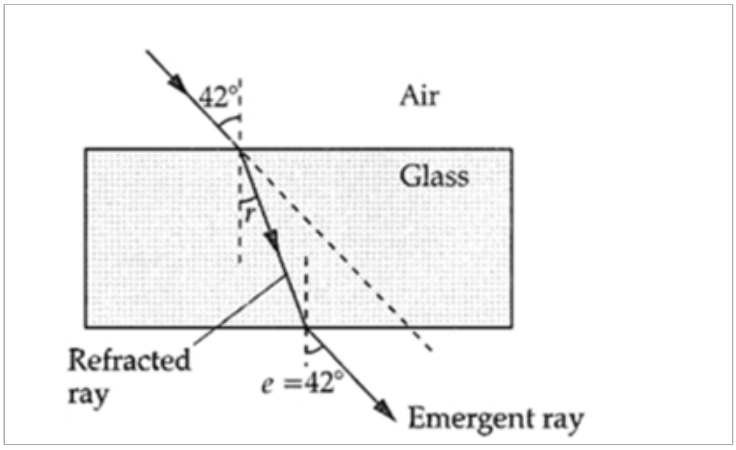
(OR)

34.B. A ray of light strikes the surface of a rectangular glass block such that the angle of incidence is [2]

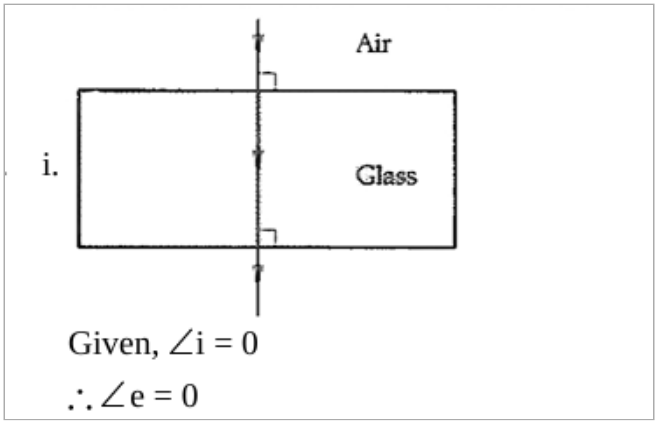
i. 0° ii. 42°

Sketch a diagram to show the approximate path taken by the ray in each case as it passes through the glass block and emerges.

Answer

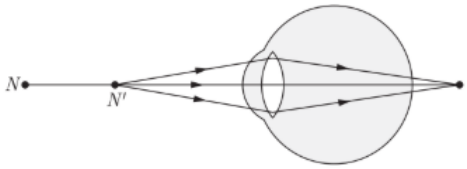


b) Given, i = 42° therfore angle e = 42° (1)



a) Given, angle i = 0 Therefore angle e = 0 (1)

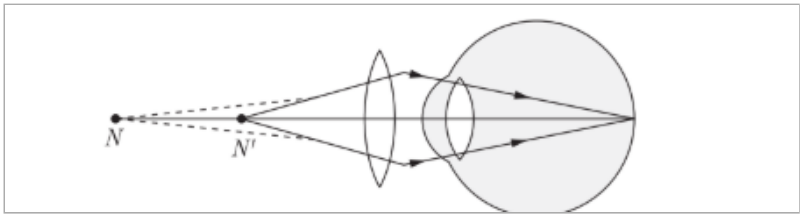
35. Study the diagram given below and answer the questions that follow: [3]



(i) Name the defect of vision represented in the diagram. Give reason for your answer.
(ii) List two causes of this defect.
(iii) With the help of a diagram show how this defect of vision is corrected.

Answer

defect is hyper-metropia because for point is situated at infinity but the near point has shifted away from D = 25 cm (1)



(iii) Convex lens of suitable focal length is required to correct this defect (1)

Answer

(ii) Causes of hypermetromia: (a) Focal length of eye lens is too long. (b) Eye ball has become too small. (1)

36. (i) Why can't two magnetic field lines cross each other? [3]
(ii) State the conclusion which can be drawn from the pattern of magnetic field lines inside the solenoid.
(iii) Name any two factors on which the magnitude of the magnetic field due to this solenoid depends.

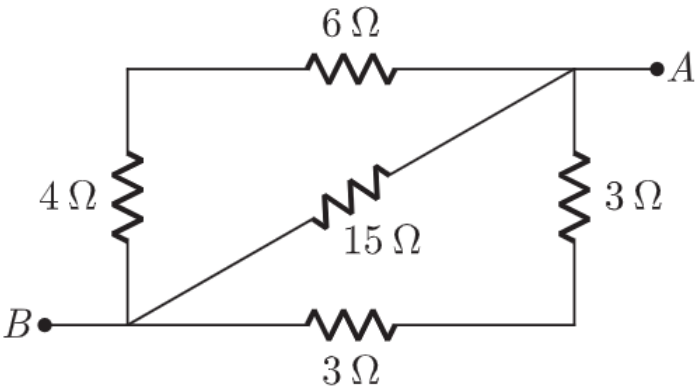
Answer

i)Two magnetic field lines can never cross each other because if they did, it would mean the magnetic field has two directions at the same point, which is impossible. (1)

ii)The magnetic field inside a long, straight solenoid is strong, uniform, and parallel, similar to that of a bar magnet. (1)

iii)Two factors affecting the magnetic field of a solenoid: Current through the solenoid. Number of turns per unit length (turns density). (1)

37. Calculate the effective resistance between A and B in the circuit given below: [3]



Answer

In the above circuit 4 ohm and 6 ohm resistance are connected in the series combination: R = 6 + 4 = 10 ohm (0.5)

and the resistance 3 ohm and 3 ohm are connected in the series combination. R = 3 + 3 = 6 ohm (0.5)

Now the circuit diagram becomes as follow

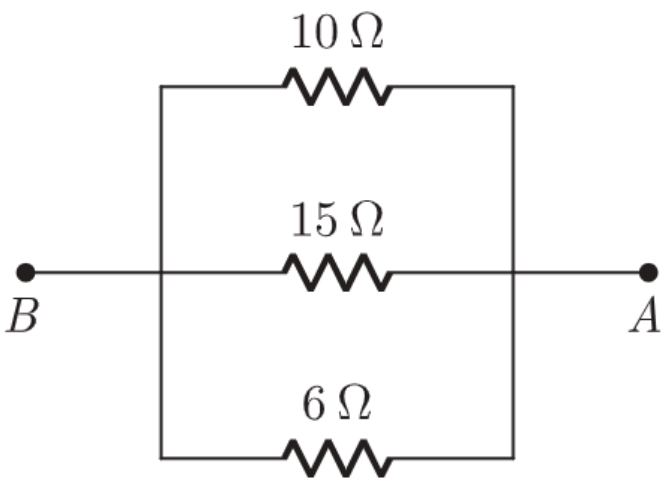


Diagram (1)

Answer

These three resistances (10 Ω, 6 Ω, and 15 Ω) are all in parallel between (2)

$$\frac{1}{R} = \frac{1}{10} + \frac{1}{6} + \frac{1}{15} = 3\ ohm.$$

38. Study the data given below showing the focal length of three concave mirrors A, B and C and the respective distances of objects placed in front of the mirrors:

Case	Mirror	Focal Length (cm)	Object Distance (cm)
1	A	20	45
2	B	15	30
3	C	30	20

38.A. In which one of the above cases the mirror will form a diminished image of the object? Justify your answer. [1]

Answer

Case-1, because the object is placed beyond the centre of curvature (u > 2f), so the concave mirror forms a diminished, real and inverted image. (1)

38.B. List any two properties of the image formed in Case-2. [1]

Answer

Real and inverted, (0.5)

Same size as the object (0.5)

Any valid response (1)

38.C. An object is placed at a distance of 18 cm from the pole of a concave mirror of focal length 12 cm. Find the position of the image formed in this case. [2]

Answer

Object distance: u=−18cm; Focal length: f=−12cm; Mirror formula: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ (1)

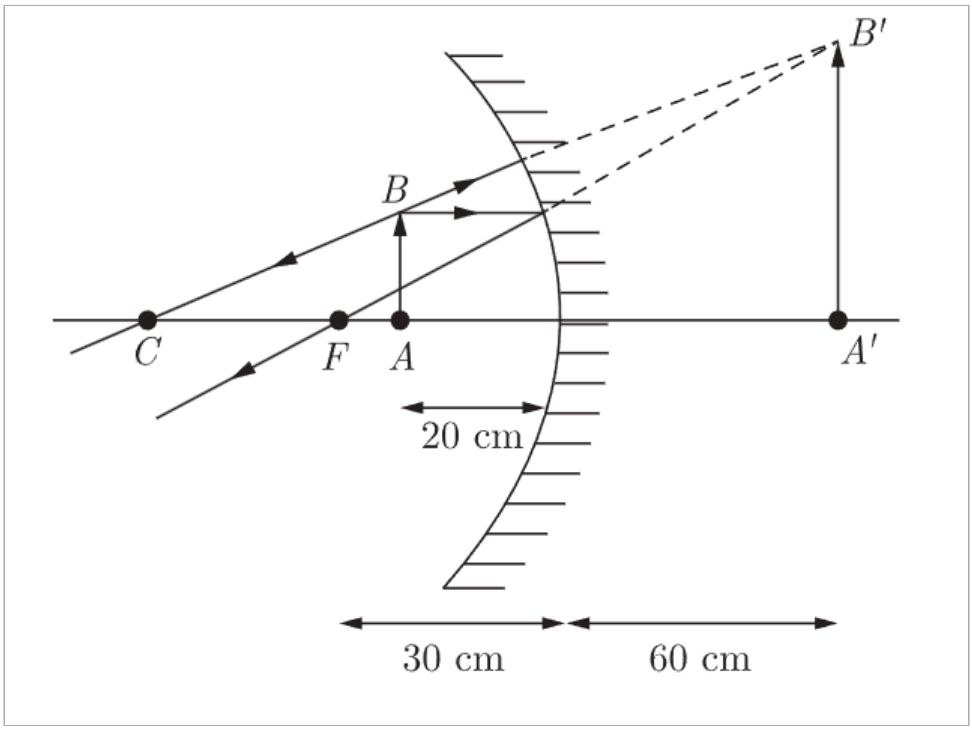
$\frac{1}{-12} = \frac{1}{v} + \frac{1}{-18}$; $\frac{1}{v} = -\frac{3}{36} + \frac{2}{36} = -\frac{1}{36}$; (1)

$v = -36\ cm$

(OR)

38.D. Case 3: An object is placed 20 cm in front of a concave mirror of focal length 30 cm. Draw a ray diagram to show the formation of the image. [2]

Answer



Ray diagram showing the formation of the image. (2)

39. A school plans to install decorative LED strips powered by a 12 V battery. The engineer recommends using four resistors of equal resistance connected in parallel to reduce

overheating.

39.A.i. Explain how the equivalent resistance of this setup helps reduce the heating of the circuit. [2]

Answer ⇦

When resistors are connected in parallel, the current in the circuit divides into separate branches instead of passing through a single path. (1)

Because the current is shared between the parallel resistors, the total resistance of the circuit becomes less than the resistance of any one resistor. A lower total resistance results in the current being distributed more evenly across the resistors, which prevents excessive heating in any one part of the circuit and keeps the overall heating effect controlled and safe. (1)

39.A.ii. Derive the expression for equivalent resistance of four identical resistors R connected in parallel. [2]

Answer ⇦

For four identical resistors connected in parallel, each resistor has resistance, R. In a parallel connection, the reciprocal of the equivalent resistance is equal to the sum of the reciprocals of individual resistances. Therefore, (1)

$$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$$

$$\frac{1}{R_p} = \frac{4}{R}\,; R_p = \frac{R}{4}$$ (1)

39.A.iii. If each resistor is 8 Ω, calculate the total resistance and the current drawn from a 12 V battery. [1]

Answer ⇦

Given each resistor has resistance R=8Ω.; $R_p = \frac{8}{4} = 2\Omega$ (0.5)

$$I = \frac{V}{R} = \frac{12}{2} = 6A$$ (0.5)

(OR)

39. A student is designing a heating device using nichrome wire for laboratory use. She has two nichrome wires of the same material:

- Wire A: Length = 1 m, diameter = 0.3 mm
- Wire B: Length = 1 m, diameter = 0.6 mm

She wants the device to reach higher temperatures faster.

39.B.i. Which wire should she choose? Why? [1]

Answer ⇦

Wire A, because it has a smaller diameter and therefore a smaller cross-sectional area, which gives it a higher resistance, and a wire (1)

with higher resistance produces more heat, allowing the device to reach higher temperatures faster.

39.B.ii. Justify your answer using the relationship between resistance and dimensions of a conductor. [2]

Answer 🔗

The resistance of a conductor depends directly on its length and inversely on its area of cross-section. Since both wires have the same material and the same length, the only factor affecting resistance is the cross-sectional area. (1)

A smaller diameter gives a smaller area of cross-section, which increases resistance. Therefore, Wire A will have greater resistance than Wire B. (1)

39.B.iii. If the resistance of Wire A at 20°C is 26 Ω, calculate the resistance of Wire B. [1]

Answer 🔗

The diameter of Wire B is double that of Wire A, so its cross-sectional area becomes four times larger because area is proportional to the square of the diameter. Since resistance is inversely proportional to area, the resistance of Wire B will be one-fourth of the resistance of Wire A. (0.5)

Given that the resistance of Wire A is 26 Ω, the resistance of Wire B is $\frac{26}{4} = 6.5\Omega$. (0.5)

39.B.iv. Explain how the chosen wire affects heat generation using Joule's law. [1]

Answer 🔗

According to Joule's law of heating, the heat produced in a conductor is directly proportional to the resistance when current flows through it. Therefore, a wire with higher resistance produces more heat for the same current, so Wire A will heat up faster and reach higher temperatures. (1)