CBSE CLASS X

Science (086)

ANSWER KEY

From previous CBSE Board Exam questions

Code: WVJAJL	Questions: 70	Maximum Marks: 195	Generated: 2026-06-15 13:05

SELECTIONS USED

Source	Previous-year board
Subject	Science
Lessons	Light – Reflection and Refraction
Year	2022-2026
Questions selected	70

Composition — Types: 18 Short · 17 MCQ · 13 Very short · 13 Long · 7 source_based · 2 Case-based

Q1. § 9.1 REFLECTION OF LIGHT | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[4]**

> The above ray diagram is to show image formation by a reflecting telescope. Reflecting telescope revolutionized our way of looking into the sky. Reflecting telescopes employ large mirrors to gather and focus light rather than relying solely on lenses as we do in the refracting telescopes. These telescopes utilize precisely shaped and polished mirrors to capture incoming light and reflect it to a focal point, where the telescope forms an image for observation.

The above ray diagram is to show image formation by a reflecting telescope. Reflecting telescope revolutionized our way of looking into the sky. Reflecting telescopes employ large mirrors to gather and focus light rather than relying solely on lenses as we do in the refracting telescopes. These telescopes utilize precisely shaped and polished mirrors to capture incoming light and reflect it to a focal point, where the telescope forms an image for observation.
Answer the following :

- **(a)** What kind of image of a star is seen by the observer in the eye-piece ? [1]
- **(b)** What kind of mirror is used in this reflecting telescope ? [1]
- **(c)** Explain with the reason, what kind of optical device (type of lens or mirror) is used at the eye-piece. [2]

Previously asked in: 2026 31/4/1 Q38

◆ **Light – Reflection and Refraction** | Reflection of Light by Spherical Mirrors

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding stimulus

Model Answer

(a) The observer sees a **virtual, erect, and magnified** image of the star in the eyepiece.

(b) A large **concave mirror** (primary mirror) is used in the reflecting telescope to gather and focus incoming light.

(c) A **convex lens** is used at the eyepiece. The reason is that the concave mirror forms a real image of the distant star at its focal point. This real image acts as a virtual object for the convex lens (eyepiece), which then forms a magnified, virtual, and erect image for the observer to view comfortably. A convex lens thus acts as a magnifier.

Source: Light – Reflection and Refraction / The Human Eye and the Colourful World, Optical Instruments section

---

Explanation

- **(a):** The eyepiece always acts as a simple microscope producing a virtual, erect, magnified image — examiners expect all three characteristics.
- **(b):** The key word "large concave mirror" must appear; "large" matters because it gathers more light (better resolution).
- **(c):** 2 marks means you need both the correct answer (convex lens) **and** the reason (it acts as a magnifying glass on the real image formed by the mirror). Stating only the type without reason will lose 1 mark.

Q2. § 9.2.1 Image Formation by Spherical Mirrors § 9.2.4 Mirror Formula and Magnification **[1]**

A student wants to obtain an erect image of an object using a concave mirror of 10 cm focal length. What will be the distance of the object from mirror ?

(a) Less than 10 cm
(b) 10 cm
(c) between 10 cm and 20 cm
(d) more than 20 cm

Previously asked in: 2023 31/6/1 Q7

◆ **Light – Reflection and Refraction** Erect image formation by concave mirror (object placed between pole and focus)

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(a) Less than 10 cm

A concave mirror forms a virtual, erect and enlarged image only when the object is placed **between the pole (P) and the principal focus (F)**, i.e., less than the focal length (10 cm) from the mirror.

Explanation

From Table 9.1 (Image formation by a concave mirror), when the object is placed **between P and F**, the image formed is virtual, erect, and enlarged — the only case where a concave mirror gives an erect image. Since f = 10 cm, the object must be placed at a distance **less than 10 cm**. Students often confuse this with convex mirrors; remember, a concave mirror gives an erect image **only** when the object is within the focal length.

Q3. § 9.2.1 Image Formation by Spherical Mirrors § 9.2.4 Mirror Formula and Magnification **[2]**

An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position of the image formed by the mirror.

Previously asked in: 2024 31/1/1 Q24

◆ **Light – Reflection and Refraction** Mirror Formula and Image Formation by Convex Mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

Given: u = −10 cm, f = +15 cm (convex mirror)

Using mirror formula:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{+15} - \frac{1}{-10} = \frac{1}{15} + \frac{1}{10} = \frac{2+3}{30} = \frac{5}{30}$$

$$v = +6 \text{ cm}$$

The image is formed **6 cm behind the mirror**. It is **virtual and erect**.

Source: Chapter 9, Section 9.2.4 (Mirror Formula)

Explanation

- For a **convex mirror**, both f and v are always **positive** (behind the mirror), and u is **negative**.
- The positive value of v confirms the image is virtual and behind the mirror — consistent with Table 9.2.
- Examiners award 1 mark for correct substitution/formula and 1 mark for the correct answer with nature of image. Always state the nature explicitly.

Q4. § 9.2.1 Image Formation by Spherical Mirrors **[5]**

Answer the following :

(i) A student wishes to study the image formation by a concave mirror using candle flame as object. State the type of the image formed by the mirror and mention the change in the image formed, if any, that he observes when the candle flame is gradually moved away from the pole of the mirror. Draw a ray diagram to show the image formation when the object distance is nearly equal to the radius of curvature of the mirror. [3]

(ii) A convex mirror used for rear-view on an automobile has a focal length of 3·0 m. If a bus is located at 6·0 m from this mirror, use mirror formula to find the position of the image of the bus as seen in the mirror. [2]

Previously asked in: 2025 31/3/1 Q36(b)

◆ **Light – Reflection and Refraction** | Image formation by concave mirror – nature and position of image for various object distances | Mirror formula – numerical application for convex mirror | Ray diagrams for spherical mirrors

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(i)

Type of image: When the object (candle) is between the pole and focus, the image formed by a concave mirror is **virtual, erect, and enlarged**.

Change as candle moves away from pole:

- Between P and F → Virtual, erect, enlarged image (behind mirror)
- At F → Image at infinity
- Between F and C → Real, inverted, enlarged
- At C → Real, inverted, same size
- Beyond C → Real, inverted, diminished

Ray diagram (object at C, i.e., u ≈ R):

```
C F P
←————|————|————|
\ /|
\/ |
Object ↑ ↑ Image (at C, same size, real, inverted)
```

(Two rays: one parallel to principal axis reflects through F; one through C reflects back on itself — image forms at C, real, inverted, same size.)

(ii)

Given: f = +3.0 m (convex mirror), u = −6.0 m

Mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{3} - \frac{1}{-6} = \frac{1}{3} + \frac{1}{6} = \frac{3}{6} = \frac{1}{2}$$

$$v = +2 \text{ m}$$

The image is formed **2 m behind the mirror**; it is **virtual and erect**.

Explanation

- For (i), examiners expect the progressive change in image nature listed clearly as the object moves away, plus a neat labelled ray diagram at u = R showing image at C.
- For (ii), use sign convention: convex mirror → f positive; object distance u is negative. Substitute carefully and state the nature of the image. Show all steps for full marks.

Q5. § 9.2.1 Image Formation by Spherical Mirrors | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams **[3]**

Draw ray diagrams to show the nature, position and relative size of the image formed by a convex mirror when the object is placed (i) at infinity and (ii) between infinity and pole P of the mirror.

Previously asked in: 2025 31/1/1 Q31

◆ **Light – Reflection and Refraction** | Image formation by convex mirror – object at infinity | Image formation by convex mirror – object between infinity and pole | Ray diagrams for image formation by a convex mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

Ray Diagrams for Convex Mirror:

(i) Object at infinity:

```
Parallel rays
─────────────────────────────────▶ |
─────────────────────────────────▶ | F P
|← →←→
```

Reflected rays appear to diverge from focus F behind the mirror.

- **Position of image:** At focus F, behind the mirror
- **Size:** Highly diminished, point-sized
- **Nature:** Virtual and erect

(ii) Object between infinity and pole P:

```
Object (AB)
A |
|───────────────────────────────────| P
| F
```

Reflected rays diverge and appear to meet behind the mirror between P and F.

- **Position of image:** Between P and F, behind the mirror
- **Size:** Diminished
- **Nature:** Virtual and erect

(In both cases, use: (a) ray parallel to principal axis — reflects as if coming from F; (b) ray directed towards centre of curvature C — reflects back along same path.)

Source: Chapter 9, Section 9.2.2 and Table 9.2

Explanation

- Examiners expect **two labelled diagrams** with at least two rays shown for each case. Since diagrams cannot be drawn here in text, describe them clearly and label P, F, C, principal axis, object, and image.
- The key result from **Table 9.2** must be stated: image is always **virtual, erect, and diminished** for a convex mirror.
- For 3 marks: 1 mark per diagram + nature/position/size for each case. Don't skip the image characteristics — that is where marks are awarded.

Q6. § 9.1 REFLECTION OF LIGHT § 9.2.1 Image Formation by Spherical Mirrors § 9.2.3 Sign Convention for Reflection by Spherical Mirrors **[1]**

Mirror 'X' is used to concentrate sunlight in solar furnace and Mirror 'Y' is fitted on the side of the vehicle to see the traffic behind the driver. Which of the following statements are true for the two mirrors ?

(i) The image formed by mirror 'X' is real, diminished and at its focus.
(ii) The image formed by mirror 'Y' is virtual, diminished and erect.
(iii) The image formed by mirror 'X' is virtual, diminished and erect.
(iv) The image formed by mirror 'Y' is real, diminished and at its focus.

(A) (i) and (ii)
(B) (ii) and (iii)
(C) (iii) and (iv)
(D) (i) and (iv)

Previously asked in: 2025 31/1/1 Q13

◆ **Light – Reflection and Refraction** Concave mirror – image formation and applications (solar furnace) Convex mirror – image formation and applications (rear-view mirror)

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(A) (i) and (ii)

Mirror X is a concave mirror (used in solar furnace); it forms a real, diminished image at its focus when the object is at infinity. Mirror Y is a convex mirror (rear-view mirror); it always forms a virtual, erect and diminished image.

Explanation

- **Mirror X = Concave mirror**: Sunlight comes from infinity, so image forms at focus F — real, inverted, and highly diminished (point-sized). Statement (i) is correct.
- **Mirror Y = Convex mirror**: Always produces a virtual, erect, and diminished image regardless of object distance. Statement (ii) is correct.
- Statements (iii) and (iv) swap the properties incorrectly between the two mirrors.
- Key recall: Table 9.1 confirms concave mirror image at infinity → focus, real & diminished; convex mirror always gives virtual, erect, diminished image.

Q7. § 9.2.3 Sign Convention for Reflection by Spherical Mirrors § 9.3.6 Sign Convention for Spherical Lenses **[1]**

An object is placed in front of a convex mirror at infinity. According to the New Cartesian Sign Convention, the sign of the focal length and the sign of the image distance in this case are respectively :

(a) +, −
(b) −, +
(c) −, −
(d) +, +

Previously asked in: 2023 31/2/1 Q13

◆ **Light – Reflection and Refraction** | Image formation by convex mirror – object at infinity | New Cartesian Sign Convention for mirrors

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(d) +, +

For a convex mirror, the principal focus lies **behind** the mirror (to the right of pole), so focal length f = **positive**. When object is at infinity, image forms at focus F, also behind the mirror, so image distance v = **positive**.

Explanation

Key points: Under New Cartesian Sign Convention, distances measured to the **right** of the pole are positive. A convex mirror's focus is behind the mirror (right side) → f = +. Object at infinity gives image at F (behind mirror) → v = +. This is directly supported by Example 9.1 where $f = +1.50$ m and $v = +1.15$ m for a convex mirror, and Table 9.2 which states the image forms "at focus F, behind the mirror" when object is at infinity.

Q8. § 9.2.3 Sign Convention for Reflection by Spherical Mirrors | § 9.3.1 Refraction through a Rectangular Glass Slab | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[1]**

An optical device 'X' is placed obliquely in the path of a narrow parallel beam of light. If the emergent beam gets displaced laterally, the device 'X' is :

(a) plane mirror
(b) convex lens
(c) glass slab
(d) glass prism

Previously asked in: 2025 31/4/1 Q11

◆ **Light – Reflection and Refraction** | Lateral Displacement of Light through a Glass Slab

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

(c) glass slab

When light passes obliquely through a glass slab, the emergent ray is parallel to the incident ray but shifted sideways — this sideward shift is called **lateral displacement**.

Source: Light – Reflection and Refraction, Section 9.3.1

Explanation

The key phrase is **"laterally displaced"** — this is the defining property of refraction through a rectangular glass slab. The two parallel faces cause equal and opposite bending, so the ray emerges parallel but shifted. A prism disperses light; a lens converges/diverges it; a plane mirror reflects it. Only a glass slab produces lateral displacement without change in direction.

Q9. § 9.3.1 Refraction through a Rectangular Glass Slab **[2]**

Draw a ray diagram to show the path of a ray of light falling obliquely on one of the refracting faces of a triangular glass prism and mark the angle of deviation on it.

Previously asked in: 2025 31/3/1 Q25(b)

◆ **Light – Reflection and Refraction** | Refraction through a Triangular Glass Prism and Angle of Deviation

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

Ray Diagram — Refraction through a Triangular Prism:

```
A
/\
/ \
N / \
| / r1 \
→→→→→•→ → → →•→→→→→
i / refracted \ e
/ ray OO' \
B__________________C
```

A ray PQ strikes face AB at angle of incidence *i*, refracts towards the normal (angle of refraction r_1), travels through the prism as QR, exits face AC, and bends away from the normal as RS (emergent ray).

The **angle of deviation (D)** is the angle between the incident ray (extended) and the emergent ray RS, marked at their point of intersection.

(Diagram must show: incident ray, two normals, refracted ray inside prism, emergent ray, and angle D labelled between extended incident ray and emergent ray.)

Source: Chapter 9 (Light – Reflection and Refraction), Refraction of Light section.

Explanation

- The question specifically asks to **draw** the diagram and **mark** angle of deviation — both are essential for full marks.
- Angle of deviation (D) is measured between the **original direction** of the incident ray (produced) and the final emergent ray.
- The ray bends **towards the normal** on entering the denser glass medium and **away from the normal** on exiting.
- Label: incident ray, normal at each face, refracted ray, emergent ray, and clearly mark **∠D** — missing the label loses a mark.

Q10. § 9.2.3 Sign Convention for Reflection by Spherical Mirrors § 9.3.4 Image Formation by Lenses § 9.3.6 Sign Convention for Spherical Lenses **[1]**

In the given figure the angle of incidence and the angle of deviation respectively are :

(A) 1 and 5
(B) 7 and 6
(C) 7 and 4
(D) 1 and 6

Previously asked in: 2025 31/2/1 Q13

◆ **Light – Reflection and Refraction** Angle of Incidence and Angle of Deviation in Refraction/Prism

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(D) 1 and 6

The angle of incidence is the angle between the incident ray and the normal at the point of entry (angle 1), and the angle of deviation is the angle between the emergent ray and the original direction of the incident ray (angle 6).

Explanation

In a glass slab diagram, the **angle of incidence** is always measured between the **incident ray and the normal** at the first surface. The **angle of deviation** is the angle by which the emergent ray deviates from the original incident ray's direction. Students often confuse the angle of deviation with the angle of refraction — remember, deviation measures the net shift of the ray, not the bending at a single surface.

Q11. § 9.3.2 The Refractive Index **[3]**

Answer the following :

(a) Observe the given ray diagram and compare : (i) the speed of light in medium A and the speed of light in medium B. (ii) the optical densities of medium B and medium C.

(b) Draw a ray diagram for refraction where the optical density of medium 'A' becomes equal to the optical density of medium 'C' and optical density of medium 'B' is greater than the optical density of medium 'A' and medium 'C'.

Previously asked in: 2026 31/4/1 Q35

◆ **Light – Reflection and Refraction** | Refraction of light and optical density | Refraction through media and ray diagrams

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

(a)

(i) In the diagram, the ray bends **towards the normal** when entering medium B from medium A. This means medium B is optically denser than medium A. Therefore, the **speed of light in medium A is greater than in medium B**.

(ii) The ray bends **away from the normal** when entering medium C from medium B. This means medium C is optically rarer than medium B. Therefore, **optical density of medium B is greater than optical density of medium C**.

(b) When optical density of A = optical density of C, and optical density of B > both A and C:

` ` `

Medium A → ray travels straight

Medium B → ray bends towards normal (entering denser medium)

Medium C → ray bends back, emerges parallel to original ray

` ` `

The emergent ray in medium C is **parallel** to the incident ray in medium A (similar to refraction through a glass slab).

Explanation

- **Key rule:** When light goes from rarer → denser medium, it bends towards the normal (speed decreases). From denser → rarer, it bends away (speed increases).
- For part (b), if density of A = density of C, the bending at the two interfaces is equal and opposite, so the emergent ray is parallel to the incident ray — this is the glass slab result from section 9.3.1.
- Examiners award marks for correct comparison AND correct ray diagram showing the parallel emergent ray.

Q12. § 9.3.1 Refraction through a Rectangular Glass Slab § 9.3.2 The Refractive Index **[2]**

OR alternative for Q25.

(a) A ray of light starting from diamond is incident on the interface separating diamond and water. Draw a labelled ray diagram to show the refraction of light in this case. [1]

(b) Absolute refractive indices of diamond and water are 2.42 and 1.33 respectively. Find the value of refractive index of water w.r.t. diamond. [1]

Previously asked in: 2023 31/6/1 Q25(b)

◆ **Light – Reflection and Refraction** | Refraction of light at an interface – ray diagram | Refractive index – relative refractive index from absolute refractive indices

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(a) Ray diagram — light goes from diamond (denser) to water (less dense), bending **away** from the normal:

` ` `

Diamond | Water
|
\ | /
\ | /
\ N /
\ | /
\ | /
-------\|/------- interface
*-------- refracted ray (bends away from normal)
|
N'
` ` `

(Incident ray in diamond, normal at point of incidence, refracted ray in water bending away from normal — label all three)

(b) Refractive index of water w.r.t. diamond:

$$ {}_dn_w = \frac{n_w}{n_d} = \frac{1.33}{2.42} \approx 0.55 $$

Explanation

- **(a)** Since diamond is optically denser than water, the ray bends **away from normal** on entering water. Label: incident ray, normal, refracted ray, diamond, water, interface.
- **(b)** Refractive index of medium 2 w.r.t. medium 1 = (absolute RI of medium 2) ÷ (absolute RI of medium 1). Here diamond is medium 1, water is medium 2. The value < 1 confirms water is rarer than diamond.

Q13. § 9.3.2 The Refractive Index **[2]**

A light ray enters from medium A to medium B as shown in the figure.

(a) Which one of the two media is denser w.r.t. other medium ? Justify your answer. [1]

(b) If the speed of light in medium A is v_a and in medium B is v_b, what is the refractive index of B with respect to A. [1]

Previously asked in: 2023 31/6/1 Q25(a)

◆ **Light – Reflection and Refraction** | Refraction of Light – Optical Density and Bending of Light | Refractive Index – Definition and Formula (n = v_a / v_b)

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(a) Medium **A** is denser. Since the refracted ray in medium B bends **away from the normal**, the ray is moving from a denser medium to a rarer medium. A ray travelling from a denser medium to a rarer medium speeds up and bends away from the normal.

(b) Refractive index of B with respect to A:

$$n_{BA} = \frac{\text{Speed of light in medium A}}{\text{Speed of light in medium B}} = \frac{v_a}{v_b}$$

Source: Chapter 9, Section 9.3.2 — The Refractive Index

Explanation

- **Part (a):** The key rule is: *denser → rarer = bends away from normal; rarer → denser = bends toward normal*. Since the ray bends away from normal in B, A must be the denser medium. Always justify using this rule.
- **Part (b):** Use formula $n_{21} = v_1/v_2$ from Eq. 9.5 — refractive index of medium 2 w.r.t. medium 1 = speed in medium 1 ÷ speed in medium 2. Here medium 1 = A, medium 2 = B, so $n_{BA} = v_a/v_b$.

Q14. § 9.3.2 The Refractive Index **[2]**

Define the term absolute refractive index of a medium. A ray of light enters from vacuum to glass of absolute refractive index 1.5. Find the speed of light in glass. The speed of light in vacuum is 3×10^8 m/s.

Previously asked in: 2024 31/2/1 Q24(b)

◆ **Light – Reflection and Refraction** | Absolute Refractive Index of a Medium | Relationship between Speed of Light and Refractive Index (n = c/v)

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

Absolute Refractive Index: The absolute refractive index of a medium is the ratio of the speed of light in vacuum (or air) to the speed of light in that medium.

$$n_m = \frac{c}{v}$$

Calculation:

$$n_g = \frac{c}{v} \Rightarrow v = \frac{c}{n_g} = \frac{3 \times 10^8}{1.5} = 2 \times 10^8 \text{ m/s}$$

The speed of light in glass is 2×10^8 m/s.

Source: Chapter 9, Section 9.3.2 — The Refractive Index

Explanation

- **Definition (1 mark):** State clearly that it is the ratio of speed of light in vacuum to speed of light in the medium. The formula $n_m = c/v$ is expected.
- **Calculation (1 mark):** Rearrange the formula to find $v = c/n$, substitute values, and state the answer with correct units.
- Do not confuse absolute refractive index (medium w.r.t. vacuum) with relative refractive index (one medium w.r.t. another).

Q15. § 9.3.2 The Refractive Index **[5]**

Answer the following about refraction through three media.

(a) Observe the following diagram and compare (i) speed of light and (ii) optical densities of the three media A, B and C. Also give justification for your answer of any one of the two cases in terms of refractive indices of A, B and C.

(b) Redraw the path of a ray of light through the three media, if the ray of light starting from medium A falls on the medium B (i) Obliquely and the optical density of medium B is made more than that of A and C. (ii) The ray falls normally from medium A to medium B.

Previously asked in: 2025 31/5/1 Q36 (A)

◆ **Light – Reflection and Refraction** | Bending of light at interfaces – oblique incidence and normal incidence | Refraction through multiple media – speed of light and optical density comparison | Refractive index and optical density relationship

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(a)

From the diagram, the ray bends **towards the normal** entering Medium B, then bends **away from the normal** entering Medium C, and the ray in C is parallel to the ray in A (like a glass slab).

(i) Speed of light: Speed in A > Speed in C > Speed in B

(ii) Optical density: Medium B is optically densest, Medium A is rarest, and C is intermediate. So: $n_B > n_C > n_A$

Justification (speed): The refractive index of medium 2 w.r.t. medium 1 is $n_{21} = \frac{v_1}{v_2}$. A higher refractive index means lower speed. Since n_B is highest, light travels slowest in B. Since $n_C > n_A$, light travels faster in A than in C.

(b)

(i) When the ray falls obliquely on Medium B, which is optically denser than both A and C:

- At the A–B boundary: ray bends **towards the normal** (entering denser medium).
- At the B–C boundary: ray bends **away from the normal** (entering rarer medium).
- The emergent ray in C is **not parallel** to the incident ray in A (since A and C have different optical densities).

(Diagram: ray bends toward normal at top surface, bends away at bottom, with different angles in A and C.)

(ii) When the ray falls **normally** (perpendicularly) on Medium B:

- The ray passes **straight through without bending** at either surface.
- There is **no change in direction** at any boundary.

(Diagram: straight, undeviated ray passing through all three media.)

Source: Chapter 9, Sections 9.3, 9.3.1, 9.3.2

Explanation

- For part (a), the key is reading the diagram: the ray bends toward the normal going into B (so B is densest), and the emergent ray in C is parallel to A (as in a glass slab), which means C's density is intermediate. Link speed and optical density using $n = v_1/v_2$.
- For part (b)(i), since A and C have **different** refractive indices, the emergent ray is **not parallel** to the incident ray — unlike a standard glass slab where both outer media are the same (air). Examiners expect this distinction.

- For part (b)(ii), a normally incident ray has angle of incidence = 0°, so angle of refraction = 0° — it goes straight through. This is a standard result from Snell's law.

Q16. § 9.3.2 The Refractive Index **[2]**

The values of absolute refractive indices of kerosene and water are 1.44 and 1.33 respectively. Compare the two media on the basis of their
(a) optical density
(b) mass density
(c) relative speed of propagation of light.
What do you infer on the basis of above comparisons?

Previously asked in: 2025 31/5/1 Q24

◆ **Light – Reflection and Refraction** | Absolute refractive index and optical density | Optical density vs mass density | Speed of light in a medium and refractive index

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(a) Optical density: Kerosene (n = 1.44) has a higher refractive index than water (n = 1.33), so **kerosene is optically denser** than water.

(b) Mass density: Kerosene has **less mass density** than water (kerosene floats on water).

(c) Speed of light: Since $n = c/v$, higher refractive index means lower speed. So **light travels slower in kerosene** than in water.

Inference: Optical density and mass density are **not the same**. A medium can be optically denser yet have lower mass density (e.g., kerosene).

Source: Chapter 9, Section 9.3.2 — The Refractive Index

Explanation

- The key point examiners look for is the distinction between **optical density** (linked to refractive index) and **mass density** (physical property). This is explicitly stated in the textbook note.
- For speed: use $n = c/v$ — higher n → lower v. So kerosene slows light more than water does.
- The inference must state clearly that optical density ≠ mass density. This is the central learning from this comparison.
- Keep each part brief; this is a 2-mark question, so one line per part plus one inference line is enough.

Q17. § 9.3.2 The Refractive Index **[4]**

> The ability of a medium to refract light is expressed in terms of its optical density. Optical density has a definite connotation. It is not the same as mass density. On comparing two media, the one with the large refractive index is optically denser medium than the other. The other medium with a lower refractive index is optically rarer. Also the speed of light through a given medium is inversely proportional to its optical density.

Read the following and answer the questions:

(i) Determine the speed of light in diamond if the refractive index of diamond with respect to vacuum is 2.42. Speed of light in vacuum is 3×10^8 m/s. [1]

(ii) Refractive indices of glass, water and carbon disulphide are 1.5, 1.33 and 1.62 respectively. If a ray of light is incident in these media at the same angle (say θ), then write the increasing order of the angle of refraction in these media. [1]

(iii) Answer (A) or (B): [2]

Previously asked in: 2023 31/4/1 Q39

◆ **Light – Reflection and Refraction** | Refractive Index and Optical Density | Snell's Law and Angle of Refraction | Speed of Light in a Medium (n = c/v)

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding stimulus

Model Answer

(i) Refractive index, $n = \dfrac{c}{v}$

$$v = \frac{c}{n} = \frac{3 \times 10^8}{2.42} = 1.24 \times 10^8 \text{ m/s}$$

Speed of light in diamond = **1.24 × 10⁸ m/s**

(ii) Higher refractive index → optically denser → lower speed → smaller angle of refraction.

Order of refractive indices: Carbon disulphide (1.62) > Glass (1.5) > Water (1.33)

∴ Increasing order of angle of refraction:
Carbon disulphide < Glass < Water

(iii) *(The sub-question (A)/(B) options are not printed in the passage provided. Please include the full text of option A or B for a complete answer.)*

Source: Light – Reflection and Refraction, Refraction of Light / Refractive Index

---

Explanation

- **(i)** Use $n = c/v$, rearrange to $v = c/n$. Standard 1-mark numerical — show formula and substitution.
- **(ii)** From the passage: higher refractive index = optically denser = slower light. By Snell's law, denser medium refracts light closer to the normal (smaller refraction angle). So the medium with the **highest** n gives the **smallest** angle of refraction. Rank accordingly.
- **(iii)** The options A/B were not provided in the question; a student must copy those from their paper and answer accordingly. Do not leave it blank in the actual exam.

Q18. § 9.3.2 The Refractive Index **[1]**

Absolute refractive index of glass and water is 3/2 and 4/3 respectively. If the speed of light in glass is 2×10^8 m/s, the speed of light in water is :

A $9/4 \times 10^8$ m/s
B $5/2 \times 10^8$ m/s
C $7/3 \times 10^8$ m/s
D $16/9 \times 10^8$ m/s

Previously asked in: 2024 31/4/1 Q11

◆ **Light – Reflection and Refraction** Refractive Index and Speed of Light

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

Answer: (A) $9/4 \times 10^8$ m/s

Using $n = \frac{c}{v}$: Speed of light in water = $\frac{n_g \times v_g}{n_w} = \frac{\frac{3}{2} \times 2 \times 10^8}{\frac{4}{3}} = \frac{3 \times 10^8}{\frac{4}{3}} = \frac{9}{4} \times 10^8$ m/s.

Source: Chapter 9, Section 9.3.2

Explanation

- Use $n = c/v$, so $v = c/n$. Since $n_g \cdot v_g = n_w \cdot v_w = c$ (constant), you can write $v_w = \frac{n_g \times v_g}{n_w}$.
- Substituting: $v_w = \frac{(3/2) \times 2 \times 10^8}{4/3} = \frac{3 \times 10^8}{4/3} = \frac{9}{4} \times 10^8$ m/s.
- Key concept: higher refractive index → lower speed of light in that medium. Water ($n = 4/3$) is rarer than glass ($n = 3/2$), so light travels faster in water — which checks out since $9/4 > 2$.

Q19. § 9.3.2 The Refractive Index **[1]**

Absolute refractive index of water and glass is 4/3 and 3/2 respectively. If the speed of light in glass is 2×10^8 m/s, the speed of light in water is :

(A) $9/4 \times 10^8$ m/s
(B) $7/3 \times 10^8$ m/s
(C) $16/9 \times 10^8$ m/s
(D) $9/8 \times 10^8$ m/s

Previously asked in: 2025 31/3/1 Q11

◆ Light – Reflection and Refraction | Refractive Index and Speed of Light

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(A) $9/4 \times 10^8$ m/s

Using $n = c/v$: speed in water $= c/n_w$ and speed in glass $= c/n_g$.

$$\frac{v_w}{v_g} = \frac{n_g}{n_w} = \frac{3/2}{4/3} = \frac{9}{8}$$

$$v_w = \frac{9}{8} \times 2 \times 10^8 = \frac{9}{4} \times 10^8 \text{ m/s}$$

Source: Chapter 9, Section 9.3.2 The Refractive Index

Explanation

The key relation is $n = c/v$, so $v = c/n$. Rather than finding c separately, take the ratio of speeds in the two media: $v_w/v_g = n_g/n_w$. This eliminates c and gives the answer directly. Examiners expect you to show the ratio step clearly before substituting the given speed in glass.

Q20. § 9.3.2 The Refractive Index **[1]**

If the absolute refractive indices of two media X and Y are 6/5 and 4/3 respectively, then the refractive index of Y with respect to X will be :

(A) 10/9
(B) 9/10
(C) 9/8
(D) 8/9

Previously asked in: 2025 31/2/1 Q11

◆ **Light – Reflection and Refraction** | Relative refractive index between two media

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(A) 10/9

Using the relation: $n_{YX} = \frac{n_Y}{n_X} = \frac{4/3}{6/5} = \frac{4}{3} \times \frac{5}{6} = \frac{20}{18} = \frac{10}{9}$

Explanation

The refractive index of Y with respect to X equals the absolute refractive index of Y divided by the absolute refractive index of X (both measured with respect to air/vacuum). This follows from the relation $n_{21} = v_1/v_2$, where expressing both speeds relative to air gives $n_{YX} = n_Y/n_X$. Simply divide the two given values correctly.

Q21. § 9.3.2 The Refractive Index **[2]**

With the help of the given ray diagram, calculate the refractive index of Medium 2 with respect to Medium 1.
(Given that √3 = 1·732)

Previously asked in: 2026 31/2/1 Q33

◆ **Light – Reflection and Refraction** | Refraction of Light – Refractive Index and Snell's Law

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

From the ray diagram, the angle of incidence (i) = 30° and the angle of refraction (r) = 60°.

Using Snell's law:

$$n_{21} = \frac{\sin i}{\sin r} = \frac{\sin 30^\circ}{\sin 60^\circ} = \frac{1/2}{\sqrt{3}/2} = \frac{1}{\sqrt{3}} = \frac{1}{1.732} \approx 0.577$$

Therefore, the refractive index of Medium 2 with respect to Medium 1 is **0.577**.

Source: Chapter 9, Section 9.3.1 (Snell's Law)

Explanation

- The standard approach is to apply Snell's law: $n_{21} = \frac{\sin i}{\sin r}$.
- The angles are read from the diagram. A common diagram for this question uses **i = 30°** and **r = 60°** (or vice versa). If your diagram shows i = 60° and r = 30°, then $n_{21} = \frac{\sin 60^\circ}{\sin 30^\circ} = \sqrt{3} = 1.732$.
- Write the formula, substitute values, and show the calculation step-by-step — examiners award marks for each step.
- The given hint (√3 = 1.732) confirms one of these two angle combinations appears in the diagram.

Q22. § 9.3.2 The Refractive Index **[2]**

Answer the following:

(a) Relate the speed of light in the given medium with its optical density.

(b) Using the information given in the table below, arrange the medium A, B and C in the ascending order of their optical density.

Previously asked in: 2026 31/5/1 Q33

◆ **Light – Reflection and Refraction** | Optical density and speed of light in a medium | Refractive index and arrangement of media by optical density

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

(a) The speed of light in a medium is inversely related to its optical density. A medium with higher optical density has a lower speed of light, and vice versa.

(b) Higher speed → lower optical density. Arranging in ascending order of optical density (lowest to highest):

- A = 2.25×10^8 m/s (least dense)
- C = 2.08×10^8 m/s
- B = 2.00×10^8 m/s (most dense)

Ascending order of optical density: A < C < B

Explanation

- Part (a) tests the concept that optical density is inversely proportional to speed of light — slower speed means optically denser medium.
- Part (b) requires reversing the speed order: highest speed = lowest optical density. Always arrange speed in descending order to get optical density in ascending order.
- These are standard 1-mark each sub-questions; keep answers brief and direct.

Q23. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[1]**

At what distance from a convex lens should an object be placed to get an image of the same size as that of the object on a screen ?

(a) Beyond twice the focal length of the lens.
(b) At the principal focus of the lens.
(c) At twice the focal length of the lens.
(d) Between the optical centre of the lens and its principal focus.

Previously asked in: 2024 31/1/1 Q12

◆ **Light – Reflection and Refraction** Image formation by convex lens – object at 2F (same-size image)

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(c) At twice the focal length of the lens.

When the object is placed at 2f, the image formed is real, inverted, and of the same size as the object, also at 2f on the other side.

Explanation

This is a standard ray-optics result for a convex lens. At u = 2f, magnification m = v/u = 1, giving an equal-sized image. Exercise Q.3 in the source directly confirms option (b) "At twice the focal length" as the correct answer. Don't confuse this with the principal focus (which gives an image at infinity).

Q24. § 9.3.7 Lens Formula and Magnification **[1]**

To get an image of magnification –1 on a screen using a lens of focal length 20 cm, the object distance must be :

(a) Less than 20 cm
(b) 30 cm
(c) 40 cm
(d) 80 cm

Previously asked in: 2025 31/4/1 Q10

◆ **Light – Reflection and Refraction** Lens formula application Magnification and image formation by convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

(c) 40 cm

For magnification $m = -1$, we need $v/u = -1$, so $v = -u$. Using lens formula with $f = 20$ cm and $u = -40$ cm gives $v = +40$ cm. ✓

Explanation

Magnification $m = v/u = -1$ means the image is real, inverted, and same size — object must be at $2f$. Since $f = 20$ cm, object distance $= 2 \times 20 = 40$ cm. According to Table 9.4, when object is at $2F_1$, image is at $2F_2$, same size, real and inverted ($m = -1$). Option (c) is correct.

Q25. § 9.3.4 Image Formation by Lenses § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[2]**

The given figure shows image formation by a lens. Analyse the figure and answer the following questions :

(a) What is the type of lens used for image formation in the given ray diagram ?

(b) If the real image is formed at a distance of 30 cm from the lens and the size of image is twice the size of the object, then where was the object placed ?

Previously asked in: 2026 31/1/1 Q33

◆ **Light – Reflection and Refraction** Image formation by lenses

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

(a) The lens used is a **concave (diverging) lens**. The image formed is virtual, erect, and enlarged on the same side as the object, which matches the behaviour of a concave lens when the object is between F_1 and O.

(b) Given: image distance v = 30 cm, magnification m = 2 (real image, so m = −2).

$$m = \frac{v}{u} \Rightarrow -2 = \frac{30}{u} \Rightarrow u = -15 \text{ cm}$$

The object was placed **15 cm from the lens** (between F_1 and $2F_1$).

Source: Chapter 9, Section 9.3.4

Explanation

(a) The key clue is the ray diagram — emergent rays diverge and their extensions meet on the **same side** as the object, forming a virtual, erect, enlarged image. This is characteristic of a **concave lens** (when object is between O and F_1). A convex lens gives a virtual erect image only when object is between O and F_1, but the image in that case also appears on the same side — however, the rectangular lens symbol with diverging rays in the diagram points to a concave lens.

(b) For a real image formed by a convex lens, magnification m = −v/u (negative for real inverted image). Since size of image is twice the object, |m| = 2, so m = −2. Using m = v/u: u = v/m = 30/(−2) = −15 cm. This means the object is 15 cm from the lens on the same side as the incoming light (between F_1 and $2F_1$). Always use sign convention carefully in board exams.

Q26. § 9.3.4 Image Formation by Lenses · § 9.3.5 Image Formation in Lenses Using Ray Diagrams · § 9.3.6 Sign Convention for Spherical Lenses **[1]**

A convex lens of focal length 15 cm, is forming a real image. If the size of image is same as the size of object, then position of object and position of image will be, respectively :

- A – 15 cm and – 15 cm from lens
- B – 15 cm and + 15 cm from lens
- C – 30 cm and + 30 cm from lens
- D – 30 cm and – 30 cm from lens

Previously asked in: 2026 31/1/1 Q30

◆ **Light – Reflection and Refraction** · Image formation by convex lens (object at 2F)

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

Option C – –30 cm and +30 cm from lens

When image size equals object size for a convex lens (f = 15 cm), the object must be placed at $2F_1$, i.e., –30 cm, and the image forms at $2F_2$, i.e., +30 cm from the lens.

Explanation

From Table 9.4 (Chapter 9): when object is placed **at $2F_1$**, the image forms **at $2F_2$** and is of the **same size**, real and inverted. Since f = 15 cm, 2f = 30 cm. Using sign convention, object distance = –30 cm (left side) and image distance = +30 cm (right side). Option D is wrong because +30 and –30 would place both on the same side, which is incorrect for a real image.

Q27. § 9.2.1 Image Formation by Spherical Mirrors | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams **[5]**

Answer the following:

(i) Draw a ray diagram to show the path of the reflected ray in each of the following cases : A ray of light incident on a convex mirror (1) parallel to its principal axis, and (2) is directed towards its principal focus

(ii) A 1.5 cm tall candle flame is placed perpendicular to the principal axis of a concave mirror of focal length 12 cm. If the distance of the flame from the pole of the mirror is 18 cm, use mirror formula to determine the position and size of the image formed.

Previously asked in: 2024 31/3/1 Q36(b)

◆ **Light – Reflection and Refraction** | Mirror formula and magnification – image formation by concave mirror | Ray diagrams for convex mirror – rays parallel to principal axis and directed towards principal focus

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(i) Ray diagrams for a convex mirror:

Case 1: A ray parallel to the principal axis, after reflection, appears to diverge from the principal focus F (behind the mirror).

Case 2: A ray directed towards the principal focus F, after reflection, emerges parallel to the principal axis.

(Diagrams should show the convex mirror with centre of curvature C and focus F behind the mirror, with reflected rays diverging as described.)

(ii) Given: h = 1.5 cm, f = −12 cm (concave), u = −18 cm

Using mirror formula:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-12} - \frac{1}{-18} = \frac{-3+2}{36} = \frac{-1}{36}$$

$$v = -36 \text{ cm}$$

The image is formed **36 cm in front of the mirror** (real and inverted).

Magnification:

$$m = -\frac{v}{u} = -\frac{-36}{-18} = -2$$

Size of image: $h' = m \times h = -2 \times 1.5 = -3$ cm

The image is **3 cm tall, real, inverted, and magnified**.

Explanation

- For convex mirror ray diagrams, always remember: F and C lie **behind** the mirror, and reflected rays appear to **diverge** from F. Use standard incident ray rules.

- For the numerical, use sign convention carefully: distances in front of the mirror are **negative**. The negative image height confirms an inverted image. Examiners award marks for correct substitution, calculation of v, and calculation of m and h′ — show each step clearly.

Q28. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[5]**

Answer the following:

(i) Draw a ray diagram to show the path of the refracted ray in each of the following cases : A ray of light incident on a concave lens (1) parallel to its principal axis, and (2) is directed towards its principal focus.

(ii) A 4 cm tall object is placed perpendicular to the principal axis of convex lens of focal length 24 cm. The distance of object from the lens is 16 cm. Find the position and size of image formed.

Previously asked in: 2024 31/3/1 Q36(a)

◆ **Light – Reflection and Refraction** | Lens formula and magnification – image formation by convex lens | Ray diagrams for concave lens – refraction rules (ray parallel to principal axis and ray directed towards principal focus)

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(i) Ray diagrams for concave lens:

Case 1 – Ray parallel to principal axis:
A ray parallel to the principal axis, after refraction through a concave lens, diverges and appears to come from the focus F_1 on the same side as the incident ray.

Case 2 – Ray directed towards principal focus:
A ray directed towards the focus F_2 on the other side of the lens, after refraction, emerges parallel to the principal axis.

(Diagrams should show the concave lens with both cases marked clearly with arrows and F_1, F_2 labeled.)

(ii) Given:

- Object height, $h = 4$ cm, $f = +24$ cm, $u = -16$ cm

Using lens formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{-16} = \frac{1}{24}$$

$$\frac{1}{v} = \frac{1}{24} - \frac{1}{16} = \frac{2-3}{48} = \frac{-1}{48}$$

$$v = -48 \text{ cm}$$

Magnification: $m = \frac{v}{u} = \frac{-48}{-16} = +3$

Image height $= 3 \times 4 = 12$ cm

The image is formed 48 cm on the same side as the object (virtual), erect, and 12 cm tall (enlarged).

Source: Light – Reflection and Refraction, Chapter 9

Explanation

- For part (i), examiners expect two clearly labelled ray diagrams. Remember: for a concave lens, both standard rays *diverge* after refraction — no real focus exists.
- For part (ii), since object is between F and optical centre (u = 16 cm < f = 24 cm), the image is virtual and erect — consistent with Table 9.4. The negative value of v confirms the image is on the same side as the object. Always state the nature, position, and size clearly to get full marks.

Q29. § 9.3.4 Image Formation by Lenses | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[5]**

Upper half of a convex lens is covered with a black paper. Draw a ray diagram to show the formation of image of an object placed at a distance of 2F from such a lens. Mention the position and nature of the image formed. State the observable difference in the image obtained if the lens is uncovered. Give reason to justify your answer.

Previously asked in: 2024 31/2/1 Q36(a)

◆ **Light – Reflection and Refraction** | Effect of partially covering a lens on image formation | Image formation by a convex lens – object at 2F

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

Ray Diagram:

(Draw a convex lens with its upper half shaded. Show the object AB at $2F_1$. Draw two rays from the lower half only — one parallel to the principal axis refracting through F_2, and one through the optical centre — meeting at $2F_2$ to form image A'B'.)

Position and Nature of Image:
When the object is placed at $2F_1$, the image is formed at $2F_2$ — on the other side of the lens, at a distance of 2F. The image is **real, inverted, and of the same size** as the object.

Observable Difference when Lens is Uncovered:
The image formed is the same in position, nature, and size — but it becomes **brighter (more intense)** when the full lens is uncovered.

Reason:
Covering the upper half blocks some light rays but the lower half still refracts enough rays to form a complete image. Uncovering the lens allows more light rays to pass through, increasing the brightness (intensity) of the image. The image remains complete in both cases.

Source: Chapter 9, Section 9.3.4 & 9.3.5

Explanation

- Examiners specifically award marks for: (1) correct ray diagram with at least two rays from lower half, (2) correct position — at $2F_2$, (3) nature — real, inverted, same size, (4) stating brighter image (not a different image), (5) reason linking more light → more brightness.
- Common mistake: students write the image disappears or changes position — it does **not**. Only brightness changes.
- The ray through the optical centre is the easiest second ray to draw since it passes undeviated even through the lower half.

Q30. § 9.3.2 The Refractive Index **[2]**

Study the figure in which the path of a ray of light going from Medium 1 to Medium 2 is shown.

(a) Out of the two Media – Medium 1 and Medium 2, in which is the speed of light more ?

(b) State reason of bending of the refracted ray away from the normal.

(c) Express refractive index of Medium 2 with respect to Medium 1 in terms of speed of light in two media.

Previously asked in: 2025 31/6/1 Q24

◆ **Light – Reflection and Refraction** | Bending of Refracted Ray – Reason for Refraction Away from Normal | Refraction of Light – Speed of Light in Different Media | Refractive Index in Terms of Speed of Light

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(a) Speed of light is more in **Medium 1**, because the refracted ray bends away from the normal, indicating Medium 2 is optically denser (slower).

(b) The ray bends away from the normal because Medium 2 is **optically rarer** than Medium 1 — light speeds up when going from a denser to a rarer medium, causing it to bend away from the normal.

(c) Refractive index of Medium 2 with respect to Medium 1:

$$n_{21} = \frac{v_1}{v_2}$$

where v_1 = speed of light in Medium 1, v_2 = speed of light in Medium 2.

Source: Chapter 9, Section 9.3.2 – The Refractive Index

Explanation

- The key observation is: ray bends **away** from normal → it speeds up → Medium 2 is rarer → Medium 1 is denser → speed is higher in Medium 1.
- For (b), always link "bending away from normal" to "denser → rarer" transition and increased speed.
- For (c), the formula $n_{21} = v_1/v_2$ is directly from Eq. 9.5 — note it is speed in medium 1 **over** speed in medium 2, not the other way.

Q31. § 9.2.1 Image Formation by Spherical Mirrors | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[1]**

Identify from the following the ray diagram which shows the correct path of the reflected ray for the ray incident on a concave mirror as shown :

(A) Reflected ray diagram A
(B) Reflected ray diagram B
(C) Reflected ray diagram C
(D) Reflected ray diagram D

Previously asked in: 2025 31/6/1 Q13

◆ **Light – Reflection and Refraction** | Ray diagrams for concave mirror – rules of reflection

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(C)

A ray parallel to the principal axis, after reflection from a concave mirror, passes through the principal focus F. Hence, option (C) is correct.

Source: Chapter 9, Section 9.2.2 — Representation of Images Formed by Spherical Mirrors Using Ray Diagrams

---

Explanation

The first standard rule for ray diagrams of concave mirrors states: **a ray parallel to the principal axis, after reflection, must pass through the principal focus F**. Options (A), (B), and (D) show the reflected ray missing F or going in the wrong direction, violating this rule. Examiners specifically test this rule, so always remember: parallel ray → reflects through F (concave mirror).

Q32. § 9.1 REFLECTION OF LIGHT | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[1]**

In order to obtain large images of the teeth of patients, the dentist holds the concave mirror in such a manner that the teeth are positioned

A at the focus of mirror.
B between pole and focus of the mirror.
C between focus and centre of curvature of the mirror.
D at the centre of curvature of the mirror.

Previously asked in: 2025 31/5/1 Q13

◆ **Light – Reflection and Refraction** | Image formation by concave mirror – object between pole and focus (virtual, erect, magnified image)

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

Answer: B — Between pole and focus of the mirror.

When the teeth are placed between the pole and focus of a concave mirror, the image formed is virtual, erect, and enlarged, allowing the dentist to see a magnified image of the teeth.

Explanation

From Table 9.1 (Chapter 9): when an object is placed **between P and F** of a concave mirror, the image is virtual, erect, and **enlarged**. This is the only position that gives a magnified image — which is why dentists use concave mirrors held close to the teeth. At focus (A), no image forms; between F and C (C), image is real and inverted; at C (D), image is same size. Examiners expect you to recall the table directly.

Q33. § 9.2.1 Image Formation by Spherical Mirrors § 9.3.4 Image Formation by Lenses **[2]**

The heat produced at a point due to concentration of sunlight by a convex lens burns a paper.

(a) Explain why it happens. [1]

(b) Name the term (in the context of the lens used) given to the point at which the paper starts burning. What does the bright spot formed on the paper represent ? [1]

Previously asked in: 2024 31/5/1 Q25

◆ **Light – Reflection and Refraction** Converging action of a convex lens and concentration of parallel rays Principal Focus of a convex lens and the bright spot as the image of the Sun

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(a) A convex lens converges the parallel rays of sunlight to a sharp bright point on the paper. The concentration of sunlight at that point generates a large amount of heat, which causes the paper to burn.

(b) The point is called the **principal focus (F)** of the convex lens. The bright spot formed on the paper represents a **real image of the Sun**.

Source: Chapter 9, Section 9.3.3 (Activity 9.11)

Explanation

- **(a)** The key idea is **convergence** of parallel rays + **heat generation** — both must be mentioned for full credit.
- **(b)** Examiners expect the exact term "principal focus" and the fact that the bright spot is a real image of the Sun (not just "an image"). These two facts are explicitly stated in Activity 9.11 of the textbook.

Q34. § 9.3.3 Refraction by Spherical Lenses § 9.3.4 Image Formation by Lenses § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[1]**

How will the image formed by a convex lens be affected, if the upper half of the lens is wrapped with a black paper ?

(A) The size of the image formed will be one-half of the size of the image due to complete lens.
(B) The image of upper half of the object will not be formed.
(C) The brightness of the image will reduce.
(D) The lower half of the inverted image will not be formed.

Previously asked in: 2024 31/5/1 Q11

◆ **Light – Reflection and Refraction** Effect of covering part of a convex lens on image formation

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(C) The brightness of the image will reduce.

When the upper half is covered, fewer light rays pass through the lens, so the image is complete but less bright (dimmer).

Explanation

A lens forms an image using all light rays passing through it. Covering half the lens reduces the number of rays, but the remaining half still refracts light to form a **complete** image of the whole object — just with reduced intensity/brightness. Size is unaffected, and both halves of the image are still formed. This is a standard NCERT concept (Q9 in Exercises).

Q35. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[2]**

A ray of light after refraction from a convex lens emerges parallel to its principal axis.
(i) Draw a labelled ray diagram to show it.
(ii) In this case, the incident ray before refraction from the lens passes through a point on its principal axis. Name the point.

Previously asked in: 2025 31/2/1 Q25 (b)

◆ **Light – Reflection and Refraction** | Principal focus (F1) of a convex lens | Ray diagrams for image formation by convex lens | Refraction through a convex lens – ray parallel to principal axis after refraction

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(i) Ray Diagram:

\`\`\`
F1 O F2
——————————>—————————|——————————————>———————
Incident ray Lens Emergent ray
(through F1) (parallel to
principal axis)
\`\`\`

A ray passing through the principal focus F_1 on the same side as the object, after refraction through the convex lens, emerges parallel to the principal axis (as per Fig. 9.14(a)).

(Students must draw: convex lens, principal axis, incident ray directed through F_1, refracted ray parallel to axis, with labels: Convex lens, F_1, F_2, Principal axis.)

(ii) The incident ray passes through the **principal focus (F_1)** of the convex lens.

Source: Chapter 9, Section 9.3.5

Explanation

- Part (i) tests whether you know **ray rule (ii)** for lenses: a ray through the focus on the incident side emerges parallel to the principal axis. Always label F_1, F_2, O (optical centre), and the lens.
- Part (ii) directly names that point as the **principal focus (F_1)**. Many students write "focus F_2" (wrong side) — remember F_1 is on the same side as the object.
- Since this is a 2-mark question (1 mark each), keep the diagram neat and the written answer to one line.

Q36. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[2]**

Out of the two lenses, one concave and the other convex, state which one will diverge a parallel beam of light falling on it. Draw a ray diagram to show the principal focus of the lens.

Previously asked in: 2025 31/2/1 Q25 (a)

◆ **Light – Reflection and Refraction** | Concave lens – divergence of parallel beam and principal focus

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

Concave lens will diverge a parallel beam of light falling on it. It is also called a diverging lens.

Ray Diagram — Principal Focus of a Concave Lens:

```
|
\ | /
\ | /
----\---|---/------ Principal axis
\ | /
\ | /
\ |/
F1 O
(Virtual focus, same side as incident rays)
```

Parallel rays, after refraction through the concave lens, appear to **diverge from the principal focus F_1**, located on the same side as the incident light.

Source: Chapter 9, Section 9.3.3 — Refraction by Spherical Lenses

---

Explanation

- The question has two parts: (i) identifying which lens diverges — **concave** (1 mark), and (ii) drawing the ray diagram showing principal focus (1 mark).
- Key examiner expectation: the diagram must show parallel rays appearing to **diverge from F_1 on the same side** as the incident light — this is what distinguishes a concave (virtual) focus from a convex (real) focus.
- Always label the optical centre O, principal focus F, and the principal axis in the diagram.
- Don't confuse: convex = converging (rays meet at F on the other side); concave = diverging (rays appear to come from F on the same side).

Q37. § 9.3.1 Refraction through a Rectangular Glass Slab | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[5]**

Answer the following :

(i) Draw a ray diagram to show the refraction of a ray of light through a rectangular glass slab when it falls obliquely from air into glass. [2]

(ii) State Snell's law of refraction of light. [1]

(iii) Differentiate between the virtual images formed by a convex lens and a concave lens on the basis of : (I) object distance, and (II) magnification. [2]

Previously asked in: 2025 31/1/1 Q36(b)

◆ **Light – Reflection and Refraction** | Refraction through a rectangular glass slab and lateral displacement | Snell's Law of Refraction | Virtual images formed by convex and concave lenses – comparison

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(i) Ray diagram — Refraction through a rectangular glass slab:

```
N
|
E | Air
\ |
\ | (incident ray)
\ |i
------O----------- AB (air-glass surface)
\
r\ Glass
\
O'
---------|-------- CD (glass-air surface)
\r'
\ Air
\
H
|
M'
```

- Ray EO is the **incident ray** (oblique, in air).
- OO′ is the **refracted ray** (bends towards normal inside glass; angle of refraction < angle of incidence).
- O′H is the **emergent ray** (bends away from normal; parallel to EO but laterally displaced).
- NN′ ⊥ AB and MM′ ⊥ CD are the normals at the two surfaces.

(ii) Snell's Law:

The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant for a given colour of light and a given pair of media:

$$\frac{\sin i}{\sin r} = \text{constant (refractive index)}$$

(iii) Differences between virtual images formed by convex and concave lenses:

Basis	Convex Lens	Concave Lens
(I) Object distance	Object must be placed **between the optical centre O and focus F_1** ($u < f$).	Object can be placed **anywhere between optical centre O and infinity**; virtual image is always formed.
(II) Magnification	Magnification is **greater than 1** (image is enlarged).	Magnification is **less than 1** (image is diminished).

Source: Chapter 9, Section 9.3.1 (Refraction through a Rectangular Glass Slab) and Section 9.3.4 (Image Formation by Lenses)

Explanation

- **(i)** Draw the diagram neatly and label: incident ray, refracted ray, emergent ray, normals (NN′, MM′), angles *i* and *r*, surfaces AB and CD, and media (Air/Glass). The emergent ray must be shown **parallel** to the incident ray (lateral displacement). Examiners award marks for correct bending direction (towards normal entering glass, away from normal leaving glass) and correct labelling.
- **(ii)** State both parts of Snell's law clearly and write the formula. Many students write only the formula and lose the statement mark.
- **(iii)** This is a 2-mark differentiation, so a table with two clear rows (one per basis) is the cleanest format. Key facts to remember: convex lens forms a virtual image only when the object is inside the focal length ($m > 1$); a concave lens **always** forms a virtual, erect, diminished image ($m < 1$) for any object position.

Q38. § 9.2.1 Image Formation by Spherical Mirrors § 9.3.5 Image Formation in Lenses Using Ray Diagrams § 9.3.8 Power of a Lens **[1]**

Rays from the sun converge at a point 25 cm behind a convex lens. The distance at which an object be placed in front of the lens to get a virtual image, is :

(A) 20 cm
(B) 40 cm
(C) 50 cm
(D) More than 50 cm

Previously asked in: 2026 31/5/1 Q30

◆ **Light – Reflection and Refraction** Focal length from parallel rays (sun rays) and virtual image formation by convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

Focal length of lens = 25 cm (rays from sun converge at focus). For a virtual image in a convex lens, object must be placed **between F and optical centre**, i.e., at a distance **less than 25 cm → (A) 20 cm**.

Explanation

Sunlight (parallel rays) converges at 25 cm → $f = 25$ cm. A convex lens forms a virtual, erect, magnified image only when the object is placed between the optical centre and F ($u < f$). Among the options, only 20 cm < 25 cm satisfies this condition. All other options (40, 50, >50 cm) place the object beyond F, giving a real image.

Q39. § 9.2.1 Image Formation by Spherical Mirrors § 9.3.5 Image Formation in Lenses Using Ray Diagrams § 9.3.6 Sign Convention for Spherical Lenses **[3]**

Answer the following:

(a) Complete the following ray diagram to show the formation of image :

(b) Mention the nature, position and size of the image formed in this case.

(c) State the sign of the image distance in this case using the Cartesian sign convention.

Previously asked in: 2023 31/1/1 Q30

◆ Light – Reflection and Refraction | Cartesian sign convention for image distance | Nature, position and size of image formed by a lens/mirror | Ray diagram for image formation by a lens/mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding rag

Model Answer

(a) Ray Diagram:

- **Ray 1:** Parallel to principal axis → after reflection, passes through F (focus).
- **Ray 2:** Directed towards centre of curvature C → reflects back along the same path.
- The two reflected rays diverge; extend them behind the mirror (dashed lines). They appear to meet behind the mirror between P and C, giving a virtual image **A′B′**.

(b) Nature, Position and Size of Image:

- **Position:** Behind the mirror, between P and C.
- **Nature:** Virtual and erect.
- **Size:** Enlarged (magnified), larger than the object.

(This occurs when object is placed between P and F of a concave mirror.)

(c) Sign of Image Distance:

The image is formed **behind** the mirror (on the same side as the object in a concave mirror's convention). By Cartesian sign convention, this distance is **positive (+)**.

Explanation

- **(a)** Examiners check that Ray 1 reflects through F and Ray 2 reflects back on itself through C; dashed lines behind the mirror show virtual image formation correctly.
- **(b)** This is the standard case: object between P and F of a concave mirror → virtual, erect, magnified image behind the mirror (as in Exercise Q2 of the chapter).
- **(c)** In Cartesian convention, distances measured in the direction of incident light (in front of mirror) are negative; behind the mirror is opposite to incident light, so image distance **v is positive**.

Q40. § 9.3.5 Image Formation in Lenses Using Ray Diagrams | § 9.3.6 Sign Convention for Spherical Lenses | § 9.3.7 Lens Formula and Magnification **[5]**

An object is placed at a distance of 30 cm from the optical centre of a concave lens of focal length 15 cm. Use lens formula to determine the distance of the image from the optical centre of the lens.

Previously asked in: 2024 31/2/1 Q36(b)

◆ **Light – Reflection and Refraction** | Lens Formula and Image Distance for Concave Lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

Given:

- Object-distance, u = −30 cm (object on left of lens)
- Focal length, f = −15 cm (concave lens, negative sign)
- Image-distance, v = ?

Using Lens Formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$\frac{1}{v} = \frac{1}{-15} + \frac{1}{-30}$$

$$\frac{1}{v} = -\frac{2}{30} - \frac{1}{30} = \frac{-3}{30} = \frac{-1}{10}$$

$$\boxed{v = -10 \text{ cm}}$$

Result: The image is formed at a distance of **10 cm** from the optical centre, on the **same side as the object** (negative sign).

The image is **virtual, erect, and diminished**.

Source: Light – Reflection and Refraction, Section 9.3.7

Explanation

- Always apply sign convention first: for a concave lens, both f and u are negative.
- Rearrange the lens formula as $\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ — this avoids sign errors.
- A negative v confirms the image is virtual and on the same side as the object, which is always the case for a concave lens with a real object.
- Examiners award marks for: correct signs (1 mark), correct substitution (1 mark), correct calculation (1 mark), result with unit (1 mark), and nature of image (1 mark).

Q41. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[3]**

A convex lens can form a (i) real, inverted and magnified image as well as (ii) virtual, erect and magnified image of an object. If the focal length of the lens is 10 cm, what should be the range of the object distance in both cases ? Draw ray diagrams to justify your answer.

Previously asked in: 2023 31/5/1 Q30 (b)

◆ **Light – Reflection and Refraction** | Image formation by a convex lens – real, inverted and magnified image | Image formation by a convex lens – virtual, erect and magnified image | Lens formula and sign convention | Ray diagrams for convex lens image formation

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

Case (i): Real, inverted and magnified image

For a convex lens to form a real, inverted and **magnified** image, the object must be placed **between F and 2F**, i.e., object distance u must satisfy:

$$f < |u| < 2f \implies 10\text{ cm} < |u| < 20\text{ cm}$$

Ray Diagram (i):

(Object between F and 2F; image forms beyond 2F on the other side — real, inverted, magnified)

```
|
O | I
↑ F 2F 2F' ↑↑
---●--●----●-----●----●---
|
```

Case (ii): Virtual, erect and magnified image

For a virtual, erect and magnified image, the object must be placed **between the optical centre and F**, i.e.:

$$0 < |u| < f \implies 0 < |u| < 10\text{ cm}$$

Ray Diagram (ii):

(Object between O and F; image forms on the same side as object — virtual, erect, magnified)

```
|
I↑↑ | O↑
F
---●--●--●----------
|
```

Source: Chapter 9, Section 9.3.5 – Image Formation in Lenses Using Ray Diagrams

---

Explanation

- Examiners look for **both ranges stated clearly** with reference to f = 10 cm, and **two ray diagrams** (one per case). Without the diagrams you lose marks.

- Key rule: real magnified → object between F and 2F ($|m| > 1$, m negative); virtual magnified → object between O and F ($|m| > 1$, m positive).
- State the range in numbers (10 cm to 20 cm, and 0 to 10 cm) since f = 10 cm is given — this shows you applied the concept.
- In board exams, even a rough labelled ray diagram with correct rays earns full credit for the diagram component.

Q42. § 9.3.1 Refraction through a Rectangular Glass Slab | § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[5]**

Answer the following :

(i) "In refraction of light through a rectangular glass slab, the emergent ray is always parallel to the direction of the incident ray." Why ? Explain with the help of a ray diagram. What happens when a ray of light falls normally on one of the faces of a rectangular glass prism ? Draw diagram. [3]

(ii) An object is placed at a distance of 30 cm from the optical centre of a concave lens of focal length 20 cm. Use Lens formula to determine the position of the image formed in this case. [2]

Previously asked in: 2025 31/3/1 Q36(a)

◆ **Light – Reflection and Refraction** | Lens formula application – image position using concave lens | Normal incidence on a face of a rectangular glass prism – no refraction/straight-through ray | Refraction through a rectangular glass slab – lateral displacement and emergent ray parallel to incident ray

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(i)

When a ray of light passes through a rectangular glass slab, it refracts at two parallel faces — AB (air to glass) and CD (glass to air). The bending at these two faces is **equal and opposite** because the faces are parallel to each other. Hence, the emergent ray comes out parallel to the incident ray, though it is laterally displaced.

Ray Diagram:

```
E N
\ |
\i |
----O-------+---- AB (air-glass)
|r |
OO'(refracted ray)
----O'------+---- CD (glass-air)
| |
\ M'
H (emergent, parallel to EO)
```

When light falls normally on a face: The angle of incidence = 0°, so the ray passes straight through without any bending (no refraction). It continues in the same direction.

(ii)

Given: $u = -30$ cm, $f = -20$ cm (concave lens)

Using lens formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-20} + \frac{1}{-30}$$

$$\frac{1}{v} = \frac{-3-2}{60} = \frac{-5}{60} = \frac{-1}{12}$$

$$v = -12 \text{ cm}$$

The image is formed **12 cm in front of the lens** (on the same side as the object). It is **virtual and erect**.

Source: Chapter 9, Section 9.3.1 (Refraction through a Rectangular Glass Slab) and Sign Convention for Spherical Lenses

---

Explanation

- **(i)** The key reason is "equal and opposite bending at two parallel faces" — state this clearly. Examiners award marks for the diagram showing incident ray, refracted ray inside slab, and emergent ray parallel to incident. For normal incidence, state that angle of incidence = 0°, so no bending occurs — the ray goes straight through.
- **(ii)** Always write the lens formula first, substitute with correct signs (both u and f are negative for a concave lens with real object), and state the nature of the image. A negative v confirms the image is on the same side as the object — virtual and erect, consistent with Table 9.5.

Q43. § 9.3.4 Image Formation by Lenses | § 9.3.5 Image Formation in Lenses Using Ray Diagrams | § 9.3.6 Sign Convention for Spherical Lenses **[2]**

An object is placed at a distance of 60 cm from a concave lens of focal length 30 cm. Use lens formula to find the position of the image formed in this case.

Previously asked in: 2025 31/1/1 Q24

◆ **Light – Reflection and Refraction** | Lens Formula Application – Concave Lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

Given: u = –60 cm, f = –30 cm (concave lens)

Using lens formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-30} + \frac{1}{-60}$$

$$\frac{1}{v} = \frac{-2-1}{60} = \frac{-3}{60} = \frac{-1}{20}$$

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

The image is formed **20 cm in front of the lens** (on the same side as the object). It is virtual and erect.

Source: Light – Reflection and Refraction, Chapter 9

Explanation

- Always assign signs first: object distance u is negative (object on left), focal length f is negative for concave lens.
- Use $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ carefully — rearrange to find v.
- A negative v confirms the image is on the same side as the object → virtual and erect, which is consistent with a concave lens always forming such images.
- Examiners award 1 mark for correct substitution/working and 1 mark for the correct answer with sign and position statement.

Q44. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[4]**

Observation table for a convex lens:

S.No.	Object distance (u) cm	Image distance (v) cm
1	−150	+30
2	−75	+37.5
3	−50	+50
4	−37.5	+75
5	−30	+150
6	−15	+37.5

The variation of image distance (v) with the object distance (u) for a convex lens is given in the following observation table. Analyse it and answer the questions given below :

(a) Without calculation, find out the focal length of the given convex lens. Justify your answer. [1]

(b) Which one of the observations given in the table is not correct and why ? [1]

(c) Find out the value of magnification for u = −30 cm. Write the nature of the image formed. Give reason for your answer. [2]

Previously asked in: 2026 31/3/1 Q38

◆ **Light – Reflection and Refraction** | Convex lens – image distance vs object distance analysis | Focal length of a convex lens from u-v data | Lens formula and image formation rules for convex lens | Magnification produced by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding stimulus

Model Answer

(a) Focal length = **25 cm**.

At S.No. 3, u = −50 cm and v = +50 cm, meaning the object is at 2F and the image is also at 2F. This happens only when u = 2f, so 2f = 50 cm → **f = 25 cm**.

(b) Observation **S.No. 6** (u = −15 cm) is incorrect. Since u = −15 cm is less than f (25 cm), the object lies between F and the lens; a convex lens then forms a **virtual image on the same side as the object** (v should be negative), but the table shows v = +37.5 cm (positive/real), which is wrong.

(c)

$$m = \frac{v}{u} = \frac{+150}{-30} = -5$$

The image is **real, inverted, and highly magnified** (|m| > 1, m is negative). Negative magnification indicates a real and inverted image formed on the other side of the lens.

Source: Light – Reflection and Refraction, Convex Lens / Lens Formula section

---

Explanation

- **Part (a):** The quickest no-calculation clue is S.No. 3 where |u| = |v| = 50 cm. For a convex lens, u = v only when both equal 2f, giving f = 25 cm.
- **Part (b):** When the object is inside the focal length (u < f), a convex lens always produces a virtual, erect image — v must be negative in the sign convention used here. The table's positive v for S.No. 6 contradicts this.
- **Part (c):** Use m = v/u. Negative m → real + inverted; |m| = 5 → highly magnified. Always state all three characteristics of the image.

Q45. § 9.2.1 Image Formation by Spherical Mirrors **[4]**

> Table showing focal length of three concave mirrors A, B and C and the respective object distances.

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 :

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

(ii) List two properties of the image formed in case 2. [1]

(iii) What is the nature and size of the image formed by mirror C ? Draw ray diagram to justify your answer. [2]

Previously asked in: 2024 31/1/1 Q39

◆ **Light – Reflection and Refraction**

Image formation by concave mirror – effect of object distance relative to focal length and centre of curvature

Mirror formula and magnification concepts for concave mirrors

Ray diagram for concave mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding stimulus

Model Answer

(i) Case 1 (Mirror A) will form a diminished image.
Justification: Object distance (45 cm) > 2f (40 cm), so the object is beyond C. A concave mirror forms a diminished image when the object is placed beyond the centre of curvature.

(ii) In Case 2, f = 15 cm, object distance = 30 cm = 2f (at centre of curvature). Properties of image:

- Real and inverted
- Same size as the object (at C)

(iii) For Mirror C: f = 30 cm, object distance = 20 cm < f. The object is placed **between the pole and focus**.

Nature and size: Virtual, erect, and **magnified** image is formed behind the mirror.

Ray Diagram:

(Diagram showing object between P and F of concave mirror, with two rays — one parallel to principal axis reflecting through F, and one directed towards F reflecting parallel — diverging after reflection, with virtual image formed behind mirror, larger than object.)

Explanation

- For (i), compare object distance with 2f: if u > 2f → diminished image (beyond C rule).
- For (ii), object at C (u = 2f) always gives real, inverted, same-sized image — a standard result to memorise.
- For (iii), object between P and F is the only case where a concave mirror gives a virtual, erect, magnified image. CBSE expects the ray diagram with at least two rays clearly showing the virtual image behind the mirror. Label P, F, C on the diagram.

Q46. § 9.3.4 Image Formation by Lenses **[3]**

> Observation table recording distance of flame from the lens and distance of the image from the lens.

A student placed a candle flame at different distances from a convex lens and focused its image on a screen. He recorded his observation in tabular form as given below :
Analyse the observation table and on the basis of your analysis only, answer the following questions (without doing any calculations) :
(a) What is the focal length of the convex lens used ? Give reason to justify your answer.
(b) Which one of the sets of observations is not correct and why ?
(c) Draw ray diagram to show image formation for any correct set of observation.

(a) What is the focal length of the convex lens used ? Give reason to justify your answer.

(b) Which one of the sets of observations is not correct and why ?

(c) Draw ray diagram to show image formation for any correct set of observation.

Previously asked in: 2025 31/6/1 Q31

◆ **Light – Reflection and Refraction** | Convex lens – image formation at various object distances | Focal length determination from lens observations | Identifying incorrect observations using lens rules | Ray diagrams for image formation by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding stimulus

Model Answer

(a) Focal length = **15 cm**
Reason: In rows 4 and 5, when object distance = 30 cm, image distance = 30 cm (equal distances, so object is at 2F). This means 2F = 30 cm, hence F = 15 cm.

(b) S.No. **8** (u = −12 cm) is incorrect. Since the object is placed at 12 cm, which is less than the focal length (15 cm), a convex lens cannot form a real image on the screen; the image would be virtual.

(c) Ray diagram for S.No. 4 (object at 2F, u = −30 cm):

```
F 2F 2F F
-----|----|----|lens|----|-----
[obj] [img]
```

Two rays drawn: one parallel to principal axis refracting through F, and one through optical centre passing undeviated — image forms at 2F on the other side, real, inverted, same size.

Source: Science Lab Manual / Light – Reflection and Refraction, Convex Lens experiment

---

Explanation

- **For (a):** The key observation is symmetry — when u = v, the object is at 2F. Rows 4 & 5 confirm this without any calculation.
- **For (b):** Any object within the focal length of a convex lens gives a virtual image (cannot be caught on screen), so u = −12 cm < f = 15 cm is impossible in this experiment.
- **For (c):** CBSE expects a neat, labelled ray diagram with at least two rays; examiners award 1 mark for the diagram, so keep it clear and label F, 2F, object, image.

Q47. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[5]**

Analyse the following observation table showing variation of image distance (v) with object distance (u) in case of a convex lens and answer the questions that follow without doing any calculations :

(a) Determine the focal length of the lens. Give reason for your answer.

(b) Find magnification of the image formed in Observation No. 3.

(c) The numerical value of magnifications in cases of observation 1 and 2 is same. List two differences in the images formed in these two cases.

Previously asked in: 2025 31/5/1 Q36 (B)

◆ **Light – Reflection and Refraction** | Convex lens – image distance vs object distance (observation table) | Focal length of a convex lens | Magnification by a convex lens (m = v/u) | Nature and characteristics of images formed by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

(a) Focal length = 20 cm

In Observation 4, u = –40 cm and v = +40 cm, i.e., the image is formed at 2F on the other side. This means 2F = 40 cm, so **f = 20 cm**.
(Alternatively, applying lens formula to any observation gives f = +20 cm.)

(b) For Observation 3: u = –30 cm, v = +60 cm

$$m = \frac{v}{u} = \frac{+60}{-30} = \mathbf{-2}$$

The magnification is –2 (image is real, inverted and enlarged, twice the size of the object).

(c) In Observation 1, u = –15 cm (object between F and O), v = –60 cm (negative).
In Observation 2, u = –25 cm (object between F and 2F), v = +100 cm (positive).
Numerical magnification = 4 in both cases.

	Observation 1	Observation 2
Nature	Virtual and erect	Real and inverted
Position	Same side as object	Opposite side of lens

Source: Light – Reflection and Refraction, Sections 9.3.4, 9.3.7

Explanation

- **(a)** When |u| = |v|, the object is at 2F, so the image forms at 2F on the other side — this is the quickest way to read f without calculation. Observation 4 directly gives this.
- **(b)** Use m = v/u with correct signs. A negative m means real and inverted.
- **(c)** The key contrast is virtual/erect vs real/inverted, and image on same side vs opposite side. "Numerical magnification same" means |m| = 4 in both, but the sign (and hence nature) differs. Examiners expect two clear, distinct differences stated as a comparison.

Q48. § 9.2.4 Mirror Formula and Magnification § 9.3.7 Lens Formula and Magnification **[3]**

If we want to obtain a virtual and magnified image of an object by using a concave mirror of focal length 18 cm, where should the object be placed? Use mirror formula to determine the object distance for an image of magnification +2 produced by this mirror to justify your answer.

Previously asked in: 2025 31/4/1 Q31

◆ **Light – Reflection and Refraction** | Concave mirror – virtual and magnified image formation | Mirror formula and magnification

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

For a virtual and magnified image, the object must be placed **between the pole (P) and the principal focus (F)** of the concave mirror, i.e., between 0 and 18 cm from the mirror.

Verification using mirror formula:

Given: $f = -18$ cm, $m = +2$

Since $m = -\frac{v}{u}$,

$$+2 = -\frac{v}{u} \implies v = -2u$$

Applying mirror formula:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{-2u} + \frac{1}{u} = \frac{1}{-18}$$

$$\frac{-1+2}{2u} = \frac{1}{-18}$$

$$\frac{1}{2u} = \frac{-1}{18} \implies u = -9 \text{ cm}$$

The object distance is **9 cm**, which lies between P and F (0 to 18 cm). This confirms that placing the object between the pole and focus gives a virtual, magnified image.

Source: Chapter 9, Section 9.2.4 — Mirror Formula and Magnification

---

Explanation

- The key concept: a concave mirror gives a **virtual, erect, magnified** image **only** when the object is between P and F (refer Table 9.1).
- Magnification is **positive** for virtual images in mirrors, so $m = +2$ is the right clue.
- Use $m = -v/u$ (mirror formula, not lens formula) to link v and u, then substitute into the mirror formula.
- Sign convention: object distance u is negative (object in front of mirror); focal length f of concave mirror is negative.
- The calculated $u = -9$ cm (between 0 and 18 cm) justifies the initial statement — examiners look for this logical closure.

Q49. § 9.3.7 Lens Formula and Magnification **[3]**

Answer the following :

(i) An object of 5 cm height is placed at a distance of 20 cm from the optical centre of a concave lens of focal length 18 cm. Calculate (1) image distance and (2) the magnification in this case.

(ii) Compare the values of magnification obtained by a concave lens and a convex lens when both the lenses form virtual images.

Previously asked in: 2023 31/5/1 Q30 (a)

◆ **Light – Reflection and Refraction** | Lens formula and image distance calculation (concave lens) | Magnification produced by a lens | Nature and characteristics of images formed by concave and convex lenses

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

(i)

Given: h = 5 cm, u = −20 cm, f = −18 cm (concave lens)

Using lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-18} + \frac{1}{-20} = \frac{-10-9}{180} = \frac{-19}{180}$$

(1) Image distance: $v = \frac{-180}{19} \approx -9.47$ cm (virtual, same side as object)

(2) Magnification: $m = \frac{v}{u} = \frac{-180/19}{-20} = \frac{180}{380} \approx +0.47$

(ii)

A concave lens always forms a virtual image with magnification **m < 1** (diminished).
A convex lens forms a virtual image (object between F and O) with magnification **m > 1** (enlarged).

Source: Light – Reflection and Refraction, Section 9.3.4

Explanation

- Always use sign convention: distances measured from optical centre; concave lens has negative focal length.
- For part (ii), examiners expect a direct comparison: concave → m < 1; convex → m > 1. This follows directly from Table 9.5 and Table 9.4 in the textbook.
- Show formula and substitution clearly for full marks.

Q50. § 9.3.6 Sign Convention for Spherical Lenses | § 9.3.7 Lens Formula and Magnification **[3]**

(B) An object of height 10 cm is placed 25 cm away from the optical centre of a converging lens of focal length 15 cm. Calculate the image-distance and height of the image formed.

Previously asked in: 2023 31/4/1 Q30 (B)

◆ **Light – Reflection and Refraction** | Lens Formula and Magnification (Converging Lens)

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

Given: h = +10 cm, u = −25 cm, f = +15 cm (converging lens)

Using Lens Formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{15} + \frac{1}{(-25)} = \frac{1}{15} - \frac{1}{25} = \frac{5-3}{75} = \frac{2}{75}$$

$$v = +37.5 \text{ cm}$$

The image is formed **37.5 cm on the other side** of the lens. It is **real and inverted**.

Height of image:

$$h' = h \times \frac{v}{u} = 10 \times \frac{+37.5}{-25} = -15 \text{ cm}$$

The image height is **15 cm** (negative sign indicates it is inverted).

Source: Chapter 9, Section 9.3.7 – Lens Formula and Magnification

---

Explanation

- Always apply sign convention: object on left → u is negative; converging lens → f is positive.
- The formula for lenses is $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ (not the mirror formula).
- A positive v confirms real image on the opposite side; negative h′ confirms inverted image.
- Examiners award marks for: correct substitution with signs (1 mark), correct v (1 mark), correct h′ (1 mark).

Q51. § 9.3.4 Image Formation by Lenses | § 9.3.7 Lens Formula and Magnification **[5]**

Answer the following:

(a) An object is placed in front of a convex lens of focal length f. If the distance of the object from the lens is 2f, draw a ray diagram to show the formation of the image. Write the value of magnification in this case.

(b) A student has focussed the image of a candle flame on a white screen using a convex lens. The situation is as given below : Length of the flame = 2 cm Focal length of the lens = 12 cm Distance of the flame from the lens = 16 cm If the flame is perpendicular to the principal axis of the lens, calculate the values of the following : (i) Distance of the image from the lens (ii) Length of the image formed

Previously asked in: 2023 31/2/1 Q36

◆ **Light – Reflection and Refraction** | Lens formula and magnification calculations | Refraction through a convex lens – ray diagram and image formation

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

(a)

Ray Diagram: Object placed at $2F_1$ (distance = 2f from lens):

```
|
O | I
↑ ----+---- ↓
2F₁ F₁ O F₂ 2F₂
```

Two rays are drawn: (1) parallel to principal axis, refracts through F_2; (2) through optical centre, passes undeviated. Image forms at $2F_2$ — **real, inverted, same size as object**.

$$\text{Magnification} = -1$$

(b)

Given: h = 2 cm, f = 12 cm, u = −16 cm

(i) Distance of image from lens:

Using lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-16} = \frac{1}{12}$$

$$\frac{1}{v} = \frac{1}{12} - \frac{1}{16} = \frac{4-3}{48} = \frac{1}{48}$$

$$v = +48 \text{ cm}$$

The image is formed **48 cm** from the lens (on the opposite side).

(ii) Length of image:

$$m = \frac{v}{u} = \frac{48}{-16} = -3$$

$$h' = m \times h = -3 \times 2 = -6 \text{ cm}$$

Length of image = **6 cm** (real and inverted).

Source: Light – Reflection and Refraction, Section 9.3.4 & 9.3.6

Explanation

- **Part (a):** At u = 2f, image forms at 2f on the other side — same size. Magnification = −1 (negative sign shows inversion). The ray diagram must show two standard rays meeting at $2F_2$.
- **Part (b):** Always use sign convention: u is negative (object on left). Apply lens formula carefully. Magnification = v/u; multiply by object height to get image height. Negative h′ confirms real, inverted image. Examiners award marks for formula, substitution, and correct final answer with units.

Q52. § 9.2.1 Image Formation by Spherical Mirrors § 9.2.4 Mirror Formula and Magnification **[3]**

(a) A student has focussed the image of an object of height 3 cm on a white screen using a concave mirror of focal length 12 cm. If the distance of the object from the mirror is 18 cm, find the values of the following :

(i) Distance of the image from the mirror

(ii) Height of the image

Previously asked in: 2023 31/2/1 Q31 (a)

◆ **Light – Reflection and Refraction** Magnification and image height calculation (concave mirror) Mirror formula and image distance calculation (concave mirror)

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(i) Distance of the image from the mirror:

Given: h = +3 cm, f = −12 cm (concave), u = −18 cm

Using mirror formula:

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

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

$$v = -36 \text{ cm}$$

The image is formed **36 cm in front of the mirror** (real and inverted).

(ii) Height of the image:

$$m = -\frac{v}{u} = -\frac{-36}{-18} = -2$$

$$h' = m \times h = -2 \times 3 = -6 \text{ cm}$$

The height of the image is **6 cm** (negative sign indicates it is real and inverted).

Source: Chapter 9, Section 9.2.4 — Mirror Formula and Magnification

---

Explanation

- **Sign convention:** For a concave mirror, f and u are both negative (distances measured in front of the mirror). Always assign signs before substituting.
- **Examiners look for:** correct substitution with signs, the mirror formula working shown step-by-step, and both answers stated clearly with units and nature.
- The negative value of h′ confirms the image is **real and inverted** — mentioning this adds quality to the answer.

- Object is between C and F ($u = 18$ cm, $f = 12$ cm), so the image is expected beyond C — $v = 36$ cm confirms this, consistent with Table 9.1.

Q53. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[5]**

(i) Define principal axis of a lens. Draw a ray diagram to show what happens when a ray of light parallel to the principal axis of a concave lens passes through it.
(ii) The focal length of a concave lens is 20 cm. At what distance from the lens should a 5 cm tall object be placed so that its image is formed at a distance of 15 cm from the lens ? Also calculate the size of the image formed.

Previously asked in: 2024 31/4/1 Q36 (b)

◆ **Light – Reflection and Refraction** | Lens formula and magnification – concave lens numerical | Principal axis of a lens – definition | Ray diagram for concave (diverging) lens – ray parallel to principal axis

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(i) Principal Axis: The straight line passing through the two centres of curvature of the two surfaces of a lens (i.e., through its optical centre) is called the **principal axis**.

Ray Diagram – Concave Lens:

```
|
\ | /
\ | /
----\---O---------/-----→ Principal Axis
F1 | /
| /
```

A ray parallel to the principal axis, after refraction through a concave lens, **appears to diverge** from the principal focus (F_1) located on the **same side** as the incident ray.

(ii) Given:

- Focal length of concave lens, f = −20 cm
- Object height, h = 5 cm
- Image distance, v = −15 cm (image is virtual, on same side as object)
- Object distance, u = ?

Using lens formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{-15} - \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = \frac{1}{-15} + \frac{1}{20} = \frac{-4+3}{60} = \frac{-1}{60}$$

$$\therefore u = -60 \text{ cm}$$

The object should be placed **60 cm** from the lens.

Size of image:

$$m = \frac{v}{u} = \frac{-15}{-60} = +\frac{1}{4}$$

$$h' = m \times h = \frac{1}{4} \times 5 = 1.25 \text{ cm}$$

The image is **1.25 cm** tall, virtual, erect, and diminished.

Source: Chapter 9, Sections 9.3.5 and 9.3.6

Explanation

- **Part (i):** Examiners expect a one-line definition and a ray diagram clearly showing the incident ray parallel to the principal axis diverging after refraction, with the diverged ray appearing to come from F_1 on the same side. Label the lens, principal axis, and F_1.
- **Part (ii):** For a concave lens, both f and v are **negative** by sign convention (real-is-positive/new Cartesian). Apply the lens formula correctly. The magnification formula $m = v/u$ gives the image height directly. A common error is using wrong signs — always state the signs used.
- The image formed by a concave lens is always virtual, erect, and diminished — confirm this matches your answer.

Q54. § 9.2.4 Mirror Formula and Magnification § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[5]**

The variation of image distance (v) with object distance (u) for a convex lens is given in the following observation table. Analyse it and answer the questions that follow :

(i) Without calculation, find the focal length of the convex lens. Justify your answer.

(ii) Which observation is not correct ? Why ? Draw ray diagram to find the position of the image formed for this position of the object.

(iii) Find the approximate value of magnification for u = −30 cm.

Previously asked in: 2024 31/4/1 Q36 (a)

◆ **Light – Reflection and Refraction** Convex lens – image distance vs object distance analysis Lens formula and magnification Ray diagrams for image formation by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

(i) Focal Length:
From observation 3, u = −50 cm and v = +50 cm. Using lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{50} - \frac{1}{-50} = \frac{2}{50}$$

f = +25 cm

Justification (without calculation): When object is placed at 2f, image is also formed at 2f on the other side. Here |u| = |v| = 50 cm, so 2f = 50 cm, giving **f = 25 cm**.

(ii) Incorrect Observation:
Observation 6 (u = −15 cm, v = +37.5 cm) is incorrect.

Since f = 25 cm and u = −15 cm, the object is placed **within the focal length** (between O and F). For such a position, a convex lens forms a **virtual, erect, magnified** image on the **same side** as the object, so v should be **negative**, not positive.

Ray Diagram: *(Draw object between O and F; two rays — one parallel to principal axis refracted through F_2, one through optical centre straight — diverging rays are extended backward to meet on the same side, giving a virtual, erect, magnified image.)*

(iii) Magnification for u = −30 cm:
From table, v = +150 cm.

$$m = \frac{v}{u} = \frac{+150}{-30} = -\mathbf{5}$$

The image is real, inverted and 5 times magnified.

Source: Chapter 9, Sections 9.3.6 and 9.3.7

Explanation

- **(i)** The key insight is symmetry: when u = v numerically, the object is at 2f. No calculation needed — just state this logic clearly.
- **(ii)** Examiners expect you to identify that u = −15 cm < f = 25 cm (object inside focal length), so image must be virtual (v negative). Must also draw a ray diagram showing virtual image on same side.

- **(iii)** Use m = v/u directly from the table values with correct signs. The negative value confirms real and inverted image — mention this for full marks.

Q55. § 9.3.4 Image Formation by Lenses **[3]**

A convex lens forms an 80 cm long image of a 20 cm long object which is kept at a distance of 60 cm from the optical centre of the lens. If the object and the image are on the same side of the lens, find (i) the nature of the image, (ii) the position of the image, and (iii) the focal length of the lens.

Previously asked in: 2025 31/2/1 Q31

◆ Light – Reflection and Refraction | Convex lens – image formation and magnification | Lens formula and focal length calculation | Virtual and erect image formed by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

Given: Object size (h) = 20 cm, Image size (h') = 80 cm, Object distance (u) = −60 cm

Magnification: $m = \frac{h'}{h} = \frac{80}{20} = +4$

(i) Nature of the image: Since the image and object are on the **same side** of the lens, the image is **virtual and erect** (magnification is positive).

(ii) Position of the image:

$$m = \frac{v}{u} \Rightarrow +4 = \frac{v}{-60} \Rightarrow v = -240 \text{ cm}$$

The image is formed **240 cm from the optical centre, on the same side as the object**.

(iii) Focal length: Using lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$:

$$\frac{1}{f} = \frac{1}{-240} - \frac{1}{-60} = \frac{-1+4}{240} = \frac{3}{240}$$

$$f = +80 \text{ cm}$$

Source: Chapter 9, Section 9.3.6

Explanation

- When object and image are on the **same side** of a convex lens, the image is **virtual and erect** — this matches Table 9.4 (object between F1 and O).
- Apply sign convention: u is negative (object on left); virtual image also on the same (left) side, so v is negative too.
- Magnification $m = v/u = h'/h$; since the image is virtual and erect, m is **positive**, confirming both v and u have the same sign.
- Examiners award one mark each for (i) nature, (ii) position, and (iii) focal length. Show formula and substitution clearly.

Q56. § 9.3.7 Lens Formula and Magnification **[3]**

Answer the following :

(a) Write the expression for the magnification produced by a lens in terms of object distance and image distance.

(b) A 4 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 20 cm. Calculate the size of the image formed, if the distance of the object from the lens is 10 cm.

Previously asked in: 2026 31/2/1 Q35

◆ **Light – Reflection and Refraction** | Image formation by a convex lens using lens formula and magnification | Magnification produced by a lens (formula in terms of object and image distance)

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(a) The magnification produced by a lens is given by:

$$m = \frac{v}{u}$$

where v is the image distance and u is the object distance from the optical centre.

(b) Given: Object height h = 4 cm, f = +20 cm, u = −10 cm

Using the lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} = \frac{1}{20} + \frac{1}{(-10)} = \frac{1}{20} - \frac{1}{10} = \frac{-1}{20}$$

So v = −20 cm

Magnification: $m = \frac{v}{u} = \frac{-20}{-10} = +2$

Size of image: $h' = m \times h = 2 \times 4 = \mathbf{8\ cm}$

The image is virtual, erect and enlarged.

Source: Chapter 9, Section 9.3

Explanation

- **(a)** is a standard 1-mark definition — write only the formula with symbols defined.
- **(b)** Since u = 10 cm < f = 20 cm, the object is between F and O; expect a virtual, erect, magnified image (consistent with Table 9.4). Always use sign convention: distances measured against incident light are negative, so $u = -10$ cm.
- Show all steps clearly — substitution, calculation of v, then m, then h' — each step can carry a mark.

Q57. § 9.3.6 Sign Convention for Spherical Lenses **[1]**

From the following options choose the one which gives negative magnification greater than one :

(A) Concave mirror; Nature of image – real
(B) Concave mirror; Nature of image – virtual
(C) Convex mirror; Nature of image – real
(D) Convex mirror; Nature of image – virtual

Previously asked in: 2026 31/2/1 Q30

◆ **Light – Reflection and Refraction** | Magnification by mirrors and lenses – sign and magnitude

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

(A) Concave mirror; Nature of image – real

A real image formed by a concave mirror has negative magnification (inverted image). When the image is enlarged (object between F and C), $|m| > 1$ and m is negative.

Explanation

Negative magnification means the image is real and inverted ($m = -v/u$, with v negative and u negative, giving m negative). For $|m| > 1$, the image must be enlarged, which occurs in a concave mirror when a real image is formed (object between F and C). A convex mirror never forms a real image, and the virtual image from a concave mirror has positive magnification. So option (A) is correct.

Q58. § 9.3.8 Power of a Lens **[4]**

> Many optical instruments consist of a number of lenses. They are combined to increase the magnification and sharpness of the image. The net power (P) of the lenses placed in contact is given by the algebraic sum of the powers of the individual lenses P1, P2, P3 ...
> P = P1 + P2 + P3 ...
> This is also termed as the simple additive property of the power of lens, widely used to design lens systems of cameras, microscopes and telescopes. These lens systems can have a combination of convex lenses and also concave lenses.

Read the case carefully and answer the questions that follow.

(a) What is the nature (convergent / divergent) of the combination of a convex lens of power + 4 D and a concave lens of power −2 D ? [1]

(b) Calculate the focal length of a lens of power −2·5 D. [1]

(c) Draw a ray diagram to show the nature and position of an image formed by a convex lens of power + 0·1 D, when an object is placed at a distance of 20 cm from its optical centre. [2]

Previously asked in: 2023 31/5/1 Q39

◆ **Light – Reflection and Refraction** | Power of a lens and combination of lenses | Ray diagram for image formation by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding stimulus

Model Answer

(a) Net Power = +4 D + (−2 D) = **+2 D**

Since the net power is positive, the combination is **convergent**.

(b) Power P = −2.5 D

$$f = \frac{1}{P} = \frac{1}{-2.5} = -0.4 \text{ m} = -40 \text{ cm}$$

The focal length is **−40 cm** (concave lens).

(c) Power = +0.1 D → $f = \frac{1}{0.1} = 10$ m = 1000 cm

Object distance = 20 cm. Since the object is placed **between the optical centre and focus** (20 cm < 1000 cm = f), the image formed is:

- **Virtual, erect, and magnified**
- Formed on the **same side as the object**

(Ray diagram: Two rays from object tip — one parallel to principal axis refracting through F, one through optical centre — diverging rays extended back to meet behind the lens on the same side.)

Source: Light – Reflection and Refraction, Power of a Lens

Explanation

- **(a)** Simply add the powers algebraically; positive result → converging.
- **(b)** Use $f(\text{m}) = 1/P$; negative f confirms concave lens.
- **(c)** First find f from P. Since object distance (20 cm) < f (1000 cm), it's the "between O and F" case → virtual, erect, magnified image. Examiners award 1 mark for correct ray diagram and 1 mark for stating

> nature/position of image. Draw and label clearly.

Q59. § 9.3.7 Lens Formula and Magnification | § 9.3.8 Power of a Lens **[3]**

The power of a lens is +4D. Find the focal length of this lens. An object is placed at a distance of 50 cm from the optical centre of this lens. State the nature and magnification of the image formed by the lens and also draw a ray diagram to justify your answer.

Previously asked in: 2023 31/4/1 Q31

◆ **Light – Reflection and Refraction** | Image formation by a convex lens – nature and magnification | Power of a lens and focal length | Ray diagram for image formation by a convex lens

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

Finding focal length:

$$P = \frac{1}{f} \Rightarrow f = \frac{1}{P} = \frac{1}{+4} = +0.25 \text{ m} = 25 \text{ cm}$$

This is a **convex lens**.

Applying lens formula (u = −50 cm, f = +25 cm):

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v} = \frac{1}{25} + \frac{1}{(-50)} = \frac{2-1}{50} = \frac{1}{50}$$

$$v = +50 \text{ cm}$$

Magnification:

$$m = \frac{v}{u} = \frac{+50}{-50} = -1$$

Nature of image: Real, inverted, and of the same size as the object (formed at $2F_2$, 50 cm on the other side of the lens).

Ray Diagram:

```
|
O | I
2F₁ F₁ O F₂ 2F₂
←50cm→|← 50cm →
```

(Object at $2F_1$; image forms at $2F_2$, real and inverted.)

Source: Chapter 9, Sections 9.3.7 and 9.3.8

Explanation

- Since P = +4D (positive), the lens is convex; f = 1/P in metres = 0.25 m = 25 cm.
- Object is placed at u = −50 cm = 2f, so by Table 9.4, image forms at $2F_2$ on the other side — real, inverted, same size.
- Lens formula confirms v = +50 cm; magnification m = v/u = −1 (negative sign → real and inverted; |m| = 1 → same size).
- Draw the standard two-ray diagram: one ray parallel to principal axis refracts through F_2; another through optical centre goes straight. Examiners expect the ray diagram to be labelled with $2F_1$, F_1, O, F_2, $2F_2$.

Q60. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[3]**

(b) Define power of a lens. The focal length of a lens is −10 cm. Write the nature of the lens and find its power. If an object is placed at a distance of 20 cm from the optical centre of this lens, according to the New Cartesian Sign Convention, what will be the sign of magnification in this case ?

Previously asked in: 2023 31/2/1 Q31 (b)

◆ **Light – Reflection and Refraction** | Concave Lens – Nature and Focal Length | Power of a Lens | Sign of Magnification using New Cartesian Sign Convention

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding rag

Model Answer

Power of a lens: The power of a lens is defined as the reciprocal of its focal length. $P = \frac{1}{f}$. Its SI unit is dioptre (D).

Nature of lens: Since $f = -10$ cm $= -0.1$ m, the lens is a **concave (diverging) lens**.

Power:

$$P = \frac{1}{f} = \frac{1}{-0.1\text{ m}} = -10\text{ D}$$

Sign of magnification:
Object distance $u = -20$ cm (by sign convention). Using lens formula with $f = -10$ cm:

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-10} + \frac{1}{-20} = \frac{-3}{20}$$

$$v = -\frac{20}{3}\text{ cm}$$

$$m = \frac{v}{u} = \frac{-20/3}{-20} = +\frac{1}{3}$$

The sign of magnification is **positive**, indicating the image is virtual and erect.

Source: Chapter 9, Sections 9.3.7 and 9.3.8

Explanation

- Always define power clearly and state its SI unit — examiners award 1 mark for this.
- A negative focal length **always** means a concave lens — state this explicitly.
- For sign convention: object is placed to the left, so u is **negative**. Use the lens formula to find v, then compute $m = v/u$. A concave lens always gives a virtual, erect image, so m is always **positive** for a real object.
- Show the calculation step-by-step for full marks; don't skip to the answer.

Q61. § 9.3.6 Sign Convention for Spherical Lenses § 9.3.7 Lens Formula and Magnification **[5]**

Answer the following :

(i) The power of a lens 'X' is – 2·5 D. Name the lens and determine its focal length in cm. For which eye defect of vision will an optician prescribe this type of lens as a corrective lens ? [2]

(ii) "The value of magnification 'm' for a lens is – 2." Using new Cartesian Sign Convention and considering that an object is placed at a distance of 20 cm from the optical centre of this lens, state : (I) the nature of the image formed; (II) size of the image compared to the size of the object; (III) position of the image, and (IV) sign of the height of the image. [2]

(iii) The numerical values of the focal lengths of two lenses A and B are 10 cm and 20 cm respectively. Which one of the two will show higher degree of convergence/divergence ? Give reason to justify your answer. [1]

Previously asked in: 2025 31/1/1 Q36(a)

◆ **Light – Reflection and Refraction** | Concave (diverging) lens and myopia correction | Lens formula (1/v - 1/u = 1/f) | Magnification by lenses and image characteristics | New Cartesian Sign Convention for lenses | Power of a lens and focal length

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(i) The lens X is a **concave (diverging) lens** (negative power indicates concave lens).

Focal length: $f = \frac{1}{P} = \frac{1}{-2.5} = -0.4 \text{ m} = -\mathbf{40} \text{ cm}$

This lens is prescribed for **myopia (short-sightedness)**.

(ii) Given: $m = -2$, object distance $u = -20$ cm (by sign convention).

Since $m = \frac{v}{u}$: $-2 = \frac{v}{-20}$, so $v = +40$ cm.

(I) Nature: **Real and inverted** (m is negative).

(II) Size: Image is **twice the size** of the object (|m| = 2, enlarged).

(III) Position: Image is formed **40 cm on the opposite side** of the lens from the object.

(IV) Sign of image height: **Negative** (inverted image has negative height by sign convention).

(iii) Lens **A** (focal length 10 cm) shows a **higher degree of convergence/divergence**.

Reason: Power $P = \frac{1}{f}$; smaller focal length means greater power, hence greater ability to converge or diverge light.

Source: Chapter 9, Sections 9.3.4, 9.3.6

Explanation

- For (i): Power formula $P = 1/f$ (f in metres); negative power → concave lens → myopia correction. Examiner expects the eye defect named correctly.
- For (ii): Apply $m = v/u$ with sign convention (u is negative). Negative m means real and inverted image; |m| > 1 means enlarged. Image height is negative when image is inverted.
- For (iii): The key relationship is $P \propto 1/f$ — just state it and compare the two lenses. One line with reason is enough for 1 mark.

Q62. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[4]**

> Lenses can form different types of images depending upon their focal length and position of object. A convex lens can create real, inverted or virtual, erect images, while a concave lens forms only virtual and diminished images. The focal length determines the power of lens. Convex lenses have positive focal length while concave lenses have negative focal length by convention. When lenses are placed together, their combined power is determined by the sum of their individual powers. Ray diagrams help to visualize how light converges or diverges through lens to form an image.

Read the following passage and answer the questions given :

(a) A convex lens of focal length 20 cm is used to form an image. If an object is placed at 40 cm from the lens, what will be the position and nature of image ? [1]

(b) Illustrate the formation of image with the help of ray diagram, when the object is placed between the optical centre and principal focus of concave lens. [1]

(c) A lens combination consists of a convex lens of focal length 30 cm and a concave lens of focal length 15 cm placed together. Find the equivalent focal length and power of this lens combination. [2]

Previously asked in: 2026 31/1/1 Q38

◆ **Light – Reflection and Refraction** | Focal length and power of a lens | Image formation by convex and concave lenses

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding stimulus

Model Answer

(a)

Using lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Given: f = +20 cm, u = −40 cm

$\frac{1}{v} = \frac{1}{20} + \frac{1}{(-40)} = \frac{2-1}{40} = \frac{1}{40}$

∴ v = +40 cm

Image is formed at 40 cm on the other side of the lens; it is real, inverted, and same size as the object.

(b)

```
F' O F
←---------|---------|--------|--------→
\ | /
\ virtual, /
\ erect, /
\diminish /
\ image /
```

When object is between O and F of a concave lens, the image is formed on the same side as the object — **virtual, erect, and diminished**.

(Ray diagram: two rays diverge after refraction; their extensions meet on the same side as the object.)

(c)

Given: f_1 = +30 cm, f_2 = −15 cm

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{30} + \frac{1}{-15} = \frac{1-2}{30} = \frac{-1}{30}$$

∴ **F = −30 cm**

Power: $P = \frac{1}{F(\text{in m})} = \frac{1}{-0.30}$

∴ **P = −3.33 D**

The combination acts as a **concave (diverging) lens**.

Source: Light – Reflection and Refraction, Lens Formula and Power of a Lens

---

Explanation

- **(a)** Apply the standard lens formula with sign convention (u is negative). At 2f, image forms at 2f — real, inverted, same size. Examiners expect the formula, substitution, and nature of image.
- **(b)** A ray diagram must show at least two rays and indicate the virtual, erect, diminished image on the same side as the object. Even a rough labeled sketch earns the mark.
- **(c)** Use $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ and $P = P_1 + P_2$. State the sign and nature of the combination — concave — to get full marks. Remember to convert cm to metres for power.

Q63. § 9.3.1 Refraction through a Rectangular Glass Slab | § 9.3.2 The Refractive Index **[2]**

State two laws of refraction of light.

Previously asked in: 2024 31/2/1 Q24(a)

◆ **Light – Reflection and Refraction** | Laws of Refraction of Light

Generated by claude-sonnet-4-6 · 2026-06-15 06:51 · grounding rag

Model Answer

The two laws of refraction of light are:

1. The incident ray, the refracted ray, and the normal to the interface of the two transparent media at the point of incidence, all lie in the **same plane**.
1. The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a **constant** for a given pair of media and given colour of light. This is known as **Snell's law**.

$$\frac{\sin i}{\sin r} = \text{constant}$$

Source: Chapter 9, Section 9.3.1

Explanation

- Both laws must be stated for full 2 marks (1 mark each).
- Law 1 is about geometry (coplanarity); Law 2 is Snell's law — always name it.
- Writing the formula for Snell's law strengthens the answer but is not mandatory for 2 marks.
- Avoid writing about refractive index here — the question only asks for the laws, not their implications.

Q64. § 9.3.2 The Refractive Index **[2]**

A ray of light enters into medium B from medium A as shown in the given figure :

(a) Which one of these two media is optically denser than the other medium ? Justify your answer. [1]

(b) If the speed of light in medium A is VA and in medium B is VB, then what is the refractive index of medium B with respect to medium A ? [1]

Previously asked in: 2026 31/3/1 Q33

◆ **Light – Reflection and Refraction** | Refraction of light – bending towards/away from normal and optical density | Refractive index of one medium with respect to another (ratio of speeds of light)

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(a) Medium B is optically denser than medium A. This is because the ray of light bends **towards the normal** while entering medium B from medium A, which happens when light travels from a rarer (optically less dense) medium to a denser medium.

(b) The refractive index of medium B with respect to medium A is:

$$n_{BA} = \frac{\text{Speed of light in medium A}}{\text{Speed of light in medium B}} = \frac{V_A}{V_B}$$

Source: Chapter 9, Section 9.3.2 — The Refractive Index

Explanation

- **(a):** The key rule is: light bends **towards** the normal → going into denser medium; bends **away** → going into rarer medium. Always justify with this rule.
- **(b):** Refractive index of medium 2 w.r.t. medium 1 = speed in medium 1 ÷ speed in medium 2. Don't flip it. Here medium A is "1" and medium B is "2", so it's V_A/V_B.

Q65. § 9.1 REFLECTION OF LIGHT | § 9.2.1 Image Formation by Spherical Mirrors | § 9.2.2 Representation of Images Formed by Spherical Mirrors Using Ray Diagrams **[4]**

> A student took three concave mirrors of different focal lengths and performed the experiment to see the image formation by placing an object at different distances with these mirrors as shown in the following table.

Answer the sub-parts based on the experiment with three concave mirrors as given in the table.

(a) List two properties of the image formed in Case I.

(b) In which one of the cases given in the table, the mirror will form real image of same size and why ?

(c) Name the type of mirror used by dentists. Give reason why do they use such type of mirrors.

Previously asked in: 2023 31/6/1 Q39

◆ **Light – Reflection and Refraction** | Image formation by concave mirror at various object distances | Real image of same size – object at centre of curvature of concave mirror | Uses of concave mirrors (dentist's mirror)

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding stimulus

Model Answer

(a) In Case I, object-distance = 45 cm, focal length = 20 cm → radius of curvature = 40 cm. Object is beyond C (45 > 40).
Properties of image:

- Real and inverted
- Diminished (smaller than object)

(b) Case II — object-distance = 30 cm, focal length = 15 cm → radius of curvature = 30 cm. The object is placed at the centre of curvature (C). When an object is placed at C, a concave mirror forms a real, inverted image of the **same size** at C itself.

(c) Dentists use a **concave mirror**. It is used because when a tooth (object) is placed within the focal length of a concave mirror, it produces a **magnified, erect, and virtual** image, enabling the dentist to clearly examine the tooth.

Explanation

- For (a): Compare object-distance with 2f (= radius of curvature). 45 > 40, so object is beyond C → image is real, inverted, and diminished.
- For (b): Image is same size only when object is placed at C (u = 2f). Case II: 2f = 30 cm = object-distance. This is the key condition to state.
- For (c): A standard fact — dentists/doctors use concave mirrors for magnified images. Always justify with the property (virtual, erect, magnified when object is inside focus).

Q66. § 9.2.1 Image Formation by Spherical Mirrors **[4]**

> Hold a concave mirror in your hand and direct its reflecting surface towards the sun. Direct the light reflected by the mirror on to a white card-board held close to the mirror. Move the card-board back and forth gradually until you find a bright, sharp spot of light on the board. This spot of light is the image of the sun on the sheet of paper; which is also termed as "Principal Focus" of the concave mirror.

Read the passage and answer the following:

(a) List two applications of concave mirror. [1]

(b) If the distance between the mirror and the principal focus is 15 cm, find the radius of curvature of the mirror. [1]

(c) Draw a ray diagram to show the type of image formed when an object is placed between pole and focus of a concave mirror. [2]

Previously asked in: 2023 31/1/1 Q39

◆ **Light – Reflection and Refraction** · Applications of concave mirror · Radius of curvature and focal length relationship (R = 2f) · Ray diagram for concave mirror – object between pole and focus

Generated by claude-sonnet-4-6 · 2026-06-15 06:52 · grounding stimulus

Model Answer

(a) Two applications of a concave mirror:

1. Used as a shaving/makeup mirror (gives magnified, erect image).
2. Used as a reflector in torches, headlights, and solar furnaces.

(b) Focal length (f) = 15 cm

Radius of curvature R = 2f = 2 × 15 = **30 cm**

(c) Ray diagram — object placed between pole (P) and focus (F):

```
/
Object / (Reflected rays diverge)
↑ / ←————————————————————
| ( Mirror Virtual, erect,
P F magnified image
behind the mirror
```

Key features: Incident ray parallel to principal axis reflects through F; incident ray through C reflects back on itself. Reflected rays diverge — when extended behind the mirror, they meet to form a **virtual, erect, and magnified** image behind the mirror.

Explanation

- **(a)** Any two standard applications suffice for 1 mark — examiners accept torch/headlight reflector, solar furnace, shaving mirror, ENT doctor's mirror, etc.
- **(b)** The formula R = 2f is the key relationship. Always show the working step for a calculation question.
- **(c)** For 2 marks, examiners look for: correct position of object (between P and F), at least two correct rays drawn, reflected rays shown diverging, and image correctly labelled as virtual, erect, and magnified behind the mirror. Since a proper diagram cannot be drawn in text, draw it neatly on your answer sheet with labelled points P, F, C, object, and image.

Q67. § 9.3.5 Image Formation in Lenses Using Ray Diagrams **[3]**

(A) Define the following terms in the context of a diverging mirror :
(i) Principal focus
(ii) Focal length
Draw a labelled ray diagram to illustrate your answer.

Previously asked in: 2023 31/4/1 Q30 (A)

◆ **Light – Reflection and Refraction** | Focal Length of a Diverging (Convex) Mirror | Principal Focus of a Diverging (Convex) Mirror | Ray Diagram for Convex (Diverging) Mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:50 · grounding rag

Model Answer

(i) Principal Focus of a Diverging (Convex) Mirror:
The point on the principal axis from which incident rays, parallel to the principal axis, appear to *diverge* after reflection from a convex mirror is called its principal focus (F). It is a virtual focus, located behind the mirror.

(ii) Focal Length:
The distance between the pole (P) of the convex mirror and its principal focus (F) is called the focal length. It is positive for a convex mirror.

Ray Diagram:

```
Incident ray (parallel to principal axis)
──────────────────────────►
\ Reflected ray (diverging)
\─────────────────────────►
──────────────────────F────────────P ( ( ( ( convex mirror
*
(Virtual focus F, behind mirror)
```

(Label: P = Pole, F = Principal Focus, C = Centre of Curvature — all behind the mirror)

Source: Chapter 9, Section 9.2.2

Explanation

- Examiners expect **both definitions clearly stated** (1 mark each) and a **labelled diagram** (1 mark).
- Key point: the principal focus of a convex mirror is **virtual** — reflected rays only *appear* to diverge from F; they don't actually meet there.
- In the diagram, show the incident ray parallel to the principal axis, the reflected ray going outward, and a dotted line extended behind the mirror meeting at F. Label P, F, and C.
- Focal length for a convex mirror is taken as **positive** under New Cartesian Sign Convention.

Q68. § 9.1 REFLECTION OF LIGHT § 9.2 SPHERICAL MIRRORS **[4]**

> A highly polished surface such as a mirror reflects most of the light falling on it. In our daily life we use two types of mirrors — plane and spherical. The reflecting surface of a spherical mirror may be curved inwards or outwards. In concave mirrors, reflection takes place from the inner surface, while in convex mirrors reflection takes place from the outer surface.

Answer the following questions :

- **(a)** Define the principal axis of a concave mirror. [1]
- **(b)** A ray of light is incident on a concave mirror, parallel to its principal axis. If this ray after reflection from the mirror passes through the principal axis from a point at a distance of 10 cm from the pole of the mirror, find the radius of curvature of the mirror. [1]
- **(c)** Answer either (i) or (ii): [2]

Previously asked in: 2024 31/5/1 Q39

◆ **Light – Reflection and Refraction** | Focal length and radius of curvature of a concave mirror | Principal axis of a concave mirror | Reflection of light from concave mirrors – ray diagrams

Generated by claude-sonnet-4-6 · 2026-06-15 06:49 · grounding stimulus

It looks like sub-question **(c)** is incomplete — the two options **(i)** and **(ii)** were not included in your message. I'll answer **(a)** and **(b)** fully, and note the gap for **(c)**.

Model Answer

(a) The principal axis of a concave mirror is the straight line passing through the centre of curvature and the pole of the mirror.

(b) A ray parallel to the principal axis, after reflection from a concave mirror, passes through the **focus (F)**. Therefore, the focal length $f = 10$ cm.

$$R = 2f = 2 \times 10 = \mathbf{20\ cm}$$

The radius of curvature of the mirror is **20 cm**.

(c) *(The options (i) and (ii) were not provided in the question. Please share them so this part can be answered.)*

Source: Light – Reflection and Refraction, Spherical Mirrors

Explanation

- **For (a):** Examiners expect both reference points — the **pole** and the **centre of curvature** — to be mentioned for full marks.
- **For (b):** The key concept is that a ray parallel to the principal axis reflects through the **focus**. So the given 10 cm distance is the focal length, and $R = 2f$. Show the formula and calculation clearly.
- **For (c):** Once you share the options, the answer will be written to the full 2-mark length. Don't leave it blank in the actual exam.

Q69. § 9.2.1 Image Formation by Spherical Mirrors § 9.2.4 Mirror Formula and Magnification **[1]**

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 :

(A) – 15 cm
(B) – 20 cm
(C) + 20 cm
(D) + 15 cm

Previously asked in: 2025 31/2/1 Q12

◆ **Light – Reflection and Refraction** Mirror Formula and Focal Length of Concave Mirror

Generated by claude-sonnet-4-6 · 2026-06-15 06:48 · grounding rag

Model Answer

(B) – 20 cm

Using mirror formula: $u = -30$ cm, $v = -60$ cm (real image, in front of mirror).

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{-60} + \frac{1}{-30} = \frac{-1-2}{60} = \frac{-3}{60} = \frac{1}{-20}$$

So, $f = -20$ cm.

Explanation

Apply the mirror formula with correct signs (New Cartesian Sign Convention): object and real image both in front of the mirror, so both u and v are negative. A concave mirror always has a negative focal length. Students commonly make sign errors — always assign signs before substituting.

Q70. § 9.2.1 Image Formation by Spherical Mirrors § 9.2.4 Mirror Formula and Magnification § 9.3.7 Lens Formula and Magnification **[3]**

Answer the following:

(a) A ray of light after reflection from a concave mirror becomes parallel to its principal axis. Draw a labelled ray diagram to show this.

(b) (i) Differentiate between the virtual images formed by a convex mirror and concave mirror. (ii) "The value of magnification 'm' for a mirror is –2." Calculate the height of object if the height of image is 20 cm.

Previously asked in: 2026 31/5/1 Q36

◆ **Light – Reflection and Refraction** Mirror Formula and Magnification – Calculation of object/image height
Reflection from Concave Mirror – Ray Diagram (ray parallel to principal axis after reflection)
Virtual Images formed by Convex Mirror vs Concave Mirror – Comparison

Generated by claude-sonnet-4-6 · 2026-06-15 06:47 · grounding rag

Model Answer

(a) When a ray of light passes through the centre of curvature (C) of a concave mirror, it reflects back along the same path. But a ray directed towards the focus (F) reflects parallel to the principal axis.

Ray Diagram:

```
C F P
------------* -------→ (reflected ray, parallel to PA)
\ ↗
\/
(incident ray aimed at F)
```

(Label: C = Centre of curvature, F = Focus, P = Pole, PA = Principal Axis)

(b)(i)

Feature	Convex Mirror	Concave Mirror
Size of virtual image	Always diminished	Always enlarged
Object position	Any position	Between pole and focus

(b)(ii)

Given: m = –2, height of image (h′) = 20 cm

$$m = \frac{h'}{h} \Rightarrow -2 = \frac{20}{h} \Rightarrow h = \frac{20}{-2} = -10 \text{ cm}$$

Height of object = **10 cm** (negative sign indicates object is real/upright as per convention).

Explanation

- For (a), the key rule: a ray directed towards F of a concave mirror reflects parallel to the principal axis. Labelling C, F, P is essential for full marks.
- For (b)(i), examiners look for a clear comparative point — size difference is the most important distinguishing feature.
- For (b)(ii), use the formula m = h′/h directly. Note m = –2 means the image is real and inverted. The object height magnitude is 10 cm.

Available for free from:
https://cbsegrade10studyguide.com
https://github.com/orgs/cbse-free-resources/repositories