Answer Key – Class 12 Physics (Ray Optics: Concave & Convex Mirrors)

Scheme: 2 marks each. For numericals: (1) correct formula & substitution (1 mark), (2) correct value wit convention: object distances $u < 0$ (real objects), for **concave** $f < 0$, for **convex** $f > 0$. Relation: $R =$

Q1

(i) Pole (P): The geometric center of the reflecting surface of a spherical mirror.

(ii) Centre of curvature (C): The center of the sphere of which the mirror is a part; lies on the principal

Q2

Given: Concave mirror, $R = 60\,\text{cm}$.
Use: $R = 2f \Rightarrow f = \frac{R}{2}$. For concave, $f < 0$.
Work: $f = \frac{60}{2} = 30\,\text{cm} \Rightarrow f = -30\,\text{cm}$.

Ans: $f = -30\,\text{cm}$.

Q3

Given: Convex mirror, $R = 40\,\text{cm}$.
Use: $R = 2f \Rightarrow f = \frac{R}{2} = 20\,\text{cm}$, for convex $f > 0$.
Ans: $f = +20\,\text{cm}$.

Q4

Object beyond C (concave):

- **Construction (any two principal rays):** (1) Ray $\parallel$ axis $\rightarrow$ passes through F. (2) Ray through $C \rightarrow$
- **Image: Between C and F**, **real**, **inverted**, **diminished**.

Q5

Object at F (concave):

- **Construction:** Ray $\parallel$ axis $\rightarrow$ through F; ray through $F \rightarrow \parallel$ axis. The reflected rays are parallel.
- **Image: At infinity**, **real**, **inverted**, **highly enlarged**.

Q6

Object between F and P (concave):

- **Construction:** (1) Ray $\parallel$ axis $\rightarrow$ appears to pass from F after reflection. (2) Ray towards $C \rightarrow$ retra

- **Image: Behind the mirror**, **virtual**, **erect**, **magnified**.

Q7

Convex mirror (any object position):

- **Construction:** (1) Ray $\parallel$ axis $\to$ appears to come from F. (2) Ray towards $C \to$ appears to reflect b

- **Image: Behind the mirror**, **between P and F**, **virtual**, **erect**, **diminished**.

Q8

Given: Concave, $f = -15\,\text{cm}$, $u = -30\,\text{cm}$.
Formula: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$.
Work: $-\frac{1}{15} = \frac{1}{v} - \frac{1}{30} \Rightarrow \frac{1}{v} = -\frac{1}{30} \Rightarrow v = -30\,\text{cm}$.
Magnification: $m = -\frac{v}{u} = -\frac{-30}{-30} = -1$.

Ans: $v = -30\,\text{cm}$, $m = -1$ (real, inverted, same size).

Q9

Given: Concave, $v = -24\,\text{cm}$, $u = -36\,\text{cm}$.
Work: $\frac{1}{f} = \frac{1}{-24} + \frac{1}{-36} = -\left(\frac{1}{24} + \frac{1}{36}\right) = -\frac{5}{72} \Rightarrow f = -\frac{72}{5} = -14.4\,\text{cm}$.

Ans: $f = -14.4\,\text{cm}$.

Q10

Given: Convex, $f = +20\,\text{cm}$, $u = -40\,\text{cm}$.
Work: $\frac{1}{20} = \frac{1}{v} - \frac{1}{40} \Rightarrow \frac{1}{v} = \frac{3}{40} \Rightarrow v = \frac{40}{3} \approx +13.3\,\text{cm}$ (behind mirror).
Magnification: $m = -\frac{v}{u} = -\frac{+13.3}{-40} \approx +0.33$.

Ans: $v = +13.3\,\text{cm}$, $m \approx +0.33$ (virtual, erect, diminished).

Q11

Given: Convex, image half the size: $|m| = \frac{1}{2}$ (virtual $\to m = +\frac{1}{2}$), $u = -30\,\text{cm}$.
Use: $m = -\frac{v}{u} = +\frac{1}{2} \Rightarrow \frac{v}{30} = \frac{1}{2} \Rightarrow v = +15\,\text{cm}$.
Find f: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{15} - \frac{1}{30} = \frac{1}{30} \Rightarrow f = +30\,\text{cm}$.

Ans: $v = +15\,\text{cm}$, $f = +30\,\text{cm}$.

Q12

Given: Concave, real image 3× the size $\to m = -3$, $f = -10\,\text{cm}$.
Use: $m = -\frac{v}{u} = -3 \Rightarrow v = 3u$. And $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{3u} + \frac{1}{u} = \frac{4}{3u}$.

Solve: $\frac{1}{-10} = \frac{4}{3u} \Rightarrow u = \frac{4f}{3} = \frac{4(-10)}{3} = -\frac{40}{3} \approx -13.3\,\text{cm}$.

Then $v = 3u = -40\,\text{cm}$ (check: gives $f = -10\,\text{cm}$).

Ans: $u \approx -13.3\,\text{cm}$; image at $v = -40\,\text{cm}$, real, inverted, enlarged 3×.

Teacher Notes (optional):

- Award full credit for correct sign and magnitude; half if magnitude correct but sign missing/incorr
- Ray-diagram questions: Accept clear, labeled sketches with P, F, C, principal axis, and at least two nature/position.