Q1.   The equation

$$x^3 + 4x = 26$$

has a solution between 2 and 3
Use a trial and improvement method to find this solution.
Give your answer correct to 1 decimal place.
You **must** show all your working.

$x = $ ....

(Total 4 marks)

Q2.   The equation

$$x^3 + 2x = 26$$

has a solution between 2 and 3

Use a trial and improvement method to find this solution.
Give your answer correct to one decimal place.
You must show **all** your working.

x = ...

(Total 4 marks)

Q3.   The equation

$$x^3 + 20x = 71$$

has a solution between 2 and 3

Use a trial and improvement method to find this solution.
Give your answer correct to one decimal place.
You must show **ALL** your working.

x = ...

(Total 4 marks)

Q4.   The equation $x^3 - 5x = 60$ has a solution between 4 and 5.

Find this solution and give your answer correct to 1 decimal place.
You must show **all** your working.

x = ...

(Total 4 marks)

M1.

Working	Answer	Mark	Additional Guidance
$2 \rightarrow 16$ $3 \rightarrow 39$ $2.5 \rightarrow 25.(625)$ $2.1 \rightarrow 17.(661)2.6 \rightarrow 27.(976)$ $2.2 \rightarrow 19.(448)2.7 \rightarrow 30.(483)$ $2.3 \rightarrow 21.(367)2.8 \rightarrow 33.(152)$ $2.4 \rightarrow 23.(424)2.9 \rightarrow 35.(989)$ $2.51 \rightarrow 25.8(53)2.54 \rightarrow 26.5(47)$ $2.52 \rightarrow 26.0(83)2.55 \rightarrow 26.7(813)$ $2.53 \rightarrow 26.3(14)$	2.5	4	**B2** for trial between 2.5 and 2.6 inclusive (**B1** for a trial between 2 and 3 inclusive) **B1** for a different trial between 2.51 and 2.55 inclusive **B1** (dep on at least one previous **B1**) for 2.5 only NB trials where x has 1 d.p. should be rounded or truncated to at least 2SF; trials where x has 2 d.p. should be rounded or truncated to at least 3SF
			Total for Question: 4 marks

M2.

Working	Answer	Mark	Additional Guidance
$2 \rightarrow 12$ $3 \rightarrow 332.5 \rightarrow 20.(625)$ $2.1 \rightarrow 13.(461)2.6 \rightarrow 22.(776)$ $2.2 \rightarrow 15.(048)2.7 \rightarrow 25.(083)$ $2.3 \rightarrow 16.(767)2.8 \rightarrow 27.(5(52)$ $2.4 \rightarrow 18.(624)2.9 \rightarrow 30.(189)$ $2.73 \rightarrow 25.8(06)\mathbf{2.74 \rightarrow 26.0(508)\ or\ 26 \leftarrow}$ $2.75 \rightarrow 26.2(96)2.76 \rightarrow 26.5(45)$	2.7	4	**B2** for trial between 2.7 and 2.8 inclusive (**B1** for trial between 2 and 3 inclusive) **B1** for different trial between 2.73 and 2.75 inclusive **B1** (dep on at least one previous **B1**) for 2.7 only NB trials where x has 1 d.p should be rounded or truncated to at least 2SF; trials where x has 2 d.p. or more should be

				rounded or truncated to at least 3SF
				Total for Question: 4 marks

M3.

Working		Answer	Mark	Additional Guidance
2	48	2.6	4	**B2** for trial 2.6 ≤ x ≤ 2.7 evaluated
3	87			(**B1** for trial 2 ≤ x ≤ 3 evaluated)
2.5	65.(625)			
2.6	69.(576)			**B1** for different trial 2.6 < x ≤ 2.65
2.7	73.(683)			
2.65	71.6(09)			**B1**(dep on at least one previous **B1**) for 2.6
2.61	69.9(79)			
2.62	70.3(84)			Values evaluated can be rounded or truncated, but
2.63	70.7(91)			to at least 2sf when x has 1dp and 3sf when x has
2.64	71.1(99)			2dp
2.66	72.(021)			
2.67	72.4(34)			**NB** Allow 72 for evaluation using x = 2.66
2.68	72.8(48)			
2.69	73.2(65)			**NB** No working scores no marks even if answer is correct
				Total for Question: 4 marks

M4.

Working	Answer	Mark	Additional Guidance
f(x) =	4.3	4	**B2** for trial between 4.3 and 4.4 inclusive

x	$x^3 - 5x$
4.00	44.00
4.10	48.42
4.20	53.09
4.30	58.01
4.40	63.18
	68.62
or	
4.50	68.63
4.60	74.34
4.70	80.32
4.80	86.59
4.90	93.15
5.00	100.00
4.35	60.56

(B1 for trial between 4 and 5 inclusive)

B1 for different trial between 4.33 and 4.37 inclusive

B1 (dep on at least one previous B1) for 4.3 only

NB trials where x has 1 d.p should be rounded or truncated to at least

2 SF; trials where x has 2 d.p. or more should be rounded or truncated to at least 3 SF

Total for Question: 4 marks

E1.   Solving an equation by trial and improvement is a technique that should have been well practised by candidates and this question was answered well with many candidates gaining at least 3 of the 4 marks. Most carried out trials at 2.5 and 2.6 but a significant number of candidates then chose the value that gave an answer closest to 26 and did not carry out a trial between 2.5 and 2.6. Some of those who did carry out at least one further trial between 2.5 and 2.6 (most often at 2.55) then failed to give the final answer correct to 1 decimal place as instructed.

E2.   This was a standard trial and improvement question. Most candidates scored marks on it. Responses tended to come in 4 groups:

•   An answer of 2.7, including a trial at 2.75 – scoring 4 marks

•   An answer of 2.7, without a trial at 2.75 or equivalent – 3 marks

•   An answer of 2.8 with some correct working – 1/2 marks

•   A bizarre or incomplete answer

Many candidates still test the value of the function at $x = 2.7$ and at $x = 2.8$ and compare these values with 26. This is mathematically unsound and is worth a demonstration to students why.

On the positive side, nearly all candidates could work out the value of the cubic correctly for several values of x and many of these candidates worked fairly systematically recording values in a table. The most common error was to forget to change the value of the x term as x changed or to give the value of x as 2.74 or 2.73.
Some candidates still choose to ignore the instructions and do not write down the values of the cubic – they score no marks.

E3.   Specification A

While it was pleasing to see that most candidates now have a good grasp of this part of the syllabus and consequently scored well on this question there is still a lack of understanding for the need to calculate a value for $x = 2.65$ (or between 2.6 and 2.65).

Candidates need to be taught that evaluating at 2.6 and 2.7 and finding out which is nearer to 71 is incorrect mathematically. Failure to round their answer to 2.6 was also common, many trying to 'do better' than 1dp.

Specification B

A standard trial and improvement question which most of the candidature were able to show some method on. The setting out of the trials was generally good, making it a lot easier for markers to award marks and also for candidates to follow their own progress towards the root. As usual, many candidates got 3 out of the 4 marks for trials at 2.6, 2.7 and then putting down 2.6 as it gives a trial closer to 71. However, many candidates knew they had to evaluate a trial at 2.65 bad picked up all 4 marks. Some candidates did further trials and wrote down (often wrong) answers correct to 2 or more decimal places. They were not awarded the final mark as they had not demonstrated they fully understood the logic of the algorithm, which should be based on the bisection method or on decimal search.