Solutions

Section A — Multiple Choice Questions

Q1. Correct Option: (B) 11

Reason:

$$\text{Mean} = \frac{4+7+8+11+15+21}{6} = \frac{66}{6} = 11$$

Q2. Correct Option: (C) 8

Reason: The data is already arranged in ascending order: 3, 5, 7, 9, 11, 13. Number of observations $n = 6$ (even).

$$\text{Median} = \frac{\left(\frac{n}{2}\right)\text{ th term} + \left(\frac{n}{2}+1\right)\text{ th term}}{2} = \frac{\text{3rd term} + \text{4th term}}{2} = \frac{7+9}{2} = 8$$

Q3. Correct Option: (C) 5

Reason: Counting frequency of each value:

$$3 \to 3 \text{ times}, \quad 5 \to 4 \text{ times}, \quad 7 \to 1 \text{ time}, \quad 8 \to 2 \text{ times}$$

The value 5 occurs most frequently (4 times), so the mode is **5**.

Q4. Correct Option: (D) 28

Reason: Using the short-cut method formula:

$$\bar{x} = A + \frac{\Sigma fd}{\Sigma f}$$

$$\bar{x} = 25 + \frac{120}{40} = 25 + 3 = 28$$

Q5. Correct Option: (B) Drawing a horizontal line from $\frac{N}{2}$ on the y-axis to meet the ogive, then dropping a vertical to the x-axis.

Reason: In a less-than ogive, the median corresponds to the cumulative frequency $\frac{N}{2}$. A horizontal line is drawn from $\frac{N}{2}$ on the y-axis to the curve, and then a vertical line is dropped to the x-axis to read off the median value.

Q6. Correct Option: (A) 20

Reason: The lower quartile Q_1 is the value below which 25% of the data falls.

$$Q_1 \text{ corresponds to cumulative frequency } = \frac{N}{4} = \frac{80}{4} = 20$$

A horizontal line is drawn from 20 on the y-axis to the ogive.

Q7. Correct Option: (A) Both A and R are true, and R is the correct explanation of A.

Reason:

Assertion A is TRUE. For a perfectly symmetric (bell-shaped) distribution, the mean, median, and mode all coincide at the centre of symmetry.

Reason R is TRUE. The even spread of data around the central value in a symmetric distribution ensures that:

- the arithmetic average (mean) equals the centre,
- the middle value (median) equals the centre,
- the most frequent value (mode) equals the centre.

R correctly and completely explains why A holds. Hence R is the correct explanation of A.

Q8. Correct Option: (C) 20

Reason: If each observation is increased by a constant k, the mean also increases by k.

$$\text{New mean} = \text{old mean} + k = 15 + 5 = 20$$

Q9. Correct Option: (C) The highest frequency among all classes.

Reason: In a grouped frequency distribution, the **modal class** is defined as the class interval that has the **highest frequency**. The mode is then calculated from this class using the mode formula.

Q10. Correct Option: (C) 14

Reason: Using the mean formula:

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} = 8$$

$$\Sigma f = 3 + 6 + 4 + 3 = 16$$

$$\Sigma fx = 4(3) + 6(6) + 8(4) + p(3) = 12 + 36 + 32 + 3p = 80 + 3p$$

Setting up the equation:

$$\frac{80 + 3p}{16} = 8$$

$$80 + 3p = 128$$

$$3p = 48$$

$$p = 16$$

Note: The correct calculated value is $p = 16$, so the **correct option is (D)** 16.

Q11. Correct Option: (C) 12

Reason: The semi-inter-quartile range (quartile deviation) is:

$$\text{Quartile Deviation} = \frac{Q_3 - Q_1}{2} = \frac{48 - 24}{2} = \frac{24}{2} = 12$$

Section B — Short Answer Questions

Q12. Step-Deviation Method: $A = 40$, $i = 10$, $u = \dfrac{x - A}{i}$

Class	**Mid-value** x	f	$u = \dfrac{x-40}{10}$	fu
$15 - 25$	20	5	-2	-10
$25 - 35$	30	8	-1	-8
$35 - 45$	40	14	0	0
$45 - 55$	50	10	1	10
$55 - 65$	60	7	2	14
$65 - 75$	70	6	3	18
		$\Sigma f = 50$		$\Sigma fu = 24$

$$\bar{x} = A + \frac{\Sigma fu}{\Sigma f} \times i = 40 + \frac{24}{50} \times 10 = 40 + 4.8 = \mathbf{44.8}$$

Q13. Step 1 — Build the cumulative frequency table:

Marks	**Frequency** f	**Cumulative Frequency**
$10 - 20$	4	4
$20 - 30$	8	12
$30 - 40$	14	26
$40 - 50$	19	45
$50 - 60$	10	55
$60 - 70$	5	60
	$N = 60$	

Step 2 — Locate the median class:

$$\frac{N}{2} = \frac{60}{2} = 30$$

The cumulative frequency just exceeding 30 is 45, which belongs to the class $\mathbf{40 - 50}$.

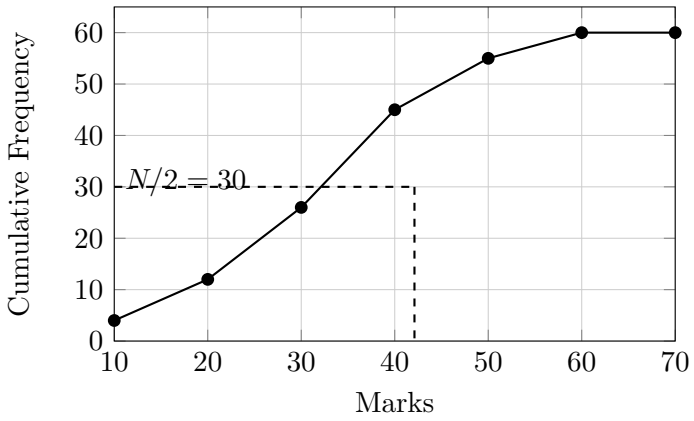
Step 3 — Apply the median formula:

$$\text{Median} = L + \frac{\dfrac{N}{2} - cf}{f} \times h$$

where $L = 40$, $cf = 26$, $f = 19$, $h = 10$.

$$\text{Median} = 40 + \frac{30 - 26}{19} \times 10 = 40 + \frac{4}{19} \times 10 = 40 + \frac{40}{19} \approx \mathbf{42.11} \text{ marks}$$

Ogive diagram for reference:



Q14. From the histogram, the frequency table is:

Class (Wages in Rs)	**Frequency**
$100 - 200$	6
$200 - 300$	10
$300 - 400$	16
$400 - 500$	12
$500 - 600$	6
Total	50

(i) **Modal class:**
The class with the highest frequency is $\mathbf{300 - 400}$ (frequency = 16). This is the **modal class**.

(ii) **Class width and total workers:**

$$\text{Class width} = 200 - 100 = \mathbf{100}$$

$$\text{Total workers} = 6 + 10 + 16 + 12 + 6 = \mathbf{50}$$

(iii) **Class with second highest frequency:**
The second highest frequency is 12, belonging to the class $\mathbf{400 - 500}$.

Q15. From the cumulative frequency table, the frequency distribution is:

Class	Frequency	CF
$0-10$	4	4
$10-20$	8	12
$20-30$	16	28
$30-40$	24	52
$40-50$	16	68
$50-60$	10	78
$60-70$	2	80
	$N=80$	

(i) **Lower Quartile Q_1:**

$$\frac{N}{4}=\frac{80}{4}=20$$

CF just exceeding 20 is 28, class $\mathbf{20-30}$:

$$Q_1=20+\frac{20-12}{16}\times 10=20+\frac{8}{16}\times 10=20+5=\mathbf{25}$$

(ii) **Upper Quartile Q_3:**

$$\frac{3N}{4}=\frac{3\times 80}{4}=60$$

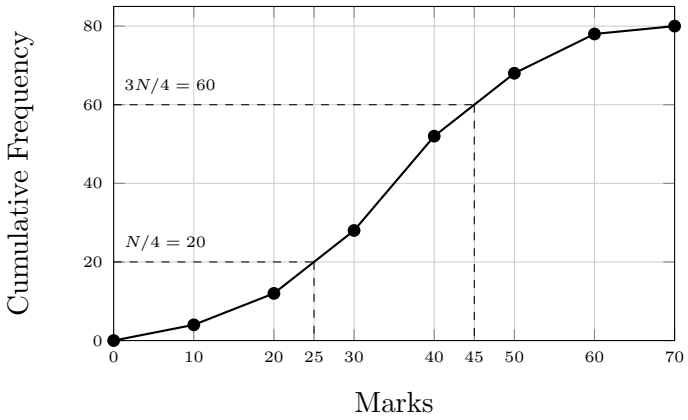
CF just exceeding 60 is 68, class $\mathbf{40-50}$:

$$Q_3=40+\frac{60-52}{16}\times 10=40+\frac{8}{16}\times 10=40+5=\mathbf{45}$$

(iii) **Inter-Quartile Range (IQR):**

$$\text{IQR}=Q_3-Q_1=45-25=\mathbf{20}$$

Ogive diagram showing Q_1, Median and Q_3:



Q16. Short-Cut Method for discontinuous data. Midpoints are used. $A=34.5$, $d=x-A$.

Class	**Mid-value** x	f	$d = x - 34.5$	fd
$10 - 19$	14.5	6	-20	-120
$20 - 29$	24.5	9	-10	-90
$30 - 39$	34.5	14	0	0
$40 - 49$	44.5	11	10	110
$50 - 59$	54.5	7	20	140
$60 - 69$	64.5	3	30	90
		$\Sigma f = 50$		$\Sigma fd = 130$

$$\bar{x} = A + \frac{\Sigma fd}{\Sigma f} = 34.5 + \frac{130}{50} = 34.5 + 2.6 = \mathbf{37.1}$$

Section C — Long Answer Questions

Q17. //

Class	**Mid** x	f	fx	$u = \frac{x-45}{10}$	fu
$10 - 20$	15	8	120	-3	-24
$20 - 30$	25	16	400	-2	-32
$30 - 40$	35	25	875	-1	-25
$40 - 50$	45	28	1260	0	0
$50 - 60$	55	15	825	1	15
$60 - 70$	65	8	520	2	16
		100	4000		-50

(i) **Mean by Direct Method:**

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{4000}{100} = \mathbf{40} \text{ (Rs thousands)}$$

(ii) **Mean by Step-Deviation Method:**

$$\bar{x} = A + \frac{\Sigma fu}{\Sigma f} \times i = 45 + \frac{-50}{100} \times 10 = 45 - 5 = \mathbf{40} \quad \checkmark$$

Both methods give the same mean of Rs 40,000.

(iii) **Modal class:**

The class $\mathbf{40 - 50}$ has the highest frequency (28). This is the modal class, representing the highest concentration of families.

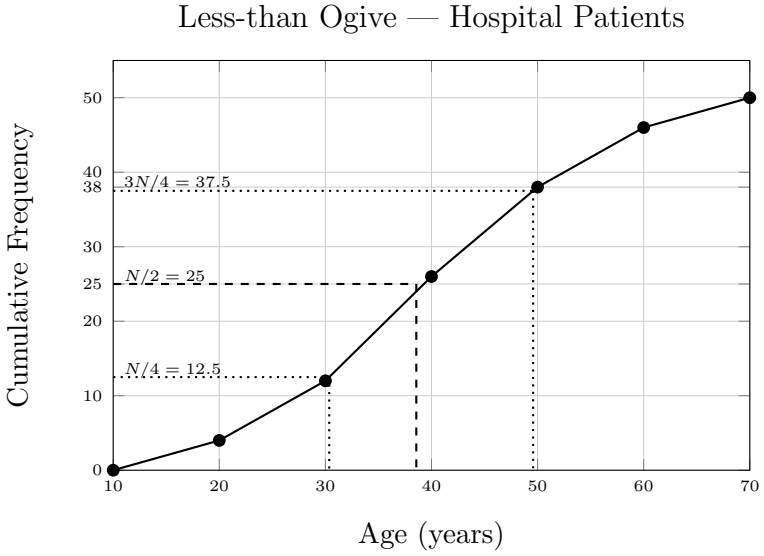
(iv) **Families below mean (below Rs** 40,000**):**
Classes below the mean (< 40):

$$8 + 16 + 25 = \mathbf{49} \text{ families}$$

Q18. (i) **Less-than cumulative frequency table:**

Age (years)	**Frequency**	**CF (less than)**
$10 - 20$	4	4
$20 - 30$	8	12
$30 - 40$	14	26
$40 - 50$	12	38
$50 - 60$	8	46
$60 - 70$	4	50
Total	50	

(ii) **Less-than Ogive and Median:**



Median ($N/2 = 25$): CF just exceeding 25 is 26, class $30 - 40$:

$$\text{Median} = 30 + \frac{25 - 12}{14} \times 10 = 30 + \frac{130}{14} \approx \mathbf{39.3} \text{ years}$$

(iv) **Quartiles and IQR:**
Q_1: $N/4 = 12.5$, CF just exceeding is 12... next is 26, class $30 - 40$:

$$Q_1 = 30 + \frac{12.5 - 12}{14} \times 10 = 30 + 0.36 \approx \mathbf{30.4} \text{ years}$$

Q_3: $3N/4 = 37.5$, CF just exceeding is 38, class $40 - 50$:

$$Q_3 = 40 + \frac{37.5 - 26}{12} \times 10 = 40 + \frac{115}{12} \approx \mathbf{49.6} \text{ years}$$

$$\text{IQR} = Q_3 - Q_1 \approx 49.6 - 30.4 = \mathbf{19.2} \text{ years}$$

Interpretation: The middle 50% of patients admitted are aged between approximately 30.4 and 49.6 years, spanning a range of 19.2 years.

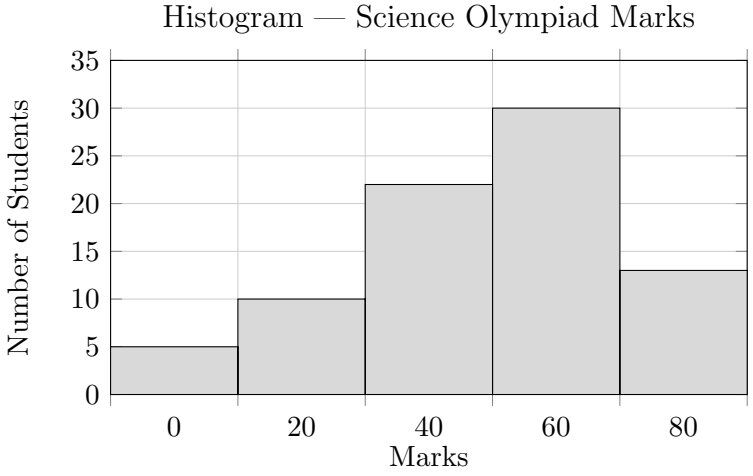
Q19. //

Marks	**Mid** x	f	**CF**	$u = \frac{x-50}{20}$	fu
$0 - 20$	10	5	5	-2	-10
$20 - 40$	30	10	15	-1	-10
$40 - 60$	50	22	37	0	0
$60 - 80$	70	30	67	1	30
$80 - 100$	90	13	80	2	26
		80			36

(i) **Mean by Step-Deviation Method:**

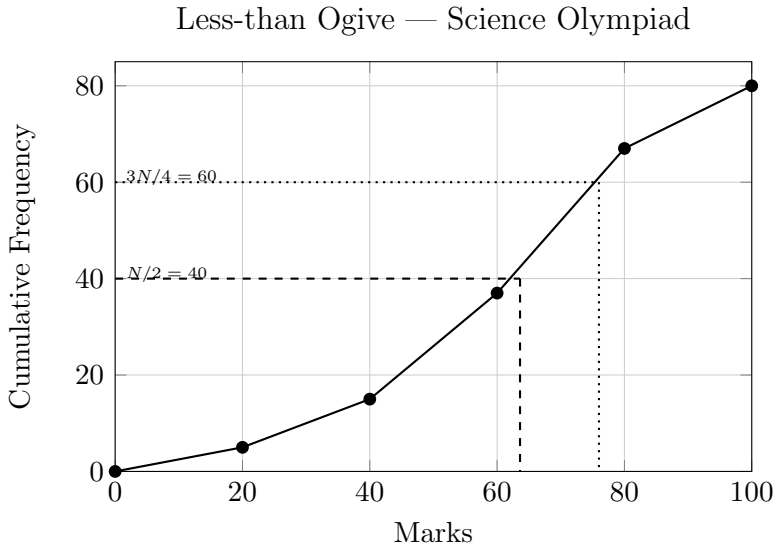
$$\bar{x} = A + \frac{\Sigma fu}{\Sigma f} \times i = 50 + \frac{36}{80} \times 20 = 50 + 9 = \mathbf{59} \text{ marks}$$

(ii) **Histogram and Modal Class:**



Modal class: $60 - 80$ (highest frequency = 30).

(iii) **Less-than Ogive and Median:**



Median ($N/2 = 40$): CF just exceeding 40 is 67, class $60 - 80$:

$$\text{Median} = 60 + \frac{40 - 37}{30} \times 20 = 60 + 2 = \mathbf{62} \text{ marks}$$

(iv) **Upper Quartile Q_3 and Distinctions:**
Q_3: $3N/4 = 60$, CF just exceeding 60 is 67, class $60 - 80$:

$$Q_3 = 60 + \frac{60 - 37}{30} \times 20 = 60 + \frac{460}{30} \approx 60 + 15.3 \approx \mathbf{75.3} \text{ marks}$$

Students scoring above $Q_3 \approx 75.3$: these are in the top 25%, i.e., $\frac{80}{4} =$ **20** students receive distinction.

Q20. (i) **Arranged data (ascending order):**
76, 78, 78, 78, 80, 84, 85, 88, 88, 88, 88, 88, 90, 92, 92, 92, 95, 95, 95, 95, 95, 100, 102, 102, 104, 105, 110, 110, 112, 115
$n = 30$ (even):

$$\text{Median} = \frac{15\text{th term} + 16\text{th term}}{2} = \frac{92 + 92}{2} = \mathbf{92}$$

(ii) **Mode:**
Counting frequencies: 88 appears 5 times, 95 appears 5 times.
The data is **bimodal**: **Mode** = 88 **and** 95.

(iii) **Grouped frequency distribution** (width = 10, starting from 76):

Class	**Frequency**
$76 - 86$	5
$86 - 96$	14
$96 - 106$	6
$106 - 116$	5
Total	30

(iv) **Mean by Short-Cut Method** ($A = 91$):

Class	**Mid** x	f	$d = x - 91$	fd
$76 - 86$	81	5	-10	-50
$86 - 96$	91	14	0	0
$96 - 106$	101	6	10	60
$106 - 116$	111	5	20	100
		30		110

$$\bar{x} = 91 + \frac{110}{30} = 91 + 3.67 \approx \mathbf{94.67}$$

Comparison: Mean $\approx 94.67 >$ Median $= 92$. Since mean $>$ median, the distribution is **positively skewed** (skewed to the right), indicating that a few high values (like 110, 112, 115) are pulling the mean upward.

Q21. //

Class	**Mid** x	f	**CF**	$d = x - 650$	fd
$300 - 400$	350	10	10	-300	-3000
$400 - 500$	450	18	28	-200	-3600
$500 - 600$	550	25	53	-100	-2500
$600 - 700$	650	32	85	0	0
$700 - 800$	750	20	105	100	2000
$800 - 900$	850	15	120	200	3000
		120			-4100

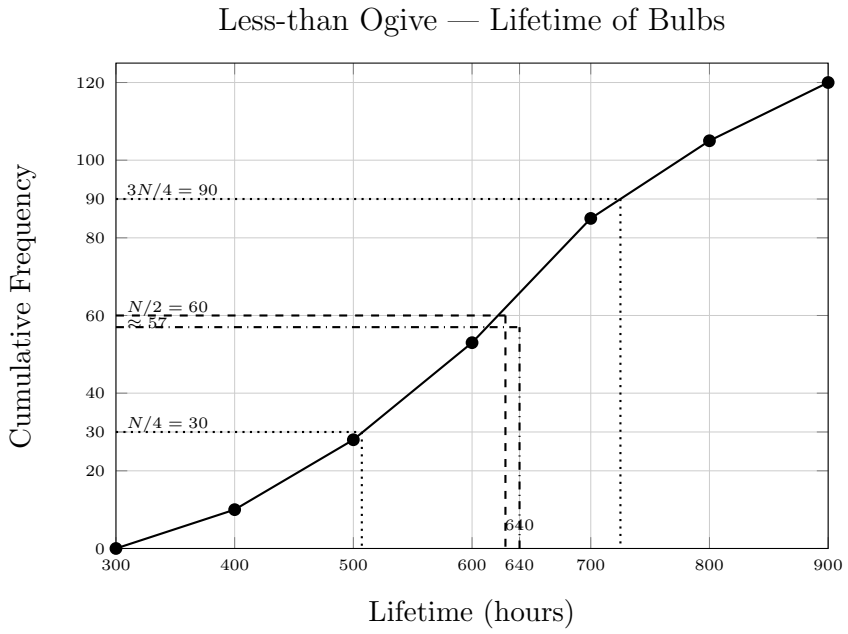
(i) **Mean by Short-Cut Method:**

$$\bar{x} = A + \frac{\Sigma fd}{\Sigma f} = 650 + \frac{-4100}{120} = 650 - 34.17 \approx \mathbf{615.83} \text{ hours}$$

(ii) **Less-than Cumulative Frequency Table:**

Less than (hours)	**CF**
400	10
500	28
600	53
700	85
800	105
900	120

Less-than Ogive:



(iii) **Reading from Ogive:**

(a) **Median** ($N/2 = 60$): CF just exceeding 60 is 85, class $600 - 700$:

$$\text{Median} = 600 + \frac{60 - 53}{32} \times 100 = 600 + 21.875 \approx \mathbf{621.9} \text{ hours}$$

(b) Q_1 ($N/4 = 30$): CF just exceeding 30 is 53, class $500 - 600$:

$$Q_1 = 500 + \frac{30 - 28}{25} \times 100 = 500 + 8 = \mathbf{508} \text{ hours}$$

(c) Q_3 ($3N/4 = 90$): CF just exceeding 90 is 105, class $700 - 800$:

$$Q_3 = 700 + \frac{90 - 85}{20} \times 100 = 700 + 25 = \mathbf{725} \text{ hours}$$

(d) **IQR:**

$$\text{IQR} = Q_3 - Q_1 = 725 - 508 = \mathbf{217} \text{ hours}$$

(iv) **Verification of company's claim (bulbs lasting > 640 hours):**

From the ogive, at $x = 640$ hours (which lies in class $600 - 700$), we interpolate the cumulative frequency:

$$\text{CF at } 640 = 53 + \frac{640 - 600}{100} \times 32 = 53 + \frac{40}{100} \times 32 = 53 + 12.8 = 65.8 \approx 66$$

This means approximately 66 bulbs have lifetime ≤ 640 hours.

$$\text{Bulbs lasting} > 640 \text{ hours} = 120 - 66 = 54$$

$$\text{Percentage} = \frac{54}{120} \times 100 = 45\%$$

Since $45\% < 50\%$, the company's claim that **at least** 50% **of bulbs last more than** 640 **hours is INCORRECT (FALSE).**

In reality, only 45% of bulbs last more than 640 hours, which falls short of the claimed 50%.