



MARKSCHEME

November 2009

MATHEMATICS

Standard Level

Paper 2

Deadlines (different to IBIS/Scoris)

Samples to Team Leaders	5 December
Everything to IB Cardiff	12 December

NB THE ACCURACY PENALTY ONLY APPLIES TO QUESTION 8 IN NOVEMBER 2009

*This markscheme is **confidential** and for the exclusive use of examiners in this examination session.*

*It is the property of the International Baccalaureate and must **not** be reproduced or distributed to any other person without the authorization of IB Cardiff.*

Instructions to Examiners

Abbreviations

- M** Marks awarded for attempting to use a correct **Method**; working must be seen.
- (M)** Marks awarded for **Method**; may be implied by **correct** subsequent working.
- A** Marks awarded for an **Answer** or for **Accuracy**; often dependent on preceding **M** marks.
- (A)** Marks awarded for an **Answer** or for **Accuracy**; may be implied by **correct** subsequent working.
- R** Marks awarded for clear **Reasoning**.
- N** Marks awarded for **correct** answers if **no** working shown.
- AG** Answer given in the question and so no marks are awarded.

Using the markscheme

1 General

Mark according to scoris instructions and hints to examiners, using annotations when required, but see point 10 about the **AP** – only apply **AP** to question 8 for N09.

2 Method and Answer/Accuracy marks

- Do **not** automatically award full marks for a correct answer; all working **must** be checked, and marks awarded according to the markscheme.
- It is generally not possible to award **M0** followed by **AI**, as **A** mark(s) depend on the preceding **M** mark(s), if any. An exception to this rule is when work for **MI** is missing, as opposed to incorrect (see point 4.)
- Where **M** and **A** marks are noted on the same line, *e.g.* **MIAI**, this usually means **MI** for an **attempt** to use an appropriate method (*e.g.* substitution into a formula) and **AI** for using the **correct** values.
- Where there are two or more **A** marks on the same line, they may be awarded independently; so if the first value is incorrect, but the next two are correct, award **A0AIAI**.
- Where the markscheme specifies **(M2)**, **N3**, *etc.*, do **not** split the marks, unless there is a note. (Example 1)
- Once a correct answer to a question or part-question is seen, ignore further working.

3 ***N* marks**

If **no** working shown, award *N* marks for **correct** answers. In this case, ignore mark breakdown (**M**, **A**, **R**).

- Do **not** award a mixture of *N* and other marks.
- There may be fewer *N* marks available than the total of **M**, **A** and **R** marks; this is deliberate as it penalizes candidates for not following the instruction to show their working.
- There may not be a direct relationship between the *N* marks and the implied marks. There are times when all the marks are implied, but the *N* marks are not the full marks: this indicates that we want to see some of the working, without specifying what.
- For consistency within the markscheme, *N* marks are noted for every part, even when these match the mark breakdown.
- If a candidate has incorrect working, which somehow results in a correct answer, do **not** award the *N* marks for this correct answer. However, if the candidate has indicated (usually by crossing out) that the working is to be ignored, award the *N* marks for the correct answer.

4 **Implied and must be seen marks**

Implied marks appear in **brackets** e.g. (**MI**).

- Implied marks can only be awarded if **correct** work is seen or if implied in subsequent working (a correct answer does not necessarily mean that the implied marks are all awarded).
- Normally the correct work is seen or implied in the next line.
- Where there is an (**MI**) followed by **AI** for each correct answer, if no working shown, one correct answer is sufficient evidence to award the (**MI**). (Example 2)

Must be seen marks appear without **brackets** e.g. **MI**.

- Must be seen marks can only be awarded if **correct** work is seen.
- If a must be seen mark is not awarded because work is missing (as opposed to **MO** or **AO** for incorrect work) all subsequent marks may be awarded if appropriate.

5 **Follow through marks (only applied after an error is made)**

Follow through (**FT**) marks are awarded where an incorrect answer from one **part** of a question is used correctly in **subsequent** part(s) or subpart(s). To award **FT** marks, **there must be working present** and not just a final answer based on an incorrect answer to a previous part.

- Within a question part, once an **error** is made, no further **A** marks can be awarded for work which uses the error, but **M** marks may be awarded if appropriate. (However, as noted above, if an **A** mark is not awarded because work is missing, all subsequent marks may be awarded if appropriate).
- If the question becomes much simpler because of an error then use discretion to award fewer **FT** marks.
- If the error leads to an inappropriate value (e.g. probability greater than 1, use of $r > 1$ for the sum of an infinite GP, $\sin \theta = 1.5$, non integer value where integer required), do not award the mark(s) for the final answer(s).
- The markscheme may use the word “their” in a description, to indicate that candidates may be using an incorrect value. (Example 3)
- Exceptions to this rule will be explicitly noted on the markscheme.
- If a candidate makes an error in one part, but gets the correct answer(s) to subsequent part(s), award marks as appropriate, unless the question says hence. It is often possible to use a different approach in subsequent parts that does not depend on the answer to previous parts. (Example 3)

6 Mis-read

If a candidate incorrectly copies information from the question, this is a mis-read (**MR**). Apply a **MR** penalty of 1 mark to that question. Award the marks as usual and then stamp (**MR**) next to the total. Scorist will subtract 1 mark from the total for the question. A candidate should be penalized only once for a particular mis-read.

- If the question becomes much simpler because of the **MR**, then use discretion to award fewer marks.
- If the **MR** leads to an inappropriate value (e.g. probability greater than 1, use of $r > 1$ for the sum of an infinite GP, $\sin \theta = 1.5$, non integer value where integer required), do not award the mark(s) for the final answer(s).
- Miscopying of candidates' own work does **not** constitute a misread, it is an error.

7 Discretionary marks (*d*)

An examiner uses discretion to award a mark on the rare occasions when the markscheme does not cover the work seen. The mark should be labelled (**d**) and a brief **note** written next to the mark explaining this decision.

8 Alternative methods

Candidates will sometimes use methods other than those in the markscheme. Unless the question specifies a method, other correct methods should be marked in line with the markscheme. If in doubt, contact your team leader for advice.

- Alternative methods for complete questions are indicated by **METHOD 1**, **METHOD 2**, etc.
- Alternative solutions for part-questions are indicated by **EITHER . . . OR**.
- Where possible, alignment will also be used to assist examiners in identifying where these alternatives start and finish.

9 Alternative forms

Unless the question specifies otherwise, **accept** equivalent forms.

- As this is an international examination, accept all alternative forms of **notation**.
- In the markscheme, equivalent **numerical** and **algebraic** forms will generally be written in brackets immediately following the answer.
- In the markscheme, **simplified** answers, (which candidates often do not write in examinations), will generally appear in brackets. Marks should be awarded for either the form preceding the bracket or the form in brackets (if it is seen). (Example 4)

10 Accuracy of Answers

THE ACCURACY PENALTY (AP) ONLY APPLIES TO Q8 IN NOVEMBER 2009!!

For all other questions, treat accuracy errors as though the **AP** has already been applied.

- Intermediate values are sometimes written as 3.24(741). This indicates that using 3.24 (or 3.25) is acceptable, but the more accurate value is 3.24741. The digits in brackets are not required for the marks. If candidates work with three or less significant figures, this could lead to an incorrect final value – in this case, do not award the final *AI*.
- Do not accept unfinished numerical answers such as 3/0.1 (unless otherwise stated). As a rule, numerical answers with more than one part (such as fractions) should be given using integers (e.g. 6/8).

If working is shown, and candidates work with more than three significant figures, once a correct value for the final answer is seen, do not penalise for subsequent rounding errors, or for not giving their answer correct to three significant figures.

e.g. if calculations lead to the value 2.8718, award the final *AI* for any of the following answers, which are to the incorrect level, and some are also incorrectly rounded, 2.871, 2.872, 2.8, 2.9, 2, 3.

ACCURACY PENALTY ON QUESTION 8

- **Rounding errors:** only applies to final answers not to intermediate steps.
- **Level of accuracy:** when this is not specified in the question the general rule applies to final answers: *unless otherwise stated in the question all numerical answers must be given exactly or correct to three significant figures.*

Candidates should be penalized **once only IN QUESTION 8** for an accuracy error (*AP*). Award the marks as usual then stamp *AP* against the answer. Scoris will automatically deduct 1 mark from the question part where *AP* is noted. If you see another potential *AP* in the question, use *APD* (*AP* done), to avoid further penalties. When you have finished marking question 8, please check that there is only one *AP* used.

- If a final correct answer is incorrectly rounded, apply the *AP*.
- If the level of accuracy is not specified in the question, apply the *AP* for correct final answers not given to three significant figures.

If there is no working shown, and answers are given to the correct two significant figures, apply the *AP* with the *N* marks for correct two significant figures answers. However, do **not** accept answers to one significant figure without working.

11 Crossed out work

If a candidate has drawn a line through work on their examination script, or in some other way crossed out their work, do not award any marks for that work.

12 Calculators

A GDC is required for paper 2, but calculators with symbolic manipulation features (e.g. TI-89) are not allowed.

Calculator notation

The Mathematics SL guide says:

Students must always use correct mathematical notation, not calculator notation.

Do **not** accept final answers written using calculator notation. However, accept the use of calculator notation in the working.

13 Style

The markscheme often uses words to describe what the marks are for, followed by examples, using the e.g. notation. These examples are not exhaustive, and examiners should check what candidates have written, to see if they satisfy the description. Some examples may include ones using poor notation, to indicate what is acceptable. (Example 5)

EXAMPLES

Please check the references in the instructions above.

EXAMPLE 1

- | | | | |
|-----|---|-------------|-----------|
| (a) | evidence of using $\sum p_i = 1$ | <i>(M1)</i> | |
| | correct substitution | <i>AI</i> | |
| | <i>e.g.</i> $10k^2 + 3k + 0.6 = 1$, $10k^2 + 3k - 0.4 = 0$ | | |
| | $k = 0.1$ | <i>A2</i> | <i>N2</i> |

Note: Award *AI* for a final answer of $k = 0.1$, $k = -0.4$.

- | | | | |
|-----|---|-------------|-----------|
| (b) | evidence of using $E(X) = \sum p_i x_i$ | <i>(M1)</i> | |
| | correct substitution | <i>(AI)</i> | |
| | <i>e.g.</i> $-1 \times 0.2 + 2 \times 0.4 + 3 \times 0.3$ | | |
| | $E(X) = 1.5$ | <i>AI</i> | <i>N2</i> |

Note: Award *FT* marks only on values of k between 0 and 1.

EXAMPLE 2

- | | | | |
|-----|--|-------------|-----------|
| (a) | intercepts when $f(x) = 0$ | <i>(M1)</i> | |
| | Note: 1 correct answer seen is sufficient evidence to award the <i>(M1)</i> . | | |
| | $(1.54, 0)$ $(4.13, 0)$ (accept $x = 1.54$ $x = 4.13$) | <i>AIAI</i> | <i>N3</i> |

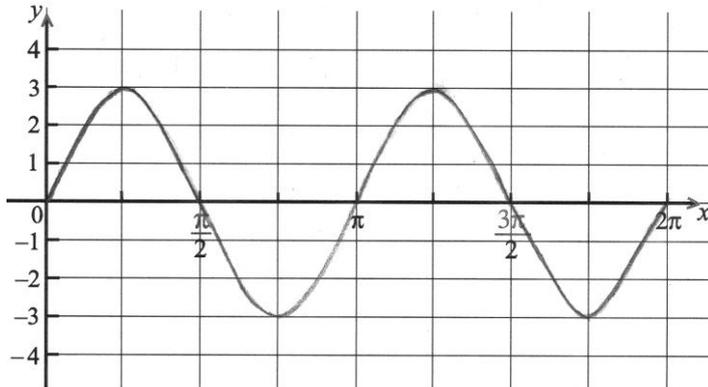
EXAMPLE 3

(a) period = π (accept 180°)

AI

NI

(b)



AIAIAI

N3

Notes: Award *AI* for amplitude 3,
AI for **their** period,
AI for a sine curve through $(0,0)$ and $(0,2\pi)$.
 If the answer to part (a) is incorrect, but the graph period is correct, award *AI*.

(c) evidence of appropriate approach

(MI)

e.g. line $y = 2$ on graph, discussion of number of solutions in the domain

4 (solutions)

AI

N2

Notes: Award the *N2* for 4 solutions, even if this is inconsistent with their graph.
 Award *MIAI FT* for incorrect answers which are consistent with their graph.

EXAMPLE 4

for differentiating $f(x) = 2 \sin(5x - 3)$, the markscheme gives:

$$f'(x) = 2 \cos(5x - 3) \cdot 5 = 10 \cos(5x - 3)$$

AI

Award *AI* for $2 \cos(5x - 3) \cdot 5$, even if $10 \cos(5x - 3)$ is not seen.

EXAMPLE 5

(i) evidence of approach

MI

e.g. $\vec{AO} + \vec{OB} = \vec{AB}$, $B - A$

SECTION A

QUESTION 1

METHOD 1

substituting into formula for S_{40}

(M1)

correct substitution

AI

$$\text{e.g. } 1900 = \frac{40(u_1 + 106)}{2}$$

$$u_1 = -11$$

AI

N2

substituting into formula for u_{40} or S_{40}

(M1)

correct substitution

AI

$$\text{e.g. } 106 = -11 + 39d, 1900 = 20(-22 + 39d)$$

$$d = 3$$

AI

N2

[6 marks]

METHOD 2

substituting into formula for S_{40}

(M1)

correct substitution

AI

$$\text{e.g. } 20(2u_1 + 39d) = 1900$$

substituting into formula for u_{40}

(M1)

correct substitution

AI

$$\text{e.g. } 106 = u_1 + 39d$$

$$u_1 = -11, d = 3$$

AIAI

N2N2

[6 marks]

QUESTION 2

(a) $f'(x) = -\sin 2x \times 2 (= -2 \sin 2x)$

AIAI

N2

Note: Award *AI* for 2, *AI* for $-\sin 2x$.

(b) $g'(x) = 3 \times \frac{1}{3x-5} \left(= \frac{3}{3x-5} \right)$

AIAI

N2

Note: Award *AI* for 3, *AI* for $\frac{1}{3x-5}$.

(c) evidence of using product rule

(M1)

$$h'(x) = (\cos 2x) \left(\frac{3}{3x-5} \right) + \ln(3x-5)(-2 \sin 2x)$$

AI

N2

[6 marks]

QUESTION 3

(a) $E(X) = 2$ *AI* *N1*

(b) evidence of appropriate approach involving binomial *(MI)*

e.g. $\binom{10}{3}(0.2)^3, (0.2)^3(0.8)^7, X \sim B(10, 0.2)$

$P(X = 3) = 0.201$ *AI* *N2*

(c) **METHOD 1**

$P(X \leq 3) = 0.10737 + 0.26844 + 0.30199 + 0.20133 (= 0.87912\dots)$ *(AI)*

evidence of using the complement (seen anywhere) *(MI)*

e.g. $1 - \text{any probability}, P(X > 3) = 1 - P(X \leq 3)$

$P(X > 3) = 0.121$ *AI* *N2*

METHOD 2

recognizing that $P(X > 3) = P(X \geq 4)$ *(MI)*

e.g. summing probabilities from $X = 4$ to $X = 10$

correct expression or values *(AI)*

e.g. $\sum_{r=4}^{10} \binom{10}{r} (0.2)^{10-r} (0.8)^r$

$0.08808 + 0.02642 + 0.005505 + 0.000786 + 0.0000737 + 0.000004 + 0.0000001$

$P(X > 3) = 0.121$ *AI* *N2*

[6 marks]

QUESTION 4

(a)
$$A^{-1} = \begin{pmatrix} 3 & 2 & -3 \\ 2 & 1 & -2 \\ -8 & -6 & 9 \end{pmatrix}$$

A2 N2

(b) evidence of subtracting matrices

(M1)

e.g.
$$\begin{pmatrix} 7 & 6 & -7 \\ 6 & 5 & -8 \\ 1 & 7 & -5 \end{pmatrix} - \begin{pmatrix} -3 & 2 & 1 \\ 5 & 3 & 4 \\ -9 & 2 & 10 \end{pmatrix}, \begin{pmatrix} 10 & 4 & -8 \\ 1 & 2 & -12 \\ 10 & 5 & -15 \end{pmatrix}, \mathbf{D} - \mathbf{C}$$

evidence of multiplying **on left** by A^{-1}

(M1)

e.g.
$$A^{-1}AB, A^{-1}(\mathbf{D} - \mathbf{C}), \begin{pmatrix} 3 & 2 & -3 \\ 2 & 1 & -2 \\ -8 & -6 & 9 \end{pmatrix} \begin{pmatrix} 10 & 4 & -8 \\ 1 & 2 & -12 \\ 10 & 5 & -15 \end{pmatrix}$$

$$\mathbf{B} = \begin{pmatrix} 2 & 1 & -3 \\ 1 & 0 & 2 \\ 4 & 1 & 1 \end{pmatrix}$$

A2 N3

[6 marks]

QUESTION 5

substituting $x = 1, y = 3$ into $f(x)$

(M1)

$3 = p + q$

A1

finding derivative

(M1)

$f'(x) = 2px + q$

A1

correct substitution, $2p + q = 8$

A1

$p = 5, q = -2$

A1A1 N2N2

[7 marks]

QUESTION 6

METHOD 1

for independence $P(A \cap B) = P(A) \times P(B)$ (RI)

expression for $P(A \cap B)$, indicating $P(B) = 2P(A)$ (AI)

e.g. $P(A) \times 2P(A)$, $x \times 2x$

substituting into $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ (MI)

correct substitution AI

e.g. $0.52 = x + 2x - 2x^2$, $0.52 = P(A) + 2P(A) - 2P(A)P(A)$

correct solutions to the equation (A2)

e.g. 0.2, 1.3 (accept the single answer 0.2)

$P(B) = 0.4$ AI

N6
[7 marks]

METHOD 2

for independence $P(A \cap B) = P(A) \times P(B)$ (RI)

expression for $P(A \cap B)$, indicating $P(A) = \frac{1}{2}P(B)$ (AI)

e.g. $P(B) \times \frac{1}{2}P(B)$, $x \times \frac{1}{2}x$

substituting into $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ (MI)

correct substitution AI

e.g. $0.52 = 0.5x + x - 0.5x^2$, $0.52 = 0.5P(B) + P(B) - 0.5P(B)P(B)$

correct solutions to the equation (A2)

e.g. 0.4, 2.6 (accept the single answer 0.4)

$P(B) = 0.4$ (accept $x = 0.4$ if x set up as $P(B)$) AI

N6
[7 marks]

QUESTION 7

METHOD 1

correct expression for **second** side, using area = 525 (A1)

e.g. let $AB = x$, $AD = \frac{525}{x}$

attempt to set up cost function using \$3 for three sides and \$11 for one side (M1)

e.g. $3(AD + BC + CD) + 11AB$

correct expression for cost A2

e.g. $\frac{525}{x} \times 3 + \frac{525}{x} \times 3 + 11x + 3x$, $\frac{525}{AB} \times 3 + \frac{525}{AB} \times 3 + 11AB + 3AB$, $\frac{3150}{x} + 14x$

EITHER

sketch of cost function (M1)

identifying minimum point (A1)

e.g. marking point on graph, $x = 15$

minimum cost is 420 (dollars) A1 N4

OR

correct derivative (may be seen in equation below) (A1)

e.g. $C'(x) = \frac{-1575}{x^2} + \frac{-1575}{x^2} + 14$

setting their derivative equal to 0 (seen anywhere) (M1)

e.g. $\frac{-3150}{x^2} + 14 = 0$

minimum cost is 420 (dollars) A1 N4

continued ...

Question 7 continued

METHOD 2

correct expression for **second** side, using area = 525 (AI)

e.g. let $AD = x$, $AB = \frac{525}{x}$

attempt to set up cost function using \$3 for three sides and \$11 for one side (MI)
 e.g. $3(AD + BC + CD) + 11AB$

correct expression for cost A2

e.g. $3\left(x + x + \frac{525}{x}\right) + \frac{525}{x} \times 11$, $3\left(AD + AD + \frac{525}{AD}\right) + \frac{525}{AD} \times 11$, $6x + \frac{7350}{x}$

EITHER

sketch of cost function (MI)

identifying minimum point (AI)

e.g. marking point on graph, $x = 35$

minimum cost is 420 (dollars) AI N4

OR

correct derivative (may be seen in equation below) (AI)

e.g. $C'(x) = 6 - \frac{7350}{x^2}$

setting their derivative equal to 0 (seen anywhere) (MI)

e.g. $6 - \frac{7350}{x^2} = 0$

minimum cost is 420 (dollars) AI N4
[7 marks]

SECTION B

QUESTION 8

- (a) choosing sine rule (M1)
 correct substitution AI
 e.g. $\frac{AD}{\sin 0.8} = \frac{4}{\sin 0.3}$

 AD = 9.71 (cm) AI N2
[3 marks]
- (b) **METHOD 1**
 finding angle $\text{OAD} = \pi - 1.1 = (2.04)$ (seen anywhere) (AI)

 choosing cosine rule (M1)
 correct substitution AI
 e.g. $\text{OD}^2 = 9.71^2 + 4^2 - 2 \times 9.71 \times 4 \times \cos(\pi - 1.1)$

 OD = 12.1 (cm) AI N3
- METHOD 2**
 finding angle $\text{OAD} = \pi - 1.1 = (2.04)$ (seen anywhere) (AI)

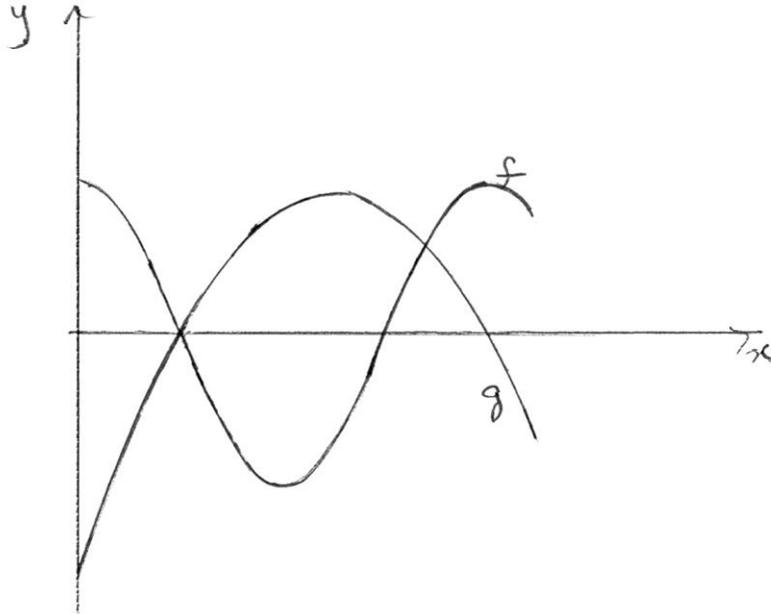
 choosing sine rule (M1)
 correct substitution AI
 e.g. $\frac{\text{OD}}{\sin(\pi - 1.1)} = \frac{9.71}{\sin 0.8} = \frac{4}{\sin 0.3}$

 OD = 12.1 (cm) AI N3
[4 marks]
- (c) correct substitution into area of a sector formula (AI)
 e.g. $\text{area} = 0.5 \times 4^2 \times 0.8$
 $\text{area} = 6.4 \text{ (cm}^2\text{)}$ AI N2
[2 marks]
- (d) substitution into area of triangle formula OAD (M1)
 correct substitution AI
 e.g. $A = \frac{1}{2} \times 4 \times 12.1 \times \sin 0.8$, $A = \frac{1}{2} \times 4 \times 9.71 \times \sin 2.04$, $A = \frac{1}{2} \times 12.1 \times 9.71 \times \sin 0.3$

 subtracting area of sector OABC from area of triangle OAD (M1)
 e.g. $\text{area ABCD} = 17.3067 - 6.4$
 $\text{area ABCD} = 10.9 \text{ (cm}^2\text{)}$ AI N2
[4 marks]
- Total [13 marks]**

QUESTION 9

(a)



AIAIAI

N3

Note: Award *AI* for *f* being of sinusoidal shape, with 2 maxima and one minimum,
AI for *g* being a parabola opening down,
AI for **two** intersection points in approximately correct position.

[3 marks]

(b) (i) (2, 0) (accept $x = 2$)

AI

N1

(ii) period = 8

A2

N2

(iii) amplitude = 5

AI

N1

[4 marks]

(c) (i) (2, 0), (8, 0) (accept $x = 2, x = 8$)

AIAI

NINI

(ii) $x = 5$ (must be an equation)

AI

N1

[3 marks]

continued ...

Question 9 continued

(d) **METHOD 1**

intersect when $x = 2$ and $x = 6.79$ (may be seen as limits of integration) **AIAI**

evidence of approach **(M1)**

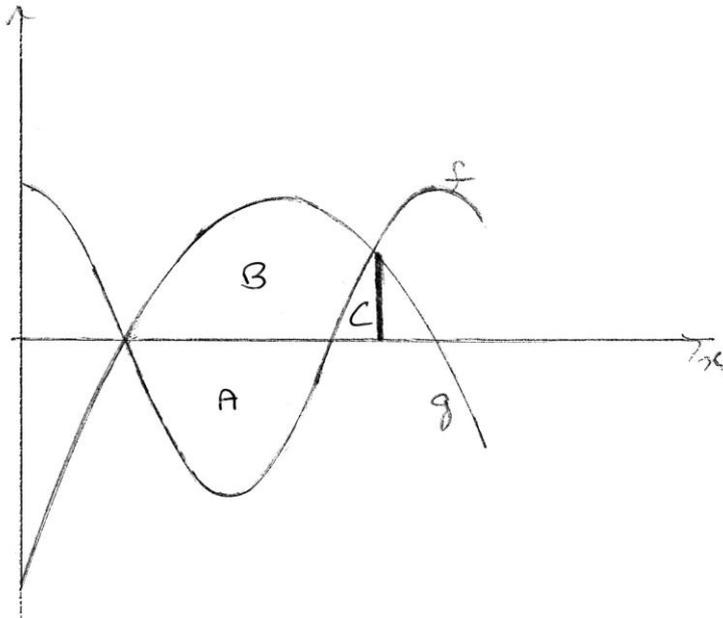
e.g. $\int g - f$, $\int f(x)dx - \int g(x)dx$, $\int_2^{6.79} \left((-0.5x^2 + 5x - 8) - \left(5 \cos \frac{\pi}{4} x \right) \right)$

area = 27.6 **A2 N3**

METHOD 2

intersect when $x = 2$ and $x = 6.79$ (seen anywhere) **AIAI**

evidence of approach using a sketch of g and f , or $g - f$. **(M1)**



e.g. area = $A + B - C$, $12.7324 + 16.0938 - 1.18129...$

area = 27.6

A2 N3
[5 marks]

Total [15 marks]

QUESTION 10

- (a) evidence of correct approach **AI**
- e.g. $\vec{PQ} = \vec{OQ} - \vec{OP}$, $\begin{pmatrix} 3 \\ -3 \\ 8 \end{pmatrix} - \begin{pmatrix} 2 \\ -1 \\ 5 \end{pmatrix}$
- $\vec{PQ} = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$ **AG** **N0**
- [1 mark]**
- (b) (i) correct description **RI** **NI**
- e.g. reference to $\begin{pmatrix} 3 \\ -3 \\ 8 \end{pmatrix}$ being the position vector of a point on the line,
a vector to the line, a point on the line.
- (ii) **any** correct expression in the form $\mathbf{r} = \mathbf{a} + t\mathbf{b}$ **A2** **N2**
- where \mathbf{a} is $\begin{pmatrix} 3 \\ -3 \\ 8 \end{pmatrix}$, and \mathbf{b} is a scalar multiple of $\begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$
- e.g. $\mathbf{r} = \begin{pmatrix} 3 \\ -3 \\ 8 \end{pmatrix} + t \begin{pmatrix} -1 \\ 2 \\ -3 \end{pmatrix}$, $\mathbf{r} = \begin{pmatrix} 3+2s \\ -3-4s \\ 8+6s \end{pmatrix}$
- [3 marks]**
- (c) **one** correct equation **(AI)**
- e.g. $3 + s = -1$, $-3 - 2s = 5$
- $s = -4$ **AI**
- $p = -4$ **AI** **N2**
- [3 marks]**
- (d) **one** correct equation **AI**
- e.g. $-3 + t = -1$, $9 - 2t = 5$
- $t = 2$ **AI**
- substituting $t = 2$
- e.g. $2 + 2q = -4$, $2q = -6$ **AI**
- $q = -3$ **AG** **N0**
- [3 marks]**

continued ...

Question 10 continued

(e) choosing correct direction vectors $\begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ -2 \\ -3 \end{pmatrix}$ *(AI)(AI)*

finding correct scalar product and magnitudes *(AI)(AI)(AI)*

scalar product $(1)(1) + (-2)(-2) + (-3)(3) (= -4)$

magnitudes $\sqrt{1^2 + (-2)^2 + 3^2} = \sqrt{14}$, $\sqrt{1^2 + (-2)^2 + (-3)^2} = \sqrt{14}$

evidence of substituting into scalar product *MI*

e.g. $\cos \theta = \frac{-4}{3.741... \times 3.741...}$

$\theta = 1.86$ radians (or 107°) *AI* *N4*
[7 marks]

Total [17 marks]
