MARKING SCHEME

JUNIOR CERTIFICATE EXAMINATION 2005

MATHEMATICS – HIGHER LEVEL – PAPER 1

GENERAL GUIDELINES FOR EXAMINERS

1. Penalties of three types are applied to candidates' work as follows:
   - Blunders - mathematical errors/omissions (-3)
   - Slips- numerical errors (-1)
   - Misreadings (provided task is not oversimplified) (-1).

   Frequently occurring errors to which these penalties must be applied are listed in the scheme. They are labelled: B1, B2, B3,…, S1, S2,…, M1, M2,…etc. These lists are not exhaustive.

2. When awarding attempt marks, e.g. Att(3), note that
   - any *correct, relevant* step in a part of a question merits at least the attempt mark for that part
   - if deductions result in a mark which is lower than the attempt mark, then the attempt mark must be awarded
   - a mark between zero and the attempt mark is never awarded.

3. Worthless work is awarded zero marks. Some examples of such work are listed in the scheme and they are labelled as W1, W2,…etc.

4. The phrase "hit or miss" means that partial marks are not awarded – the candidate receives all of the relevant marks or none.

5. The phrase "and stops" means that no more work is shown by the candidate.

6. Special notes relating to the marking of a particular part of a question are indicated by an asterisk. These notes immediately follow the box containing the relevant solution.

7. The sample solutions for each question are not intended to be exhaustive lists – there may be other correct solutions.

8. Unless otherwise indicated in the scheme, accept the best of two or more attempts – even when attempts have been cancelled.

9. The *same* error in the *same* section of a question is penalised *once* only.

10. Particular cases, verifications and answers derived from diagrams (unless requested) qualify for attempt marks at most.

11. A serious blunder, omission or misreading results in the attempt mark at most.

12. Do not penalise the use of a comma for a decimal point, e.g. €5.50 may be written as €5,50.

QUESTION 1

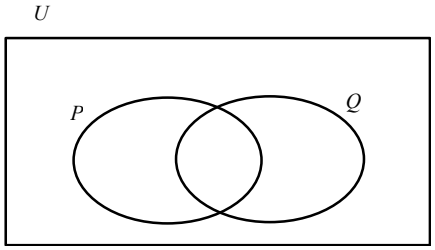
Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att 6**
Part (c)	**20 marks**	**Att 7**

Part (a) **10 marks** **Att 3**

✍ U is the universal set.

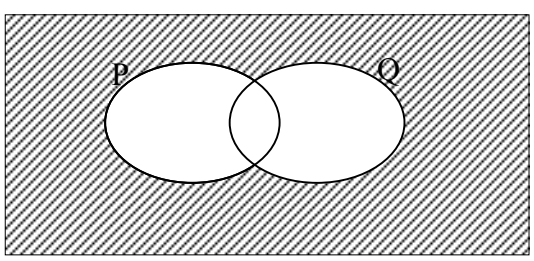
P and Q are two subsets of U.

Copy the Venn diagram into your answerbook and shade in the set $(P \cup Q)'$.



(a) **10 marks** **Att 3**

Shading of $(P \cup Q)'$



Blunders (-3)
B1 Shades (P ∪ Q) correctly.

Slips (-1)
S1 Shades (P ∩ Q)′ correctly.

Attempts (3 *marks*)
A1 Shades any region other than those mentioned above.
A2 Copies diagram with no shading.

Part (b) **20 (10,10) marks** **Att (3,3)**

(i) ✍ Light travels at a speed of approximately $(2\cdot 9\times 10^5)$ km / sec.

How many kilometres will light travel in 8 minutes?

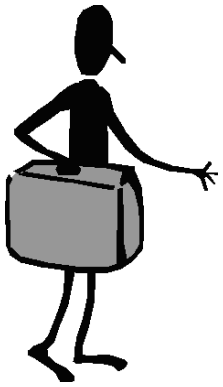
Express your answer in the form $a\times 10^n$,

where $n\in \mathbf{N}$ and $1\le a<10$.

(ii) ✍ A tourist paid \$4620 to a travel agent for a holiday in Ireland, where €1 = \$1·32.

The cost to the travel agent of organising the holiday was €2985.

Calculate, in euro, the profit made by the travel agent.



(b) (i) **10 marks** **Att 3**

(i) Distance travelled = $(2\cdot 9\times 10^5)\times 60\times 8$ or equivalent

$= 1\cdot 392\times 10^8$.

Blunders (-3)

B1 Correct answer but no work shown (✍).
B2 Not in scientific notation, e.g. 13.92×10^7 or 139200000.
B3 Any decimal error.
B4 Any error in handling indices.
B5 Error in conversion of minutes to seconds.

Slips (-1)

S1 Numerical errors to max of 3.

Attempts (3 *marks*)

A1 Indicates some knowledge of indices, e.g. evaluates 10^5 = 100000.
A2 Arrives at 1.392 or 13.92 and stops or some correct use of indices.
A3 States 1 min = 60 secs.
A4 Some knowledge of distance, speed and time formula.

Worthless (0)

W1 Incorrect answer and no work shown.
W2 Attempts to add or subtract but shows no knowledge of indices.

(b) (ii) **10 marks** **Att 3**

(ii) $\$4620 = €\left(\frac{4620}{1.32}\right)$

$= €3500$

Profit made $= €3500 - €2985$

$= €515$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Multiplies by 1.32 instead of divides.
B3 Error in decimal point.
B4 Leaves profit in $.

Slips (-1)

S1 Numerical errors to max of 3.
S2 Leaves as €3500 - €2985.

Attempts (3 *marks*)

A1 Some relevant work.

Worthless (0)

W1 Incorrect answer and no work shown.
W2 $4620 ± 1.32 and stops.

Part (c) **20 (10,5,5) marks** **Att (3,2,2)**

(i) ✍ By rounding to the nearest whole number, estimate the value of

$$\left(\frac{5\cdot 9+\sqrt[3]{27\cdot 24}}{3\cdot 06}\right)^2.$$

Then, evaluate $\left(\frac{5\cdot 9+\sqrt[3]{27\cdot 24}}{3\cdot 06}\right)^2$, correct to two decimal places.

(ii) ✍ Simplify $\sqrt{3}(2\sqrt{6}-4\sqrt{3}) \quad - \quad \sqrt{10}(3\sqrt{5}-2\sqrt{10})$,

without the use of a calculator.

Express your answer in the form $a+b\sqrt{2}$, where $a, b \in \mathbf{Z}$.

(c) (i) Estimate **10 marks** **Att 3**

(i) Estimate $\left(\frac{6+\sqrt[3]{27}}{3}\right)^2=\left(\frac{6+3}{3}\right)^2=\left(\frac{9}{3}\right)^2=\frac{81}{9}=9$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each error in decimal point.
B3 Error in precedent.
B4 Mathematical errors.

Slips (-1)

S1 Numerical errors to max of 3.
S2 Error in rounding to the nearest whole number e.g. 5.9 to 5.

Attempts (3 marks)

A1 Some correct rounding to nearest whole number.

Worthless (0)

W1 Incorrect answer and no work shown.

(c) (i) Evaluate **5 marks** **Att 2**

(i) Evaluate $\left(\frac{5.9+\sqrt[3]{27.24}}{3.06}\right)^2 = \left(\frac{8.9088627}{3.06}\right)^2 = (2.911393)^2 = 8.4762094 \cong 8.48$

* Accept correct answer and no work shown.
* Do not penalise same error if already penalised in **Estimate** above.

Blunders (-3)
B1 Each error in decimal point.
B2 Error in precedent.
B3 Mathematical errors.

Slips (-1)
S1 Numerical errors to max of 3.
S2 Failure to round off or incorrect rounding off or rounding off too soon.
S3 Answer given as 8.47 with no work shown.

Attempts (2 marks)
A1 Some correct calculation done.

Worthless (0)
W1 Incorrect answer and no work shown but **note:** S3 above.

(c) (ii) **5 marks** **Att 2**

(ii) $2\sqrt{18}-4\sqrt{9}-3\sqrt{50}+2\sqrt{100} = 6\sqrt{2}-12-15\sqrt{2}+20 = 8-9\sqrt{2}$

Blunders (-3)
B1 Correct answer, but no work shown (✍).
B2 Each error in distributive law.
B3 Each error handling surds.
B4 Not in the form $a+b\sqrt{2}$.

Slips (-1)
S1 Numerical errors to max of 3.

Attempts (2 *marks*)
A1 Some relevant effort at multiplying.
A2 Shows some knowledge of handling surds.

Worthless (0)
W1 Uses calculator.

QUESTION 2

Part (a)	**10 marks**	**Att 4**
Part (b)	**20 marks**	**Att 6**
Part (c)	**20 marks**	**Att 7**

Part (a) **10(5,5) marks** **Att (2,2)**

(i) Write down the reciprocal of $\frac{7}{2}$.

(ii) Find the value of this reciprocal, correct to 2 decimal places.

(a) (i) **5 marks** **Att 2**

(i) $\frac{2}{7}$ **or** $\frac{1}{\frac{7}{2}}$

Blunders (-3)
B1 Writes reciprocal of 2.
B2 Writes reciprocal of 7.

Worthless (0)
W1 Answer = 3.5 or equivalent.

(a) (ii) **5 marks** **Att 2**

(ii) $0{\cdot}285 \cong 0{\cdot}29$.

* Accept answer consistent with part (i).

Blunders (-3)
B1 Incorrect division.

Slips (-1)
S1 Failure to round off or incorrect rounding off i.e. 3½ or $3.5 \neq 3.50$.

Attempts (2 marks)
A1 Some correct calculation done.

Part (b) **20 (10,10) marks** **Att (3,3)**

(i) There are 25 000 fish in a fish farm.

The number of fish in the farm increases by 40% each year.

✍ How many fish will be in the farm at the end of 3 years?

(ii) The monthly line rental on Peter's mobile phone amounts to €12 · 70.

During May, the duration of his calls is 1 hr 41 mins and 50 secs.

Calls are charged at 0 · 6 cent per second.

✍ Calculate Peter's total bill for May.

(b) (i) **10 marks** **Att 3**

(i) $Y_1 = 25000 \times 1.40 = 35000$
$Y_2 = 35000 \times 1.40 = 49000$
$Y_3 = 49000 \times 1.40 = 68600$

or

$Y_1 = 25000 \quad I_1 = 0.40 \times 25000 = 10000$
$Y_2 = 35000 \quad I_2 = 0.40 \times 35000 = 14000$
$Y_3 = 49000 \quad I_3 = 0.40 \times 49000 = 19600$
$\text{Total} = 49000 + 19600 = 68600$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each error in decimal point.
B3 Stops at 49000.
B4 Mathematical error e.g. 40% taken as some incorrect fraction.
B5 Subtracts instead of adds increase.
B6 Uses 0.60 instead of 1.40.
B7 Each incorrect substitution into correct formula.

Slips (-1)

S1 Numerical errors to max of 3.
S2 Leaves as 49000 + 19600 or 49000 × 1.40.

Attempts (3 marks)

A1 $40\% = \frac{40}{100}$ and stops.
A2 Writes down formula and stops.
A3 Ignores cumulating, leading to 55000 as answer.

Worthless (0)

W1 Incorrect answer and no work shown.

(b) (ii) **10 marks** **Att 3**

(ii) 1 hr 41 min and 50 sec = 3600 + 2460 + 50
= 6110 sec
Cost of calls = € (6110 × 0.6 \ 100)
= € 36.66
Total bill for May = € 36.66 + € 12.70
= € 49·36

* Candidates may present other correct methods.

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each error in decimal point.
B3 Mathematical errors.
B4 Error in conversion of units of time, apply once only.
B5 Error in conversion of units of money.
B6 Stops at €36.66.

Slips (-1)
S1 Numerical errors to max of 3.
S2 Leaves as €36.66 + €12.70.

Attempts (3 *marks*)
A1 States 1 hr = 60 min or similar.
A2 Any correct relevant step.

Worthless (0)
W1 Incorrect answer and no work shown.

Part (c) **20 (15,5) marks** **Att (5,2)**

(i) The standard rate of income tax is 20% and the higher rate is 42%.

Sheila has tax credits of €2700 for the year and a standard rate cut-off point of €22 000.

She has a gross income of €45 000 for the year.

✍ Calculate the total tax payable by Sheila for the year.

(ii) Tony pays tax at the same rates as Sheila.

Tony has tax credits of €2900 for the year and has the same standard rate cut-off point as Sheila.

His total tax payable amounts to €13 680 for the year.

✍ Calculate Tony's gross income for the year.

(c) (i) **15 marks** **Att 5**

(i)	Tax @ 20% on €22 000	=	€4400	
	Tax @ 42% on €23 000	=	€9660	
	Total Tax	=	€14060	
	Tax Credits	=	€2700	
	Tax Due	=	€14060 - €2700	= €11360

* Candidates may present other correct methods.

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each error in decimal point.
B3 Mathematical error, e.g. 20% or 42% taken as some incorrect fraction – may incur 2 blunders.
B4 20% of some incorrect figure or 42% of some incorrect figure – may incur 2 blunders.
B5 Incorrect total tax based on candidate's figure or no total tax.
B6 Mishandles the tax credit.
B7 Stops at €14060.

Slips (-1)

S1 Numerical errors to max of 3.

Attempts (5 marks)

A1 Correct calculation of 20% or 42% and stops.
A2 Any correct relevant step.

(c) (ii) **5 marks** **Att 2**

(ii) Total tax payable = €13680
Tax credits = €2900 → 42% = €12180
Total tax = €16580 → 1% = €290
Tax @ 20% = €4400 → 100% = €29000
Tax @ 42% = €16580 - €4400 = €12180
Tony's Gross = €29000 + €22000 = €51,000

* Candidates may present other correct methods.

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each error in decimal point.
B3 Mathematical error, e.g. 20% or 42% taken as some incorrect fraction.
B4 20% of some incorrect figure or 42% of some incorrect figure.
B5 Adds 20% tax rather than subtracts.
B6 Mishandles the tax credit.
B7 Stops at €29000.

Slips (-1)

S1 Numerical errors to max of 3.
S2 Leaves as €29000 + €22000.

Attempts (2 marks)

A1 Correct calculation of 20% or 42% and stops.
A2 Any correct relevant step, e.g. some correct calculation on candidate's figures.

QUESTION 3

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att 7**
Part (c)	**20 marks**	**Att 8**

Part (a) **10 marks** **Att 3**

✍ Write $\sqrt[3]{16}$ in the form 2^k, $k \in \mathbf{Q}$.

(a) **10 marks** **Att 3**

$$\sqrt[3]{16} = \left(2^4\right)^{\frac{1}{3}} = 2^{\frac{4}{3}}$$

* $2^{1.33}$ or similar with no work shown merits 7 marks.

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in laws of indices.
B3 Error in sign of index.
B4 Answer not given in form 2^k where $k \in$ Q, but **note:** may incur other blunders also.

Slips (-1)
S1 Numerical errors to max of 3.

Attempts (3 marks)
A1 Some correct work with the indices.
A2 $2^{1.3}$ with no work shown.

Worthless (0)
W1 Uses calculator to get an answer of 2.5198421 or similar with no work shown.

Part (b) **20 (10,5,5) marks** **Att (3,2,2)**

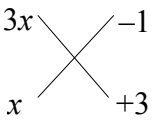
(i) Factorise $3x^2 + 8x - 3$.

(ii) ✍ Factorise $3p - c + 3pc - c^2$.

(iii) ✍ Simplify $(2x-1)^2 - (x-1)^2$.

(b) (i) **10 marks** **Att 3**

(i) *Round Brackets:* *or* *Big 'X':*



$\rightarrow$

$(3x - 1)(x + 3)$ $(3x - 1)(x + 3)$

Check (i) $3x^2$ term (ii) - 3 term (iii) middle term

* Accept correct answer and no work – **no** ✍ .

* Accept any correct method.

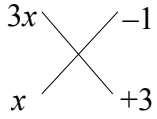
Blunders (-3)

B1 Incorrect factors of $3x^2$.

B2 Incorrect factors of - 3.

B3 Incorrect middle term.

B4 Leaves answer as:



B5 Each error in use of quadratic formula.

B6 Uses formula to get $x = \frac{1}{3}$ and x = - 3 but fails to form factors.

Attempts (3 marks)

A1 Any correct factors of $3x^2$ or - 3.

A2 Some correct substitution into correct quadratic formula.

A3 Writes down correct quadratic formula and stops.

(b) (ii) **5 marks** **Att 2**

(ii) $3p - c + 3pc - c^2$
$= 1(3p - c) + c(3p - c)$
$= (3p - c)(1 + c)$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in sign.
B3 Stops after first step, i.e. $1(3p - c) + c(3p - c)$ or similar.
B4 Answer given as $(3p - c) + (1 + c)$ but answer such as $(3p - c)$ and $(1 + c)$ merits 5 marks.

Attempts (2 *marks*)

A1 Some effort at factorising – groups off or pairs.

(b) (iii) **5 marks** **Att 2**

(iii) $(2x - 1)^2 - (x - 1)^2$

$= [(2x - 1) - (x - 1)] [(2x - 1) + (x - 1)]$
$= (2x - 1 - x + 1) (2x - 1 + x - 1)$
$= (x) (3x - 2)$
$= 3x^2 - 2x$

or

$(2x - 1)(2x - 1) - (x - 1)(x - 1)$
$= (4x^2 - 4x + 1) - (x^2 - 2x + 1)$
$= 4x^2 - 4x + 1 - x^2 + 2x - 1$
$= 3x^2 - 2x$

Blunders (-3)

B1 Correct answer but no work shown (✍).
B2 Error in index or sign.
B3 Term omitted or incorrect.
B4 Stops at $[(2x - 1) - (x - 1)] [(2x - 1) + (x - 1)]$.
B5 Incorrect factorisation of one term.
B6 Fails to simplify.

Slips (-1)

S1 Numerical errors to max of 3.

Attempts (2 *marks*)

A1 Some correct relevant work.
A2 Indicates some knowledge of the difference of two squares.

Worthless (0)

W1 Incorrect answer and no work shown but note A1.

Part (c) **20 (5,5,5,5) marks** **Att (2,2,2,2)**

A box of drinking chocolate powder costs €3 · 60.

(i) If the box contains x grams of powder,

write an expression in x to represent

the cost of 1 gram of the powder.

During a promotion, the manufacturer adds in to the box an extra 30 grams of powder.

The cost of the box of drinking chocolate remains at €3 · 60.

(ii) Write an expression in x to represent the cost of 1 gram of the powder during the promotion.

Each gram of powder, in this case, now costs 1 cent less.

(iii) Write an equation in x to represent the above information.

(iv) ✍ Solve this equation to find how many grams of powder are in the box during the promotion.

(c) (i) **5 marks** **Att 2**

(i) $\frac{3 \cdot 6}{x}$

Blunders (-3)

B1 Cost of 1 gram of powder e.g. $\frac{x}{3.6}$.

Attempts (2 *marks*)

A1 Gives answer as 3.6 (x)

A2 Any correct relevant step, e.g. trial and error – award once only i.e. in **(i)** & **(ii)**.

Worthless (0)

W1 Gives answer as 3.6 ± x.

(c) (ii) **5 marks** **Att 2**

(ii) $\frac{3 \cdot 6}{x + 30}$

Blunders (-3)

B1 Cost per gram inverted, e.g. $\frac{x + 30}{3.6}$, but do not penalise if already blundered in **(i)** above.

B2 Uses x - 30.

Attempts (2 marks)

A1 Gives answer as 3.6 (x + 30).

(c) (iii) **5 marks** **Att 2**

(iii) $\frac{3.6}{x} - \frac{3.6}{x+30} = 0.01$ or equivalent.

* Accept candidate's answer from (i) and (ii) above.

Blunders (-3)

B1 Sign error in setting up equation, e.g. $\frac{3.6}{x+30} - \frac{3.6}{x} = 0.01$.

B2 Expression not equal to 0.01 or equivalent.

Attempts (2 *marks*)

A1 Incorrect expression but uses data from (i) & (ii).

Slips (-1)

S1 Writes correct expression with required terms.

(c) (iv) **5 marks** **Att 2**

(iv)

$$\frac{3.6}{x} - \frac{3.6}{x+30} = 0.01$$

$$\frac{3.6(x+30) - 3.6(x)}{(x)(x+30)} = 0.01$$

$$3.6x + 108 - 3.6x = 0.01(x)(x+30)$$

$$0.01x^2 + 0.3x - 108 = 0$$

$$x^2 + 30x - 10800 = 0$$

$$(x-90)(x+120) = 0 \qquad x = 90. \qquad \text{Grams during promotion} = 120.$$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law.
B3 Errors in balancing equation.
B4 Mathematical / sign errors.
B5 Correct factors and stops.
B6 Incorrect factors.
B7 Errors using quadratic formula.

Slips (-1)

S1 Numerical errors to a max of 3.
S2 Leaves answer as 90.

Attempts (2 *marks*)

A1 No quadratic due to previous errors merits attempt at most.

QUESTION 4

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att 6**
Part (c)	**20 marks**	**Att 7**

Part (a) **10 marks** **Att 3**

✍ Let f be the function $f: x \to x^2 + x - 7$, $x \in \mathbf{R}$.

Find $f(-3)$.

(a) **10 marks** **Att 3**

$$\begin{aligned} f(-3) &= (-3)^2 + (-3) - 7 \\ &= 9 - 3 - 7 \\ &= -1 \end{aligned}$$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law / sign.
B3 Each term omitted or incorrect but note A2.

Slips (-1)
S1 Numerical slips to a max of 3.

Attempts (3 *marks*)
A1 Some effort at substitution and stops.
A2 No quadratic or substitutes positive number e.g. 3. Oversimplification.

Worthless (0)
W1 Incorrect answer and no work shown.

Part (b) **20 (10,10) marks** **Att (3,3)**

Helen buys stamps costing 48 cent and 60 cent.

She buys a total of 50 stamps costing €25·68.

(i) Taking x to be the number of 48 cent stamps and y to be the number of 60 cent stamps, write down two equations in x and y to represent this information.

(ii) ✍ Solve the equations to find the number of each type of stamp that Helen has purchased.

(b) (i) **10 marks** **Att 3**

(i) $x + y = 50$ and $48x + 60y = 2568$

Blunders (-3)
B1 One correct equation only.
B2 Fails to convert to cent / euro.
Attempts (3 *marks*)
A1 Incorrect equation such as $x + y = 2568$ or $48x + 60y = 50$.
A2 Any correct relevant step e.g. $48x$.

(b) (ii) **10 marks** **Att 3**

(ii) $60x + 60y = 3000$
$\underline{48x + 60y = 2568}$
$12x = 432$ $x = 36$ and $y = 14$

* No need to state type stamps – values of x and y sufficient.
* Accept candidate's solution of his/her simultaneous equations even if negative x / y.
* Trial and error with correct verification in both equations merits 10 marks.

Blunders (-3)
B1 Each different error in balancing equation or signs.
B2 Mathematical error, e.g. $108x = 5568$.
B3 Calculates the value of x **or** y correctly and stops.

Slips (-1)
S1 Finds $x = 36$ but substitutes some other value of x to find y e.g. $x = -36$.
S2 Numerical slips to a max. of 3.

Attempts (3 marks)
A1 Some correct relevant work, e.g. $48x + 48y = 2400$ and stops.
A2 Writes x in terms of y or vice-versa, e.g. $y = 50 - x$.
A3 Correct graphical solution.

Note: $x = 36$ **and** $y = 14$ without work shown merits 7 marks.

Part (c) **20 (15,5) marks** **Att (5,2)**

(i) ✍ Express in its simplest form:

$$\frac{1}{x-1} + \frac{1}{x+1}.$$

(ii) ✍ Hence, or otherwise, solve the equation:

$$\frac{1}{x-1} + \frac{1}{x+1} = 3.$$

Express your answer in the form $a \pm b\sqrt{10}$, where $a, b \in \mathbf{Q}$.

(c) (i) **15 marks** **Att 5**

(i) $\dfrac{1(x+1)+1(x-1)}{(x-1)(x+1)} = \dfrac{x+1+x-1}{(x-1)(x+1)} = \dfrac{2x}{(x-1)(x+1)}$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Incorrect common denominator or mishandles common denominator.
B3 Each different error in distributive law.
B4 Mathematical / sign errors.

Slips (-1)
S1 Numerical errors to a max of 3.

Attempts (5 *marks*)
A1 Correct denominator and stops.
A2 Leaves out denominator e.g. $1(x + 1) + 1(x - 1)$.
A3 $1(x + 1)$ or similar and stops.

Worthless (0)

W1 Adds to get $\dfrac{2}{2x}$.

(c) (ii) **5 marks** **Att 2**

(ii)

$$\frac{2x}{(x-1)(x+1)} = 3$$

$$2x = 3(x - 1)(x + 1)$$

$$2x = 3x^2 - 3$$

$$3x^2 - 2x - 3 = 0$$

$$x = \frac{2 \pm \sqrt{4+36}}{6} = \frac{2 \pm \sqrt{40}}{6}$$

$$x = \frac{2 \pm 2\sqrt{10}}{6}$$

$$x = \frac{1}{3} \pm \frac{1}{3}\sqrt{10}$$

* Accept correct solution of candidate's quadratic from part (i).

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law.
B3 Errors in balancing equation.
B4 Each error in formula, e.g. + b ± √ etc.
B5 Each different incorrect substitution into formula but **note** b = 2 ; c = 3 → 1 Blunder.
B6 Mathematical error in sign, e.g. – 4(3)(-3) = -36.
B7 Mathematical error in squaring, e.g. $(-2)^2 = -4$ or similar.
B8 Ignores a minus in square root, e.g. √–36 taken as √36.

Slips (-1)

S1 Failure to round off or rounds off incorrectly, once or twice.
S2 Numerical errors to max of 3.
S3 Answer not in required form subject to note under solution box.

Attempts (2 marks)

A1 Incorrect relevant formula with some correct substitution.
A2 Correct formula and stops.
A3 Some effort at completing the square.
A4 Solves linear equation arising from answer in part (i).

Worthless (0)

W1 Some attempt at factorising.

QUESTION 5

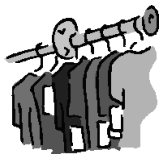
Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att 7**
Part (c)	**20 marks**	**Att 7**

Part (a) **10 marks** **Att 3**

Seven shirts and two sweaters cost €202 · 50.

A sweater costs the same as four shirts.

✍ Find the cost of one shirt.



(a) **10 marks** **Att 3**

x = cost of a shirt
$4x$ = cost of sweater

$7x + 2(4x) = €202 \cdot 50$
$7x + 8x = €202 \cdot 50$
$15x = €202 \cdot 50$
$x = €13 \cdot 50$

or

x = cost of shirt
y = cost of sweater

$7x + 2y = €202 \cdot 50$ $\quad 4x = y \Rightarrow 4x - y = 0$

$7x + 2y = €202 \cdot 50$
$8x - 2y = 0$
$15x = €202 \cdot 50$
$x = €13 \cdot 50$

* Accept non algebraic solution with work shown.

Blunders (-3)
B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law / sign.
B3 Each term omitted or incorrect.
B4 Each different error in balancing equation.
B5 Mathematical error.

Slips (-1)
S1 Numerical slips to a max of 3.

Attempts (3 marks)
A1 Some correct relevant work, e.g. one correct multiplication.
A2 Writes x = cost of shirt or similar and stops.
A3 Writes 1 sweater = 4 shirts and stops.

Worthless (0)
W1 Incorrect answer and no work shown.

Part (b) **20 (5,10,5) marks** **Att (2,3,2)**

In a school of 430 students, 250 students study History, 240 students study Geography.

Let x represent the number of students who study neither History nor Geography.

The number of students who study both History and Geography is 3 times the number who study neither of these subjects.

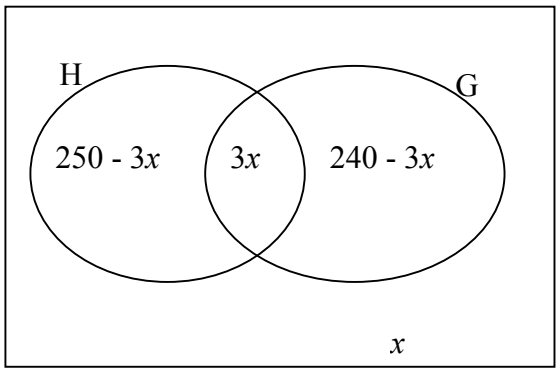
(i) ✍ Represent this information on a Venn diagram.

(ii) ✍ Write down and simplify an expression in x for the total number of students in the school.

(iii) ✍ Use this expression to find the number of students who study neither History nor Geography.

(b) (i) **5 marks** **Att 2**

(i)



* Allow omission of 430 or box on diagram.

Blunders (-3)
B1 Each element incorrectly placed or omitted.
B2 # (H ∩ G) ≠ 3x.
B3 Each different error for # (H \ G) or # (G \ H).

Attempts (2 *marks*)
A1 Any one correct value filled in.

Worthless (0)
W1 Venn diagram but none of the required values filled in.

(b) (ii) **10 marks** **Att 3**

(ii) $250 - 3x + 3x + 240 - 3x + x$
$= 250 + 240 - 3x + x$
$= 490 - 2x$

* Accept work consistent with part (i).

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each element incorrect or omitted.

Attempts (3 marks)

A1 Any one correct value written down.

(b) (iii) **5 marks** **Att 2**

(iii) $490 - 2x = 430$
$-2x = -60$
$x = 30$

* Accept work consistent with part (ii).

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law / sign.
B3 Each term omitted or incorrect.
B4 Each different error in balancing equation.

Slips (-1)

S1 Numerical slips to a max of 3.

Attempts (2 *marks*)

A1 Some correct relevant work.

Worthless (0)

W1 Incorrect answer and no work shown.

Part (c) **20 (15,5) marks** **Att (5,2)**

Let f be the function $f: x \to x^2 + bx + c,\ x \in \mathbf{R}$ and $b, c \in \mathbf{Z}$.

The graph of f cuts the x axis at the points where $x = -3$ and $x = 2$.

(i) ✍ Find the value of b and the value of c.

(ii) ✍ Find the value of x for which $f(x) = f(x + 2)$.

(c) (i) **15 marks** **Att 5**

(i) Cuts x axis $\Rightarrow y = 0$

$(-3)^2 + b(-3) + c = 0$ $\quad$ $(2)^2 + b(2) + c = 0$ $\quad$ $2b + c = -4$

$9 - 3b + c = 0$ $\quad$ $4 + 2b + c = 0$ $\quad$ $3b - c = 9$

$-3b + c = -9$ $\quad$ $2b + c = -4$ $\quad$ $5b = 5$

$b = 1$ and $c = -6$

Blunders (-3)

B1 Correct answers, but no work shown (✍).
B2 Each different error in balancing equation or signs.
B3 Calculates the value of b **or** c correctly and stops.

$x = -3$ $\quad$ $x + 3 = 0$
$x = 2$ $\quad$ $x - 2 = 0$
$(x + 3)(x - 2) = 0$
$x^2 + x - 6 = 0$
$b = 1$ and $c = -6$

Attempts (5 *marks*)

A1 Substitutes some correct value for x or $f(x)$.

(c) (ii) **5 marks** **Att 2**

(ii)
$x^2 + x - 6 = (x + 2)^2 + (x + 2) - 6$
$x^2 + x - 6 = x^2 + 4x + 4 + x + 2 - 6$
$x^2 + x - 6 = x^2 + 5x$
$-4x = 6$
$x = -1.5$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in distributive law / sign.
B3 Each term omitted or incorrect.
B4 Each different error in balancing equation.

Slips (-1)

S1 Numerical slips to a max of 3.

Attempts (2 *marks*)

A1 Some correct relevant work, e.g. one correct multiplication.

QUESTION 6

Part (a)	**10 marks**	**Att 3**
Part (b)	**25 marks**	**Att 9**
Part (c)	**15 marks**	**Att 6**

Part (a) **10 marks** **Att 3**

✍ Find the solution set of the inequality: $6 - 2x \leq 12$, $x \in \mathbf{R}$.

(a) **10 marks** **Att 3**

$6 - 2x \leq 12$
$-2x \leq 12 - 6$ or equivalent
$-2x \leq 6$
$x \geq -3$

Blunders (-3)

B1 Correct answer, but no work shown (✍).
B2 Each different error in balancing equation.
B3 Mishandles inequality, e.g. $-2x \leq 6 \Rightarrow x \leq -3$.

Slips (-1)

S1 Numerical errors to a max of 3.

Attempts (3 *marks*)

A1 Solves equation $6 - 2x = 12$ to get $x = -3$.
A2 Tests for one correct value of x and stops.
A3 Any correct balancing equation and stops.

Part (b) **25 (20,5) marks** **Att (7,2)**

Let f be the function $f: x \to 5 - 3x - 2x^2$ and g be the function $g: x \to -2x - 1$.

✍ Using the same axes and scales, draw the graph of f

and the graph of g, for $-3 \le x \le 2$, $x \in \mathbf{R}$.

(b) Quadratic Graph **20 marks** **Att 7**

$$f(x) = 5 - 3x - 2x^2$$

$f(-3) = 5 - 3(-3) - 2(-3)^2 = 5 + 9 - 18 = -4$ $\quad f(0) = 5 - 3(0) - 2(0)^2 = 5 + 0 - 0 = 5$

$f(-2) = 5 - 3(-2) - 2(-2)^2 = 5 + 6 - 8 = 3$ $\quad f(1) = 5 - 3(1) - 2(1)^2 = 5 - 3 - 2 = 0$

$f(-1) = 5 - 3(-1) - 2(-1)^2 = 5 + 3 - 2 = 6$ $\quad f(2) = 5 - 3(2) - 2(2)^2 = 5 - 6 - 8 = -9$

or

x	- 3	- 2	- 1	0	1	2
5	5	5	5	5	5	5
$-3x$	9	6	3	0	- 3	- 6
$-2x^2$	- 18	- 8	- 2	0	- 2	- 8
$f(x)$	- 4	3	6	5	0	- 9

Values for quadratic graph

Blunders (-3)

B1 Each incorrect $f(x)$ or missing $f(x)$ without work.
B2 x row added in, i.e. top row, or adds in extra row.
B3 Omits $-3x$ or 5 row (-3 for each omitted).
B4 Treating the domain as $-3 < x < 2$, can incur 2 Blunders if both omitted.
B5 Each different blunder which yields an incorrect row (full or part), e.g. $(-2x)^2$ for $-2x^2$.
B6 Avoids square for some (not all) values.
B7 Mathematical errors in tots, e.g. -18 + 14 = 4, but apply once only.
B8 Uses graph of $f: x \to 2x^2 + 3x - 5$.

Slips (-1)

S1 Numerical slips to a max. of 3.

Attempts (7 *marks*)

A1 Omits $-2x^2$ or does not treat as x^2 (Treats as linear expression).
A2 Correct or partly correct table / values but no graph drawn.

(b) Linear Graph **5 marks** **Att 2**

$g(x) = -2x - 1$

$g(-3) = -2(-3) - 1 = 6 - 1 = 5$ $g(0) = -2(0) - 1 = 0 - 1 = -1$

$g(-2) = -2(-2) - 1 = 4 - 1 = 3$ $g(1) = -2(1) - 1 = -2 - 1 = -3$

$g(-1) = -2(-1) - 1 = 2 - 1 = 1$ $g(2) = -2(2) - 1 = -4 - 1 = -5$

or

x	- 3	- 2	- 1	0	1	2
$-2x$	6	4	2	0	- 2	- 4
- 1	- 1	- 1	- 1	- 1	- 1	- 1
$g(x)$	5	3	1	- 1	- 3	- 5

Values for linear graph

* Table not necessary - Accept any two correct values (may be on graph)
* Do not penalise same error if already penalised on quadratic graph table.

Blunders (-3)

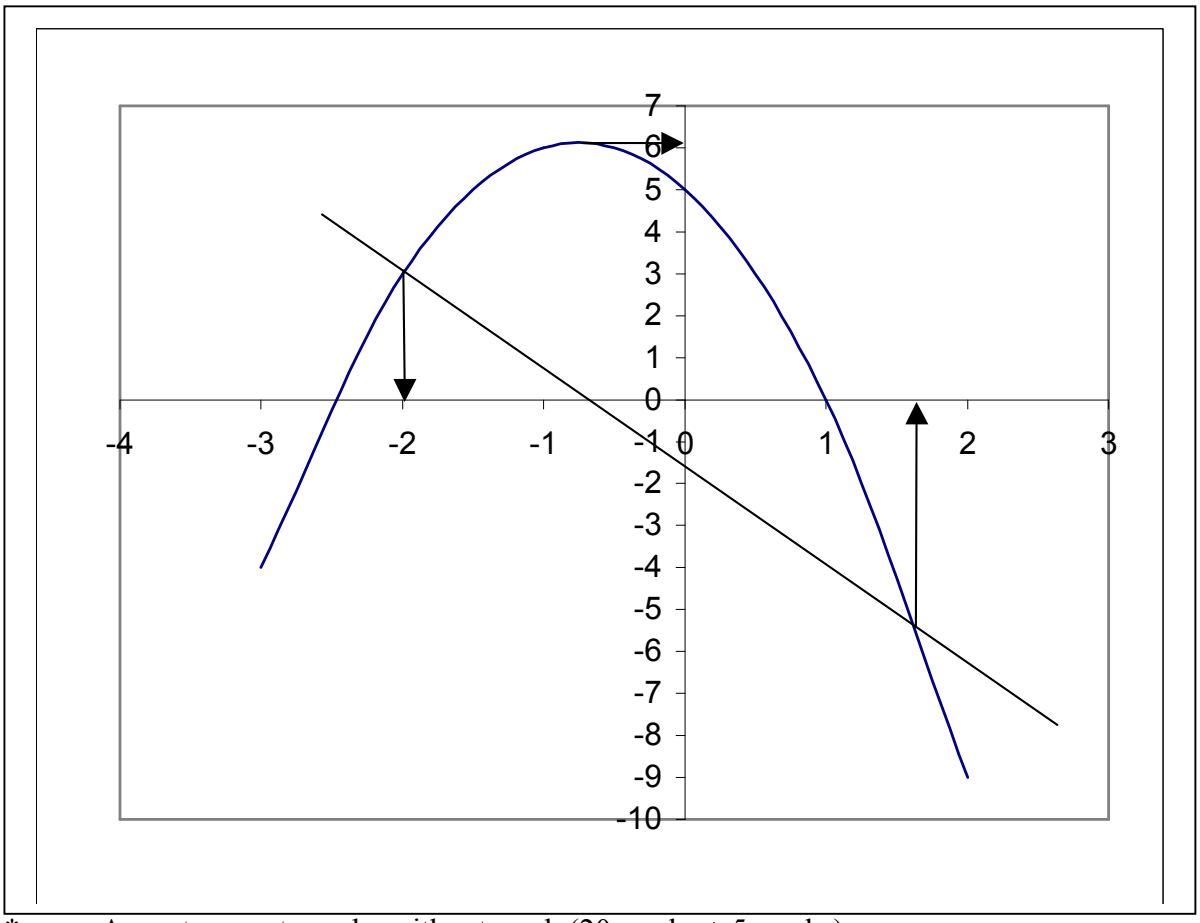
B1 $g(x) = 2x - 1$ and continues correctly (oversimplifies).

B2 -1 row treated as +1 or $-1x$

Attempts (2 *marks*)

A1 One value only calculated, but no graph drawn.

Graph of $f : x \to 5 - 3x - 2x^2$ and $g : x \to -2x - 1$



* Accept correct graphs without work (20 marks + 5 marks).

Blunders (-3)

B1 Points not joined to form a reasonable graph.
B2 (x, y) plotted as (y, x), but apply once only, or reverses axes.
B3 Scale not reasonably uniform, once.
B4 Each different blunder in plotting points from candidate's table / values.
B5 Each point omitted, if graph does not go reasonably close to where point should be.
B6 Points joined with straight lines.

Slips (-1)

S1 Graphs not on same axes and scales.

Attempts (7 *marks*)

A1 Scaled axis drawn.

Part (c) **15 (5,5,5) marks** **Att (2,2,2)**

Use your graphs from part **(b)** to estimate:

(i) ✍ the maximum value of $f(x)$

(ii) ✍ the values of x for which $f(x) = g(x)$

(iii) ✍ the range of values of x for which $f(x) \geq g(x)$.

(c) (i) **5 marks** **Att 2**

(i) Maximum value of $f(x) = 6.1$

* Accept answer consistent with candidate's curve (within tolerance of ± 0.3).

Blunders (-3)
B1 No indication on graph.
B2 x value of maximum only.
B3 Correct indication on graph but no value given or value outside tolerance.

Slips (-1)
S1 Gives coordinates of maximum point rather than maximum value.

Attempts (2 *marks*)
A1 Point indicated on graph only.

Worthless (0)
W1 Answer inconsistent with candidate's graph.

(c) (ii) **5 marks** **Att 2**

(ii) $x = 1 \cdot 5$ and $x = -2$

* Accept answer consistent with candidate's graph (within tolerance of ± 0.3)

Blunders (-3)
B1 No indication on graph.
B2 One correct value only.
B3 Correct indication on graph but no values given.
B4 Gives answer as $-2 \leq x \leq 1.5$ or similar.

Slips (-1)
S1 Gives coordinates of points of intersection rather than x values.

Attempts (2 marks)
A1 $5 - 3x - 2x^2 = -2x - 1$ even if completes correctly.

Worthless (0)
W1 Answer inconsistent with candidate's graph.

(c) (iii) **5 marks** **Att 2**

(iii) $f(x) \geq g(x) \rightarrow -2 \leq x \leq 1 \cdot 5$.

* Accept answer consistent with candidate's graph (within tolerance of ± 0.3)
* Indication on graph in part (ii) suffices for part (iii).
* Correct indication only in part (ii) merits attempt of 2 marks in part (iii).

Blunders (-3)
B1 No indication on graph.
B2 Correct indication on graph but no values given subject to second asterisk above.
B3 No inequality i.e. answers for $f(x) = g(x)$.

Slips (-1)
S1 One inequality written incorrectly.
S2 Omits equal sign in the inequality, $-2 < x < 1.5$.

Attempts (2 *marks*)
A1 $5 - 3x - 2x^2 \geq -2x - 1$ and no other work

Worthless (0)
W1 Answer inconsistent with candidate's graph.