Example 17   ◄⑨ **Self Tutor**

The data shows the results of the women's marathon at the 2008 Olympics, for all competitors who finished the race.

a Construct a cumulative frequency distribution table.

b Represent the data on a cumulative frequency graph.

c Use your graph to estimate the:

  i median finishing time

  ii number of competitors who finished in less than 2 hours 35 minutes

  iii percentage of competitors who took more than 2 hours 39 minutes to finish

  iv time taken by a competitor who finished in the top 20% of runners completing the marathon.
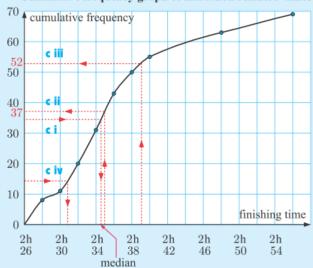
Finishing time t	Frequency
2 h 26 $\leqslant t <$ 2 h 28	8
2 h 28 $\leqslant t <$ 2 h 30	3
2 h 30 $\leqslant t <$ 2 h 32	9
2 h 32 $\leqslant t <$ 2 h 34	11
2 h 34 $\leqslant t <$ 2 h 36	12
2 h 36 $\leqslant t <$ 2 h 38	7
2 h 38 $\leqslant t <$ 2 h 40	5
2 h 40 $\leqslant t <$ 2 h 48	8
2 h 48 $\leqslant t <$ 2 h 56	6

a

Finishing time t	Frequency	Cumulative frequency
2 h 26 $\leqslant t <$ 2 h 28	8	8
2 h 28 $\leqslant t <$ 2 h 30	3	11
2 h 30 $\leqslant t <$ 2 h 32	9	20
2 h 32 $\leqslant t <$ 2 h 34	11	31
2 h 34 $\leqslant t <$ 2 h 36	12	43
2 h 36 $\leqslant t <$ 2 h 38	7	50
2 h 38 $\leqslant t <$ 2 h 40	5	55
2 h 40 $\leqslant t <$ 2 h 48	8	63
2 h 48 $\leqslant t <$ 2 h 56	6	69

← $8 + 3 = 11$ competitors completed the marathon in less than 2 hours 30 minutes.

← 50 competitors completed the marathon in less than 2 hours 38 minutes.

b

Cumulative frequency graph of marathon runners' times

The cumulative frequency gives a *running total* of the number of runners finishing by a given time.

c **i** The median is estimated using the 50th percentile. As 50% of 69 is 34.5, we start with the cumulative frequency of 34.5 and find the corresponding time.
The median is approximately 2 hours 34.5 min.

   ii There are approximately 37 competitors who took less than 2 h 35 min to complete the race.

   iii There are $69 - 52 = 17$ competitors who took more than 2 hours 39 min.
So $\frac{17}{69} \approx 26.4\%$ took more than 2 hours 39 min.

   iv The time taken is estimated using the 20th percentile. As 20% of 69 is 13.8, we find the time corresponding to a cumulative frequency of approximately 14.
The top 20% of competitors took less than 2 hours 31 minutes.