Answer 1:

10. Attempting to solve $\left|0.1x^2 - 2x + 3\right| = \log_{10} x$ numerically or graphically. *(M1)*

$x = 1.52, 1.79$ *(A1)(A1)*

$x = 17.6, 19.1$ *(A1)*

$(1.52 < x < 1.79) \cup (17.6 < x < 19.1)$ *A1A1*   *N2*

[6 marks]

Answer 2:

3. $86.4 = 50r^3$ *(A1)*

$r = 1.2 \left(= \sqrt[3]{\dfrac{86.4}{50}} \right)$ seen anywhere *(A1)*

$\dfrac{50\left(1.2^n - 1\right)}{0.2} > 33500$ OR $250\left(1.2^n - 1\right) = 33500$ *(A1)*

attempt to solve their geometric S_n inequality or equation *(M1)*

sketch OR $n > 26.9045$, $n = 26.9$ OR $S_{26} = 28368.8$ OR $S_{27} = 34092.6$ OR algebraic manipulation involving logarithms

$n = 27$ (accept $n \geq 27$) *A1*

Total [5 marks]

Answer 3:

5. (a) $u_1 = S_1 = \dfrac{2}{3} \times \dfrac{7}{8}$ **(M1)**

$= \dfrac{14}{24} \left(= \dfrac{7}{12} = 0.583333... \right)$ **A1**

[2 marks]

(b) $r = \dfrac{7}{8} \left(= 0.875 \right)$ **(A1)**

substituting their values for u_1 and r into $S_\infty = \dfrac{u_1}{1-r}$ **(M1)**

$= \dfrac{14}{3} \left(= 4.66666... \right)$ **A1**

[3 marks]

(c)   attempt to substitute their values into the inequality or formula for S_n **(M1)**

$$\dfrac{14}{3} - \sum_{r=1}^{n} \dfrac{2}{3} \left(\dfrac{7}{8} \right)^r < 0.001 \ \text{ OR } \ S_n = \dfrac{\dfrac{7}{12} \left(1 - \left(\dfrac{7}{8} \right)^n \right)}{\left(1 - \dfrac{7}{8} \right)}$$

attempt to solve their inequality using a table, graph or logarithms
(must be exponential)   **(M1)**

> **Note:** Award **(M0)** if the candidate attempts to solve $S_\infty - u_n < 0.001$.

correct critical value or at least one correct crossover value   **(A1)**

$63.2675...$ OR $S_\infty - S_{63} = 0.001036...$ OR $S_\infty - S_{64} = 0.000906...$

OR $S_\infty - S_{63} - 0.001 = 0.0000363683...$ OR $S_\infty - S_{64} - 0.001 = -0.0000931777...$

least value is $n = 64$ **A1**

[4 marks]

Total [9 marks]

Answer 4:

2. (a) $\left(1+\dfrac{5.5}{4\times100}\right)^4$ *(M1)(A1)*

     1.056   *A1*

                                  [3 marks]

(b) **EITHER**

$2P = P\times\left(1+\dfrac{5.5}{100\times4}\right)^{4n}$ **OR** $2P = P\times\left(\text{their }(a)\right)^m$ *(M1)(A1)*

Note: Award *(M1)* for substitution into loan payment formula. Award *(A1)* for correct substitution.

OR

$PV = \pm1$
$FV = \mp2$
$I\% = 5.5$
$P/Y = 4$
$C/Y = 4$
$n = 50.756\ldots$ *(M1)(A1)*

OR

$PV = \pm1$
$FV = \mp2$
$I\% = 100\left(\text{their }(a)-1\right)$
$P/Y = 1$
$C/Y = 1$ *(M1)(A1)*

THEN

$\Rightarrow 12.7$ years
Laurie will have double the amount she invested during 2032   *A1*

                                    [3 marks]

                               Total [6 marks]

Answer 5:

(a) $f(-x) = \dfrac{3(-x)^2 + 10}{(-x)^2 - 4}$ **A1**

$= \dfrac{3x^2 + 10}{x^2 - 4} = f(x)$

$f(x) = f(-x)$ **R1**

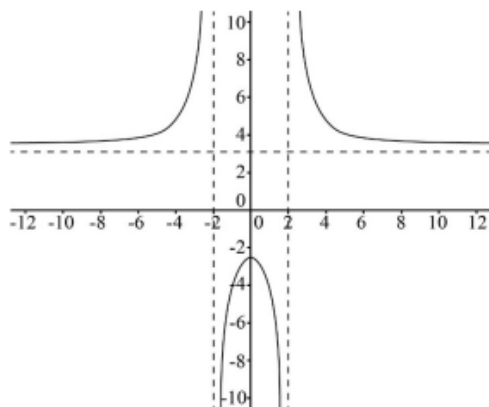hence this is an even function   **AG**

Note: Award **A1R1** for the statement, all the powers are even hence $f(x) = f(-x)$.

Note: Just stating all the powers are even is **A0R0**.

Note: Do not accept arguments based on the symmetry of the graph.

[2 marks]

(b)   (i)

correct shape in 3 parts which are asymptotic and symmetrical   **A1**
correct vertical asymptotes clear at 2 and −2   **A1**
correct horizontal asymptote clear at 3   **A1**

(ii) $f(x) > 3$ **A1**
       $f(x) \le -2.5$ **A1**

[5 marks]

Total [7 marks]

Answer 6:

6. **(a)** **METHOD 1**

$$(p+q)^3 - 3pq(p+q) \equiv p^3 + q^3$$

attempts to expand $(p+q)^3$ **M1**

$$p^3 + 3p^2q + 3pq^2 + q^3$$

$$(p+q)^3 - 3pq(p+q) \equiv p^3 + 3p^2q + 3pq^2 + q^3 - 3pq(p+q)$$

$$\equiv p^3 + 3p^2q + 3pq^2 + q^3 - 3p^2q - 3pq^2$$ **A1**

$$\equiv p^3 + q^3$$ **AG**

> **Note:** Condone the use of equals signs throughout.

METHOD 2

$$(p+q)^3 - 3pq(p+q) \equiv p^3 + q^3$$

attempts to factorise $(p+q)^3 - 3pq(p+q)$ **M1**

$$\equiv (p+q)\left((p+q)^2 - 3pq\right) \ \left(\equiv (p+q)(p^2 - pq + q^2)\right)$$

$$\equiv p^3 - p^2q + pq^2 + p^2q - pq^2 + q^3$$ **A1**

$$\equiv p^3 + q^3$$ **AG**

> **Note:** Condone the use of equals signs throughout.

METHOD 3

$$p^3 + q^3 \equiv (p+q)^3 - 3pq(p+q)$$

attempts to factorise $p^3 + q^3$ **M1**

$$\equiv (p+q)(p^2 - pq + q^2)$$

$$\equiv (p+q)\left((p+q)^2 - 3pq\right)$$ **A1**

$$\equiv (p+q)^3 - 3pq(p+q)$$ **AG**

> **Note:** Condone the use of the equals sign throughout.

[2 marks]

(b)

product of roots of $x^2 - \dfrac{5}{2}x + \dfrac{1}{2} = 0$

$\alpha\beta = \dfrac{1}{2}$ (seen anywhere)   **A1**

considers $\left(\dfrac{1}{\alpha^3} \right)\left(\dfrac{1}{\beta^3} \right)$ by stating $\dfrac{1}{(\alpha\beta)^3} (= n)$ **M1**

$$\frac{1}{(\alpha\beta)^3} = \frac{1}{\left(\frac{1}{2}\right)^3}$$

$n=8$ **A1**

sum of roots of $x^2 - \frac{5}{2}x + \frac{1}{2} = 0$

$\alpha + \beta = \frac{5}{2}$ (seen anywhere) **A1**

considers $\frac{1}{\alpha^3} + \frac{1}{\beta^3}$ by stating $\frac{(\alpha+\beta)^3 - 3\alpha\beta(\alpha+\beta)}{(\alpha\beta)^3}$ $\left(\left(\frac{\alpha+\beta}{\alpha\beta}\right)^3 - \frac{3(\alpha+\beta)}{(\alpha\beta)^2}\right)(=-m)$ **M1**

> **Note:** Award **M1** for attempting to substitute their values of $\alpha+\beta$ and $\alpha\beta$ into their expression. Award **M0** for use of $(\alpha+\beta)^3 - 3\alpha\beta(\alpha+\beta)$ only.

$$= \frac{\left(\frac{5}{2}\right)^3 - \left(\frac{3}{2}\right)\left(\frac{5}{2}\right)}{\frac{1}{8}} \quad (=125 - 30 = 95)$$
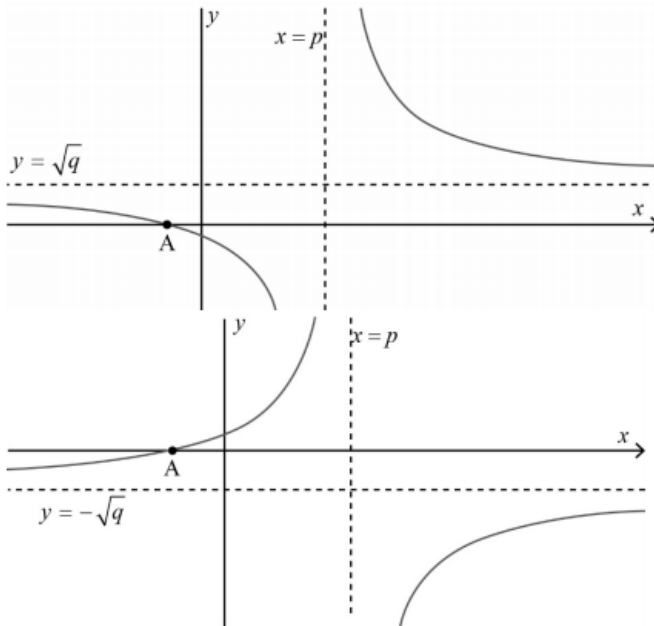
$m = -95$ **A1**

$\left(x^2 - 95x + 8 = 0\right)$

[6 marks]
Total [8 marks]

Answer 7:

(a)

either graph passing through (or touching) A   **A1**
correct shape and vertical asymptote with correct equation for either graph   **A1**
correct horizontal asymptote with correct equation for either graph   **A1**
two completely correct sketches   **A1**

[4 marks]

(b) $a\left(-\dfrac{1}{2}\right)+1=0 \Rightarrow a=2$ **A1**

from horizontal asymptote, $\left(\dfrac{a}{b}\right)^2=\dfrac{4}{9}$ **(M1)**

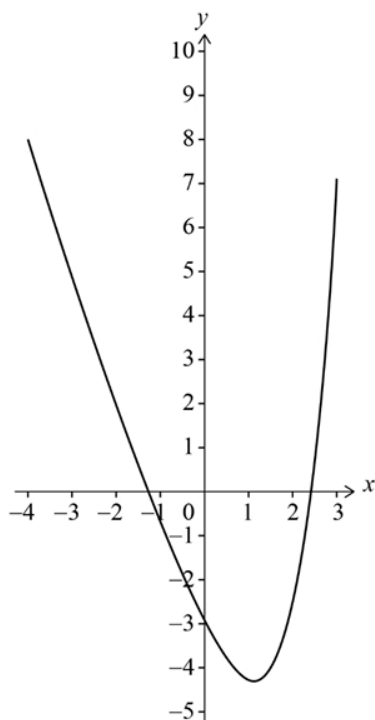$\dfrac{a}{b}=\pm\dfrac{2}{3} \Rightarrow b=\pm 3$ **A1**

from vertical asymptote, $b\left(\dfrac{4}{3}\right)+c=0$

$b=3,\ c=-4$ or $b=-3,\ c=4$ **A1**

[4 marks]

Total [8 marks]

Answer 8:

2. (a)

A1A1A1

| **Note:**	Award marks as follows:
	A1 for approximately correct roots, in the intervals $-2 < x < -1$ and $2 < x < 3$.
	A1 for y-intercept AND local minimum in approximately correct positions. Allow for y-intercept $-3.5 < y < -2.5$, and for local minimum $0.5 < x < 1.5$, $-5 < y < -4$.
	A1 for approximately correct endpoints, with the left end in the intervals $-4.5 < x < -3.5$, $7.5 < y < 8.5$ and the right end in the intervals $2.5 < x < 3.5$, $6.5 < y < 7.5$

[3 marks]

(b) $k = \dfrac{1}{2}$ **A1**

$c = -3$ (accept translate/shift 3 (units) down) **A1**

[2 marks]

Total [5 marks]

Answer 9:

(a)
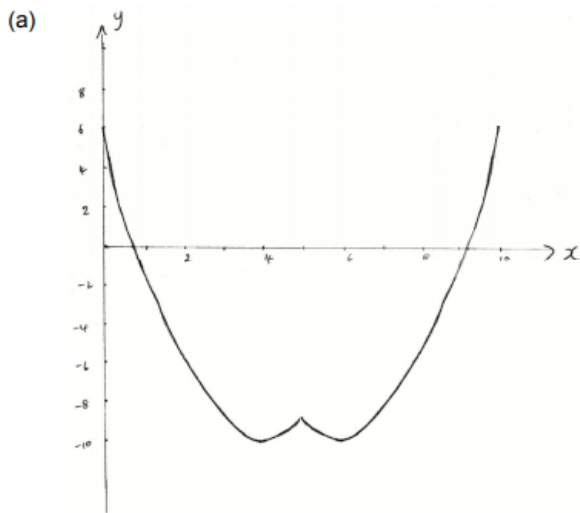
general shape including 2 minimums, cusp   **A1A1**
correct domain and symmetrical about the middle $(x = 5)$ **A1**

[3 marks]

(b) $x = 9.16$ or $x = 0.838$ **A1A1**
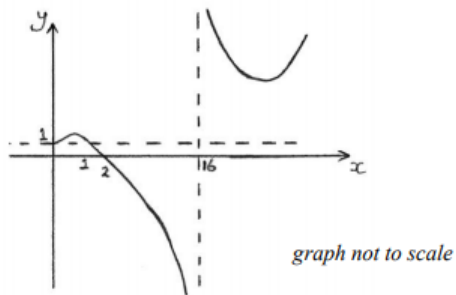
[2 marks]

Total [5 marks]

Answer 10:

9. (a) $x \geq 0$ and $x \neq 16$ *A1A1*

(b)

graph not to scale

finding crossing points *(M1)*
e.g. $4 - x^2 = 4 - \sqrt{x}$
$x = 0$ or $x = 1$ *(A1)*
$0 \leq x \leq 1$ or $x > 16$ *A1A1*

Note: Award *M1A1A1A0* for solving the inequality only for the case $x < 16$.

[6 marks]