Rewarding Learning

General Certificate of Secondary Education
2014

Additional Mathematics

Paper 2
Mechanics and Statistics

[G0302]

FRIDAY 13 JUNE, MORNING

MARK SCHEME

General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

1 **(i)** $3(2\mathbf{i} + 3\mathbf{j}) - (4\mathbf{i} - 2\mathbf{j})$

$= 6\mathbf{i} + 9\mathbf{j} - 4\mathbf{i} + 2\mathbf{j}$ M1

$= 2\mathbf{i} + 11\mathbf{j}$ W1

(ii) $|2\mathbf{i} + 11\mathbf{j}| = \sqrt{2^2 + 11^2}$

$= \sqrt{125} = 11.2$ (to 1 decimal place) MW1

(iii) angle $= \tan^{-1}\left(\frac{11}{2}\right)$

$= 79.7°$ (to 1 decimal place) MW1

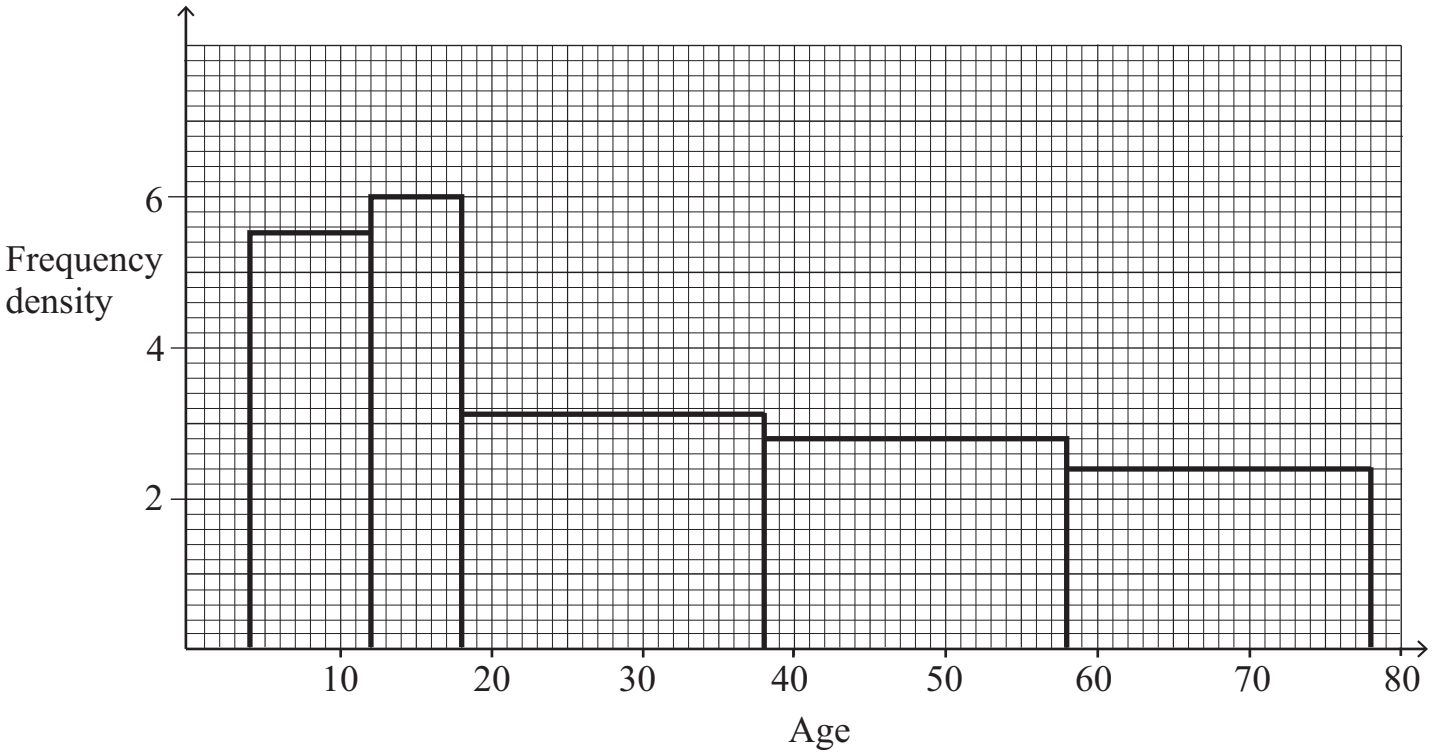
AVAILABLE MARKS

4

2

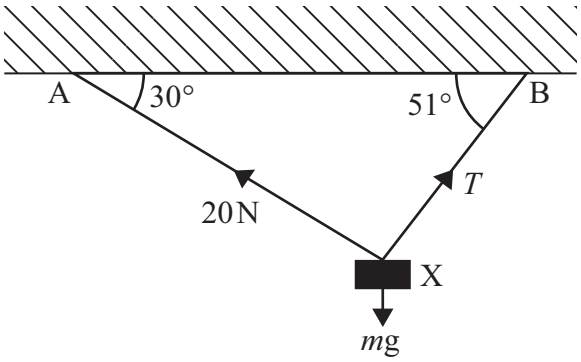
Age	4−11	12−17	18−37	38−57	58−77
Number of visitors	44	36	63	56	48
Frequency density	5.5	6	3.15	2.8	2.4

M1W1

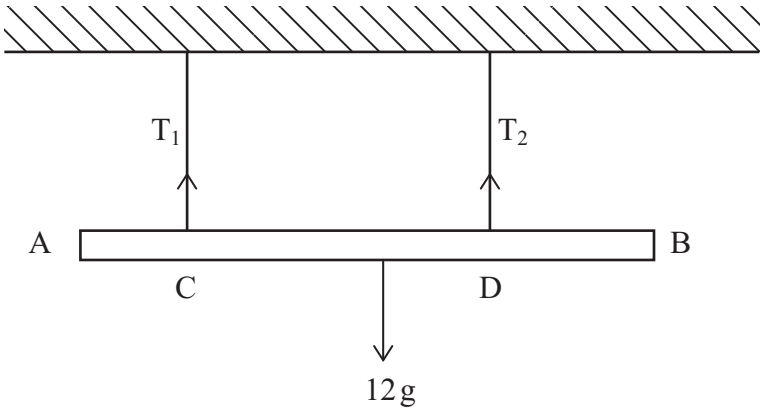


MW1 (labels)
MW1 (boundaries)
MW1 (heights)

5

			AVAILABLE MARKS
3	**(i)** There are $x + 4$ sweets in the bag.		
	So P (red) $= \dfrac{4}{x+4}$	MW1	
	(ii) P (red, red) $= \dfrac{4}{x+4} \times \dfrac{3}{x+3}$	M1 W1	
	$= \dfrac{12}{(x+4)(x+3)}$		
	(iii) $\dfrac{12}{(x+4)(x+3)} = \dfrac{1}{6}$		
	$x^2 + 7x + 12 = 72$	MW1	
	$x^2 + 7x - 60 = 0$		
	$(x + 12)(x - 5) = 0$		
	$\therefore x = -12$ (impossible) or $x = 5$		
	i.e. 5 yellow sweets	W1	5
4	**(i)** 	W1	
	(ii) Resolve horizontally:		
	$T\cos 51^\circ = 20\cos 30^\circ$	M1	
	$T = \dfrac{20\cos 30^\circ}{\cos 51^\circ} = 27.52\,\text{N}$	W1	
	(iii) Resolve vertically:		
	$mg = 20\sin 30^\circ + 27.52\sin 51^\circ$	M2	
	$m = 3.14$	W1	6

5 **(i)**



W1

(ii) Taking moments about C:

$12\,g \times 2 = T_2 \times 3$ MW1

$\therefore\ T_2 = \dfrac{12g \times 2}{3} = 80\,N$ W1

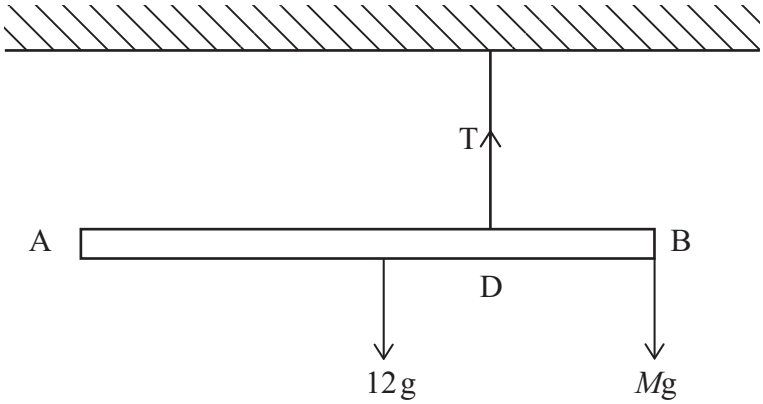
Resolve vertically:

$T_1 + T_2 = 12\,g$

$\therefore\ T_1 = 12\,g - 80 = 40\,N$ MW1

(iii) Tension at C = 0 N W1

(iv)



Taking moments about D:

$Mg \times 2 = 12\,g \times 1$ MW1 MW1

$\therefore\ M = 6$ W1 8

AVAILABLE MARKS

6 **(a)** Times in seconds are:

58, 137, 50, 64, 81, 58, 52, 116, 71, 133

AVAILABLE MARKS

(i) $\Sigma x = 820$

$\therefore$ mean $= \dfrac{820}{10} = 82$ secs — M1

$= 1$ min 22 secs — W1

(ii) $\Sigma x^2 = 77\,544$

$\therefore$ s d $= \sqrt{\dfrac{77544}{10} - 82^2}$ — M1

$= 32.1$ secs — W1

(b) **(i)** median class is 91–100

$\text{median} = 90.5 + \dfrac{(30.5 - 29) \times 10}{23}$ — MW1 (90.5+); MW1 (30.5 − 29) or (31 − 29)

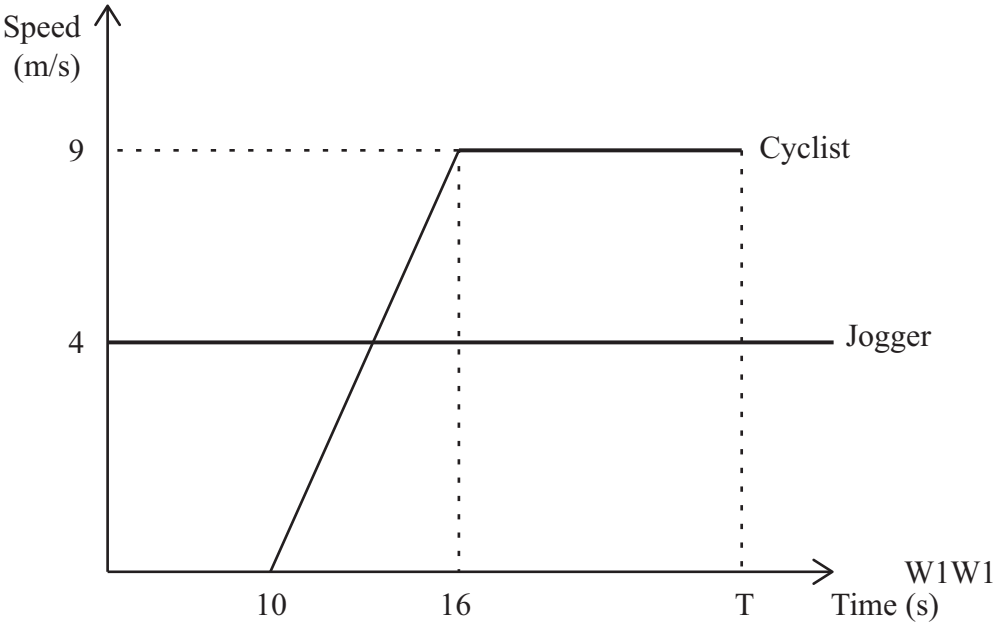
$= 91.2$ m — MW1 (10/23)

(or 91.4 m if 31 used instead of 30.5) — W1 (answer)

(ii) Assumes equal distribution within each class. — M1

9

7 **(i)**



W1W1

(ii) Distance travelled by jogger = 4T MW1

Distance travelled by cyclist $= 9(T - 16) + \frac{1}{2} \times 6 \times 9$

$= 9T - 117$ MW1

Distances equal, so

$9T - 117 = 4T$ M1

$\therefore 5T = 117$

$\therefore T = 23.4$ s W1

So time taken to reach jogger is $23.4 - 10$

$= 13.4$ s MW1

(iii) Distance travelled by cyclist is

$9T - 117$

$= 9 \times 23.4 - 117$ M1

$= 93.6\,\text{m}$ W1 9

Alternative solution:

Distance travelled by cyclist = distance travelled by jogger

$= 4 \times 23.4$ M1

$= 93.6\,\text{m}$ W1

AVAILABLE MARKS

8 **(i)** Cannot get total of 6, so

$$P(6) = 0 \qquad \text{M1}$$

(ii) A score of 8 is obtained by throwing a 6 followed by a 2, so

$$P(8) = \frac{1}{6} \times \frac{1}{6} = \frac{1}{36} \qquad \text{M1W1}$$

(iii) A score > 8 is obtained by throwing a 6 followed by a 3, 4, 5 or 6, so

$$P(>8) = \frac{1}{6} \times \frac{4}{6} = \frac{1}{9} \qquad \text{M2W1}$$

(iv) $P(12 \mid > 8) = \dfrac{P(12)}{P(> 8)} = \dfrac{\frac{1}{36}}{\frac{1}{9}}$ MW1, MW1

$$= \frac{1}{4} \qquad \text{W1}$$

AVAILABLE MARKS

9

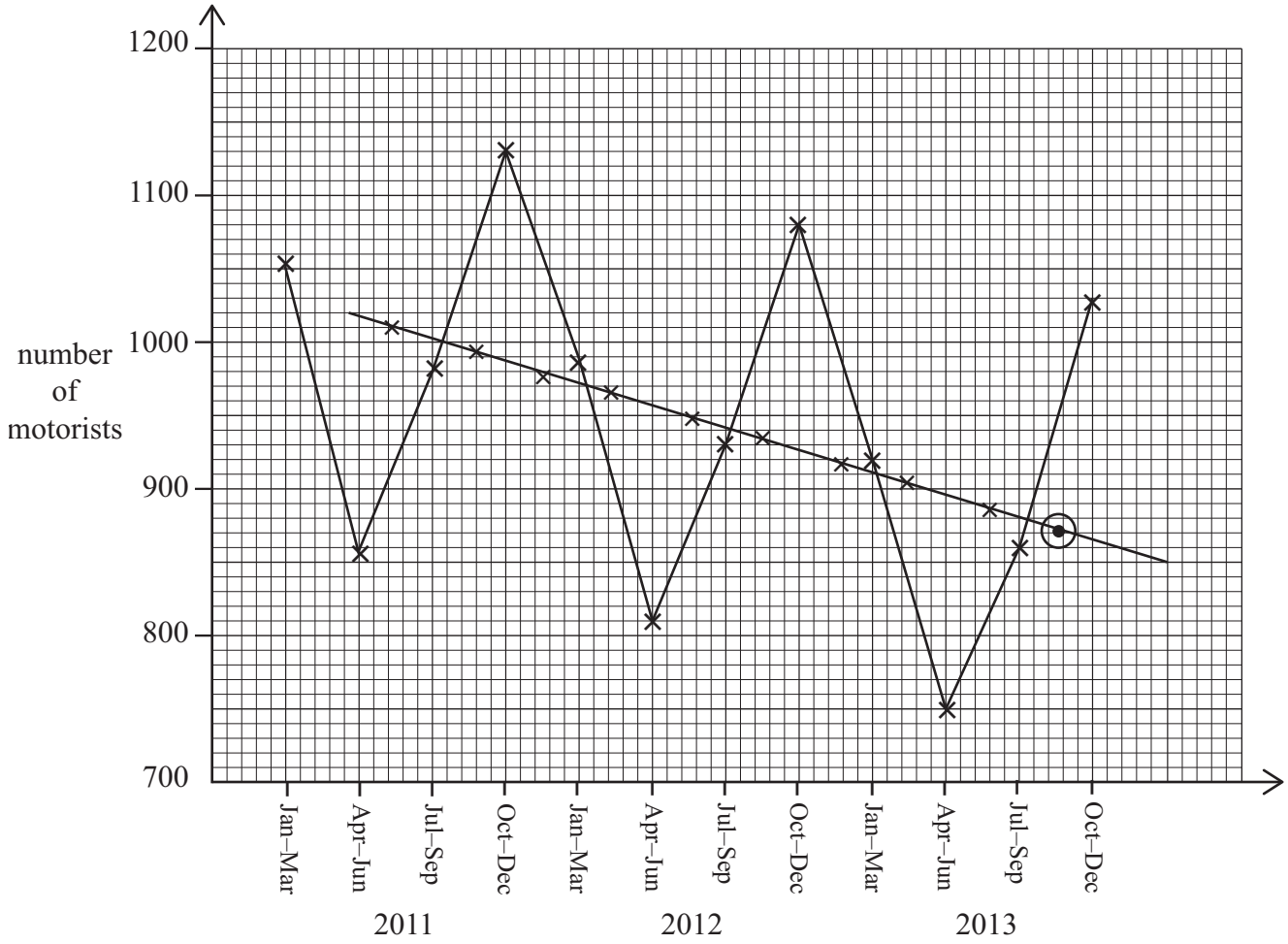
9 **(i)** 4 point moving averages:

AVAILABLE MARKS

1008
991
978
963
949
932
918
902
889

M1W1

(ii)



M2 (set)
MW1 (line)

(iii) $874 = \dfrac{749 + 862 + 1024 + x}{4}$

M2 (reading)
M1

$\therefore x = 861$
i.e. 861 motorists

W1

9

		AVAILABLE MARKS
10 **(i)**	$s = ut + \frac{1}{2}at^2$	
	$s = 0 \times 10 + \frac{1}{2} \times 5 \times 10^2$ MW1	
	$s = 250$ m W1	
(ii)	$v = u + at$	
	$v = 0 + 5 \times 10$ MW1	
	$v = 50$ m/s W1	
(iii)	Reaches maximum height when speed = 0	
	$v^2 = u^2 + 2as$	
	$0 = 50^2 + 2(-10)s$ MW1	
	$s = 125$ m W1	
	$\therefore$ max height above ground = 250 + 125 = 375 m W1	
(iv)	Time fuel burns = 10 s	
	Further time to reach max height:	
	$v = u + at$	
	$0 = 50 + (-10)t$	
	$t = 5$ s MW1	
	Time from max height to ground:	
	$s = ut + \frac{1}{2}at^2$	
	$375 = 0 + \frac{1}{2} \times 10 \times t^2$ MW1	
	$t^2 = 75$	
	$t = 8.66$ s W1	
	Total time = 10 + 5 + 8.66 = 23.66 s W1	11

Alternative solution:

AVAILABLE MARKS

(iv) Time fuel burns = 10 s
Height when fuel burns out = 250 m
Speed when fuel burns out = 50 m/s
For remainder of motion

$s = ut + \frac{1}{2}at^2$

$-250 = 50t - 5t^2$ MW1MW1

$5t^2 - 50t - 250 = 0$

$t^2 - 10t - 50 = 0$

$$t = \frac{10 \pm \sqrt{100 + 200}}{2}$$

$= -3.66$ s (ignore) or 13.66 s W1

Total time = 10 + 13.66

= 23.66 s W1

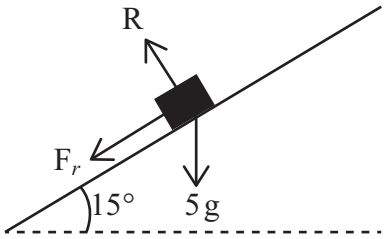
11 (i) $v = u + at$

$0 = 8 + 2a$

$a = -4$

$\therefore$ deceleration $= 4\ \text{m/s}^2$ MW1

(ii)



Resolve perpendicular to plane:

$R = 5g\cos 15° = 48.296\,\text{N}$

$R = 48.30\,\text{N}$ MW1

(iii) Resolve parallel to plane:

$F_r + 5g\sin 15° = 5 \times 4$ MW1MW1

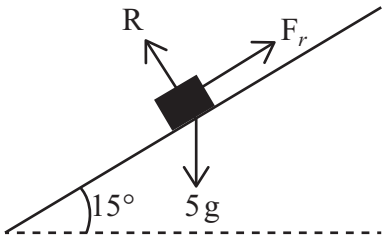
$F_r = 20 - 5g\sin 15° = 7.059\,\text{N}$

$F_r = 7.06\,\text{N}$ W1

(iv) $F_r = \mu R$

$\mu = \dfrac{7.059}{48.296} = 0.15$ M1W1

(v)



Accelerating force $= 5g\sin 15° - F_r$ M1M2

$= 5.88\,\text{N}$

Accelerating force = mass $\times$ acceleration

$5.88 = 5a$ M1

$a = 1.18\ \text{m/s}^2$ W1 12

AVAILABLE MARKS

AVAILABLE MARKS

12 (i)

Ranks (First piece)	7	2	5	3	1	10	4	9	8	6
Ranks (Second piece)	7.5	5	7.5	6	1	9	3.5	10	3.5	2

MW1 MW1

or

Ranks (First piece)	4	9	6	8	10	1	7	2	3	5
Ranks (Second piece)	3.5	6	3.5	5	10	2	7.5	1	7.5	9

(ii)

d^2	0.25	9	6.25	9	0	1	0.25	1	20.25	16

M1W1

$$r = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

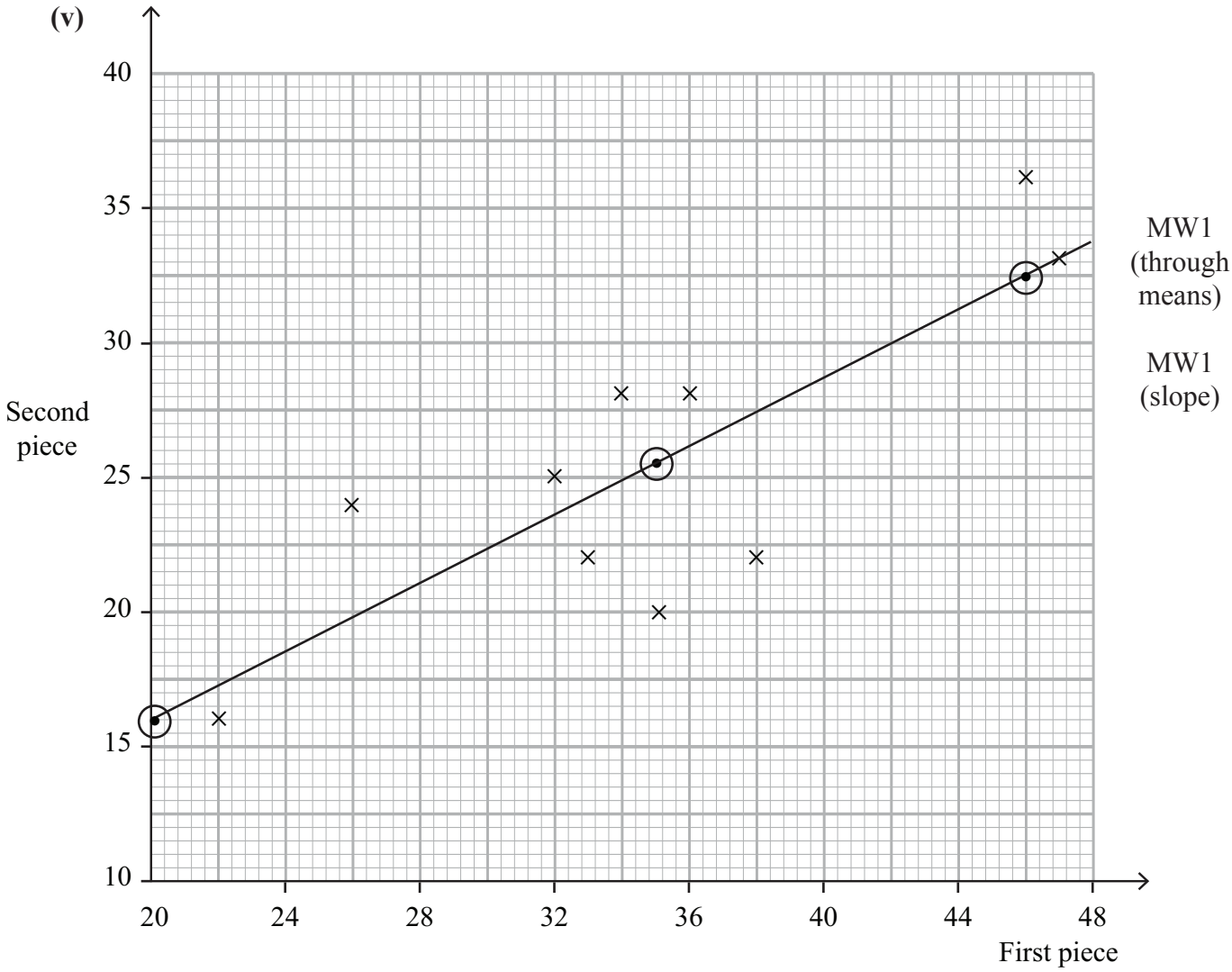
$$= 1 - \frac{6(63)}{10(99)} = 0.62$$ M1W1

(iii) Positive correlation M1

(iv) First piece: mean $= \frac{349}{10} = 34.9$

Second piece: mean $= \frac{254}{10} = 25.4$ MW1

(v)



			AVAILABLE MARKS
(vi)	Gradient $= \frac{32.5 - 16.0}{46 - 20} = 0.63$	MW1	
	Using means		
	$25.4 = 0.63(34.9) + c$		
	$\therefore\ c = 3.41$	MW1	
	So equation is		
	$y = 0.63x + 3.41$	MW1	13
		Total	**100**