Topic 6 Part 4 *[219 marks]*

1a. *[2 marks]*

Markscheme

$-5 = 5 - (2) + a(2)^2$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in equation.

$(a =) -2$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

This question proved to be quite a discriminator with a significant number of candidates achieving, at most, one or two marks in part (a). Part (b) was tested in the May 2012 series of examinations but the same errors were prevalent here as they were then. A number of candidates simply wrote the equation of the axis of symmetry in terms of y rather than x or just wrote down a numerical value rather than an equation. Expressions for the required range in part (c) fared little better with again much confusion between the variables x and y. A strict inequality was required at the turning point and a mark was lost where this was not indicated. Alternative forms for the range such as $(-\infty, 5.125]$ were, of course, accepted.

1b. *[2 marks]*

Markscheme

$x = -\frac{1}{4}$ (-0.25) ***(A1)(A1)*****(ft)** ***(C2)***

Notes: Follow through from their part (a). Award ***(A1)(A0)*****(ft)** for " x = constant". Award ***(A0)(A1)*****(ft)** for $y = -\frac{1}{4}$.

[2 marks]

Examiners report

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1c. *[2 marks]*

Markscheme

$f(x) \leq 5.125$ ***(A1)(A1)*****(ft)** ***(C2)***

Notes: Award ***(A1)*** for $f(x) \leq$ (accept y). Do not accept strict inequality. Award ***(A1)*****(ft)** for 5.125 (accept 5.13). Accept other correct notation, for example, $(-\infty, 5.125]$. Follow through from their answer to part (b).

[2 marks]

Examiners report

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2a. *[2 marks]*

Markscheme

$x = 0$ ***(A1)(A1)***

Notes: Award ***(A1)*** for x=constant, ***(A1)*** for 0. Award ***(A0)(A0)*** if answer is not an equation.

[2 marks]

Examiners report

This question was moderately well answered. The concept of vertical asymptote in part (a) seemed to be problematic for a great number of candidates. In many cases students showed partial understanding of the vertical asymptote but found it difficult to write a correct equation.

2b. *[3 marks]*

Markscheme

$b - \frac{2}{x^3}$ ***(A1)(A1)(A1)***

Note: Award ***(A1)*** for b, ***(A1)*** for -2, ***(A1)*** for
$\frac{1}{x^3}$ (or x^{-3}). Award at most ***(A1)(A1)(A0)*** if extra terms seen.

[3 marks]

Examiners report

This question was moderately well answered. The concept of vertical asymptote in part (a) seemed to be problematic for a great number of candidates. In many cases students showed partial understanding of the vertical asymptote but found it difficult to write a correct equation. Finding the derivative in part (b) proved problematic as well. It seems that the presence of the parameter b in the function may have contributed to this.

2c. *[2 marks]*

Markscheme

$3 = b - \frac{2}{(1)^3}$ ***(M1)(M1)***

Note: Award ***(M1)*** for substituting 1 into their gradient function, ***(M1)*** for equating their gradient function to 3.

$b = 5$ ***(AG)***

Note: Award at most ***(M1)(A0)*** if final line is not seen or b does not equal 5.

[2 marks]

Examiners report

This question was moderately well answered. In part (c) a great number of students substituted $b = 5$ in the equation of the function instead of substituting it in the equation of their derivative.

2d. *[3 marks]*

Markscheme

$g(1) = 3$ **or** $(1, 3)$ *(seen or implied from the line below)* ***(A1)***

$3 = 3 \times 1 + c$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their point $(1, 3)$ and gradient 3 into equation $y = mx + c$. Follow through from their point of tangency.

$y = 3x$ ***(A1)*****(ft)*****(G2)***

OR

$y - 3 = 3(x - 1)$ ***(M1)(A1)*****(ft)*****(G2)***

Note: Award ***(M1)*** for substitution of gradient 3 and their point $(1, 3)$ into $y - y_1 = m(x - x_1)$, ***(A1)*****(ft)** for correct substitutions. Follow through from their point of tangency. Award at most ***(A1)(M1)(A0)*****(ft)** if further incorrect working seen.

[3 marks]

Examiners report

This question was moderately well answered. Very few students used the GDC to find the equation of the tangent at $x = 1$ in part (d).

2e. *[2 marks]*

Markscheme

$(-0.439, 0)$ $((-0.438785..., 0))$ ***(G1)(G1)***

Notes: If no parentheses award at most ***(G1)(G0)***. Accept $x = 0.439$, $y = 0$.

[2 marks]

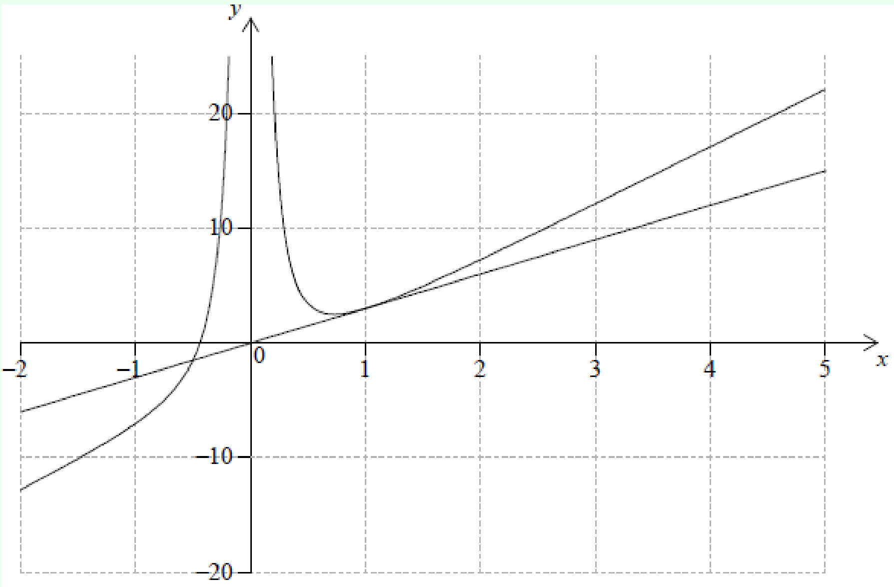
Examiners report

This question was moderately well answered. Good use of the GDC was seen in part (e), although some students wrote the x-coordinates of the point of intersection and neglected to write the y-coordinate.

2f. *[6 marks]*

Markscheme

(i)



Award ***(A1)*** for labels and some indication of scale in the stated window.

Award ***(A1)*** for correct general shape (curve must be smooth and must not cross the y-axis)

Award ***(A1)*(ft)** for x-intercept consistent with their part (e).

Award ***(A1)*** for local minimum in the first quadrant. ***(A1)(A1)(A1)*(ft)*(A1)***

(ii) Tangent to curve drawn at approximately $x = 1$ ***(A1)(A1)***

Note: Award ***(A1)*** for a line tangent to curve approximately at $x = 1$. Must be a straight line for the mark to be awarded. Award ***(A1)*(ft)** for line passing through the origin. Follow through from their answer to part (d).

[6 marks]

Examiners report

This question was moderately well answered. The sketch in part (f) was, for the most part, not well done. Often the axes labels were missing. Very few tangents to the curve at the correct point were seen. Often the intended tangent lines intersected the curve, which shows that candidates either did not know what a tangent is or did not make sense of the sketch.

2g. *[2 marks]*

Markscheme

(0.737, 2.53) ((0.736806..., 2.52604...)) ***(G1)(G1)***

Notes: Do not penalize for lack of parentheses if already penalized in (e). Accept $x = 0.737$, $y = 2.53$.

[2 marks]

Examiners report

This question was moderately well answered. Good use of the GDC was shown in part (g) for finding the coordinates of the minimum point.

2h.

[2 marks]

Markscheme

$0.737 < x < 5$ **OR** $(0.737;5)$ ***(A1)(A1)*(ft)**

Notes: Award ***(A1)*** for correct strict or weak inequalities with x seen if the interval is given as inequalities, ***(A1)*(ft)** for 0.737 and 5 or their value from part (g).

[2 marks]

Examiners report

This question was moderately well answered. Few acceptable answers were given in part (h).

3a.

[2 marks]

Markscheme

$x = 2$ ***(A1)(A1)*** ***(C2)***

Notes: Award ***(A1)(A0)*** for "x = constant" (other than 2). Award ***(A0)(A1)*** for $y = 2$. Award ***(A0)(A0)*** for only seeing 2. Award ***(A0)(A0)*** for $2 = -b / 2a$.

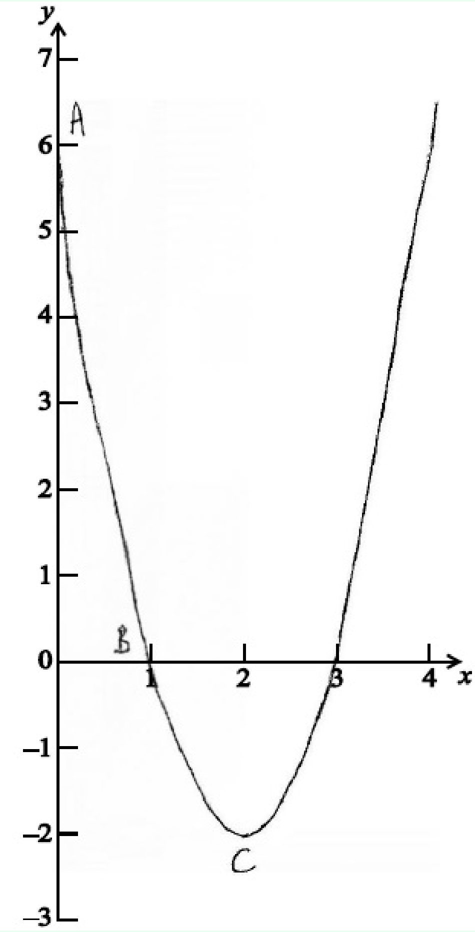
[2 marks]

Examiners report

(a) Identifying '2' and leaving this as the answer was not sufficient for any marks in this part of the question as was simply leaving the equation
$2 + \frac{-b}{2a}$.

3b. *[3 marks]*

Markscheme



(A1) for correctly plotting and labelling A, B and C

(A1) for a smooth curve passing through the three given points

(A1) for completing the symmetry of the curve over the **domain given**. *(A3)* *(C3)*

Notes: For ***A*** marks to be awarded for the curve, each segment must be a reasonable attempt at a continuous curve. If straight line segments are used, penalise once only in the last two marks.

[3 marks]

Examiners report

In part (b) whilst much good work was seen by some candidates in sketching the correct curve, others failed to recognise the symmetry, joined the given points with straight lines or simply drew curved segments which were far from smooth.

3c. *[1 mark]*

Markscheme

3 *(A1)***(ft)** *(C1)*

Notes: *(A0)* for coordinates. Accept $x = 3$ or D = 3 .

[1 mark]

Examiners report

Part (c) required, for one mark, the writing down of the x-coordinate of the point D. A significant number of candidates, including very able candidates, lost this mark by writing down (3,0).

4a. *[3 marks]*

Markscheme

(i) $2p + q = 11$ and $4p + q = 17$ ***(M1)***

Note: Award ***(M1)*** for either two correct equations or a correct equation in one unknown equivalent to $2p = 6$.

$p = 3$ ***(A1)***

(ii) $q = 5$ ***(A1)*** ***(C3)***

Notes: If only one value of p and q is correct and no working shown, award ***(M0)(A1)(A0)***.

[3 marks]

Examiners report

Candidates both understood how to interpret a mapping diagram correctly and did very well on this question or the question was very poorly answered or not answered at all. Writing down two simultaneous equations in part (a) proved to be elusive to many and this prevented further work on this question. Candidates who were able to find values of p and q (correct or otherwise) invariably made a good attempt at finding the value of s in part (c).

4b. *[1 mark]*

Markscheme

$r = 8$ ***(A1)*(ft)** ***(C1)***

Note: Follow through from their answers for p and q irrespective of whether working is seen.

[1 mark]

Examiners report

Candidates both understood how to interpret a mapping diagram correctly and did very well on this question or the question was very poorly answered or not answered at all. Writing down two simultaneous equations in part (a) proved to be elusive to many and this prevented further work on this question. Candidates who were able to find values of p and q (correct or otherwise) invariably made a good attempt at finding the value of s in part (c).

4c. *[2 marks]*

Markscheme

$3 \times 2^s + 5 = 197$ ***(M1)***

Note: Award ***(M1)*** for setting the correct equation.

$s = 6$ ***(A1)*(ft)** ***(C2)***

Note: Follow through from their values of p and q.

[2 marks]

Examiners report

Candidates both understood how to interpret a mapping diagram correctly and did very well on this question or the question was very poorly answered or not answered at all. Writing down two simultaneous equations in part (a) proved to be elusive to many and this prevented further work on this question. Candidates who were able to find values of p and q (correct or otherwise) invariably made a good attempt at finding the value of s in part (c).

5a. *[1 mark]*

Markscheme

100 °C ***(A1)*** ***(C1)***

[1 mark]

Examiners report

The majority of the candidates showed they were able to substitute values into the model. The most common mistake was to neglect converting 1.37 km into metres. Some candidates did not appreciate the practical considerations of this question; Mount Everest will never be less than one metre high. It is important to remind students to check their answers in terms of the context of the information given.

5b. *[3 marks]*

Markscheme

\(T = -0.0034 \times 1370 + 100\) ***(A1)(M1)***

Note: Award ***(A1)*** for 1370 seen, ***(M1)*** for substitution of their h into the equation.

95.3 °C (95.342) ***(A1)*** ***(C3)***

Notes: If their h is incorrect award at most ***(A0)(M1)(A0)***. If their h = 1.37 award at most ***(A0)(M1)(A1)*****(ft)**.

[3 marks]

Examiners report

The majority of the candidates showed they were able to substitute values into the model. The most common mistake was to neglect converting 1.37 km into metres. Some candidates did not appreciate the practical considerations of this question; Mount Everest will never be less than one metre high. It is important to remind students to check their answers in terms of the context of the information given.

5c. *[2 marks]*

Markscheme

$70 = -0.0034h + 100$ ***(M1)***

Note: Award ***(M1)*** for correctly substituted equation.

h = 8820 m (8823.52...) ***(A1)*** ***(C2)***

Note: The answer is 8820 m (or 8.82 km.) units are required.

[2 marks]

Examiners report

The majority of the candidates showed they were able to substitute values into the model. The most common mistake was to neglect converting 1.37 km into metres. Some candidates did not appreciate the practical considerations of this question; Mount Everest will never be less than one metre high. It is important to remind students to check their answers in terms of the context of the information given.

6a.

[3 marks]

Markscheme

(i)

$3 = \frac{-b}{-2}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in formula.

OR

$-1 + b + c = 0$

$-25 + 5b + c = 0$

$-24 + 4b = 0$ ***(M1)***

Note: Award ***(M1)*** for setting up 2 correct simultaneous equations.

OR

$-2x + b = 0$ ***(M1)***

Note: Award ***(M1)*** for correct derivative of
$f(x)$ equated to zero.

$b = 6$ ***(A1)*** ***(C2)***

(ii)

$0 = -(5)^2 + 6 \times 5 + c$

$c = -5$ ***(A1)*****(ft)** ***(C1)***

Note: Follow through from their value for b.

Note: Alternatively candidates may answer part (a) using the method below, and not as two separate parts.

$(x - 5)(-x + 1)$ ***(M1)***

$-x^2 + 6x - 5$ ***(A1)***

$b = 6$ $c = -5$ ***(A1)*** ***(C3)***

[3 marks]

Examiners report

Question 11 proved to be the most problematic of the whole paper. Many candidates attempted this question but were not able to set up a system of equations to find the value of b or use the formula
$x = \frac{-b}{2a}$. From the working seen, many candidates did not understand the non-standard notation for the domain, with a number believing it to be a coordinate pair. This was taken into careful consideration by the senior examiners when setting the grade boundaries for this paper.

6b.

[3 marks]

Markscheme

$-5 \le y \le 4$ ***(A1)*****(ft)*****(A1)*****(ft)*****(A1)*** ***(C3)***

Notes: Accept [–5, 4]. Award ***(A1)*****(ft)** for –5, ***(A1)*****(ft)** for 4. ***(A1)*** for inequalities in the correct direction or brackets with values in the correct order or a clear word statement of the range. Follow through from their part (a).

[3 marks]

Examiners report

Question 11 proved to be the most problematic of the whole paper. Many candidates attempted this question but were not able to set up a system of equations to find the value of b or use the formula $x = \frac{-b}{2a}$. From the working seen, many candidates did not understand the non-standard notation for the domain, with a number believing it to be a coordinate pair. This was taken into careful consideration by the senior examiners when setting the grade boundaries for this paper.

7a.

[4 marks]

Markscheme

(i) $2^0 + 3$ ***(M1)***

Note: Award ***(M1)*** for correct substitution.

$= 4$ ***(A1)*** ***(C2)***

(ii) $3.5 = 2^{-b} + 3$ ***(M1)***

Note: Award ***(M1)*** for correct substitution.

$b = 1$ ***(A1)*** ***(C2)***

[4 marks]

Examiners report

Most candidates answered parts (a) i and ii correctly, however a large number of candidates could not find the correct equation for part (b).

7b.

[2 marks]

Markscheme

$y = 3$ ***(A1)(A1)*** ***(C2)***

Notes: y = constant (other than 3) award ***(A1)(A0)***.

[2 marks]

Examiners report

Most candidates answered parts (a) i and ii correctly, however a large number of candidates could not find the correct equation for part (b).

8a.

[3 marks]

Markscheme

(i) 40

(ii) 20

(iii) 10 ***(A3)***

Notes: Award ***(A0)(A1)*****(ft)*****(A1)*****(ft)** for −40, −20, −10.

Award ***(A1)(A0)(A1)*****(ft)** for 40, 60, 70 seen.

Award ***(A0)(A0)(A1)*****(ft)** for −40, −60, −70 seen.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

8b. *[2 marks]*

Markscheme

$24 - k = 5$ or equivalent ***(A1)(M1)***

Note: Award ***(A1)*** for 5 seen, ***(M1)*** for difference from 24 indicated.

$k = 19$ ***(AG)***

Note: If 19 is not seen award at most ***(A1)(M0)***.

Examiners report

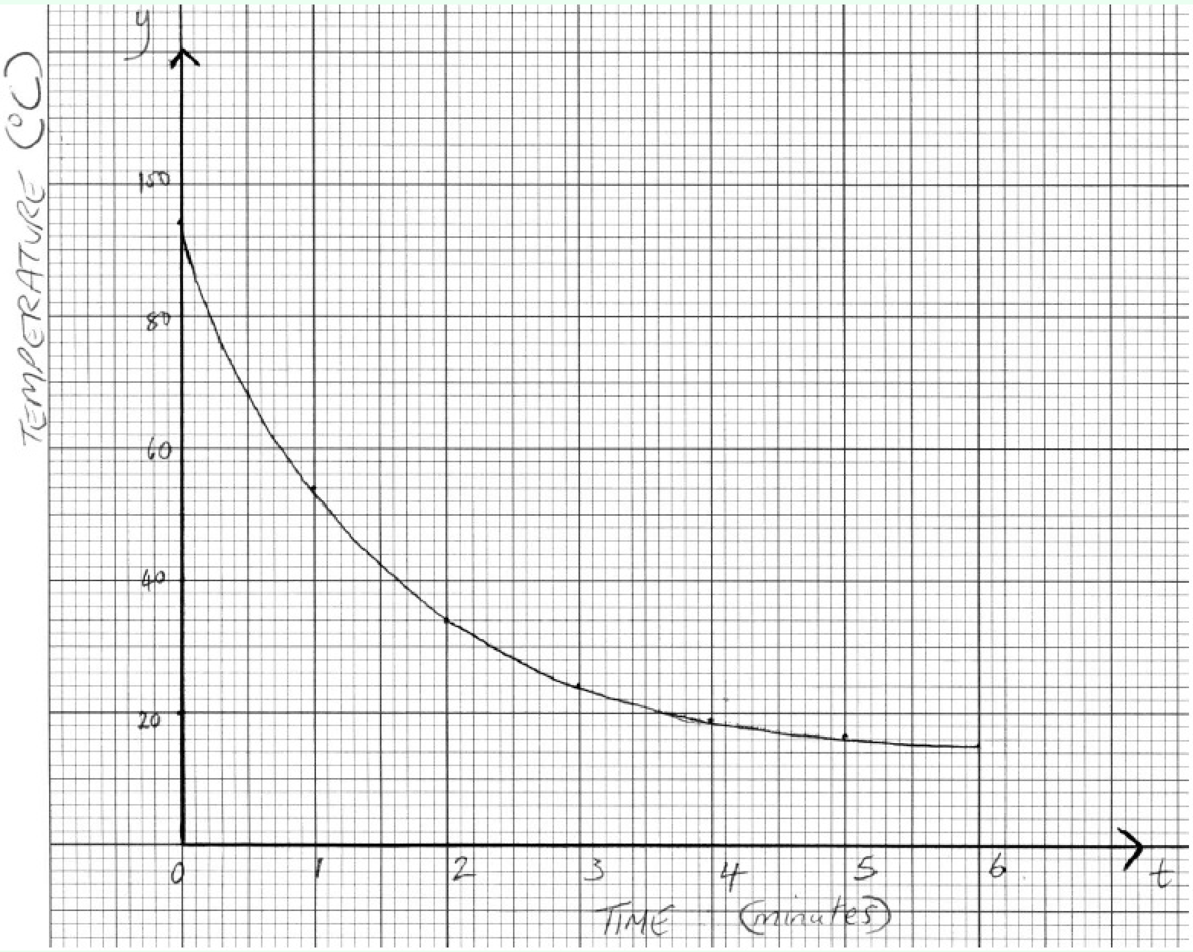
Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

8c.

[4 marks]

Markscheme



(A1)(A1)(A1)(A1)

Note: Award ***(A1)*** for scales and labelled axes (t or "time" and y or "temperature").

Accept the use of x on the horizontal axis only if "time" is also seen as the label.

Award ***(A2)*** for all seven points accurately plotted, award ***(A1)*** for **5 or 6** points accurately plotted, award ***(A0)*** for 4 points or fewer accurately plotted.

Award ***(A1)*** for smooth curve that passes through all points on domain [0, 6].

If graph paper is not used or one or more scales is missing, award a maximum of ***(A0)(A0)(A0)(A1)***.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

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8d.

[2 marks]

Markscheme

(i)

$94 = p + q$ ***(A1)***

(ii)

$54 = 0.5p + q$ ***(A1)***

Note: The equations need not be simplified; accept, for example
$94 = p(2^{-0}) + q$.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of
r, it seems better that the former is simply not taught.

8e.

[2 marks]

Markscheme

$p = 80$, $q = 14$ ***(G1)(G1)*****(ft)**

Note: If the equations have been incorrectly simplified, follow through even if no working is shown.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of
r, it seems better that the former is simply not taught.

8f.

[2 marks]

Markscheme

$y = 14$ ***(A1)(A1)*****(ft)**

Note: Award ***(A1)*** for y = a constant, ***(A1)*** for their 14. Follow through from part (e) only if their q lies between 0 and 15.25 inclusive.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

8g. *[4 marks]*

Markscheme

(i) –0.878 (–0.87787...)   ***(G2)***

Note: Award ***(G1)*** if –0.877 seen only. If negative sign omitted award a maximum of ***(A1)(A0)***.

(ii) y = –11.7t + 71.6 (y = –11.6517...t + 71.6336...)   ***(G1)(G1)***

Note: Award ***(G1)*** for –11.7t, ***(G1)*** for 71.6.

If y = is omitted award at most ***(G0)(G1)***.

If the use of x in part (c) has **not** been penalized (the axis has been labelled “time”) then award at most ***(G0)(G1)***.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

8h. *[2 marks]*

Markscheme

−11.6517...(3) + 71.6339...   ***(M1)***

Note: Award ***(M1)*** for correct substitution in their part (g)(ii).

= 36.7 (36.6785...)   ***(A1)*(ft)*(G2)***

Note: Follow through from part (g). Accept 36.5 for use of the 3sf answers from part (g).

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

8i. *[2 marks]*

Markscheme

$\frac{36.6785...-24}{24} \times 100$ ***(M1)***

Note: Award ***(M1)*** for their correct substitution in percentage error formula.

= 52.8% (52.82738...) ***(A1)*(ft)*(G2)***

Note: Follow through from part (h). Accept 52.1% for use of 36.5.

Accept 52.9 % for use of 36.7. If partial working ($\times 100$ omitted) is followed by their correct answer award ***(M1)(A1)***. If partial working is followed by an incorrect answer award ***(M0)(A0)***. The percentage sign is not required.

Examiners report

Almost all candidates were able to score on the first parts of this question; errors occurring only when insufficient care was taken in reading what the question was asking for. The graph was usually well drawn, other than for those who have no idea what centimetres are.

The majority were able to determine the simultaneous equations, if only in unsimplified form; there was less success in solving these – though this is easily done via the GDC (the preferred approach) and the equation of the asymptote proved a discriminating task. The final parts, involving correlation and regression were largely independent of the previous parts and were accessible to most. Hopefully, contrasting the large percentage error with the value of the correlation coefficient will be valuable in class discussions. Given the many scripts that gave the value of the coefficient of determination as that of r, it seems better that the former is simply not taught.

9a. *[1 mark]*

Markscheme

5 ***(A1)*** ***(C1)***

Examiners report

Many candidates did not see the connection between the x-intercepts and the factored form of a quadratic function. The syllabus explicitly sates that the graphs of quadratics should be linked to solutions of quadratic equations by factorizing and vice versa. This was one of the most challenging questions for candidates.

9b. *[2 marks]*

Markscheme

$\frac{-b}{2(-1)} = 2$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in axis of symmetry formula.

OR

$y = 5 + bx - x^2$

$9 = 5 + b(2) - (2)^2$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of 9 and 2 into their quadratic equation.

$(b =)4$ ***(A1)*****(ft)*** ***(C2)***

Note: Follow through from part (a).

Examiners report

Many candidates did not see the connection between the *x*-intercepts and the factored form of a quadratic function. The syllabus explicitly sates that the graphs of quadratics should be linked to solutions of quadratic equations by factorizing and vice versa. This was one of the most challenging questions for candidates.

9c. *[2 marks]*

Markscheme

5, −1 ***(A1)*****(ft)*****(A1)*****(ft)*** ***(C2)***

Notes: Follow through from parts (a) and (b), irrespective of working shown.

Examiners report

Many candidates did not see the connection between the *x*-intercepts and the factored form of a quadratic function. The syllabus explicitly sates that the graphs of quadratics should be linked to solutions of quadratic equations by factorizing and vice versa. This was one of the most challenging questions for candidates.

9d. *[1 mark]*

Markscheme

$f(x) = -(x - 5)(x + 1)$ ***(A1)*****(ft)*** ***(C1)***

Notes: Follow through from part (c).

Examiners report

Many candidates did not see the connection between the *x*-intercepts and the factored form of a quadratic function. The syllabus explicitly sates that the graphs of quadratics should be linked to solutions of quadratic equations by factorizing and vice versa. This was one of the most challenging questions for candidates.

10a. *[2 marks]*

Markscheme

$\frac{14}{(1)} + (1) - 6$ ***(M1)***

Note: Award ***(M1)*** for substituting $x = 1$ into f.

$= 9$ ***(A1)(G2)***

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x + 6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10b. *[3 marks]*

Markscheme

$-\frac{14}{x^2} + 1$ ***(A3)***

Note: Award ***(A1)*** for -14, ***(A1)*** for $\frac{14}{x^2}$ or for x^{-2}, ***(A1)*** for 1.

Award at most ***(A2)*** if any extra terms are present.

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x + 6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10c. *[3 marks]*

Markscheme

$-\frac{14}{x^2}+1=0$ or
$f'(x)=0$ ***(M1)***

Note: Award ***(M1)*** for equating **their** derivative in part (b) to 0.

$\frac{14}{x^2}=1$ or
$x^2=14$ or equivalent ***(M1)***

Note: Award ***(M1)*** for correct rearrangement of their equation.

$x=3.74165...(\sqrt{14})$ ***(A1)***

$x=3.7$ ***(AG)***

Notes: Both the unrounded and rounded answers must be seen to award the ***(A1)***. This is a "show that" question; appeals to their GDC are not accepted –award a maximum of ***(M1)(M0)(A0)***.

Specifically,
$-\frac{14}{x^2}+1=0$ followed by
$x=3.74165...,x=3.7$ is awarded ***(M1)(M0)(A0)***.

Examiners report

Most candidates were able to evaluate the function and find the derivative for
$x+6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10d. *[3 marks]*

Markscheme

$1.48 \leqslant y \leqslant 9$ ***(A1)(A1)*(ft)*(A1)***

Note: Accept alternative notations, for example [1.48,9]. (
$x=\sqrt{14}$ leads to answer 1.48331...)

Note: Award ***(A1)*** for 1.48331…seen, accept 1.48378… from using the given answer
$x=3.7$, ***(A1)*(ft)** for their 9 from part (a) seen, ***(A1)*** for the correct notation for their interval (accept
$\leqslant y \leqslant$ or
$\leqslant f \leqslant$).

Examiners report

Most candidates were able to evaluate the function and find the derivative for
$x+6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10e. *[1 mark]*

Markscheme

3 ***(A1)***

Note: Do not accept a coordinate pair.

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x + 6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10f. *[2 marks]*

Markscheme

$\frac{3-9}{7-1}$ ***(M1)***

Note: Award ***(M1)*** for their correct substitution into the gradient formula.

$= -1$ ***(A1)*(ft)*(G2)***

Note: Follow through from their answers to parts (a) and (e).

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x + 6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10g. *[2 marks]*

$x = 4$
$y = 6$

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x+6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10h. *[2 marks]*

Markscheme

$-\frac{14}{4^2}+1$ ***(M1)***

Note: Award ***(M1)*** for substitution into their gradient function.

Follow through from their answers to parts (b) and (g).

$=\frac{1}{8}(0.125)$ ***(A1)*****(ft)*****(G2)***

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x+6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

10i. *[3 marks]*

Markscheme

$y-1.5=\frac{1}{8}(x-4)$ ***(M1)*****(ft)*****(M1)***

Note: Award ***(M1)*** for substituting their (4, 1.5) in any straight line formula,

(M1) for substituting their gradient in any straight line formula.

$y=\frac{x}{8}+4$ ***(A1)*****(ft)*****(G2)***

Note: The form of the line has been specified in the question.

Examiners report

Most candidates were able to evaluate the function and find the derivative for $x+6$ but the term with the negative index was problematic. The few candidates who equated their derivative to zero at the local minimum point progressed well and showed a thorough understanding of the differential calculus. Many did not attain full marks for the range of the function, either confusing this with the statistical concept of range or using the *y*-coordinate at B. Most were able to find the gradient and midpoint of the straight line passing through A and B. The final parts were also challenging for the majority: many had difficulty finding the gradient of the tangent L, instead using the slope formula for a straight line; the most common error in part (i) was to substitute in the coordinates of midpoint M rather than the point on the curve. Greater insight into the problem would have come from using the given sketch of the curve and annotating it; it seems that many candidates do not link the algebraic nature of the differential calculus with the curve in question.

11a. *[1 mark]*

Markscheme

800 ***(A1) (C1)***

Examiners report

[N/A]

11b. *[3 marks]*

Markscheme

$800 \times 3^{(0.5\times 2.5)}$ ***(M1)***

Note: Award ***(M1)*** for correctly substituted formula.

$= 3158.57...$ ***(A1)***

$= 3200$ ***(A1) (C3)***

Notes: Final ***(A1)*** is given for correctly rounding ***their*** answer. This may be awarded regardless of a preceding ***(A0)***.

Examiners report

[N/A]

11c. *[2 marks]*

Markscheme

$5500 = 800 \times 3^{(0.5\times t)}$ ***(M1)***

Notes: Award ***(M1)*** for equating function to 5500. Accept correct alternative methods.

$= 3.51$ hours $(3.50968...)$ ***(A1) (C2)***

Examiners report

[N/A]

12a. *[3 marks]*

Markscheme

$120 + 10 \times 4$ ***(M1)(A1)***

Notes: Award ***(M1)*** for substituted AP formula, ***(A1)*** for correct substitutions. Accept a list of 4 correct terms.

= 160 ***(A1)(G3)***

Examiners report

[N/A]

12b. *[3 marks]*

Markscheme

$120 + (n - 1) \times 10 = 260$ ***(M1)(M1)***

Notes: Award ***(M1)*** for correctly substituted AP formula, ***(M1)*** for equating to 260. Accept a list of correct terms showing at least the 14^{th} and 15^{th} terms.

= 15 ***(A1)(G2)***

Examiners report

[N/A]

12c. *[4 marks]*

Markscheme

$\frac{15}{2}(120 + 260)$ **or**
$\frac{15}{2}(2 \times 120 + (15 - 1) \times 10)$ ***(M1)(A1)*(ft)**

Notes: Award ***(M1)*** for substituted AP sum formula, ***(A1)*(ft)** for correct substitutions. Accept a sum of a list of 15 correct terms. Follow through from their answer to part (b).

2850 seconds ***(A1)*(ft)*(G2)***

Note: Award ***(G2)*** for 2850 seen with no working shown.

47.5 minutes ***(A1)*(ft)*(G3)***

Notes: A final ***(A1)*(ft)** can be awarded for correct conversion from seconds into minutes of their incorrect answer. Follow through from their answer to part (b).

Examiners report

[N/A]

12d. *[3 markes]*

Markscheme

$120 \times 1.06^{3-1}$ ***(M1)(A1)***

Notes: Award ***(M1)*** for substituted GP formula, ***(A1)*** for correct substitutions. Accept a list of 3 correct terms.

= 135 (134.832) ***(A1)(G2)***

Examiners report

[N/A]

12e. *[3 marks]*

Markscheme

$S_4 = \frac{120(1.06^4 - 1)}{(1.06 - 1)}$ ***(M1)(A1)***

Notes: Award ***(M1)*** for substituted GP sum formula, ***(A1)*** for correct substitutions. Accept a sum of a list of 4 correct terms.

= 525 (524.953...) ***(A1)(G2)***

Examiners report

[N/A]

12f. *[3 marks]*

Markscheme

$120 + (n-1) \times 10 < 120 \times 1.06^{n-1}$ ***(M1)(M1)***

Notes: Award ***(M1)*** for correct left hand side, ***(M1)*** for correct right hand side. Accept an equation. Follow through from their expressions given in parts (a) and (d).

OR

List of at least 2 terms for both sequences (120, 130, … and 120, 127.2, …) ***(M1)***

List of correct 12$^{\text{th}}$ and 13$^{\text{th}}$ terms for both sequences (..., 230, 240 and …, 227.8, 241.5) ***(M1)***

OR

A sketch with a line and an exponential curve, ***(M1)***

An indication of the correct intersection point ***(M1)***

13$^{\text{th}}$ lap ***(A1)*(ft)*(G2)***

Note: Do not award the final ***(A1)*(ft)** if final answer is not a positive integer.

Examiners report

[N/A]

13a. *[3 marks]*

Markscheme

$y = -\frac{75^2}{10} + \frac{27}{2} \times 75$ ***(M1)***

Note: Award ***(M1)*** for substitution of 75 in the formula of the function.

= 450 ***(A1)***

Yes, point A is on the bike track. ***(A1)***

Note: Do not award the final ***(A1)*** if correct working is not seen.

Examiners report

[N/A]

13b. *[2 marks]*

Markscheme

$\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{2x}{10} + \frac{27}{2} \left(\frac{\mathrm{d}y}{\mathrm{d}x} = -0.2x + 13.5\right)$ ***(A1)(A1)***

Notes: Award ***(A1)*** for each correct term. If extra terms are seen award at most ***(A1)(A0)***. Accept equivalent forms.

Examiners report

[N/A]

13c. *[4 marks]*

Markscheme

$-\frac{2x}{10}+\frac{27}{2}=0$ ***(M1)***

Note: Award ***(M1)*** for equating their derivative from part (b) to zero.

$x=67.5$ ***(A1)*****(ft)**

Note: Follow through from their derivative from part (b).

$(\text{Their})\ 67.5\neq 75$ ***(R1)***

Note: Award ***(R1)*** for a comparison of their 67.5 with 75. Comparison may be implied (*eg* 67.5 is the *x*-coordinate of the furthest north point).

OR

$\frac{dy}{dx}=-\frac{2\times(75)}{10}+\frac{27}{2}$ ***(M1)***

Note: Award ***(M1)*** for substitution of 75 into their derivative from part (b).

$=-1.5$ ***(A1)*****(ft)**

Note: Follow through from their derivative from part (b).

$(\text{Their})-1.5\neq 0$ ***(R1)***

Note: Award ***(R1)*** for a comparison of their –1.5 with 0. Comparison may be implied (*eg* The gradient of the parabola at the furthest north point (vertex) is 0).

Hence A is not the furthest north point. ***(A1)*****(ft)**

Note: Do not award ***(R0)(A1)*****(ft)**. Follow through from their derivative from part (b).

Examiners report

[N/A]

13d. *[3 marks]*

Markscheme

(i) M(50,175) ***(A1)***

Note: If parentheses are omitted award ***(A0)***. Accept $x = 50$, $y = 175$.

(ii)
$\frac{350-0}{100-0}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in gradient formula.

$= 3.5\left(\frac{350}{100}, \frac{7}{2}\right)$ ***(A1)*****(ft)*****(G2)***

Note: Follow through from (d)(i) if midpoint is used to calculate gradient. Award ***(G1)(G0)*** for answer $3.5x$ without working.

Examiners report

[N/A]

13e. *[3 marks]*

Markscheme

$y = 3.5x + 150$ ***(A1)*****(ft)*****(A1)*****(ft)**

Note: Award ***(A1)*****(ft)** for using their gradient from part (d), ***(A1)*****(ft)** for correct equation of line.

$3.5x - y = -150$ **or**
$7x - 2y = -300$ (or equivalent) ***(A1)*****(ft)**

Note: Award ***(A1)*****(ft)** for expressing their equation in the form
$ax + by = c$.

Examiners report

[N/A]

13f. *[2 marks]*

Markscheme

(18.4, 214) (18.3772..., 214.320...) ***(A1)*****(ft)*****(A1)*****(ft)*****(G2)*****(ft)**

Notes: Follow through from their equation in (e). Coordinates must be positive for follow through marks to be awarded. If parentheses are omitted and not already penalized in (d)(i) award at most ***(A0)(A1)*****(ft)**. If coordinates of the two intersection points are given award ***(A0)(A1)*****(ft)**. Accept $x = 18.4$, $y = 214$.

Examiners report

[N/A]

14a. *[2 marks]*

Markscheme

Thursday's sales,

$6b + 9m = 23.40$ ***(A1)***

$2b + 3m = 7.80$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

a) Nearly all the candidates were able to write the equation but very few simplified it.

14b. *[2 marks]*

Markscheme

$m = 1.40$ *(accept 1.4)* ***(A1)*****(ft)**

$b = 1.80$ *(accept 1.8)* ***(A1)*****(ft)**

*Award **(A1)**(d) for a reasonable attempt to solve by hand and answer incorrect.* ***(C2)***

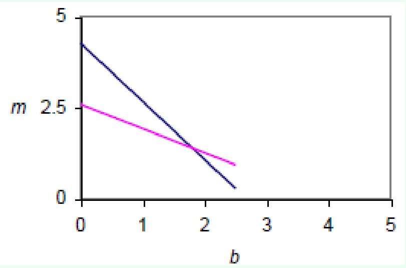
[2 marks]

Examiners report

b) A majority of candidates were able to find the values of b and m. Some used the right method but made arithmetical errors, many of which were due to them using the method of substitution which involved fractions. GDC use was expected.

14c. *[2 marks]*

Markscheme



(A1)(A1)**(ft)**

***(A1)** each for two reasonable straight lines. The intersection point must be approximately correct to earn both marks, otherwise penalise at least one line.*

Note: The follow through mark is for candidate's line from (a). ***(C2)***

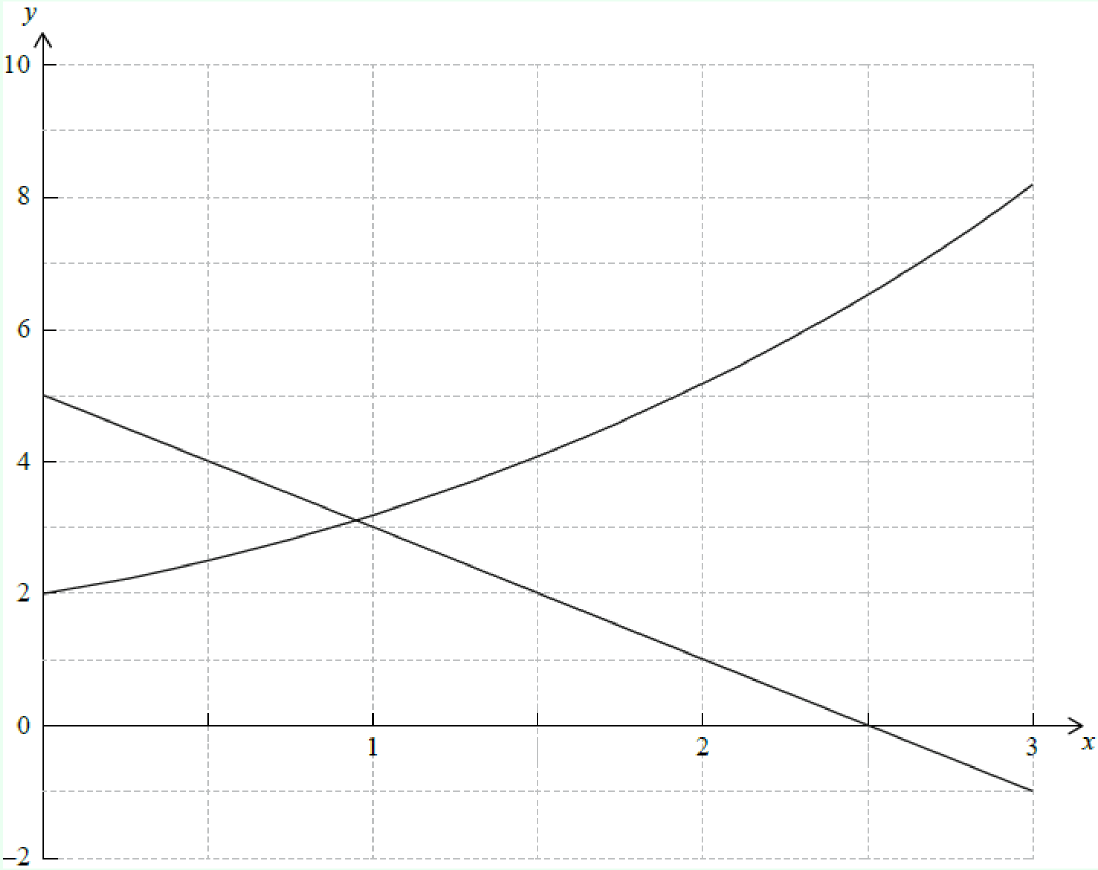
[2 marks]

Examiners report

c) A majority of candidates did not attempt this part. For those who did, very few were able to sketch the graph correctly. Common errors were to plot the point (1.4, 1.8) or draw a straight line through that point and the origin.

15a. *[2 marks]*

Markscheme



Note: Award *(A1)* correct endpoints, *(A1)* for smooth curve. *(A1)(A1)* *(C2)*

Examiners report

[N/A]

15b. *[1 mark]*

Markscheme

$(0, 2)$ *(A1)* *(C1)*

Note: Accept
$x = 0$,
$y = 2$

Examiners report

[N/A]

15c. *[2 marks]*

Markscheme

Straight line in the given domain *(A1)*
Axes intercepts in the correct positions *(A1)* *(C2)*

Examiners report

[N/A]

15d.

[1 mark]

Markscheme

$x = 0.943$ ($0.94259\ldots$) ***(A1)*** ***(C1)***

Note: Award ***(A0)*** if y-coordinate given.

Examiners report

[N/A]

16a.

[1 mark]

Markscheme

B, F ***(C1)***

Examiners report

[N/A]

16b.

[1 mark]

Markscheme

H ***(C1)***

Examiners report

[N/A]

16c.

[1 mark]

Markscheme

F ***(C1)***

Examiners report

[N/A]

16d.

[1 mark]

Markscheme

A, E ***(C1)***

Examiners report

[N/A]

16e.

[2 marks]

Markscheme

C *(C2)*

Examiners report

[N/A]

17a.

[2 marks]

Markscheme

$50a + b = 37$ ***(A1)(A1)*** ***(C2)***

Note: Award ***(A1)*** for
$50a + b$, ***(A1)*** for
$= 37$.

Examiners report

[N/A]

17b.

[2 marks]

Markscheme

$a = 0.4$,
$b = 17$ ***(A1)*****(ft)*****(A1)*****(ft)*** ***(C2)***

Notes: Award ***(M1)*** for attempt to solve their equations if this is done analytically. If the GDC is used, award **(ft)** even if no working seen.

Examiners report

[N/A]

17c.

[2 marks]

Markscheme

$T = 0.4(60) + 17$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their values and
60 into equation for
T.

$T = 41\ (^\circ\mathrm{C})$ ***(A1)*****(ft)*** ***(C2)***

Note: Follow through from their part (b).

Examiners report

[N/A]

18a. *[2 marks]*

Markscheme

$f'(x) = 15x^2 - 15x^4$ ***(A1)(A1) (C2)***

Note: Award a maximum of ***(A1)(A0)*** if extra terms seen.

Examiners report

[N/A]

18b. *[2 marks]*

Markscheme

$f'(1) = 0$ ***(M1)***

Note: Award ***(M1)*** for
$f'(x) = 0$.

$y = 3$ ***(A1)*(ft)** ***(C2)***

Note: Follow through from their answer to part (a).

Examiners report

[N/A]

18c. *[2 marks]*

Markscheme

$(-1.38, 3)$
$(-1.38481\ldots, 3)$ ***(A1)*(ft)*(A1)*(ft)** ***(C2)***

Note: Follow through from their answer to parts (a) and (b).

Note: Accept
$x = -1.38,$
$y = 3$ (
$x = -1.38481\ldots,$
$y = 3$) .

Examiners report

[N/A]

19a. *[2 marks]*

Markscheme

$P(x) = I(x) - C(x)$ ***(M1)***
$= -x^2 + 150x - 2600$ ***(A1) (C2)***

Examiners report

[N/A]

19b.

[2 marks]

Markscheme

$-2x + 150 = 0$ ***(M1)***

Note: Award ***(M1)*** for setting
$P'(x) = 0$.

OR

Award ***(M1)*** for sketch of
$P(x)$ and maximum point identified. ***(M1)***
$x = 75$ ***(A1)*(ft)** ***(C2)***

Note: Follow through from their answer to part (a).

Examiners report

[N/A]

19c.

[2 marks]

Markscheme

$\frac{7875}{75}$ ***(M1)***

Note: Award ***(M1)*** for
7875 seen.

$= 105$ ***(A1)*(ft)** ***(C2)***

Note: Follow through from their answer to part (b).

Examiners report

[N/A]

20a.

[2 marks]

Markscheme

$d = 0$,
$k = 100$ ***(M1)(A1)(G2)***

Note: Award ***(M1)*** for
$d = 0$ seen.

Examiners report

[N/A]

20b.

[2 marks]

Markscheme

$I = 100 \times (1.05)^{-25} = 29.5(\%)$ ($29.5302\ldots$) ***(M1)(A1)*(ft)*(G2)***

Examiners report

[N/A]

20c.

[2 marks]

Markscheme

$65 = 100 \times (1.05)^{-d}$ ***(M1)***

Note: Award ***(M1)*** for sketch with line drawn at $y = 65$.

$d = 8.83\ (\mathrm{m})$ ($8.82929\ldots$) ***(A1)*(ft)*(G2)***

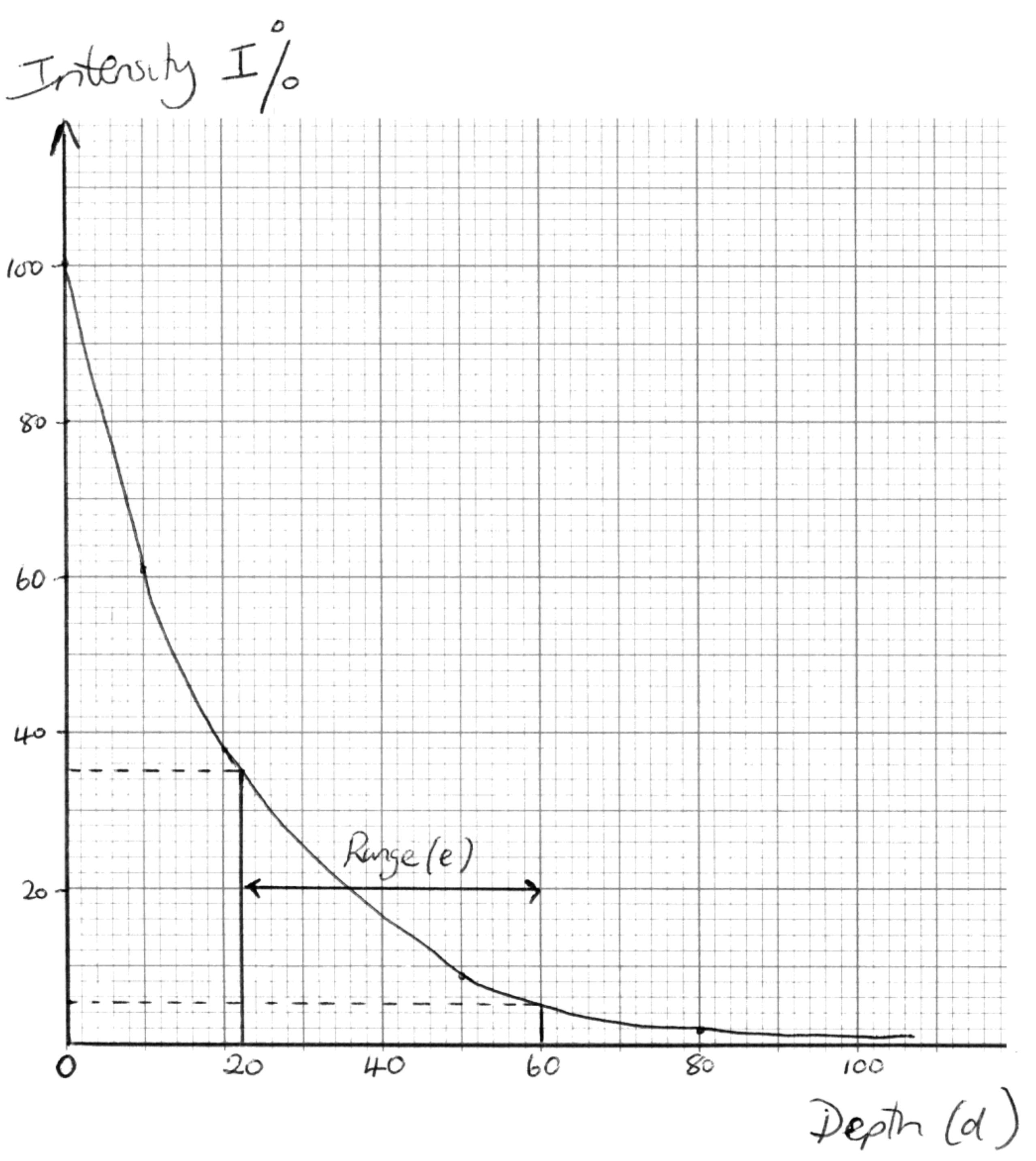
Examiners report

[N/A]

20d.

[4 marks]

Markscheme



(A1) for labels and scales
(A2) for all points correct, ***(A1)*** for 3 or 4 points correct
(A1) for smooth curve asymptotic to the x-axis ***(A4)***

Examiners report

[N/A]

20e. *[2 marks]*

Markscheme

Lines in approx correct positions **on** graph ***(M1)***
The range of values indicated (arrows or shading)
22–
60 m ***(A1)***

Examiners report

[N/A]

21a. *[1 mark]*

Markscheme

equation of asymptote is $x = 0$ ***(A1)***

(Must be an equation.)

[1 mark]

Examiners report

(i) An attempt at part (a) was seen only rarely. If there was an attempt, it was often not a meaningful equation. If an equation was seen, sometimes it was for y, not x.

21b. *[2 marks]*

Markscheme

$f'(x) = 2x + 3x^{-2}$ *(or equivalent)* ***(A1)*** *for each term* ***(A1)(A1)***

[2 marks]

Examiners report

The derivative seemed manageable for many, though with the expected mis-handling of the negative power quite often. Parts (c) and (d) proved problematical. Marking of (d) was lenient and it was reaffirmed that testing of the concept in (d) will be done in a more straightforward context in future, when done at all.

21c. *[2 marks]*

Markscheme

stationary point (–1.14, 3.93) ***(G1)(G1)*(ft)**

(-1,4) or similar error is awarded ***(G0)(G1)*(ft)***. Here and also as follow through in part (d) accept exact values*
$-\left(\frac{3}{2}\right)^{\frac{1}{3}}$ *for the x coordinate and*
$3\left(\frac{3}{2}\right)^{\frac{2}{3}}$ *for the y coordinate.*

OR
$2x + \frac{3}{x^2} = 0$ *or equivalent*

Correct coordinates as above ***(M1)***

Follow through from candidate's
$f'(x)$. ***(A1)*(ft)**

[2 marks]

Examiners report

The derivative seemed manageable for many, though with the expected mis-handling of the negative power quite often. Parts (c) and (d) proved problematical. Marking of (d) was lenient and it was reaffirmed that testing of the concept in (d) will be done in a more straightforward context in future, when done at all.

21d. *[3 marks]*

Markscheme

In all alternative answers for (d), follow through from candidate's x coordinate in part (c).

Alternative answers include:

$-1.14 \leq x < 0, \quad 0 < x < 5$ ***(A1)(A1)*(ft)*(A1)***

OR [–1.14,0), (0,5)

*Accept alternative bracket notation for open interval] [. (Union of these sets is not correct, award **(A2)** if all else is right in this case.)*

OR
$-1.14 \leqslant x < 5, x \neq 0$

*In all versions 0 **must** be excluded **(A1)**. -1.14 must be the left bound . 5 must be the right bound **(A1)**. For*
$x \geqslant -1.14$ *or*
$x > -1.14$ *alone, award **(A1)**. For*
$-1.4 \leqslant x < 0$ *together with*
$x > 0$ *award **(A2)**.*

[3 marks]

Examiners report

The derivative seemed manageable for many, though with the expected mis-handling of the negative power quite often. Parts (c) and (d) proved problematical. Marking of (d) was lenient and it was reaffirmed that testing of the concept in (d) will be done in a more straightforward context in future, when done at all.

21e. *[1 mark]*

Markscheme

a = 5.30 *(3sf)* *(Allow (5.30, 0) but 5.3 receives an **(AP)**.)* ***(A1)***

[1 mark]

Examiners report

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.

21f. *[2 marks]*

Markscheme

$\frac{\mathrm{d}y}{\mathrm{d}x} = -0.042x + 1.245$ ***(A1)** for each term.* ***(A1)(A1)***

[2 marks]

Examiners report

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.

21g. *[4 marks]*

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

(i) Maximum value when
$f'(x) = 0$,
$-0.042x + 1.245 = 0$, ***(M1)***

(M1) *is for either of the above but at least one must be seen.*

(x = 29.6.)

Football has travelled 29.6 – 5.30 = 24.3 m (3sf) horizontally. ***(A1)*****(ft)**

*For answer of 24.3 m with no working or for correct subtraction of 5.3 from candidate's x-coordinate at the maximum (if not 29.6), award **(A1)**(d).*

(UP) (ii) Maximum vertical height, f (29.6) = 12.4 m ***(M1)(A1)*****(ft)*****(G2)***

(M1) *is for substitution into f of a value seen in part (c)(i). f(24.3) with or without evaluation is awarded **(M1)(A0)**. For any other value without working, award **(G0)**. If lines are seen on the graph in part (d) award **(M1)** and then **(A1)** for candidate's value* ± 0.5 *(3sf not required.)*

[4 marks]

Examiners report

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

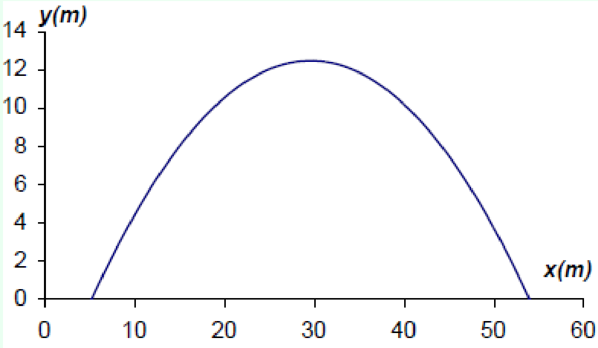
As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.

21h.

[4 marks]

Markscheme

(not to scale)



***(A1)(A1)(A1)*(ft)*(A1)*(ft)**

*Award **(A1)** for labels (units not required) and scale, **(A1)(ft)** for max*(29.6,12.4), ***(A1)*(ft)** for *x-intercepts at 5.30 and 53.9, (all coordinates can be within 0.5), **(A1)** for well-drawn parabola ending at the x-intercepts.*

[4 marks]

Examiners report

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.

21i.

[2 marks]

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

(UP) $f(40.3) = 10.1$ m (3sf).

*Follow through from (a). If graph used, award **(M1)** for lines drawn and **(A1)** for candidate's value* ± 0.5. *(3sf not required).*   ***(M1)(A1)*(ft)*(G2)***

[2 marks]

Examiners report

(ii) Many candidates failed to recognise that extensive use of the GDC was intended for this question. An indicator of this was the choice of awkward coefficients. It is recognised that the context confused some candidates and that the horizontal shift was a bit disturbing for some.

Nevertheless, a lot of candidates could have earned more marks here if they had persevered. Many gave up on the graph, and elementary marks for scale and labels were lost unnecessarily.

As this was the first time for the unit penalty, we were lenient about the units left off the labels but this is likely to change in the future.