ExtendedMathematics
Topic:Algebra-2
Year:May2013-May2023
Paper-4
Answers

Question 1

(a)	**(i)**	$x \geq 5$	1	−1 once for strict inequalities in (i) to (iii)
	(ii)	$y \geq 11$	1	
	(iii)	$x + y \geq 20$	1	
(b)		$4x + 8y \leq 160$ **and** divide by 4	1	If there is a final inequality it must be the given one
(c)	**(i)**	$x = 5$ ruled	1	Must be on correct grid line
		$y = 11$ ruled	1	Must be on correct grid line
		$x + y = 20$ ruled	2	**B1** for one axis intercept correct when extended if necessary but not parallel to an axis
		$x + 2y = 40$ ruled	2	**B1** for one axis intercept correct when extended if necessary but not parallel to an axis
		Correct shading of **unwanted** region	1 dep	Dependent on 6 marks earned for the boundaries
	(ii)	29	2	**M1** for $x + y$ evaluated where (x, y) is a point in their **quadrilateral and** x and y are integers

Question 2

(i)	final answer $\dfrac{25 - 8x}{20}$	2	**M1** for $\dfrac{5 \times 5 - 4 \times 2x}{5 \times 4}$ or better seen
(ii)	final answer $\dfrac{2x^2 + 5x + 9}{3(x + 3)}$	3	**B1** for $2x^2 + 6x - x - 3$ soi \
and **B1** for denom $3(x + 3)$ or $3x + 9$ seen

Question 3

final answer $\dfrac{7}{2x+3}$ www	4	**B1** for $7(x+3)$ in numerator and **B2** for $(2x+3)(x+3)$ in denominator or **SC1** for $(2x+a)(x+b)$ where a and b are integers and $a+2b=9$ or $ab=9$ After **B1** scored, **SC1** for final answer $\dfrac{7}{2(x+1.5)}$ or $\dfrac{3.5}{x+1.5}$

Question 4

(a)	$\dfrac{x}{x+3}$ cao	3	**B1** for $(x+3)(x-3)$ **B1** for $x(x-3)$
(b)	$\dfrac{3}{2}$ and -5	7	**M2** for $15(x+1)-20x = 2x(x+1)$ or **M1** for multiplication by one denominator only or $\dfrac{15(x+1)-20x}{x(x+1)}$ and **B2** for $2x^2+7x-15\ [=0]$ or **B1** for $15x+15-20x$ or $2x^2+2x$ and **M2** for $(2x-3)(x+5)$ or *their* correct factors or formula or **M1** for $(2x+a)(x+b)$ where $ab=-15$ or $a+2b=7$ **A1** for $x=\dfrac{3}{2}$ and -5

Question 5

$\dfrac{4x-7}{10}$ final answer nfww	3	**M2** for $\dfrac{5(2x-1)-2(3x+1)}{2\times5}$ or $\dfrac{5(2x-1)}{5\times2}-\dfrac{2(3x+1)}{5\times2}$ or **M1** for attempt to convert to common denominator of 10 or multiple of 10 with one error in numerator

Question 6

$\dfrac{2x-1}{2(x-3)}$ or $\dfrac{2x-1}{2x-6}$ final answer nfww	**3**	**M2** for $2(x+3)(x-3)$ or $(2x-6)(x+3)$ or $(2x+6)(x-3)$ seen **or M1** for $2(x^2-9)$ seen

Question 7

(a)	$y=2$ oe	**1**	
	$y=2x$ oe	**2**	**M1** for $y=kx$, $k\neq 0$ or gradient 2 soi
	$y=-\dfrac{1}{2}x+5$ oe	**2**	**M1** for gradient $-\frac{1}{2}$ soi or $y=kx+5$ oe or $x+2y=k$ $k\neq 0$ oe If L^2 **and** L^3 both correct but interchanged then **SC3**
(b)	$y\geq 2$ oe $y\leq 2x$ oe $y\leq -\dfrac{1}{2}x+5$ oe	**3**	**B1** for each correct inequality, allow in any order After 0 scored, **SC1** for all inequalities reversed
(c) (i)	4 [bushes], 3 [trees]	**2**	**M1** for any correct trial using integer coordinates in region or $30x+200y=720$ seen
(ii)	2 [bushes], 4 [trees]	**2**	**M1** for any correct trial using integer coordinates in region
	860	**1**	

Question 7

132	**3**	**M1** for $y=k\sqrt{x}$ oe or $\sqrt{x}=ky$ oe **A1** for $k=6$ oe or better or for $k=0.1666$ to 0.167 $[k=6$ implies M1A1] oe

Question 8

20 with supporting algebraic working	**6**	**B2** for $\dfrac{x}{2.5}+\dfrac{x-14.5}{0.5}=19$ oe or **B1** for $\dfrac{x}{2.5}$ or $\dfrac{x-14.5}{.5}$ **M1dep on B2** for first completed correct move to clear both fractions **M1** for second completed correct move to collect terms in x to a single term **M1** for third completed correct move to collect numeric term[s] leading to $ax=b$ **SC1** for 20 with no algebraic working

Question 9

$7 \times 2 + (2x-3)(x+4) = 2(x+4)$ **M1**   Allow if bracket[s] omitted but recovers

$2x^2 + 8x - 3x - 12$ or better seen   **B1**

$2x^2 + 3x - 6 = 0$ **A1**   with no errors seen and brackets correctly expanded on both sides
and no omission of brackets

Question 10

$\dfrac{x-1}{x+5}$ as final answer nfww   **4**   **B3** for $(x-1)(x-2)$ and $(x+5)(x-2)$

or **B2** for $(x-1)(x-2)$ or $(x+5)(x-2)$

or **SC1** for $(x+a)(x+b)$ where
$a+b = 3$ or -3 or $ab = 2$ or -10

Question 11

(i) $\dfrac{x^8}{3}$ final answer   **1**

(ii) $15x^7y^3$ final answer   **2**   **M1** for 2 elements correct

(iii) $16x^8$ final answer   **2**   **M1** for $16x^k$ or kx^8

Question 12

$\dfrac{x+5}{x^2}$ or $\dfrac{1}{x} + \dfrac{5}{x^2}$ final answer

nfww   **3**   **B1** for $(x+5)(x-5)$
and
B1 for $x^2(x-5)$

Question 13

$x > 0.5$ oe **final answer nfww**   **3**   **B2 nfww** for 0.5 with no/incorrect inequality or equals sign as answer
or **M2** for $7x + 15x > 6 + 5$ or better
or $-6 - 5 > -7x - 15x$ or better
or **M1** for $6 - 15x$ seen

Question 14

(a)	$4x + 10y < 80$	1	With no errors seen
(b)	$y > x$	1	
	$y \leqslant 6$ or $y < 7$	1	Accept $0 \leqslant y \leqslant 6$ or $0 < y \leqslant 6$ or $0 \leqslant y < 7$ or $0 < y < 7$
(c)	ruled broken line through $(5, 6)$ to $(10, 4)$	B2	SC1 for correct only at $(5, 6)$ or $(10, 4)$
	ruled broken line $y = x$	B1	
	ruled solid line $y = 6$ or broken $y = 7$	B1	Must be consistent with *their* (b)
	correct region indicated	B1	
(d)	76	2	SC1 for $(4, 6)$ indicated or $4x + 10y$ evaluated for (x, y) in *their* region, x, y integers

Question 15

$\dfrac{3x^2 + 5x - 14}{(3x - 5)(x - 1)}$ final answer	3	B1 for denom $(3x - 5)(x - 1)$ oe isw and B1 for $3x^2 + 6x - 5x - 10$ soi

Question 16

$\dfrac{27x^6}{64}$ final answer	2	B1 for 2 [out of 3] elements correct in the right form in final answer or final answer contains 27 and 64 and $x^{[-]6}$ or $\dfrac{3x^2}{4}$ seen or $\dfrac{729x^{12}}{4096}$ seen

Question 17

(a)	(i)	$x \geqslant 100$ final answer	1	
	(ii)	$y \geqslant 120$ final answer	1	
	(iii)	$x + y \leqslant 300$ final answer	1	
	(iv)	$40x + 80y \geqslant 16000$ or $0.4x + 0.8y \geqslant 160$	M1	with no errors seen but isw substitution of values after correct inequality
(b)		$x = 100$ ruled	B1	
		$y = 120$ ruled	B1	
		$x + y = 300$ ruled	B1	
		$x + 2y = 400$ ruled	B2	Allow **B1** for line with negative gradient passing through (400, 0) or (0, 200) when extended
		Correct shading	B1	Dep on all previous marks earned Condone any clear indication of the required region
(c)		200	2	**M1** for $x = 100$ and $y = 200$ selected or for $x \times 0.4 + y \times 0.8$ oe evaluated where (x, y) is an integer point in *their* [unshaded] region

Question 18

$\dfrac{At}{t + r}$	final answer oe nfww	4	**B1** for $t(A - x) = xr$ or $tA - tx = xr$ or $A = \dfrac{xr}{t} + x$ **M1** for correctly completing multiplication by t (eliminating any bracket) and x terms isolated **M1** for correct factorisation **M1** dep for correct division

Question 19

$$\frac{13x+8}{(x-4)(3x-2)} \quad \text{final answer} \quad \text{nfww}$$

	3	**B1** for $6(3x-2)-5(x-4)$ or better seen

B1 for $(x-4)(3x-2)$ oe seen as denom

or **SC2** for final answer $\dfrac{13x-32}{(x-4)(3x-2)}$

Question 20

6, 7

3

B2 for answer of 6 or 7
OR
M1 for $t < 8$
M1 for $t \geqslant \dfrac{37}{7}$
OR
SC2 for final answer of 5, 6, 7 or
6, 7, 8
or **SC1** for final answer of 5, 6, 7, 8

Question 21

$t = -2$ nfww

5

M1 for $2(t+3)(t+3)-t^2$ or better seen
M1 for denominator[s] $t(t+3)$ isw or for $t(t+3)$ isw on RHS

M1dep for $2t^2+12t+18-t^2 = t^2+3t$ oe
dependent on both numerators and denominator
expanding to give quadratics

A1 for $9t+18=0$ oe

Question 22

$$\frac{x^2+3x+3}{(x+2)(x+1)} \quad \text{or} \quad \frac{x^2+3x+3}{x^2+3x+2} \quad \text{final}$$

answer   nfww

4

M1 for $(2x+3)(x+1) - x(x+2)$ oe isw

B1 for common denominator
$= (x+2)(x+1)$ isw or x^2+3x+2 isw

B1 for $2x^2+2x+3x+3$ or better
  or $-x^2-2x$
  or x^2+3x+3

Question 23

(a)	(i)	$x \geqslant 5$ oe $y \leqslant 8$ oe $x + y \leqslant 15$ oe $y > x$ oe or $y \geqslant x + 1$		4	Condone $5 \leqslant x \leqslant 15$ Condone $0 < y \leqslant 8$ **B1** for each -1 for first occurrence of strict inequalities used in first 3 inequalities
	(ii)	$x = 5$ ruled $y = 8$ ruled $x + y = 15$ ruled $y = x$ ruled broken line		1 1 1 1	Allow $y = x + 1$ ruled only after $y \geqslant x + 1$ in **(a)(i)**
		Correct region indicated		1dep	Dependent on all marks for lines earned Accept R written in correct quadrilateral or any other unambiguous indication or accept in triangle if $y = x + 1$ used and all marks for lines earned
(b)		78		2	**B1** for $(7, 8)$ chosen or **M1** for a calculation shown of the form $6x + 4.5y$ where (x, y) is clearly in *their* region and both x and y are integers

Question 24

(a)	15 nfww	3	**M1** for $y = k\sqrt{(x+2)}$ oe
			A1 for $k = 3$
(b)	$\dfrac{x+6}{x-2}$ nfww final answer	5	**B2** for $(x+6)^2$ oe
			or **SC1** for $(x+a)(x+b)$ where $ab = 36$ or $a + b = 12$ or $x(x+6) + 6(x+6)$
			B2 for $(x-2)(x+6)$
			or **SC1** for $(x+a)(x+b)$ where $ab = -12$ or $a + b = 4$ or $x(x+6) - 2(x+6)$ or $x(x-2) + 6(x-2)$
(c)	$\dfrac{X}{W^2+1}$ nfww final answer	5	**M1** for $W^2 = \dfrac{X-a}{a}$ or $W\sqrt{a} = \sqrt{X-a}$
			M1 for next productive step
			M1 for 2nd productive step
			M1 for 3rd productive step
			M1 for final step leading to $a =$
(d)	$\dfrac{-7x-1}{x^2-1}$ or $\dfrac{-7x-1}{(x-1)(x+1)}$ final answer	5	**M1** for common denominator $(x-1)(x+1)$ isw
			M1 for $(x-2)(x-1) - (x+3)(x+1)$
			B2 for $x^2 - 2x - x + 2 - (x^2 + 3x + x + 3)$ oe
			or **B1** for either expansion

Question 25

$x > \dfrac{12}{5}$ oe final answer	2	**B1** for $\dfrac{12}{5}$ oe in answer with incorrect or no sign
		or **M1** for one correct step e.g. $5x > 9 + 3$

Question 26

$r = \dfrac{1}{p+7}$ final answer nfww

4

M1 removes fraction correctly
M1 collects terms in r
M1 removes r as a factor from their terms in r
M1dep divides by bracket to leave r and denominator simplified

Question 27

(i)	5	1	
(ii)	$\dfrac{1}{2}$ oe	1	
(iii)	$\dfrac{5}{3}$ oe	2	**M1** for $2^{3x} = 2^5$ oe or better

or **SC1** for either denominator or numerator of index correct in final answer |
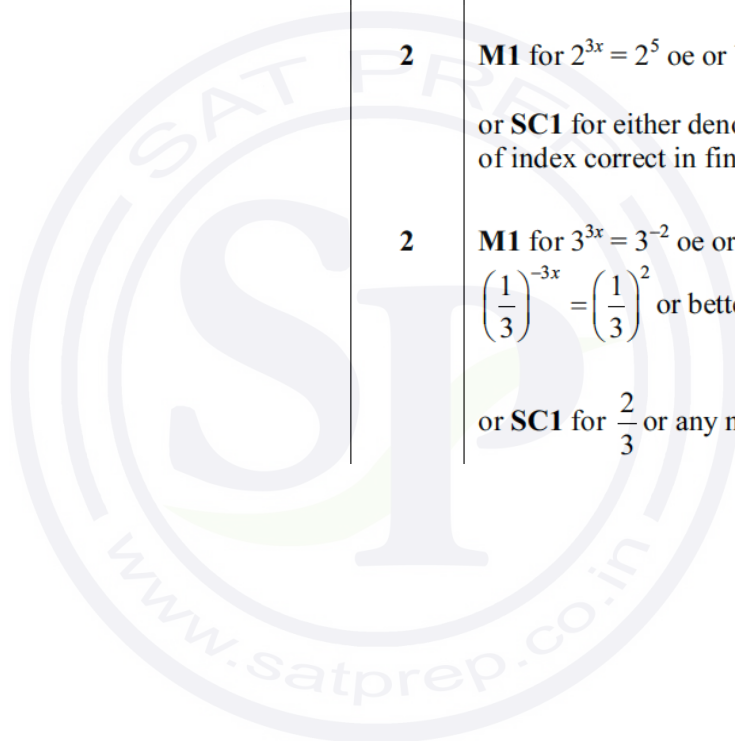| **(iv)** | $-\dfrac{2}{3}$ oe | 2 | **M1** for $3^{3x} = 3^{-2}$ oe or better or $\left(\dfrac{1}{3}\right)^{-3x} = \left(\dfrac{1}{3}\right)^{2}$ or better

or **SC1** for $\dfrac{2}{3}$ or any negative index |

Question 28

5 and $-\dfrac{27}{2}$ oe | 7 | **M2** for $12 \times 2(2x-1) + (x+3)(2x-1) = 12 \times 3(x+3)$ oe
or
M1 for a common denominator with 2 or more of the terms

and
B2 for $2x^2 + 17x - 135\ [= 0]$ oe
or
B1 for $48x - 24$ or $2x^2 - x + 6x - 3$ or $36x + 108$
  or $2x^2 - x + 54x - 27$
  or $132 - 12x$
  or $37x + 111 - 2x^2 - 6x$

and
M2 for $(2x+27)(x-5)$ or *their* correct factors or formula
or
M1 for $2x(x-5) + 27(x-5)$ or $x(2x+27) - 5(2x+27)$
or $(2x+a)(x+b)$ where $ab = -135$ or $a + 2b = 17$

Question 29

$x \geqslant 3.5$ final answer | 2 | **M1** for $6x - 2x \geqslant 14$ or better

Question 30

$\dfrac{1000}{x(x+1)}$ final answer | 3 | **M1** for $1000(x+1) - 1000x$
M1 for denominator $x(x+1)$

Question 31

(i)	$x + y \geqslant 9$ oe	1	
	$y \geqslant 2$ oe	1	If zero scored, **SC1** for $x + y > 9$ **and** $y > 2$
(ii)	Fully correct diagram with **unwanted** region shaded	4	**B1** for $2x + 3y = 24$ ruled
			B1 for $x + y = 9$ ruled
			B1 for $y = 2$ ruled
(iii)	20	1	
	$[x =]\ 7$	1	
	$[y =]\ 2$	1	If zero scored, **SC1** for $2x + 3y$ evaluated from integers

Question 32

(a)	$x < 10$ oe	1	Accept $x \leqslant 9$
	$y \geqslant 2$ oe	1	Accept $y > 1$
(b)	$x + 3y \leqslant 21$ oe	1	Mark answer line isw
(c)	ruled broken line $x = 10$	**B1**	or ruled line $x = 9$
	ruled line $y = 2$	**B1**	or ruled broken line $y = 1$
	ruled line from $(0, 7)$ to $(21, 0)$	**B2**	**SC1** for line with negative gradient correct only at $(0, 7)$ or $(21, 0)$
	correct region indicated cao	1	
(d) (i)	4	1	
(ii)	20	1	

Question 33

| $\dfrac{7x^2 - 12x - 10}{(2x - 5)(x - 1)}$ oe final answer nfww | 4 | **B1** for common denom $(2x - 5)(x - 1)$ seen oe isw
 M1 for $x(x - 1) + (3x + 2)(2x - 5)$ soi isw
 B1 for $6x^2 - 15x + 4x - 10$ soi |

Question 34

)(i)	1	1	
(ii)	x^{10} final answer	1	
(iii)	$9x^{16}$ final answer	2	**B1** for x^{12} or x^{16} or $(3x^8)^2$ seen

Question 35

$\dfrac{2(x+3)}{x+10}$ or $\dfrac{2x+6}{x+10}$
final answer nfww

| | 3 | **M2** for $(x+10)(x-3)$
 or
 M1 for $(x+a)(x+b)$ where $ab = -30$
 or $a+b=7$ |

Question 36

(a)	$y > x$	1	
	$x \geqslant 15$	1	
	$y < 50$	1	
	$x + y \leqslant 70$	1	
(b)	Four correct ruled lines and correct region indicated	5	all lines ruled **B1** for $y = x$ broken **B1** for $x = 15$ **B1** for $y = 50$ broken **B1** for $x + y = 70$
(c)	189	2	**M1** for $(21, 49)$ seen or for $2x + 3y$ written for a point (x, y) in *their* region where x and y are integers

Question 37

$[\pm]\sqrt{k-s}$ final answer

| | 2 | **M1** for $t^2 = k - s$ |

Question 38

$\dfrac{4x^2 - 7x - 8}{x(x+1)}$ or

$\dfrac{4x^2 - 7x - 8}{x^2 + x}$ final answer

| | 3 | **M1** for $(x-8)(x+1) + 3x \times x$ oe isw

 B1 for common denominator $x(x+1)$ oe isw |

Question 39

3, 4, 5, 6 nfww

| | 3 | **B2** for 3 correct or 4 correct and 1 extra

 or **M2** for $n > \dfrac{18}{8}$ oe and $n \leqslant 6$
 or **M1** for $18 < 8n \ [\leqslant 30 + 3n]$
 or $[18 - 3n <] 5n \leqslant 30$ seen |

Question 40

(i)	$x \geqslant 2$ oe $y \leqslant 5$ oe $y \geqslant \dfrac{1}{2}x$ oe	4	**SC3** for $x > 2$ and $y < 5$ and $y > \dfrac{1}{2}x$ **OR** **B1** for $x \geqslant 2$ **B1** for $y \leqslant 5$ **B2** for $y \geqslant \dfrac{1}{2}x$ or **M1** for $y \geqslant kx$ $(k > 0)$ **OR** **SC2** for all three boundary lines identified but with incorrect sign(s) If 0 scored **SC1** for one or two correct boundary lines with incorrect sign(s)
(ii)	$(5, 4)$	2	**M1** for one trial of an integer point inside region or for $3x + 5y = 35$ drawn

Question 41

(i)	$243p^{10}$ final answer	2	**B1** for answer $243p^k$ or kp^{10} $(k \neq 0)$
(ii)	$9xy^4$ final answer	2	**B1** for answer with two correct elements in correct form of expression
(iii)	$\dfrac{m^2}{25}$ final answer	1	

Question 42

$[x =] \dfrac{2m}{k+1}$	4	**M1** for $xk = 2m - x$ or $k = \dfrac{2m}{x} - 1$ **M1** for $xk + x = 2m$ or $k + 1 = \dfrac{2m}{x}$ **M1** for $x(k+1) = 2m$

Question 43

(i)	$10a^5c^9$ final answer	2	**B1** for final answer with $10a^kc^9$ or $10a^5c^k$ or ka^5c^9
(ii)	$\dfrac{8a^6}{c^9}$ or $8a^6c^{-9}$ final answer	2	**B1** for final answer with $\dfrac{8a^6}{c^k}$ or $\dfrac{8a^k}{c^9}$ or $\dfrac{ka^6}{c^9}$ $[k \neq 0]$ or for correct answer seen

Question 44

0.5 or $\dfrac{1}{2}$	3	**M1** for $y = \dfrac{k}{(x+2)^2}$ oe **B1** for $k = 50$ or **M2** for $2(3+2)^2 = y(8+2)^2$ oe

Question 45

$\dfrac{7x-x^2}{2(x-2)}$ or $\dfrac{7x-x^2}{2x-4}$ oe final answer	3	**M1** for $5 \times 2 - (x-5)(x-2)$ oe seen **M1** for common denominator $2(x-2)$ oe isw

Question 46

$[P=]\ \dfrac{100A}{100+TR}$ final answer	3	**M1** for $100A = 100P + PRT$ or for $A = P(1 + \dfrac{RT}{100})$ **M1** for $100A = P(100 + RT)$ or for $\dfrac{A}{1+\dfrac{RT}{100}} = P$ or for $100A = P(1 + RT)$ after $100A = P + PRT$ as first step

Question 47

2	3	**M1** for $y = \dfrac{k}{(x+3)^2}$ oe **M1** for $y = \dfrac{their\ k}{(7+3)^2}$ oe OR **M2** for $8(2+3)^2 = y(7+3)^2$ oe

Question 48

| $x > -5$ final answer | 3 | **M1** for $3x - 6 < 7x + 14$ |
| | | **M1** for $their(-6) - their14 < 7x - 3x$ oe |

Question 49

| $-1, 0, 1, 2$ final answer | 3 | **B2** for 3 correct values and no incorrect values or 4 correct values and one incorrect value or **M2** for $-\dfrac{7}{4} < n \leqslant 2$ oe |
| | | or **M1** for $-\dfrac{7}{4} < n \leqslant k$ or $k < n \leqslant 2$ oe |

Question 50

)(i)	a^9	1	
)(ii)	$125x^3y^6$ final answer	2	**B1** for 2 correct elements if in form kx^ny^m
)(iii)	$\dfrac{4y^{[1]}}{3x^4}$ final answer	3	**B2** for $\left(\dfrac{3x^4}{4y^{[1]}}\right)^{[-1]}$ oe seen OR **B1** for $3x^4$ or $4y^{[1]}$ **and** **M1** for $\left(\dfrac{64y^3}{27x^{12}}\right)^{\left[\frac{1}{3}\right]}$ oe If 0 scored, **SC1** for $\dfrac{64y^{[1]}}{27x^4}$ or $\dfrac{0.333x^{-4}}{0.25y^{-1}}$ seen

Question 51

5.5	4	**M1** for $5 \times 3(x-4) + x + 2 = 5 \times 6$
		M1 for $15x - 60 + x + 2 = 30$ **FT** *their* first step or $3x - 12 + \dfrac{x+2}{5} = 6$
		If M0M0, **SC1** for $3x - 12 + x + 2 = 30$ oe
		M1dep for $16x = 88$ **FT** *their* previous steps

Question 52

(i) | 1.991×10^3 | 4 | **B3** for 1991 or 1.99×10^3 or $1.991... \times 10^3$ or **B2** for 1990 or 1991. …

OR

M1 for $104.3 \times 26.5 + \frac{1}{2} \times (-2.2) \times 26.5^2$
oe
B1 for *their* seen value correctly rounded to 4 sf
B1 for *their* seen value correctly converted into standard form

(ii) | $\frac{2(s-ut)}{t^2}$ oe final answer | 3 | **M1** for correct multiplication by 2 oe
M1 for correct rearrangement to isolate term with a
M1 for correct division by t^2

for 3 marks e.g. cannot have a fraction in denominator nor $\div t^2$ in numerator

Question 53

$\frac{3x+3}{2}$ oe final answer | 3 | **M1** for $8x - 2y = 5x - 3$

or $4x - y = \frac{1}{2}(5x - 3)$

M1FT for isolating the y term correctly

Question 54

$9x^6$ | 2 | **M1** for $(3x^3)^2$ or $\left(729x^{18}\right)^{\frac{1}{3}}$ seen

or for $9x^k$ or kx^6 as final answer

Question 55

$\frac{x}{x-5}$ final answer nfww | 3 | **M1** for $x(x+5)$
M1 for $(x-5)(x+5)$

Question 56

(i) | $\frac{m-7}{5}$ oe final answer | 2 | **M1** for $5p = m - 7$ or $p + \frac{7}{5} = \frac{m}{5}$

(ii) | $[\pm]\sqrt{\dfrac{y^2 - h}{2}}$ or $[\pm]\sqrt{\dfrac{h - y^2}{-2}}$ oe
final answer | 3 | **M1** for first correct step isolate term in p or divide by ±2
M1 for second correct step FT *their* first step

Question 57

9(a)	$x + y \geqslant 6$ oe $y \leqslant x$ oe $x \leqslant 8$	3	**B1** for each	
9(b)	$4x + 6y \leqslant 60$	1		
9(c)	Correct region indicated cao	6	**B1** for $x + y = 6$ ruled and long enough **B1** for $x = y$ ruled and long enough **B1** for $x = 8$ ruled and long enough **B2** for $2x + 3y = 30$ ruled and long enough or **B1** for ruled line through (0, 10) or (15, 0) but not $y = 10$ or $x = 15$	
(d)(i)	6, 6	1		
(d)(ii)	34	2	**M1** for trying $4x + 6y$ with (4, 3) or (5, 2) or (6, 1) or (7, 0)	

Question 58

(a)	$n - 5 + 3n + 10 > 105$ or better	B1		
	$n > 25$ final answer	B2	**M1** for $4n > 100$	
(b)	4.8	3	**M1** for $y = \dfrac{k}{x^2}$ or better **M1** for $[y =] \dfrac{\text{their } k}{5^2}$ OR **M2** for $y \times 5^2 = 7.5 \times 4^2$	

Question 59

(a)	$\dfrac{10x}{(x-3)(x+2)}$ or $\dfrac{10x}{x^2 - x - 6}$ final answer	4	**M1** for common denominator $(x-3)(x+2)$ isw **M1** for $(x+3)(x+2) - (x-2)(x-3)$ isw **B1** for correct numerator in terms of x only	
(b)	14	2	**M1** for $12 - \dfrac{k}{2} = 5$ or $2^{\frac{k}{2}} = \dfrac{2^{12}}{2^5}$ oe or $\dfrac{4096}{32}$ or $12 - 5$ or $2^{12} \div 2^{\frac{14}{2}}$ $[= 32]$ seen	

Question 60

$[x =] \dfrac{3}{y-1}$ final answer

		3	**M1** for $xy = 3 + x$
			M1 for $xy - x = 3$ or $x - \dfrac{x}{y} = \dfrac{3}{y}$
			M1 for factorising and dividing

Question 61

$m \geq 3.4$ oe final answer

| | | 2 | **M1** for $12 + 5 \leq 8m - 3m$ or better or $3m - 8m \leq -5 - 12$ or better |

Question 62

(a)	$y \geqslant x$ oe	1	
(b)	$2.25x + 1.5y \leqslant 22.5$ oe	**M1**	
	One step shown to $3x + 2y \leqslant 30$	**A1**	
(c)	$y = 10$ ruled	1	Broken line
	$3x + 2y = 30$ ruled	**B2**	Solid line **B1** for line passing through $(0, 15)$ or $(10, 0)$
	$y = x$ ruled	**B1**	Solid line
	Correct region indicated	**B1**	
(d)	412	2	**M1** for $(4, 9)$ identified or for evaluation $40x + 28y$ for an integer point in the region ($x > 0$ and $y > 0$)

Question 63

| 75.6 | | 2 | **M1** for $5.2 \times 7 + \dfrac{1}{2} \times 1.6 \times 7^2$ |

Question 64

| $9x^6$ | | 2 | **B1** for $9x^k$ or kx^6 |

Question 65

| 2, 3, 4, 5 | | 2 | **B1** for 3 correct and no extra or 4 correct and one extra or **M1** for $1 < x \leqslant 5$ |

Question 66

$$\frac{4x+5}{(x-1)(2x+1)}$$

or $\dfrac{4x+5}{2x^2-x-1}$ final answer

| | **3** | **M1** for $3(2x+1)-2(x-1)$ oe isw |
| | | **M1** for $(x-1)(2x+1)$ oe isw |

Question 67

$x > 7.5$ final answer

| | **2** | **B1** for $12+3 < 5x-3x$ oe |

Question 68

$27x^6y^{12}$

| | **2** | **B1** for two of 27, x^6 and y^{12} correct |

Question 69

0.5 or $\dfrac{1}{2}$

	3	**M2** for $4 = 6x + 2x$ or better
		or
		M1 for $2(2-x) = 6x$ oe

Question 67

(a)	$-2 < x \leqslant 1$	**2**	**B1** for $-2 < x$ or $x \leqslant 1$
(b)(i)	$(x+2)^2 - 3$	**2**	**M1** for $(x+2)^2 + k$
(b)(ii)	$(x+2)^2 = 3$	**M1**	**FTdep** *their* **(b)(i)** for $k < 0$
	-3.73 or $-3.732...$ and -0.268 or $-0.2679...$	**B1**	
(b)(iii)	$(-2, -3)$	**2**	**FT** *their* $(x+2)^2 - 3$ **B1** for each coordinate
(b)(iv)	Correct sketch 	**2**	Parabola with minimum point in correct quadrant and both x-intercepts negative and positive y-intercept **B1** for parabola with minimum point.
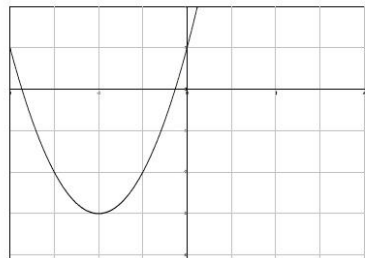
Question 71

(a)(i)	7^{11} cao	**1**	
(a)(ii)	7^{10} cao	**1**	
(a)(iii)	7^2 cao	**1**	If answers 11, 10 and 2 in **(a)** then allow **SC1** in this part
(b)	$1000x^9y^{12}$ final answer	**3**	**B2** for correct answer seen or answer of the form $1000x^9y^k$ or $1000x^ky^{12}$ or kx^9y^{12} or **B1** for answer with one correct element in product or $(10x^3y^4)^{[3]}$ seen
(c)(i)	108	**2**	**M1** for [540 =] 2^2 [×] 3^3 [×] 5 or **B1** for 108 oe not in prime factor form e.g. $2^2 \times 3 \times 9$
(c)(ii)	30 240	**2**	**M1** for $(540 \times 2^5 \times 3^3 \times 7) \div$ *their* **(c)(i)** oe or **B1** for answer 30 240 oe not in prime factor form e.g. $2^5 \times 3^3 \times 35$
(c)(iii)	98	**2**	**B1** for 592 704 seen or $2^6 \times 3^3 \times 7^3$ seen or 2×7^2 oe seen
(d)(i)	$(x - 7)(x + 4)$ final answer	**2**	**M1** for $x(x - 7) + 4(x - 7)$ or $x(x + 4) - 7(x + 4)$ or better or for $(x + a)(x + b)$ where $ab = -28$ or $a + b = -3$
(d)(ii)	$(a + 2b)(11a + 14b)$ final answer	**2**	**M1** for $(a + 2b)(7(a + 2b) + 4a)$ or $(a + pb)(11a + qb)$ where $pq = 28$ or $11p + q = 36$ If 0 scored, **SC1** for $a + 2b(11a + 14b)$
(e)	$[y =]\dfrac{5x-1}{2}$ oe final answer	**4**	**B2** for $2x - 1 = -2x + 2y - x$ oe or **B1** for $9^x = 3^{2x}$ or better **M1dep** for correct rearrangement of *their* 5 term 'linear' equation in y and x to make y the subject

Question 72

$\dfrac{2x^2 +12x -5}{x(x-1)}$ or $\dfrac{2x^2 +12x -5}{x^2 -x}$ final answer	**3**	**B1** for common denominator $x(x-1)$ oe **B1** for $(x-1)(x+5)+x(x+8)$ or better

Question 73

(a)	87	3	**M2** for $3c + 4c = 587 + 22$ or better or **M1** for $3c + 2(2c - 11)$ [= 587 or 5.87]
(b)	1.1[0]	3	**M2** for $22w + 22 = 42w$ or better or **M1** for $\dfrac{22}{w} = \dfrac{42}{w+1}$ oe OR **B2** for number of bottles = 20 or **M1** for $Nw = 22$ and $N(w+1) = 42$
(c)(i)	$\dfrac{9}{x} + \dfrac{5}{2x+1} = 2.5$ oe	**M2**	**M1** for $\dfrac{9}{x}$ or $\dfrac{5}{2x+1}$
	$9(2x+1) + 5x = 2.5x(2x+1)$ oe or $\dfrac{9(2x+1)+5x}{x(2x+1)}$ [= 2.5 oe]	**M1**	Correctly clearing fractions, or correctly collecting into a single fraction FT *their* expression dep on two fractions both with algebraic denominators
	All brackets expanded leading to $10x^2 - 41x - 18 = 0$ with no errors or omissions	**A1**	
(c)(ii)	$(2x - 9)(5x + 2)$ or $\dfrac{-(-41) \pm \sqrt{(-41)^2 - 4(10)(-18)}}{2(10)}$	**M2**	**B1** for $(ax+b)(cx+d)$ with $ac = 10$ and $bd = -18$ or $ad + bc = -41$ or $\sqrt{(-41)^2 - 4(10)(-18)}$ or $\dfrac{-(-41) + \sqrt{q}}{2(10)}$ oe or $\dfrac{-(-41) - \sqrt{q}}{2(10)}$ oe or both or **M1** for $\left(x - \dfrac{41}{20}\right)^2 - \dfrac{18}{10} - \left(\dfrac{41}{20}\right)^2 = 0$ or better
	10	**A2**	**A1** for $[x =] \dfrac{9}{2}$ oe or **M1** for $2 \times$ *their* positive root + 1

Question 74

(a)(i)	$\dfrac{12}{x}$ or $12 \div x$ final answer	**1**		
(a)(ii)	$\dfrac{12}{x-4} - their\ \dfrac{12}{x} = 1.5$ oe	**M1**	Accept 3 or more term equivalents	
	$12x - 12(x-4) = 1.5x(x-4)$ or $\dfrac{12x - 12(x-4)}{x(x-4)}$ [= 1.5]	**M1**	Correctly clearing fractions, or correctly collecting into a 'single fraction' FT *their* expression dep on two fractions both with algebraic denominators	
	$12x - 12x + 48 = 1.5x^2 - 6x$	**M1**	Correctly multiplying *their* two sets of brackets FT *their* expression dep on two fractions both with algebraic denominators or first M1 given	
	$[1.5x^2 - 6x - 48 = 0]$ $x^2 - 4x - 32 = 0$	**A1**	One further step either 3 term equation or division throughout by 1.5 leading to solution With no errors or omissions seen, dep on **M3**	
(a)(iii)	$(x+4)(x-8)$	**M2**	**M1** for $(x+a)(x+b)$ where $ab = -32$ or $a + b = -4$ or for $x(x+4) - 8(x+4)$ or $x(x-8) + 4(x-8)$	
	-4 and 8	**B1**		
(a)(iv)	3	**2**	**FT** $\dfrac{12}{their\ 8 - 4}$ **M1** for $\dfrac{12}{their\ 8 - 4}$ or $\dfrac{12}{their\ 8} + 1.5$ oe or for answer $\dfrac{12}{their\ 8}$	
(b)	69.6	**3**	**M2** for $\dfrac{430\ \text{to}\ 440}{6 + 0.25}$ or $\dfrac{440 - 5}{6\ \text{to}\ 6.5}$ oe or **M1** for $440 + 5$ oe or $440 - 5$ oe or $6 + 0.25$ oe or $6 - 0.25$ oe seen	

Question 75

(a)(i)	$4.5, 4\frac{1}{2}$ or $\frac{9}{2}$	**3**	**M1** for $8x - 12 = 24$ or $2x - 3 = 6$ **M1** for reaching $ax = b$ correctly FT *their* first step
(a)(ii)	$x > -\frac{4}{3}$ or $x > -1\frac{1}{3}$ final answer	**2**	**M1** for $6x > 6 - 14$ or $x + \frac{14}{6} > 1$
(b)	$[y =] \sqrt[3]{\dfrac{2x^3 - V}{3}}$ oe final answer	**3**	**M1** for isolating term in y **M1** for division by 3 or FT *their* first step **M1** for cube root or FT *their* previous step to the final answer
(c)	$4n^2 - 20n + 12$	**M2**	**B1** for $4n^2 - 10n - 10n + 25$
	$4(n^2 - 5n + 3)$ or correct explanation linked to expression	**A1**	with no errors seen e.g. 4, [–]20 and 12 are all multiples of 4 or divides each term or each coefficient by 4
(d)(i)	$p = -3$ and $q = 23$	**3**	**B2** for $23 - 2(x - 3)^2$ OR **M1** for $[q] - 2x^2 - 4px - 2p^2$ or $-2(x - 3)^2$ seen **B1** for either $p = -3$ or $q = 23$ or **FT** $q = 5 + 2(their\ p)^2$
(d)(ii)	$(3, 23)$	**1**	**FT** *their* (d)(i)
(e)	69	**2**	**M1** for figs 13^2 oe

Question 76

(a)(i)	$\dfrac{10}{3}$ or $3\dfrac{1}{3}$ or 3.33[3…]	3	**M1** for $42 - 12x = 3x - 8$ oe or for $7 - 2x = \dfrac{3x}{6} - \dfrac{8}{6}$ oe **M1** for reaching $ax = b$ correctly FT *their* first step
(a)(ii)	-2.5 or $-2\dfrac{1}{2}$ or $-\dfrac{5}{2}$	3	**M1** for $3 \times 2x = 2(x - 5)$ oe **M1** for reaching $ax = b$ correctly FT *their* first step
(b)(i)	$2(x + 12y)(x - 12y)$ final answer	3	**B2** for $(2x + 24y)(x - 12y)$ or $(2x - 24y)(x + 12y)$ or for $2(x + 12y)(x - 12y)$ seen OR **M2** for $k(x + 12y)(x - 12y)$ or **M1** for $2(x^2 - 144y^2)$
(b)(ii)	$(5x - 8)(x + 5)$ final answer	2	**M1** for $5x(x + 5) - 8(x + 5)$ or $x(5x - 8) + 5(5x - 8)$ or for $(5x + a)(x + b)$ where $ab = -40$ or $a + 5b = 17$
(c)	$4x^2 - 17x + 9 [= 0]$ oe	**B1**	
	$\dfrac{[--]17 \pm \sqrt{([-]17)^2 - 4(4)(9)}}{2 \times 4}$	**B2**	**FT** *their* 3 term quadratic **B1FT** for $\sqrt{([-]17)^2 - 4(4)(9)}$ or better or $\left(x - \dfrac{17}{8}\right)^2$ oe or $\sqrt{\dfrac{([-]17)^2 - 4(4)(9)}{4}}$ or better and **B1FT** for $\dfrac{[--]17 + \sqrt{q}}{2(4)}$ or $\dfrac{[--]17 - \sqrt{q}}{2(4)}$ or better or $\dfrac{17}{8} + \sqrt{\dfrac{145}{64}}$ oe or $\dfrac{17}{8} - \sqrt{\dfrac{145}{64}}$ oe or $\dfrac{\frac{[--]17}{2} + \sqrt{q}}{4}$ or $\dfrac{\frac{[--]17}{2} - \sqrt{q}}{4}$
	0.62 and 3.63 cao	**B2**	**B1** for each **SC1** for 0.6[0] or 0.619 to 0.620 **and** 3.6[0] or 3.6301 to 3.6302 or 0.62 and 3.63 seen in working or -0.62 and -3.63 as final answers

Question 77

(a)	$\dfrac{12}{x}+\dfrac{26}{x+10}=2.8$ oe isw	3	**B2** for $\dfrac{12}{x}+\dfrac{26}{x+10}$ oe isw OR **B1** for $\dfrac{26}{x+10}$ seen **B1** for time = 2.8 or $\dfrac{168}{60}$ or $2\dfrac{48}{60}$ oe
(b)	$12(x+10)+26x=2.8x(x+10)$ or better	M2	**FT** *their* time, provided 2 algebraic fractions one in x and other in $\pm x \pm 10$ **M1** for $12(x+10)+26x$ seen or better
	$12x+120+26x=2.8x^2+28x$	M1	**FT** *their* equation dep on M2
	$2.8x^2-10x-120=0$ oe or $30x+300+65x=7x^2+70x$ or better leading to $7x^2-25x-300=0$	A1	with no errors or omissions
(c)	$\dfrac{[--]25\pm\sqrt{([-]25)^2-4\times7\times-300}}{2\times7}$ oe	B2	**B1** for $\sqrt{([-]25)^2-4(7)(-300)}$ or better or for $\dfrac{[--]25+\sqrt{q}}{2\times7}$ or $\dfrac{[--]25-\sqrt{q}}{2\times7}$
	-5 and 8.57 or 8.571…	B2	**B1** for each or **SC1** for final answers 5 and -8.57
(d)	84 to 84.01…	2	**FT** $\dfrac{720}{\textit{their }\text{positive answer}}$ to 3 sf or better **M1** for $\dfrac{12}{\textit{their }\text{positive answer}}[\times 60\ ]$ oe

Question 78

(a)	1, 2, 3	**2**	**M1** for $15 - 8 > 5n - 3n$ oe If 0 scored, **B1** for 2 correct answers and no others or 3 correct answers with one extra value
(b)(i)	$10y + 8x \leqslant 80$ oe final answer $x > 4$ oe final answer $2y > x - 4$ oe final answer	**3**	**B1** for each If 0 scored, **SC1** for $10y + 8x < 80$ oe final answer and $x \geqslant 4$ oe final answer and $2y \geqslant x - 4$ oe final answer
(b)(ii)	23 final answer	**2**	**M1** for 7 and 2 selected soi

Question 79

(a)	$x^2 - x - 30[= 0]$	**B3**	**M1** for $(2x+1)(x-1) - x^2 = 29$ oe **B1** for $(2x+1)(x-1) = 2x^2 - 2x + x - 1$ oe soi
	$(x-6)(x+5)$ oe	**M1**	or correct factors for *their* 3 term quadratic equation or for correct substitution into quadratic formula or correctly completing the square for *their* 3 term quadratic equation
	$x = 6$ cao	**B1**	
	12 or $2 \times$ *their x* evaluated or $k = 2x$ stated	**B1 FT**	
(b)(i)	$(y+1)^3 - y^3 = 5$ oe	**M1**	
	$(y+1)^3 = y^3 + 3y^2 + 3y + 1$ soi	**B2**	**B1** for $(y+1)^2 = y^2 + y + y + 1$ oe soi
	Completion to $3y^2 + 3y - 4 = 0$	**A1**	With no errors or omissions
(b)(ii)	$\dfrac{-3 \pm \sqrt{3^2 - 4(3)(-4)}}{2 \times 3}$	**B2**	or **B1** for $\sqrt{3^2 - 4(3)(-4)}$ or for $\dfrac{-3 + \sqrt{\ldots}}{2 \times 3}$ or $\dfrac{-3 - \sqrt{\ldots}}{2 \times 3}$
	0.44	**B2**	**B1** for 0.758 or 0.7583…

Question 80

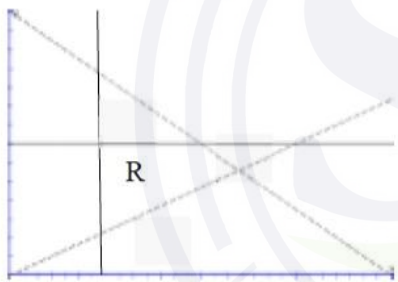|			
(a)(i)	6	3	**B2** for $4x + 6 = 30$ or better or **M1** for $x + x + 7 + 2x - 1 \; [= 30]$
(a)(ii)	21	3	**M2** for $(555 - \textit{their } x \times 15 - \textit{their } (x + 7) \times 18) \div \textit{their } (2x - 1)$ or **M1** for *their* $x \times 15$ or *their* $(x + 7) \times 18$
(b)(i)	8	2	**M1** for isolating the term in w or correctly removing all fractions e.g. $\dfrac{3w}{16} = 1 + \dfrac{1}{2}$ or better or $3w - 16 = 8$
(b)(ii)	−3	2	**M1** for $2^{-y} = 8$ or $2^y = \dfrac{1}{8}$ or $2^{-y} = \textit{their } w$ or better
(c)(i)	$[p =] \dfrac{1}{2}$ oe $[q =] 1$	2	**B1** for each If zero scored, **SC1** for 2 values satisfying one of the original equations
(c)(ii)	$[u =]$ 30 and 150 $[v =]$ 0 and 360	4	**B1** for each OR **SC1** for sin $u = \textit{their } p$ and cos $v = \textit{their } q$ **SC1** if their two different angles for u sum to 180 or if their different two angles for v sum to 360

Question 81

(i)	p^{14} final answer	1	
(ii)	$6m^4$ final answer	2	**B1** for $6m^k$ or km^4 in final answer or correct answer seen and spoilt
(iii)	$\dfrac{4}{3x^3y^9}$ or $\dfrac{4x^{-3}y^{-9}}{3}$ final answer	3	**B2** for correct answer seen and spoilt or 2 correct elements in final answer or **B1** for one of $\dfrac{4}{3}$ or $\dfrac{3}{4}$ oe or x^3 or y^9 seen

Question 82

(a)(i)	$27x^6y^{12}$ final answer	2	**B1** for two terms correct in answer e.g. $27x^6y^k$ or $27x^ky^{12}$ or kx^6y^{12} or for correct answer seen then spoilt
(a)(ii)	$\dfrac{x^{24}y^{12}}{64}$ final answer	3	**B2** for final answer with two correct elements or final answer $\dfrac{64}{x^{24}y^{12}}$ or $\dfrac{64^{-1}}{x^{-24}y^{-12}}$ or better or for correct answer seen or **B1** for 64 or x^{24} or y^{12} seen in final answer or final answer $\dfrac{k}{x^{-24}y^{-12}}$ or **M1** for first correct step seen eg $\left(\dfrac{x^{16}y^8}{16}\right)^{\left[\frac{3}{2}\right]}$ or $\left(\dfrac{4}{x^8y^4}\right)^{[-3]}$ or $\left(\dfrac{4096}{x^{48}y^{24}}\right)^{\left[\frac{1}{2}\right]}$

(b)(i)	$(x + 3)(x - 3)$ final answer	1	
(b)(ii)	$\dfrac{x+3}{2y+5}$ final answer	3	**M2** for $(x - 3)(2y + 5)$ or **M1** for $2y(x - 3) + 5(x - 3)$ or $x(2y + 5) - 3(2y + 5)$

Question 83

(a)	$y \leqslant 7$ oe $x + y < 14$ oe $y > \dfrac{2}{3}x$ oe	3	**B1** for each
(b)	$x = 4$ solid $y = 7$ solid $x + y = 14$ dashed $y = \dfrac{2}{3}x$ dashed	M4	**B1** for each
	correct shading everywhere but region R 	A2	**M1dep** (dependent on **M4** or **B1B1B1B0** where the only error is wrong use of solid/dashed lines) for shading the correct side of 3 of the 4 lines.
(c)	4 dresses and 3 shirts	1	
(d)	106	2	**M1** for $10x + 6y$ evaluated for (x, y) in *their* region R or **B1** for $(7, 6)$ After 0 scored, **SC1** for answer 112 or 116