IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N06/5/MATSD/SP1/ENG/TZ0/XX/M+

MARKSCHEME

November 2006

MATHEMATICAL STUDIES

Standard Level

Paper 1

19 pages

Paper 1 Markscheme
Instructions to Examiners

Notes: **If in doubt about these instructions or any other marking issues, contact your team leader for clarification.**

The number of marks for each question is 6.

Unless otherwise stated in the question, all numerical answers must be given exactly or correct to three significant figures.

1 Abbreviations

The markscheme may make use of the following abbreviations:

M Marks awarded for **Method**

A Marks awarded for an **Answer** or for **Accuracy**

C Marks awarded for **Correct** answers (irrespective of working shown)

R Marks awarded for clear **Reasoning**

ft Marks that can be awarded as **follow through** from previous results in the question

2 Method of Marking

(a) All marking must be done using a **red** pen.

(b) Marks must be noted on candidates' scripts as in the markscheme:

- A correct answer only needs ***C*** marks to be shown, otherwise show the breakdown of individual marks using the abbreviations ***(M1)***, ***(A2)*** *etc*.
- Write down and circle the total for **each question** at the end of the question.
- Transfer the total for **each question** to the front cover sheet and write down the total mark for the paper.

(c) In this paper, the maximum mark is awarded for a **correct answer on the answer line**. **There is no need to check the working!** Award ***C*** marks and move on.

(d) If the answer does not appear on the answer line, but the correct answer is seen in the working box with no subsequent working, award the maximum mark.

(e) If the **answer is wrong**, marks should be awarded for the working according to the markscheme.

(f) Working crossed out by the candidate should not be awarded any marks.

(g) A correct answer in the working box transcribed inaccurately to the answer line can receive full marks.

(h) If correct working results in a correct answer **in the working box** but then further working is developed, full marks should **not** be awarded. In most such cases it will be a single final answer

mark that is lost, however, a statement on the answer line should always be taken as the candidate's final decision on the answer **as long as it is unambiguous**.

Please note: Assignment of marks to the answers in all the following examples is for demonstration purposes only. Marks for actual examination questions will not necessarily follow the same pattern.

Implementation:

Question: Factorise $x^2 - 5x - 6$

Markscheme	Candidates' Scripts	Marking
$(x-6)(x+1)$ ***(A1)(A1)***	(i) Answer line: $(x-6)(x+1)$	***(C2)***
	(ii) Answer line: $(x+6)(x+1)$	***(A0) (A1)***
	(iii) Working box: $(x-6)(x+1)$ followed by answer line: x = 6 and -1, or just 6,-1	***(A1)*** ***(A0)***
	(iv) Working box: $(x-6)(x+1)$ then x = 6,-1 followed by answer line: x = 6 and -1, or just 6,-1 or factors and roots together	***(A1)*** ***(A0)***
	but	
	(v) Working box: $(x-6)(x+1)$ then x = 6,-1 followed by answer line: $(x-6)(x+1)$ only	***(C2)***
	(vi) Working box: $(x-6)(x+1)$ then x = 6,-1 and answer line empty	***(A1)(A0)***

Question: Using Pythagoras to find a side of a triangle:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4}=\sqrt{13}$ ***(M1)(A1)*** (3.61 3sf)	(i) Answer line: $\sqrt{13}$ or 3.61 or both	***(C2)***
	(ii) Working box: $\sqrt{9+4}=\sqrt{13}=6.50$ Answer line 6.5	***(M1)*** ***(A0)***
	(iii) Working box: $\sqrt{9+4}=\sqrt{13}=6.50$ Answer line empty	***(M1)(A0)***
	(iv) Working box: $\sqrt{9+4}=\sqrt{13}=3.61$ but answer line 3.16	***(M1)(A1)***
	For further considerations on this problem with regard to accuracy see later examples.	*(obvious transcription error)*

Question: Calculate the gradient of the line passing through the points (5,3) and (0,9).

Markscheme	Candidates' Scripts	Marking
$\frac{9-3}{0-5}=-\frac{6}{5}$ ***(M1)(A1)***	(i) Working: $m=\frac{9-3}{0-5}=-\frac{6}{5}$ followed by $y = -6x/5 +9$ but -6/5 on answer line	***(C2)***
	(ii) Working box: $m=\frac{9-3}{0-5}=-\frac{6}{5}$ followed by $y = -6x/5 +9$ and then answer line: either $y = -6x/5+9$ or $y = -6x/5$ or nothing at all on the answer line	***(M1)*** ***(A0)*** (even if -6/5 is **also** on the answer line)

3 Follow through (ft) Marks

Errors made at any step of a solution can affect all working that follows. To limit the severity of the penalty, **follow through (ft)** marks can be awarded. Markschemes will indicate where it is appropriate to apply follow through in a question with **'(ft)'** appended to the eligible mark(s).

- If an answer resulting from follow through is extremely unrealistic (*e.g.* negative distances or wrong by large order of magnitude) then the final ***A*** mark should not be awarded. If in doubt, contact your team leader.

- If a question is transformed by an error into a **different**, **much simpler question** then follow through might not apply or might be reduced. In this situation consult your team leader and record the decision on the candidate's script.

- To award follow through marks for a question part, **there must be working present for that part** and not just an answer based on the follow through. An isolated follow through answer, with no working, must be regarded as incorrect and receives no marks **even if it seems approximately correct**.

- Inadvertent use of radians will be penalised the first time it occurs. Subsequent use, even in later questions, will normally be allowed follow through marks, unless the answer is unrealistic. Cases of this kind will be addressed on an individual basis.

Implementation: The following examples illustrate correct use of the **follow through** process in straightforward situations.

Question: An investment problem with two different rates of interest and a total amount of \$600 split across the rates in consecutive periods:

Markscheme	Candidate's Script	Marking
(a) \$ 600 × 1.02 ***(M1)*** = \$ 612 ***(A1)*** (b) \$ $(\frac{612}{2} \times 1.02) + (\frac{612}{2} \times 1.04)$ ***(M1)*** = \$ 630.36 ***(A1)*****(ft)** ***Note: The (M1) is for splitting the value from (a) and forming a sum of products.*** Here the ***(ft)*** indicates a possible follow through from part (a).	Case (i) (a) Final amount after 1st period = \$ 600 × 1.02 = \$ 602 (b) Amount after 2nd period = 301 × 1.02 + 301 × 1.04 = \$ 620.06 but note Case (ii) an ***(M0)*** almost always prohibits the **associated** ***(ft)*** so (a) \$ 600 × 1.02 = \$ 602 (b) \$ 602 × 1.04 = \$626.08 Case (iii) (a) \$ 600 × 1.02 = \$ 602 (b) No working. 620.06 on answer line.	***(M1)*** ***(A0)*** ***(M1)*** ***(A1)*****(ft)** ***(M1)(A0)*** ***(M0)(A0)*****(ft)** ***(M1)(A0)*** ***(M0)(A0)*****(ft)**

Question: Finding angles and lengths using trigonometry

Markscheme	Candidate's Script	Marking
(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ ***(M1)(A1)*** $A = 22.0^\circ$ ***(A1)*** (b) $x = 7 \tan A$ ***(M1)*** = 2.83 ***(A1)*****(ft)**	(a) $\frac{\sin A}{4} = \frac{\sin 30}{3}$ $A = 41.8^\circ$ (b) case (i) $x = 7 \tan A$ = 6.26 ***but*** case (ii) 6.26	***(M1) (A0) (use of sine rule but with wrong values)*** ***(A0)*** *(Note: the 2nd* ***(A1)*** *here was not marked* ***(ft)*** *and cannot be awarded because there was an earlier error in the same question part.)* ***(M1)*** ***(A1)*****(ft)** ***(C0)*****(ft)**

4 Using the Markscheme

This markscheme presents a particular way in which each question might be worked and how it should be marked.

(a) As ***A*** marks are normally **dependent** on the preceding ***M*** mark being awarded, it is **not** possible to award ***(M0)(A1)***. Once an ***(M0)*** has been awarded, all subsequent ***A*** marks are lost in that part of the question, even if calculations are performed correctly, until the next ***M*** mark, unless otherwise instructed in the markscheme. (See the first example above). Similarly ***(A1)(R0)*** cannot be awarded for an answer which is accidentally correct for the wrong reasons given.

Implementation: Question: (a) χ^2 calculated followed by (b) degrees of freedom found and (c) and (d) comparison to critical value. (Interdependence of ***A*** and ***R*** marks.)

Markscheme	Candidate's Script	Marking
	Case (i)	
(a) $\chi_{calc}^2 = 3.92$ ***(A1)***	(a) $\chi_{calc}^2 = 3.92$	***(A1)***
(b) $n = 4$ ***(A1)***	(b) $n = 4$	***(A1)***
(c) $\chi_{crit}^2 = 9.488$ ***(A1)*(ft)**	(c) Don't know?	***(A0)***
(d) Do not reject null hypothesis ***(A1)*(ft)**	(d) Do not reject null hypothesis	***(A0)***
because $\chi_{calc}^2 < \chi_{crit}^2$ ***(R1)*(ft)**	because $\chi_{calc}^2 > 0$	***(R0)***
	Case (ii)	
	(a) $\chi_{calc}^2 = 3.92$	***(A1)***
	(b) $n = 4$	***(A1)***
	(c) $\chi_{crit}^2 = 4.488$	***(A0)***
	(d) Do not reject null hypothesis because $\chi_{calc}^2 < \chi_{crit}^2$	***(A1)*(ft)** ***(R1)*(ft)**
	Case (iii)	
	(a) $\chi_{calc}^2 = 3.92$	***(A1)***
	(b) $n = 1$	***(A0)***
	(c) $\chi_{crit}^2 = 3.841$	***(A1)*(ft)**
	(d) Reject null hypothesis because $\chi_{calc}^2 > \chi_{crit}^2$	***(A1)*(ft)** ***(R1)*(ft)**

(b) **Alternative methods** have not always been included. Thus, if an answer is wrong then the working must be carefully analysed in order that marks are awarded for a different method in a manner that is consistent with the markscheme.
Where alternative methods for complete questions are included in the markscheme, they are indicated by '**OR'** *etc*. This includes alternatives obtained with a graphic display calculator.

Example: Question to find the coordinates of a vertex of a given quadratic

Working	Marks
$f(x) = 2x^2 + 7x - 3$	
$x = -\frac{b}{2a} = -\frac{7}{4}$ ***(M1)*** *for use of –b/2a,* ***(A1)*** *for correct answer*	***(M1)(A1)***
$f(-7/4) = -\frac{146}{16} = -\frac{73}{8}$ ***(M1)*** *for using f(-7/4),* ***(A1)*** *for answer.*	***(M1)(A1)*(ft)**
Coordinates are (-7/4,-73/8)	***(A1)*(ft)**
OR	**OR**
$f'(x) = 4x + 7$, $4x+7 = 0$ so x = -7/4 ***(M1)*** *for attempting to take a derivative and setting it to 0* ***(A1)*** *for answer*	***(M1)*** ***(A1)***
$f(-7/4) = -\frac{146}{16} = -\frac{73}{8}$ ***(M1)*** *for using f(-7/4),* ***(A1)*** *for answer.*	***(M1)(A1)*(ft)**
Coordinates are (-7/4,-73/8)	***(A1)*(ft)**

(c) Unless the question specifies otherwise, accept **equivalent forms**. For example: $\frac{\sin\theta}{\cos\theta}$ for $\tan\theta$.
On the markscheme, these equivalent numerical or algebraic forms will sometimes be written in brackets after the required answer.

(d) As this is an international examination, all valid **alternative forms of notation** should be accepted. Some examples of these are:

Decimal points: 1.7; 1'7; $1 \cdot 7$; 1,7 .

Different descriptions of an interval: $3 < x < 5$; (3, 5);] 3, 5 [.

Different forms of notation for set properties (*e.g.* complement): A'; $\bar{A}$; A^c; $U - A$; (A *U/A.*
Different forms of logic notation: $\neg p$; p' ; $\tilde{p}$; $\bar{p}$; ~ *p.*

$$p \Rightarrow q \; ; \; p \rightarrow q \; ; \; q \Leftarrow p \; .$$

(e) Discretionary ***(d)*** marks: There will be rare occasions where the markscheme does not cover the work seen. In such cases, ***(d)*** should be used to indicate where an examiner has used discretion. It must be accompanied by a brief note to explain the decision made.

5 Accuracy of Answers

Unless otherwise stated in the question, all numerical answers must be given exactly or correct to 3 significant figures.
A penalty known as an **ACCURACY PENALTY *(AP)*** is applied if an answer is either

(i) rounded incorrectly to 3 significant figures or

(ii) rounded correctly or incorrectly to some other level of accuracy.

This penalty is applied to the **final answer** of a question part only. It applies **also** when an exact answer is incorrectly rounded.

THE ACCURACY PENALTY IS APPLIED AT MOST ONCE PER PAPER! Subsequent accuracy errors can be **ignored** and full marks awarded if all else is correct.

An accuracy penalty must be recorded in proximity to the incorrect answer as ***(A0)(AP)***.
Examiners must record the occurrence of an accuracy penalty by writing ***(AP)*** next to the relevant question total on the front of the cover sheet.

If the level of accuracy is specified in the question, a mark will be allocated for giving the answer to the required accuracy. In **all** such cases the final mark is not awarded if the rounding does not follow the instructions given in the question. This is **NOT** an accuracy penalty. A mark for specified accuracy can be regarded as a ***(ft)*** mark regardless of an immediately preceding ***(M0)***.

Rounding of an exact answer to 3 significant figures **should be accepted if performed correctly**. If the rounding is incorrect, an accuracy penalty should be applied as detailed above. Exact answers such as $\frac{1}{4}$ can be written as decimals to less than three significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential.

Ratios of π and answers taking the form of square roots of integers **(even if exact squares)** or any rational power of an integer (*e.g.* $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}, \sqrt{9}$) may be accepted as exact answers. All other powers (*e.g.* of non-integers) and values of transcendental functions such as sine and cosine must be evaluated.
Answers **with no supporting working** (usually from a GDC), which are written correct to more than 3 significant figures can be awarded full marks with an ***(AP)*** then applied. When this happens, multiple C marks can be split (*e.g.* ***(A1)(A0)(AP)*** or ***(C1)(C0)(AP)***. **Unsupported** answers with less than 3 significant figures must be deemed incorrect even if they seem approximately correct.

An accuracy penalty should not be applied to an answer that is already incorrect for some other reason.

Special cases

Answers involving units of currency can be accepted correct to 3 significant figures or correct to the nearest currency unit (*e.g.* dollar) or correct to the nearest hundredth unit (*e.g*. cent). Allow all these cases to follow through to later question parts.

An answer taken directly from the IB chi squared statistical table can be given and used to the same level of accuracy as appears in the table (3 decimal places) or correct to 3 significant figures.

For judging equivalence between 3sf and use of minutes and seconds for angles, guidelines have been issued to paper setters. This problem will be dealt with on an individual basis as the need arises.

Examples: The Pythagoras example used before:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4}=\sqrt{13}$ (***M1)(A1)*** (3.61 3sf)	(i) Working box: nothing but answer line: 3.6 or 4	***(C0)***
	(ii) Working box: nothing but answer line: 3.60555	***(C1)(C0)(AP)***
	(iii) Working box: $\sqrt{9+4}=\sqrt{13}$ Answer line: 3.6	***(M1)*** ***(A0)(AP)***
	(iv) Working box: $\sqrt{9+4}=\sqrt{13}$ Answer line: 3.60555	***(M1)*** ***(A0)(AP)***
	(v) Working box: $\sqrt{9+4}=\sqrt{13}=3.60$	***(M1)(A0)(AP)***
	(vi) Working box: $\sqrt{9+4}=\sqrt{14}=3.74$ transferred, or not, to answer line	***(M1)(A0)***

If the question specified *e.g.* correct to 4 decimal places for the answer, then there would be one extra mark available as follows:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4} = \sqrt{13}$ ***(M1)(A1)***	(i) Working box: nothing but answer line: 3.606	***(C0)***
= 3.6056 (4dp) ***(A1)*(ft)**	(ii) Working box: nothing but answer line: 3.6055	***(C0)***
	(iii) Working box: $\sqrt{9+4} = \sqrt{13}$ Answer line 3.6	***(M1)(A1)*** ***(A0)***
	(iv) Working box: $\sqrt{9+4} = \sqrt{13}$ Answer line: 3.60555	***(M1)(A1)*** ***(A0)***
	(v) Working box: $\sqrt{9+4} = \sqrt{14}$ = 3.7417 whether transferred to answer line or not.	***(M1)(A0)*** ***(A1)*(ft)**
	(vi) Working box: $\sqrt{9-4} = \sqrt{5}$ = 2.2361 whether transferred to answer line or not.	***(M0)(A0)*** ***(A1)*(ft)** *Note: this is a special case, where the initial **(M0)** does not determine the final **(A0)***
	(vii) Answer line: 3.61 or 3.606 wrong answers, no working.	***(C0)***

Premature Rounding

Accuracy errors in a final answer, which result from premature rounding earlier in the same question part, should not receive an accuracy penalty. There are two situations.
If there is a mark available for a prematurely rounded answer and the rounding occurs at this stage, then the inappropriate rounding should be penalised with ***(A0)*** but the answer can then be allowed to follow through to the end of the question. If the first stage of the answer is correct but rounded further on, then it should be penalised at an appropriate place close to where it is rounded. Some discretion should be used to deny a **(ft)** mark if the rounding is very bad and the answer far from its required value.

Example: Question: sine rule used to find angle *A*, with angle *B* and side *b* known but side *a* is first calculated using Pythagoras in an adjoining triangle.

Markscheme	Candidate's Script	Marking
$a = \sqrt{25+36} = \sqrt{61}$ ***(M1)(A1)***	(i) $a = \sqrt{25+36} = \sqrt{61}$ = 7.8	***(M1)(A0)***
$\frac{\sin(A)}{\sqrt{61}} = \frac{\sin(32)}{5}$ ***(M1)(A1)*(ft)**	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A1)*(ft)**
$A = 55.9^\circ$ ***(A1)*(ft)**	$A = 55.8^\circ$	***(A1)*(ft)**
	(ii) $a = \sqrt{25+36} = \sqrt{61}$	***(M1)(A1)***
	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A0)***
	$A = 55.8^\circ$	***(A1)*(ft)**
	(iii) $a = \sqrt{25+36} = \sqrt{61}$	***(M1)(A1)***
	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A0)***
	$A = \sin^{-1}(0.83) = 56.1^\circ$	***(A0)***
	(iv) $a = \sqrt{25+36} = \sqrt{61}$ = 8	***(M1)(A0)***
	$\frac{\sin(A)}{8} = \frac{\sin(32)}{5}$	***(M1)(A1)*(ft)**
	$A = 58.0^\circ$	***(A0)*(ft)** *(The rounding is severe and the answer quite far from correct).*

6 Graphic Display Calculators

Candidates will often be obtaining solutions directly from their calculators. They must use mathematical notation, not calculator notation. No method marks can be awarded for incorrect answers supported only by calculator notation.

Q1	(a)	0.0337 *Award **(M1)** for substituting into the formula, **(A1)** for correct answer.*	***(M1)(A1)***	***(C2)***
	(b)	(i) 0.034	***(A1)*(ft)***	***(C1)***
		(ii) 3.4%	***(A1)*(ft)***	***(C1)***
	(c)	3.4×10^{-2} *Award **(A1)** for 3.4 and **(A1)** for –2.* ***(ft)** is from candidate's answer to part (b)(i) only.*	***(A1)*(ft)(A1)*(ft)**	***(C2)*** ***[6 marks]***
Q2	(a)	"Dany (either) goes to the cinema or studies for the test but not both." *Award **(A1)** for correct propositions with or, **(A1)** for "but not both".*	***(A1)(A1)***	***(C2)***
	(b)	(i) $p \Rightarrow \neg q$ *Award **(A1)** for " $p \Rightarrow$ ", **(A1)** for " $\neg q$ ".*	***(A1)(A1)***	***(C2)***
		(ii) $q \Rightarrow \neg p$ *Award **(A1)** for " $q \Rightarrow$ ", **(A1)** for " $\neg p$ ".*	***(A1)*(ft)(A1)*(ft)**	***(C2)*** ***[6 marks]***
Q3	(a)	$\frac{20\,000\times2\times8}{100} = 3\,200$ Swiss francs *Award **(M1)** for formula with correct values.*	***(M1)(A1)***	***(C2)***
	(b)	$20\,000(1.0125)^{24} - 20\,000 =$	***(M1)(A1)***	
		= 6947.02 Swiss francs	***(A1)***	
		Principal = 26947.02 Swiss francs. ***(M1)** for correct substituted formula, **(A1)** for correct values inserted. **(A1)** for 6947.02 and **(A1)** for adding back the 20 000. The last **(A1)** follows through from the previous answer.*	***(A1)*(ft)***	
		OR		
		$20\,000\ (1.0125)^{24} =$	***(M2)(A1)***	
		26947.02 Swiss francs ***(M2)** for correct substituted formula, **(A1)** for correct substitution, **(A1)** for correct answer.*	***(A1)***	***(C4)*** ***[6 marks]***

Q4

(a) $\frac{a}{8}=\frac{1}{2}$

$a=4$ ***(A1)***

OR

OR

$\frac{2}{a}=\frac{1}{2}$

$a=4$ ***(A1)*** ***(C1)***

(b) $8\left(\frac{1}{2}\right)^{7}=0.0625$ ***(M1)(A1)*(ft)**

OR

OR

$2\left(\frac{1}{2}\right)^{5}=0.0625$ ***(M1)(A1)*(ft)** ***(C2)***

(c) $\frac{8\left((\frac{1}{2})^{12}-1\right)}{\frac{1}{2}-1}=16.0$ (3 s.f.) (= 4095/256) ***(M1)(A1)*(ft)**

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

*Award **(M1)** for using correct formula and correct substitution, **(A1)** for correct answer (15.99...). **(A1)** for correct answer to 3 s.f.*

(C3)

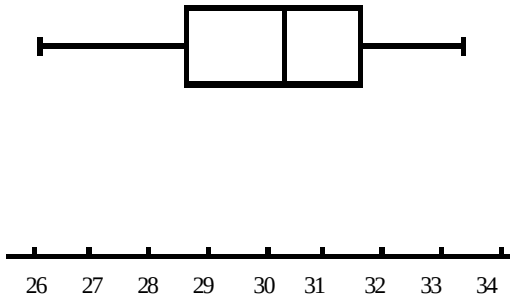
[6 marks]

Q5

(a) $\frac{2+t}{2}=3\Rightarrow t=4$ ***(M1)(A1)*** ***(C2)***

(b) q1 = 28.6 ***(A1)*** ***(C1)***

(c)



minimum = 26.1
maximum = 33.4 ***(A3)*(ft)**

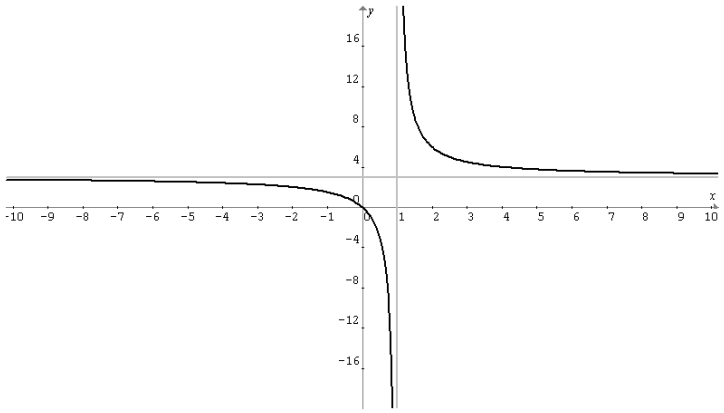
*Award **(A1)** for median in correct place, **(A1)** for box with quartiles in correct place and **(A1)** for correct whiskers joined to box with straight lines. The second **(A1)** follow through from (b).*

(C3)

[6 marks]

Q6	(a)	$2x^3 - 2x$	***(A1)***	***(C1)***
	(b)	$f'(x) = 6x^2 - 2$ *Award **(A1)** for each term.*	***(A1)*(ft)(A1)*(ft)**	***(C2)***
	(c)	gradient $= f'(-1)$ $= 6(-1)^2 - 2$ $= 4$	 ***(M1)*** ***(A1)*(ft)**	 ***(C2)***
	(d)	$\tan\theta = 4$	***(A1)*(ft)**	***(C1)***
				[6 marks]
Q7	(a)	2	***(A1)***	***(C1)***
	(b)	18	***(A1)***	***(C1)***
	(c)	$6 \le t \le 12$ *Award **(A1)** for both numbers correct, **(A1)** for inequality signs.* *Award **(A1)** for "from 6 to 12".*	***(A1)(A1)***	 ***(C2)***
	(d)	$360 / b = 24$ $b = 15$ **OR** *Substituting into the equation of the function the coordinates of any point on the graph **(M1)**.* $b = 15$	***(M1)*** ***(A1)*** **OR** ***(M1)*** ***(A1)***	 ***(C2)***
				[6 marks]

Q8	(a)	$\frac{\sin 50}{\text{AC}} = \frac{\sin 30}{400}$ *Award **(M1)** for using sine rule with values from the problem, **(A1)** for correct substitution.*	***(M1)(A1)***	
		$\text{AC} = 613$ (3 s.f.)	***(A1)***	***(C3)***
	(b)	Perimeter $= 400 + 613 + 788 = 1801$ m		
		Time in seconds $= \frac{1801}{1.8} = 1000$	***(A1)*(ft)(A1)***	
		*Award **(A1)** for the perimeter, **(A1)** for finding the time in seconds, and last **(A1)(ft)** for finding the time in minutes. The time in minutes follow through from the time in seconds.*		
		Time in minutes = $\frac{1000}{60} = \frac{50}{3}$ (=16.7 to 3 s.f.)	***(A1)*(ft)***	***(C3)***
				[6 marks]
Q9	(a)	$x = -3$ *Award **(M1)** for using property of symmetry or sketch.*	***(M1)(A1)***	***(C2)***
	(b)	(i) $f(-1) = 5$	***(A1)***	***(C1)***
		(ii) Range $= (-\infty, 5]$ or $y \leq 5$ *Award **(A1)** for "$(-\infty$", **(A1)** for "]", **(A1)** for 5.* *For $y = 5$ award **(A1)** only.* *For $y < 5$ award **(A1)(A1)**.*	***(A1)(A1)(A1)***	***(C3)***
				[6 marks]
Q10	(a)	$H_0 =$ The standard of award is independent of the examiner (or equivalent)	***(A1)***	***(C1)***
	(b)	4	***(A1)***	***(C1)***
	(c)	$f_e = \frac{30 \times 45}{135}$	***(M1)***	
		$f_e = 10$	***(A1)***	***(C2)***
	(d)	No, because the *p*-value is less than the significance level.	***(A2)***	
		OR	**OR**	
		No, because $0.0327 < 0.05$	***(A2)***	***(C2)***
				[6 marks]

Q11	(a) A(−1.79, 0.789) and B(1.14, 2.70) *Award **(C2)** for each pair of coordinates obtained from the GDC.* *Award **(A1)(A2)(ft)** if bracket is not used.*		***(C2)(C2)***
	(b) $-1.79 < x < 1.14$ *Award **(A1)** for both numbers, **(A1)** for correct inequalities.*	***(A1)(ft)(A1)(ft)***	***(C2)***
			[6 marks]
Q12	(a)  *Award **(A1)** for some indication of scale on the y-axis. Award **(A1)** for at least one asymptote drawn. Award **(A1)** for each of the two (smooth) branches. The left hand branch must pass through 0. One branch should be above the horizontal asymptote and the other below but if the asymptote is not drawn, then there should be little or no overlap in heights of the branches. If this condition is not fulfilled, award **(A1)(A0)** for the curve.*	***(A4)***	***(C4)***
	(b) (i) Horizontal asymptote $y = 3$ (ii) Vertical asymptote $x = 1$ Equations for x and y must be seen, **(ft)** if reversed.	***(A1)*** ***(A1)(ft)***	***(C2)*** ***[6 marks]***

Q13

(a) $1000 \times 0.98 \times 0.543 = 532.14$ ***(M1)(M1)(A1)***

*Award **(M1)** for multiplying by 0.98,*
***(M1)** for multiplying by 0.543. Accept 532.*

OR

$1000 \times 0.543 \times 0.02 = 10.36$ ***(M1)(M1)***
$543 - 10.86 = 532.14$ ***(A1)***
(M1)** for multiplying by 0.543, **(M1)** for multiplying by 0.02 and **(A1)** for correct answer.* ***(C3)

(b) $\frac{150 \times 1.35 - 200}{1.35} = 1.85$ GBP ***(M1)(M1)(A1)***

*Award **(M1)** for 150 ×1.35, **(M1)** for subtracting 200 or for 2.5 seen and **(A1)** for correct answer in GBP.*

OR **OR**

$150 - \frac{200}{1.35} = 1.85$ GBP ***(M1)(M1)(A1)***

*Award **(M1)** for subtracting from 150, **(M1)** for $\frac{200}{1.35}$ and **(A1)** for correct answer in GBP.* ***(C3)***

[6 marks]

Q14

(a) (i) $32\,000r^0 = 32\,000$ ***(M1)(A1)***
Award ***(M1)*** for putting $t = 0$. ***(C2)***

(ii) $32\,000r = 27\,200$ ***(M1)***
$r = 0.85$ ***(A1)*** ***(C2)***

(b) $32\,000 \times 0.85^t = 8000$ ***(M1)***
$0.85^t = 0.25$
$t = 8.53$ (3 s.f.) (accept 9) ***(A1)*(ft)**

(C2)
[6 marks]

Q15

$\bar{x}$ and σ	Team
I	B
II	C
III	D
IV	A

(A6)

*Award **(A6)** for all correct, **(A4)** for 2 correct or for 3 correct and 1 blank, **(A2)** for 1 correct but **(A0)** if the same letter appears 4 times.* ***(C6)***

[6 marks]