



**General Certificate of Secondary Education
2018**

Further Mathematics

**Unit 2 (With calculator)
Mechanics and Statistics**

[GMF21]

TUESDAY 19 JUNE, MORNING

**MARK
SCHEME**

GCSE Further Mathematics

Introduction

The mark scheme normally provides the most popular solution to each question. Other solutions given by candidates are evaluated and credit given as appropriate; these alternative methods are not usually illustrated in the published mark scheme.

The marks awarded for each question are shown in the right hand column and they are prefixed by the letters **M**, **W** and **MW** as appropriate. The key to the mark scheme is given below:

M indicates marks for correct method.

W indicates marks for accurate working, whether in calculation, reading from tables, graphs or answers.

MW indicates marks for combined method and accurate working.

A later part of a question may require a candidate to use an answer obtained from an earlier part of the same question. A candidate who gets the wrong answer to the earlier part and goes on to the later part is naturally unaware that the wrong data is being used and is actually undertaking the solution of a parallel problem from the point at which the error occurred. If such a candidate continues to apply correct method, then the candidate's individual working must be **followed through** from the error. If no further errors are made, then the candidate is penalised only for the initial error. Solutions containing two or more working or transcription errors are treated in the same way. This process is usually referred to as "follow-through marking" and allows a candidate to gain credit for that part of a solution which follows a working or transcription error.

It should be noted that where an error trivialises a question, or changes the nature of the skills being tested, then as a general rule, it would be the case that not more than half the marks for that question or part of that question would be awarded; in some cases the error may be such that no marks would be awarded.

Positive marking:

It is our intention to reward candidates for any demonstration of relevant knowledge, skills or understanding. For this reason we adopt a policy of **following through** their answers, that is, having penalised a candidate for an error, we mark the succeeding parts of the question using the candidate's value or answers and award marks accordingly.

Some common examples of this occur in the following cases:

- (a) a numerical error in one entry in a table of values might lead to several answers being incorrect, but these might not be essentially separate errors;
- (b) readings taken from candidates' inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

When the candidate misreads a question in such a way as to make the question easier, only a proportion of the marks will be available (based on the professional judgement of the examiner).

1 (i) From the **i** components

$$p + 3 - 5 = 0$$

$$p = 2$$

MW1

From the **j** components

$$-5 + q - 3 = 0$$

$$q = 8$$

MW1

(ii) $\mathbf{F} = ma$

$$= 6(3\mathbf{i} - 2\mathbf{j})$$

MW1

$$= 18\mathbf{i} - 12\mathbf{j}$$

W1

$$\text{magnitude of } \mathbf{F} = \sqrt{18^2 + (-12)^2}$$

$$= 21.63 \text{ N}$$

MW1

(iii) angle = $\tan^{-1}\left(\frac{2}{3}\right)$

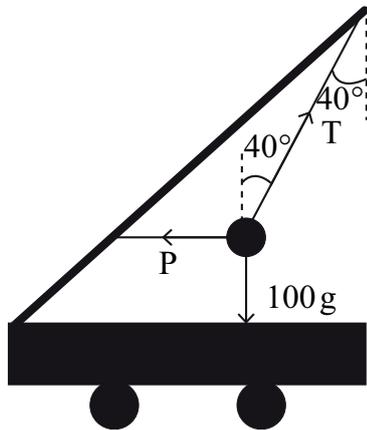
MW1

$$= 33.69^\circ$$

W1

AVAILABLE MARKS
7

2



(i) Resolving vertically

$$T \cos 40^\circ = 100 \text{ g}$$

MW1

$$T = \frac{100 \text{ g}}{\cos 40^\circ} = 1305.407$$

$$\rightarrow 1305.41 \text{ N}$$

W1

(ii) Resolving horizontally

$$P = T \sin 40^\circ$$

MW1

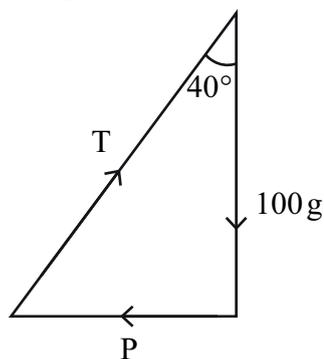
$$= 1305.407 \sin 40^\circ$$

$$= 839.10$$

W1

Alternative solution

(i) using the triangle of forces



$$\frac{100 \text{ g}}{T} = \cos 40^\circ$$

MW1

$$T = \frac{100 \text{ g}}{\cos 40^\circ} = 1305.41 \text{ N}$$

W1

$$(ii) \frac{P}{100 \text{ g}} = \tan 40^\circ \text{ or } P^2 = T^2 - 1000^2$$

MW1

$$P = 100 \text{ g} \tan 40^\circ = 839.10 \text{ or } P = \sqrt{1305.407^2 - 1000^2} = 839.10$$

W1

AVAILABLE
MARKS

4

3 (i) $u = 0, v = 6, t = 12$

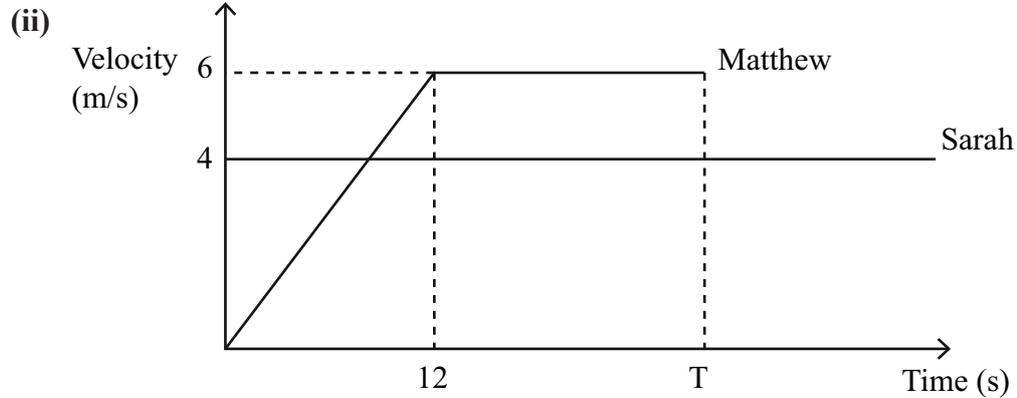
$$v = u + at$$

$$6 = 0 + 12a$$

$$a = \frac{1}{2} \text{ or } 0.5 \text{ m/s}^2$$

MW1

W1



M1 (shape)

W1 (values)

(iii) Distance for Sarah = $4T$

MW1

$$\text{Distance for Matthew} = \frac{1}{2} (T + T - 12)6 = 6T - 36$$

MW1

$$4T = 6T - 36$$

M1

$$36 = 2T$$

$$T = 18 \text{ s}$$

W1

(iv) For final 10 seconds

$$\text{Sarah's distance} = 4 \times 10 = 40 \text{ m}$$

MW1

$$\text{Matthew's distance} = \frac{1}{2} \times 10 \times 6 = 30 \text{ m}$$

MW1

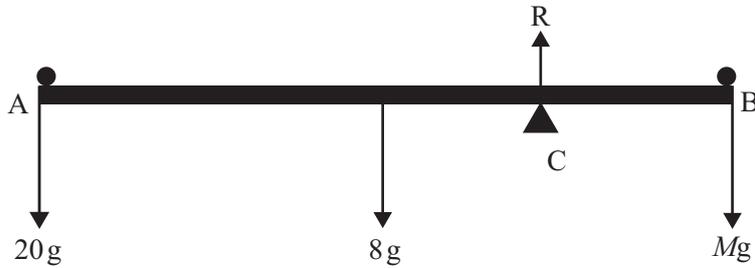
Sarah is in the lead by 10 m

MW1

AVAILABLE
MARKS

11

4 (i)



MW1 (any 2 forces)

MW1 (other 2 forces)

(ii) Taking moments about C:

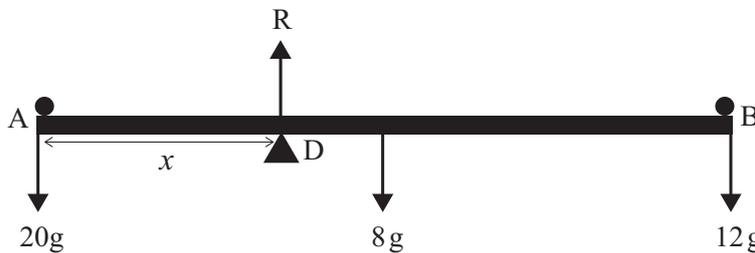
$$Mg \times 4 = 8g \times 1 + 20g \times 6$$

M1, W1

$$40M = 1280$$

$$M = 32$$

W1

(iii) $R = 20g + 8g + 12g$
 $= 40g$ or 400 N

MW1

(iv) Taking moments about A:

$$40g x = 8g \times 5 + 12g \times 10$$

M1, W1

$$400x = 1600$$

$$x = 4\text{ m}$$

W1

Alternative solutions for (iv)

(a) Taking moments about B:

$$20g \times 10 + 8g \times 5 = 40g (10 - x)$$

M1, W1

$$x = 4$$

W1

(b) Taking moments about D:

$$20g x = 8g (5 - x) + 12g (10 - x)$$

M1, W1

$$x = 4$$

W1

(c) Taking moments about centre of rod:

$$20g \times 5 = 40g (5 - x) + 12g \times 5$$

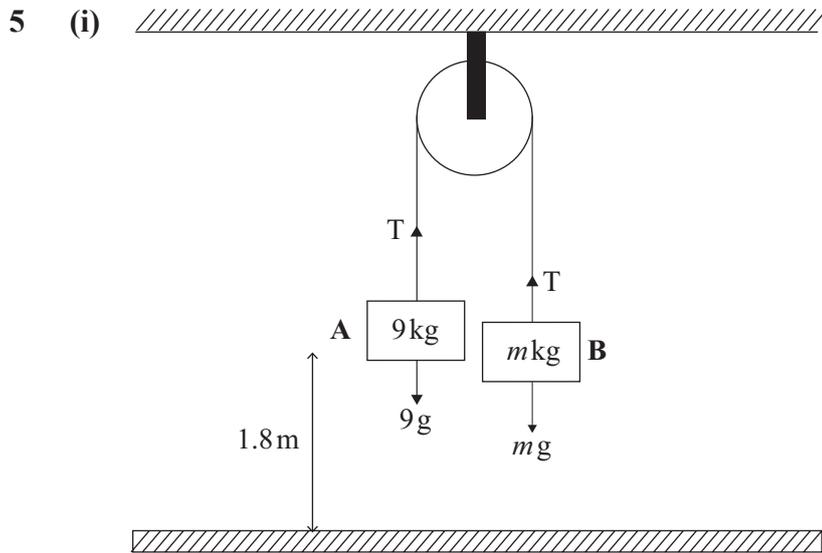
M1, W1

$$x = 4$$

W1

AVAILABLE
MARKS

9



MW1 (forces on A)

MW1 (forces on B)

(ii) $s = 1.8$, $u = 0$, $t = 1.5$

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

$$1.8 = \frac{1}{2} \times a \times 1.5^2$$

MW1

$$a = \frac{2 \times 1.8}{1.5^2}$$

W1

$$a = 1.6 \text{ m/s}^2$$

(iii) For block A

$$9g - T = 9 \times 1.6$$

MW1

$$T = 90 - 14.4 = 75.6 \text{ N}$$

W1

(iv) For block B

$$T - mg = m \times 1.6$$

$$75.6 - 10m = 1.6m$$

MW1

$$75.6 = 11.6m$$

$$m = 6.52$$

W1

(v) Force on pulley = 2T

$$= 151.2 \text{ N}$$

MW1

AVAILABLE
MARKS

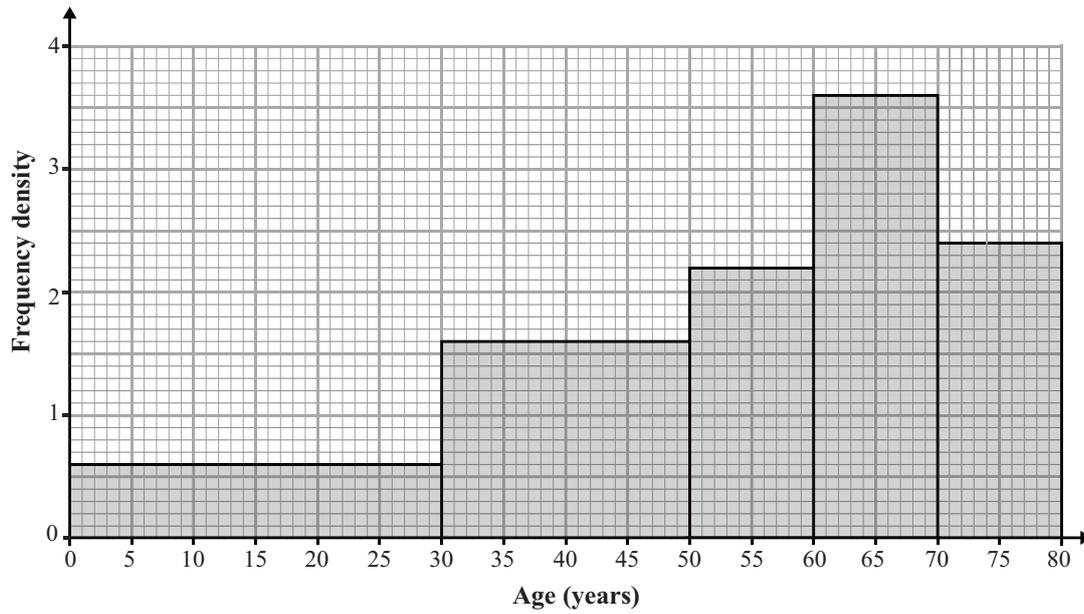
9

			AVAILABLE MARKS
6 (i) Between A and B			
$u = 1.2, v = 2.8, s = 1.6$			
$v^2 = u^2 + 2as$			
$2.8^2 = 1.2^2 + 2 \times a \times 1.6$		MW1	
$a = \frac{6.4}{3.2} = 2 \text{ m/s}^2$		W1	
(ii) Resolving horizontally			
$45 \cos 30^\circ - F_r = 12 \times 2$		MW1, MW1	
$45 \cos 30^\circ - 24 = F_r$			
$F_r = 14.971 \rightarrow 14.97 \text{ N}$		W1	
(iii) Resolving vertically			
$45 \sin 30^\circ + R = 12g$		MW1, MW1	
$R = 12g - 45 \sin 30^\circ$			
$= 97.5 \text{ N}$		W1	
$F_r = \mu R$			
$14.971 = 97.5 \mu$		MW1	
$\mu = 0.15$		W1	10
7 Estimate of median			
$= 30.5 + \frac{(25 - 18) \times 10}{16}$		M1 (30.5 + ...) MW1 (25 - 18) MW1 ($\frac{10}{16}$)	
$= 34.875 \text{ minutes}$		W1	4

8 Frequency densities are

$$\frac{18}{30} = 0.6, \quad \frac{32}{20} = 1.6, \quad \frac{22}{10} = 2.2, \quad \frac{36}{10} = 3.6, \quad \frac{24}{10} = 2.4$$

M1, W1



MW1 (heights)
 MW1 (boundaries)
 W1 (labels)

AVAILABLE
MARKS

5

9 (i)

Ranks (Length)	1	8	3	4	9	6	7	2	5
Ranks (Weight)	1	9	2	6	8	6	6	3	4

or

Ranks (Length)	9	2	7	6	1	4	3	8	5
Ranks (Weight)	9	1	8	4	2	4	4	7	6

MW1
MW1

AVAILABLE
MARKS

(ii)

d^2	0	1	1	4	1	0	1	1	1
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M1 W1

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

$$= 1 - \frac{6 \times 10}{9 \times 80}$$

$$= 0.92$$

M1

W1

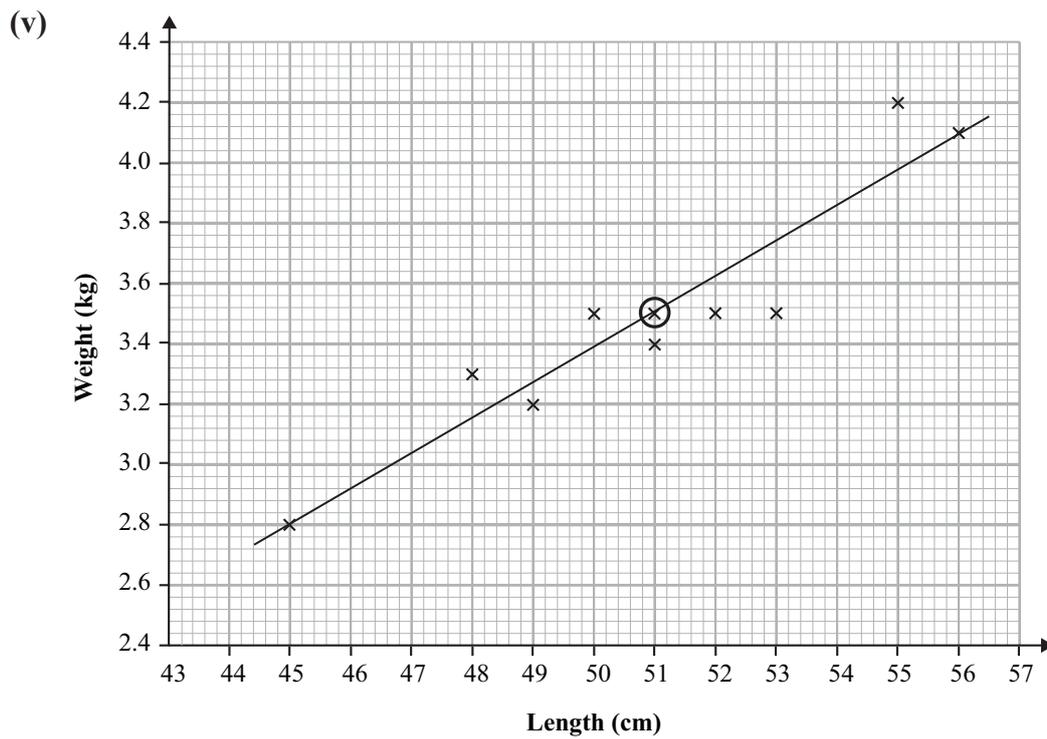
(iii) (Strong) positive correlation

M1

(iv) mean length = $\frac{459}{9} = 51$ cm

mean weight = $\frac{31.5}{9} = 3.5$ kg

MW1



M1 (through means)

W1 (slope)

$$(vi) \text{ Gradient} = \frac{3.5 - 2.8}{51 - 45} = \frac{7}{60} (= 0.11\dot{6})$$

M1

AVAILABLE
MARKS

Using means

$$3.5 = \frac{7}{60} \times 51 + c$$

$$c = -\frac{49}{20} (= -2.45)$$

M1

Equation is

$$y = \frac{7}{60}x - \frac{49}{20} \quad \text{or} \quad y = 0.12x - 2.45$$

MW1

13

$$10 \quad (i) \quad \text{mean} = \frac{78 \times 8 + 82 \times 12}{20}$$

$$= 80.4$$

MW1

W1

(ii) For the girls

$$6^2 = \frac{\sum g^2}{8} - 78^2$$

$$\sum g^2 = 48960$$

MW1

For the boys

$$12^2 = \frac{\sum b^2}{12} - 82^2$$

$$\sum b^2 = 82416$$

MW1

For all pupils

$$s^2 = \frac{(48960 + 82416)}{20} - 80.4^2$$

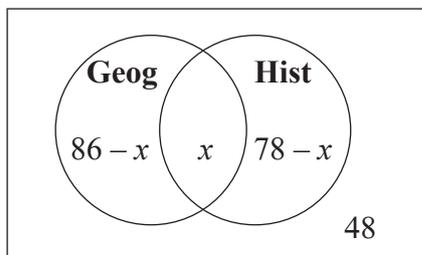
M1

$$s = 10.23$$

W1

6

11 (i)



$$86 + 78 - x = 180 - 48$$

$$[\text{or } (86 - x) + x + (78 - x) + 48 = 180]$$

$$x = 32$$

MW1

$$P(\text{Geog and Hist}) = \frac{32}{180} = \frac{8}{45} (= 0.18)$$

MW1

Alternative solution

$$P(\text{Hist or Geog}) = P(\text{Hist}) + P(\text{Geog}) - P(\text{Geog and Hist})$$

$$\frac{180 - 48}{180} = \frac{78}{180} + \frac{86}{180} - P(\text{Geog and Hist})$$

MW1

$$P(\text{Geog and Hist}) = \frac{78}{180} + \frac{86}{180} - \frac{132}{180} = \frac{32}{180} = \frac{8}{45} (= 0.18)$$

W1

$$(ii) P(\text{Hist}|\text{Geog}) = \frac{P(\text{Hist and Geog})}{P(\text{Geog})}$$

$$= \frac{\frac{8}{45}}{\frac{86}{180}}$$

MW1

$$= \frac{8}{45} \times \frac{180}{86}$$

$$= \frac{32}{86} = \frac{16}{43} (= 0.37)$$

W1

Alternative solution

Number who chose Geography = 86

Number who chose History as well = $x = 32$

MW1

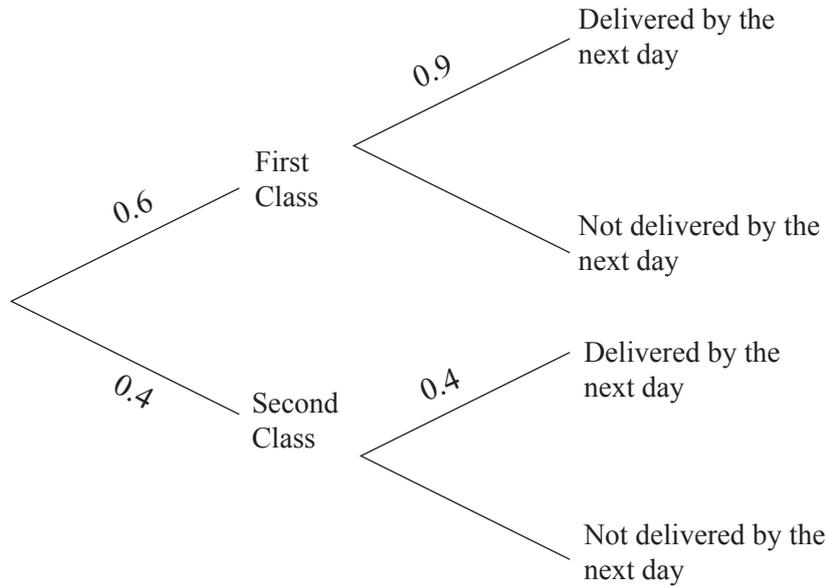
$$\text{So } P(\text{HistGeog}) = \frac{32}{86} = \frac{16}{43} (= 0.37)$$

W1

AVAILABLE
MARKS

4

12



(i) $P(\text{Delivered by the next day}) = 0.6 \times 0.9 + 0.4 \times 0.4$ M1

$= 0.7$ W1

(ii) $20 \times 0.7 = 14$ letters MW1, W1

(iii) $P(\text{First}|\text{Delivered by the next day})$

$= \frac{P(\text{First and delivered by the next day})}{P(\text{Delivered by the next day})}$

$= \frac{0.6 \times 0.9}{0.7}$ MW1 (numerator)
M1 (denominator)

$= \frac{27}{35}$ or 0.77 W1

(iv) $(0.7 \times 0.3 \times 0.3) + (0.3 \times 0.7 \times 0.3) + (0.3 \times 0.3 \times 0.7)$ M1

$= 0.189$ W1

AVAILABLE
MARKS

9

13 (a) mean = $(33.4 + 5) \times 1.5 = 57.6$

Standard deviation = $2.6 \times 1.5 = 3.9$

(b) Let x = number of matches in which 4 goals were scored

$$\begin{aligned} \text{mean (Season 1)} &= \frac{(3 \times 1) + (4 \times 2) + (7 \times 3) + (x \times 4)}{17 + x} \\ &= \frac{32 + 4x}{17 + x} \end{aligned}$$

$$\text{mean (Season 2)} = \frac{(6 \times 2) + (3 \times 3) + (x \times 4)}{12 + x} = \frac{21 + 4x}{12 + x}$$

$$\frac{32 + 4x}{17 + x} = \frac{21 + 4x}{12 + x}$$

$$(32 + 4x)(12 + x) = (21 + 4x)(17 + x)$$

$$384 + 80x + 4x^2 = 357 + 89x + 4x^2$$

$$9x = 27$$

$$x = 3$$

MW1

AVAILABLE
MARKS

MW1

MW1

MW1

MW1

MW1

M1

M1

W1

9

Total**100**