

Mark schemes

Q1.

(a) $12x^2 + 18x - 2x - 3$

Must have four terms, one in x^2 , 2 in x and a constant term. 3 terms correct

Terms may be in box method but must have correct signs

M1

$12x^2 + 16x - 3$

A1

Additional Guidance

$8x^2 + 18x - 2x - 3$

M1

$12x^2 + 18x + 2x - 3$

M1

$8x^2 + 18x + 2x - 3$

M0

$12x^2 + 18x - 2x - 3$

M0

	6x	-1
2x	12x ²	-2x
3	18x	-3

M1

	6x	-1
2x	12x ²	2x
3	18x	3

M1

(but can be recovered)

(b) Alternative method 1

$(ax \pm c)(bx \pm d)$

$ab = 4$ and $cd = \pm 3$

M1

$(4x - 3)(x + 1)$

A1

$\frac{3}{4}$ and -1

ft their brackets if M1 awarded

A1ft

Alternative method 2

$$\frac{-1 \pm \sqrt{1^2 - 4 \times 4 \times -3}}{2 \times 4}$$

Allow one error from wrong sign for -b, wrong signs for -4ac, b² as - 1

Do not accept wrong formula, ie + not ±, 2 not 2a or only dividing root by 2a

M1

$$\frac{-1 \pm \sqrt{49}}{8}$$

A1

$$\frac{3}{4} \text{ and } -1$$

oe ft on wrong sign for -b only eg -³/₄ and -1

A1

Alternative method 3

$$\left(x + \frac{1}{8}\right)^2 = \frac{49}{64}$$

M1

$$x = \pm \sqrt{\frac{49}{64}} - \frac{1}{8}$$

A1

$$\frac{3}{4} \text{ and } -1$$

oe

A1ft

Alternative method 4

Writes $x^2 + x - 12$ and

$$\left(x \pm \frac{a}{4}\right) \left(x \pm \frac{b}{4}\right) \text{ where } ab = -12$$

$$(4x \pm 4)(4x \pm 3)$$

M1

$$\left(x + \frac{4}{4}\right) \left(x - \frac{3}{4}\right)$$

oe eg (4x + 4)(4x - 3)

A1

$$\frac{3}{4} \text{ and } -1$$

oe ft their brackets if M1 awarded

A1ft

Additional Guidance

$$(2x - 1)(2x + 3), \frac{1}{2} \text{ and } -1\frac{1}{2}$$

M1, A0, A1 ft

$$\frac{1 \pm \sqrt{1^2 - 4 \times 4 \times -3}}{2 \times 4}, -\frac{3}{4} \text{ and } 1$$

M1, A0, A1 ft

$$(4x + 3)(x - 1), -\frac{3}{4} \text{ and } -1$$

M1, A0, A1 ft

$$x^2 + x - 12$$

M1

$$\left(x + \frac{2}{4}\right) \left(x - \frac{6}{4}\right)$$

A0

$$1\frac{1}{2} \text{ and } -\frac{1}{2}$$

A1ft

[5]

Q2.

$$(-3, 5)$$

B1

[1]

Q3.

use of $(x - 4)$

M1

$$(x - 4)^2 - 16 (+ 20)$$

A1

$$(x - 4)^2 - 16 + 20 = (x - 4)^2 + 4$$

Strand (ii)

Complete and correct algebraic explanation

Q1

Alternative method 1

use of $(x - 4)$

M1

$$= x^2 - 8x + 16$$

A1

$$(x - 4)^2 + 4 = x^2 - 8x + 20$$

Strand (ii)

Complete and correct algebraic explanation

Q1

Alternative method 2

$$x^2 - ax - ax + a^2 (+a)$$

M1

$$a = 4$$

A1

$$\text{Also } 4^2 + 4 = 20$$

Strand (ii)

Complete and correct algebraic explanation

Q1

(b) explains that a square is always positive (or zero) or

B1

and a positive number is added so is always positive or

B1

[5]

Q4.

(a) Alternative method 1

$$(x - 5)^2$$

M1

$$(x - 5)^2 - 13 \text{ or } a = 5 \text{ and } b = -13$$

A1

Alternative method 2

$$x^2 - 2ax + a^2 + b = x^2 - 10x + 16$$

$$\text{or } 2a = 10 \text{ or } a = 5 \text{ or } b = -13$$

M1

$$(x - 5)^2 - 13 \text{ or } a = 5 \text{ and } b = -13$$

A1

(b) 2

B1

[3]

Q5.

Alternative method 1

$$x(x + 2) \text{ or } x^2 + 2x$$

or

$$2x \times 4 \text{ or } 8x$$

or
 $4(x + 2)$ or $4x + 8$

M1

$x(x + 2)$ or $x^2 + 2x$
and
 $2x \times 4$ or $8x$
and
 $4(x + 2)$ or $4x + 8$

oe
eg $\frac{x(x+2) - 2x \times 4}{4(x+2)}$

M1dep

$x(x + 2) - 2x \times 4 = 4(x+2)$
oe equation with fractions eliminated
dep on M2

M1dep

$x^2 - 10x - 8 (= 0)$
oe 3-term quadratic equation with terms collected

A1

$$\frac{-(-10) \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$$

or $\frac{10 \pm \sqrt{100 + 32}}{2}$ or $\frac{10 \pm \sqrt{132}}{2}$

or $5 \pm \sqrt{5^2 + 8}$ or $5 \pm \sqrt{33}$

or

$[10.744, 10.745]$ and $[-0.745, -0.744]$

oe

Correct for their 3-term quadratic

Allow correct factorisation of their 3-term quadratic

M1

10.74 and -0.74
with $x^2 - 10x - 8 (= 0)$ oe seen

Must both be to 2 decimal places

A1

Alternative method 2 (from $\frac{x}{4} - 1 = \frac{2x}{x+2}$)

$x(x + 2)$ or $x^2 + 2x$

or

$(x + 2) + 2x$ or $3x + 2$

or

$12x + 8$

M1

$$\frac{x(x+2)}{4} \text{ or } \frac{x^2+2x}{4}$$

and

$$\frac{x+2+2x}{x+2} \text{ or } \frac{3x+2}{x+2}$$

M1dep

$$x(x+2) = 4(x+2+2x)$$

or

$$x(x+2) = 4(3x+2)$$

*oe equation with fractions eliminated
dep on M2*

M1dep

$$x^2 - 10x - 8 (= 0)$$

oe 3-term quadratic equation with terms collected

A1

$$\frac{-(-10) \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$$

$$\text{or } \frac{10 \pm \sqrt{100+32}}{2} \text{ or } \frac{10 \pm \sqrt{132}}{2}$$

$$\text{or } 5 \pm \sqrt{5^2+8} \text{ or } 5 \pm \sqrt{33}$$

or

$$[10.744, 10.745] \text{ and } [-0.745, -0.744]$$

oe

Correct for their 3-term quadratic

Allow correct factorisation of their 3-term quadratic

M1

$$10.74 \text{ and } -0.74$$

$$\text{with } x^2 - 10x - 8 (= 0) \text{ oe seen}$$

Must both be to 2 decimal places

A1

$$\text{Alternative method 3 } \left(\text{from } \frac{x}{4} - 1 = \frac{2x}{x+2} \right)$$

$$\frac{x-4}{4}$$

M1

$$(x-4)(x+2) \text{ or } x^2 - 4x + 2x - 8$$

$$\text{or } x^2 - 2x - 8$$

and

$$2x \times 4 \text{ or } 8x$$

M1dep

$$(x - 4)(x + 2) = 2x \times 4$$

or

$$x^2 - 4x + 2x - 8 = 8x$$

oe equation with fractions eliminated

dep on M2

M1dep

$$x^2 - 10x - 8 (= 0)$$

oe 3-term quadratic equation with terms collected

A1

$$\frac{-(-10) \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$$

$$\text{or } \frac{10 \pm \sqrt{100 + 32}}{2} \text{ or } \frac{10 \pm \sqrt{132}}{2}$$

$$\text{or } 5 \pm \sqrt{5^2 + 8} \text{ or } 5 \pm \sqrt{33}$$

or

$$[10.744, 10.745] \text{ and } [-0.745, -0.744]$$

oe

Correct for their 3-term quadratic

Allow correct factorisation of their 3-term quadratic

M1

$$10.74 \text{ and } -0.74$$

with $x^2 - 10x - 8 (= 0)$ oe seen

Must both be to 2 decimal places

A1

Additional Guidance

10.74 and -0.74 from T & I or with no working

6 marks

10.74 or -0.74 from T & I or with no working

Zero

In quadratic formula, do not allow -102 for $(-10)^2$ unless recovered

[6]

Q6.

$$\frac{x - 1}{(x - 2)(x - 1)} - \frac{x - 2}{(x - 2)(x - 1)}$$

$$\text{or } x - 1 - (x - 2)$$

$$\text{or } 2(x - 2)(x - 1)$$

$$\text{or } x^2 - 2x - x + 2$$

oe

M1

$$\text{their } [x - 1 - (x - 2)] = 2(x - 1)(x - 2)$$

$$\text{or } x - 1 - x + 2$$

or $2(x^2 - 2x - x + 2)$
oe

M1dep

$2x^2 - 6x + 3 (= 0)$
oe *Must be three terms*

A1

$$\frac{-(-6) \pm \sqrt{(-6)^2 - (4 \times 2 \times 3)}}{2 \times 2}$$

or $\frac{6 \pm \sqrt{12}}{4}$

oe
Allow one error, ft their quadratic

M1

$$\frac{-(-6) \pm \sqrt{(-6)^2 - (4 \times 2 \times 3)}}{2 \times 2}$$

or $\frac{6 \pm \sqrt{12}}{4}$

ft their quadratic, fully correct
oe
2.366(...) and 0.633(...)

A1ft

2.37 and 0.63

SC2 for one correct answer to 2 dp
SC1 for one correct answer to 3 dp or more

A1ft

Additional Guidance

T&I with two correct answers to 2 dp scores full marks T&I with two correct answers to 3 dp or more loses final A mark ft is from *their* quadratic (must have three terms) One error is an incorrect substitution in one position or a short divisor line A negative discriminant can score M1A1ftA0ft for an attempt at a solution

[6]

Q7.

$x^2 - cx - cx + c^2$

or $x^2 - 2cx + c^2$

or $a = c^2$

or $12 = 2c$

or $12x = 2cx$

or $-12x = -2cx$

M1

$$c = 6$$

A1

$$a = 36$$

ft their c2

A1ft

Alternative Method

$$(x - 6)^2 + a - 36$$

M1

$$c = 6$$

A1

$$a = 36$$

ft their c2

A1ft

[3]

Q8.

(a) Alternative method 1

$$(x + 3)^2 + \dots \text{ or } a^3$$

M1

$$(x + 3)^2 + 1$$

Accept a = 3 and b = 1

A1

Alternative method 2

$$2a = 6 \text{ and } a^2 + b = 10$$

M1

$$(x + 3)^2 + 1$$

Accept a = 3 and b = 1

A1

(b) (-3, 1)

oe

ft their a and their b

B1ft

[3]

Q9.

$$x^2 + ax + ax + a^2 (-7)$$

$$\text{or } x^2 + 2ax + a^2 (-7)$$

$$\text{or } 2ax = 10x$$

$$\text{or } 2a = 10$$

$$\text{or } a = 5$$

$$\text{or } a^2 - 7 = b$$

$$\text{or } (x + 5)^2$$

oe

M1

$$a = 5 \text{ and } b = 18$$

A1

Additional Guidance

$$(x + 5)^2 - 7 = x^2 + 10x + 18$$

M1A1

$$a = 7 \text{ and } b = 18$$

M0

[2]

Q10.

(a) $(x - 5)^2$ or $2a = 10$ or $a = 5$
or $a^2 + b = 29$

M1

$$(x - 5)^2 + 4$$

or $a = 5$ and $b = 4$

A1

(b) Alternative method 1

$$(x - 3)^2 + 5$$

M1

$$x^2 - 3x - 3x + 9 + 5$$

or $x^2 - 6x + 14$

Correct expansion of their $(x)^2 + n$

M1

$$c = -6 \text{ and } d = 14$$

A1

Alternative method 2

$$\left(x + \frac{c}{2}\right)^2 + d - \frac{c^2}{4}$$

M1

$$\frac{c}{2} = -3 \text{ and } d - \frac{c^2}{4} = 5$$

Equates coefficients for their $(x)^2 + b$

M1

$$hc = -6 \text{ and } d = 14$$

A1

Additional Guidance

$$9 + 3c + d = 5$$

M0

[5]

Q11.

$$6(2x + 5) + 1(\neq 3) \text{ or } 3(\neq 3)(2x + 5)$$

oe

May be seen as part of a fraction or fractions with denominator $(x + 3)(2x + 5)$

M1

$$6(2x + 5) + 1(\neq 3) = 3(\neq 3)(2x + 5)$$

oe

M1dep

$$6x^2 + 20x + 12 (= 0)$$

or

$$3x^2 + 10x + 6 (= 0)$$

Simplifying the expression to three terms

A1

$$\frac{-20 \pm \sqrt{20^2 - 4 \times 6 \times 12}}{2 \times 6}$$

$$\text{or } \frac{-10 \pm \sqrt{10^2 - 4 \times 3 \times 6}}{2 \times 3}$$

oe

Allow one error

-2.548... or -0.784...

Strictly ft their quadratic

M1

$$\frac{-20 \pm \sqrt{20^2 - 4 \times 6 \times 12}}{2 \times 6}$$

$$\text{or } \frac{-10 \pm \sqrt{10^2 - 4 \times 3 \times 6}}{2 \times 3}$$

oe

fully correct

A1ft

$$-0.78 \text{ and } -2.55$$

A1

Additional Guidance

One correct solution to 2 or more dp implies 4 marks

Two correct solutions to more than 2 dp implies 5 marks

$$3x^2 + 10x = -6$$

M1M1A1

ft their quadratic for the 4th and 5th marks

If no real roots M1A1ft can still be awarded

If quadratic factorises, must see correct factors for M1 and correct solutions for A1ft

If quadratic does not factorise, attempt to factorise scores M0

“Their quadratic” must be in the form $ax^2 + bx + c (= 0)$ or equivalent, no credit for solving a quadratic embedded within fractions etc

[6]

Q12.

Alternative method 1

$$5x^2 - 10x - 4 (= 0)$$

$$\text{or } -5x^2 + 10x + 4 (= 0)$$

If no rearrangement seen implied by

$$a = 5, b = -10, c = -4$$

$$\text{or } a = -5, b = 10, c = 4$$

seen or used correctly

B1

$$\frac{- -10 \pm \sqrt{(-10)^2 - 4 \times 5 \times -4}}{2 \times 5}$$

ft their 3-term quadratic (equation) seen

Allow one sign error

Allow 102 for $(-10)^2$

(do not count as a sign error)

Allow recovery of invisible brackets

Conceptual error (omission of square root, incomplete square root symbol, \pm not included, short fraction line) is M0 unless recovered

M1

$$\frac{- -10 \pm \sqrt{(-10)^2 - 4 \times 5 \times -4}}{2 \times 5}$$

$$\text{or } \frac{10 \pm \sqrt{100 + 80}}{10}$$

$$\text{or } \frac{10 \pm \sqrt{180}}{10} \text{ or } \frac{10 \pm 6\sqrt{5}}{10}$$

or 2.341(...) or 2.342

and -0.341(...) or -0.342

Fully correct substitution

ft their 3-term quadratic (equation) seen

oe eg $\frac{5 \pm 3\sqrt{5}}{5}$

Allow 102 for $(-10)2$

Allow recovery of invisible brackets

Two correct solutions > 2 dp for their 3-term quadratic equation

A1ft

2.34 and -0.34

ft B0M1A1ft

ft answers must be rounded to 2 dp

A1ft

Alternative method 2

$$5(x^2 - 2x - \frac{4}{5}) (= 0)$$

$$\text{or } x^2 - 2x - \frac{4}{5} (= 0)$$

$$\text{or } 5(x^2 - 2x) = 4 \text{ or } x^2 - 2x = \frac{4}{5}$$

May be implied

B1

$$5[(x-1)^2 - 1^2 - \frac{4}{5}] (= 0)$$

$$\text{or } (x-1)^2 - 1^2 - \frac{4}{5} (= 0)$$

$$\text{or } 5[(x-1)^2 - 1^2] = 4$$

$$\text{or } (x-1)^2 - 1^2 = \frac{4}{5}$$

ft their 3-term quadratic (equation) seen

Allow one sign error but $(x-1)2$ must be correct

M1

$$1 \pm \sqrt{1^2 + \frac{4}{5}}$$

or 2.341(...) or 2.342

and -0.341(...) or -0.342

Fully correct

ft their 3-term quadratic (equation) seen

oe eg $\frac{5 \pm 3\sqrt{5}}{5}$

Two correct solutions > 2 dp for their 3-term quadratic equation seen

A1ft

2.34 and -0.34

ft B0M1A1ft

ft answers must be rounded to 2 dp

A1ft

Additional Guidance

Do not count a sign error in a (or b) as two sign errors

eg If a should be -5 but $a = 5$ is used in both $4ac$ and $2a$, only count as one sign error

Final A1 mark can be awarded if both answers seen in working but only one is written on answer line

$5x^2 + 10x - 4 (= 0)$ seen with solutions -2.34 and 0.34

(no incorrect method seen)

B0M1A1ftA1ft

$5x^2 - 10x + 4 (= 0)$ seen with solutions 0.55 and 1.45

(no incorrect method seen)

B0M1A1ftA1ft

$5x^2 + 10x + 4 (= 0)$ seen with solutions -0.55 and -1.45

(no incorrect method seen)

B0M1A1ftA1ft

Note that the pairs of solutions seen in the three rows above can come from incorrect method so will not always score 3 marks

2.34 and -0.34 with no working or from T & I

4 marks

2.34 or -0.34 with no working or from T & I

Zero

2.3 and/or -0.3 with no working or from T & I

Zero

[4]