Rewarding Learning

General Certificate of Secondary Education
2016

Further Mathematics

Unit 2
Mechanics and Statistics

[GMF21]

THURSDAY 23 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 regard 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).

			AVAILABLE MARKS
1	**(a)** CD	MW1	
	(b) **(i)** Speed $= \frac{60}{30} = 2$ m/s	MW1	
	(ii) Distance remains constant, so speed = 0 m/s	MW1	
	(iii) Distance travelled = 60 m + 20 m = 80 m	MW1	4
2	**(i)** $v = u + at$		
	$(-4\mathbf{i} - \mathbf{j}) = (4\mathbf{i} + 5\mathbf{j}) + 4a$	MW1	
	$4a = -8\mathbf{i} - 6\mathbf{j}$		
	$a = (-2\mathbf{i} - 1.5\mathbf{j})$ m/s^2	W1	
	(ii) $s = ut + \frac{1}{2}at^2$		
	$= (4\mathbf{i} + 5\mathbf{j})\,4 + \frac{1}{2}(-2\mathbf{i} - 1.5\mathbf{j})16$	MW1	
	$= 16\mathbf{i} + 20\mathbf{j} - 16\mathbf{i} - 12\mathbf{j}$		
	$= 8\mathbf{j}$ m	W1	4
	Alternative solution		
	$s = \frac{1}{2}(u + v)t$		
	$= \frac{1}{2}\left[(4\mathbf{i} + 5\mathbf{j}) + (-4\mathbf{i} - \mathbf{j})\right]4$	MW1	
	$= \frac{1}{2}(4\mathbf{j})\,4$		
	$= 8\mathbf{j}$ m	W1	

3 **(i)** $v = u + at$

$12 = u + 3a \quad (1)$ MW1

$16 = u + 8a \quad (2)$ MW1

(ii) $(2) - (1) \rightarrow \quad 5a = 4$

$a = 0.8$ MW1

(iii) $12 = u + 3(0.8)$ or $16 = u + 8(0.8)$

$u = 9.6$ MW1

(iv) $s = \frac{1}{2}(u + v)t$

Distance AB $= \frac{1}{2}(12 + 16)5$ MW1

$= 70\,\text{m}$ W1 6

Alternative solution 1

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

Distance AB $= 12(5) + \frac{1}{2}(0.8)(5)^2$ MW1

$= 70\,\text{m}$ W1

Alternative solution 2

at A: $s = \frac{1}{2}(9.6 + 12)3$

$= 32.4\,\text{m}$

at B: $s = \frac{1}{2}(9.6 + 16)8$

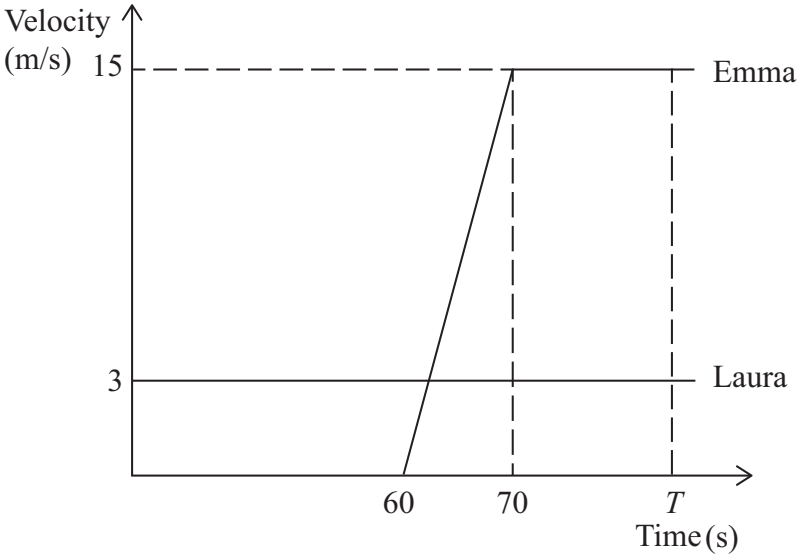
$= 102.4\,\text{m}$ MW1

Distance AB $= 102.4 - 32.4$

$= 70\,\text{m}$ MW1

AVAILABLE MARKS

4 **(i)**



MW1 (for 60–70)

MW1 (for 70–T)

(ii) Distance for Laura = $3T$ MW1

(iii) Distance for Emma $= \frac{1}{2}(15)(10) + 15(T - 70)$ MW1

$= 75 + 15T - 1050$

$= 15T - 975$ W1

Alternative solution

Distance for Emma $= \frac{1}{2}(T - 60 + T - 70)15$ MW1

$= 15T - 975$ W1

(iv) So $3T = 15T - 975$ M1

$12T = 975$

$T = 81.25$ s

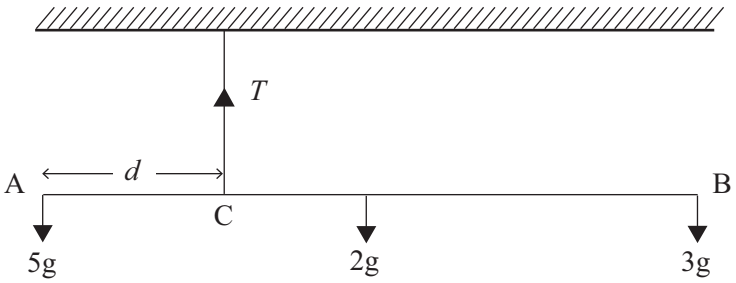
So time to catch up $= 81.25 - 60$

$= 21.25$ s MW1 7

AVAILABLE MARKS

AVAILABLE MARKS

5 **(i)**



MW2

[MW1 for 2 forces correct
MW2 for all forces correct]

(ii) Resolve vertically:

$T = 5g + 2g + 3g$

$= 10g = 100N$ MW1

(iii) Take moments about A:

$10gd = 2g \times 3 + 3g \times 6$ MW1, MW1

$10d = 24$

$d = 2.4\,m$ W1

Alternative solution

Take moments about C:

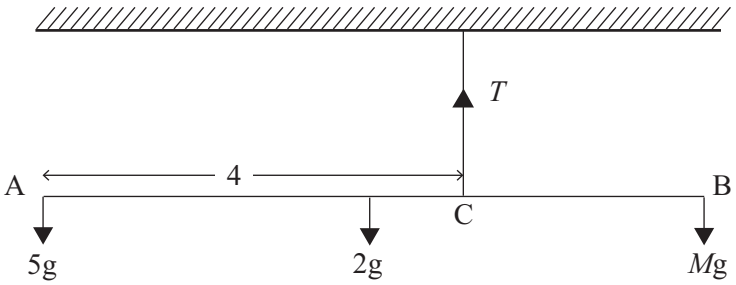
$5gd = 2g\,(3 - d) + 3g\,(6 - d)$ MW1, MW1

$5d = 6 - 2d + 18 - 3d$

$10d = 24$

$d = 2.4\,m$ W1

(iv)



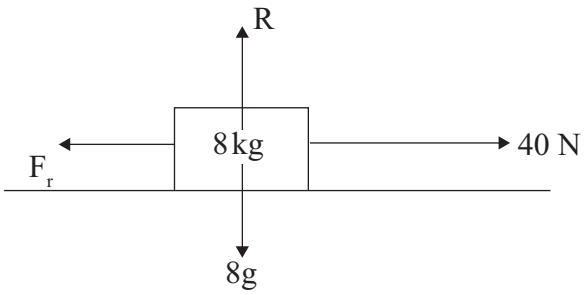
Take moments about C:

$5g \times 4 + 2g \times 1 = Mg \times 2$ MW1, MW1

$22 = 2M$

$M = 11$ W1 9

6 (i)



MW1

(ii) Resolve vertically: R = 8g = 80 N
Resolve horizontally: $F_r = 40$ N

$F_r = \mu R$
$40 = 80\mu$ MW1
$\mu = 0.5$ W1

(iii) Resolve vertically:
$50 \sin 40° + R = 8g$ MW1

$R = 80 - 50 \sin 40°$
$= 47.861\text{ N} \rightarrow 47.86\text{ N}$ W1

(iv) Resolve horizontally:
$50 \cos 40° - F_r = 8a$ MW1, MW1

$F_r = \mu R = 0.5 \times 47.861$
$= 23.931$ MW1

$8a = 50 \cos 40° - 23.931$

$a = 1.796\text{ m/s}^2 \rightarrow 1.80\text{ m/s}^2$ W1 9

AVAILABLE MARKS

				AVAILABLE MARKS
7	**(i)**	Total resistance = 1200 × 1.6 + 500 × 0.7	M1	
		= 2270 N	W1	
	(ii)	Forward force – total resistance = total mass × acceleration		
		$5330 - 2270 = 1700\,a$	MW1	
		$a = 1.8$ m/s^2	W1	
	(iii)	Forces on trailer:		
		$T - 500 \times 0.7 = 500 \times 1.8$	MW1	
		$T = 1250$ N	W1	
		Alternative solution Forces on car:		
		$5330 - 1200 \times 1.6 - T = 1200 \times 1.8$	MW1	
		$T = 1250$ N	W1	
	(iv)	$v = u + at$		
		$v = 0 + 1.8 \times 10$		
		= 18 m/s^2	MW1	
	(v)	Acceleration of trailer		
		$0 - 500 \times 0.7 = 500a$	MW1	
		$a = -0.7$ m/s^2	W1	
		$v^2 = u^2 + 2as$		
		$0 = 18^2 + 2(-0.7)s$	MW1	
		$s = 231.43$ m	W1	11
8	**(i)**	$\frac{50}{2} = 25$	M1	
		So median class = 11.4 – 12.3	MW1	
	(ii)	Modal class is 10.4 – 11.3	M1	
		Boundaries are 10.35 – 11.35	MW1	
	(iii)	Class width = e.g. 11.35 – 10.35 = 1 cm	MW1	5

9 **(i)** median class is $3.0 < M \leqslant 3.8$ M1

$$\text{median} = 3.0 + \frac{(18.5 - 14) \times 0.8}{7}$$ M1 for 3.0+(...)
MW1 (18.5 – 14)
MW1 $\left(\frac{0.8}{7}\right)$

$$= 3\frac{18}{35} = 3.51\,\text{kg}$$ W1

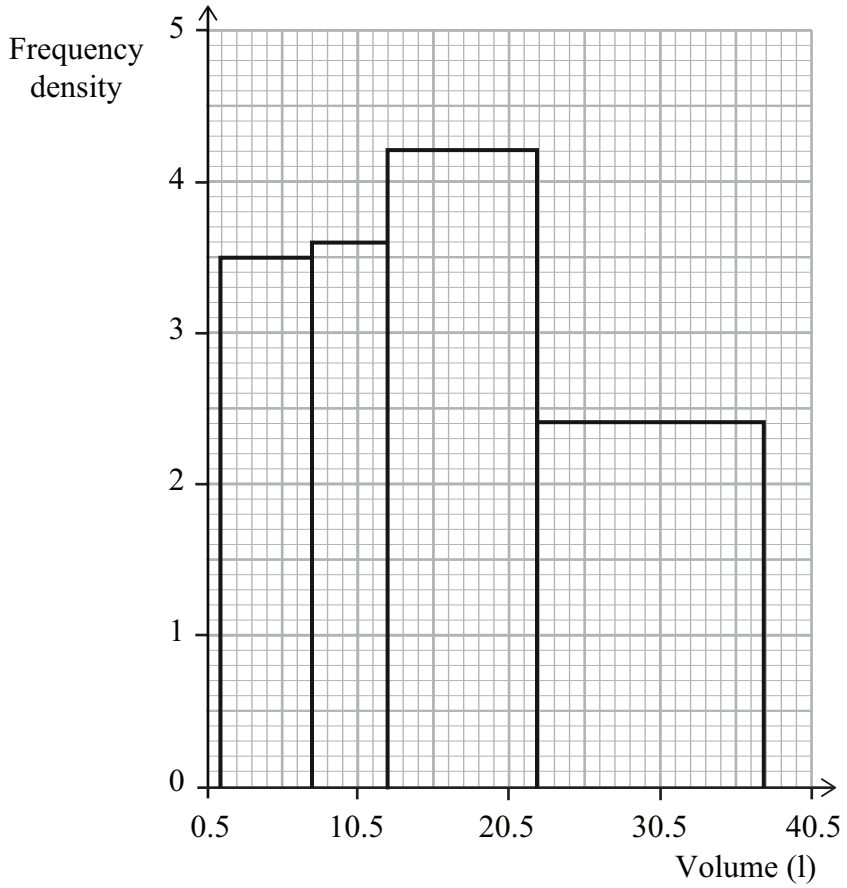
(ii) We don't know what the exact masses are,
so D M1 5

10 **(i)** Frequency = (7.5 – 1.5) × 3.5 = 21 M1, W1

(ii)

Volume (l)	8–12	13–22	23–37
Frequency	18	42	36
Frequency density	3.6	4.2	2.4

M1, W1



MW1 (boundaries)
MW1 (heights) 6

AVAILABLE MARKS

11 (i)

	Actual marks	Uniform marks
Mean	31	72
Standard deviation	4.6	9.2

MW1
MW1

(ii) Total marks for 5 candidates = 31 × 5 = 155

Total marks for 6 candidates = 155 + 43 = 198 MW1

$$\text{mean} = \frac{198}{6} = 33$$ W1

4

12 (i)

Ranks (Average speed)	2	3	8	6	5	9	1	4	7
Ranks (Time)	8	5	6	4	3	1	8	8	2

MW1
MW1

Alternative solution

Ranks (Average speed)	8	7	2	4	5	1	9	6	3
Ranks (Time)	2	5	4	6	7	9	2	2	8

MW1
MW1

d^2	36	4	4	4	4	64	49	16	25

M1, W1

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

$$= 1 - \frac{6(206)}{9(80)}$$ MW1

$$= -\frac{43}{60} = -0.72$$ W1

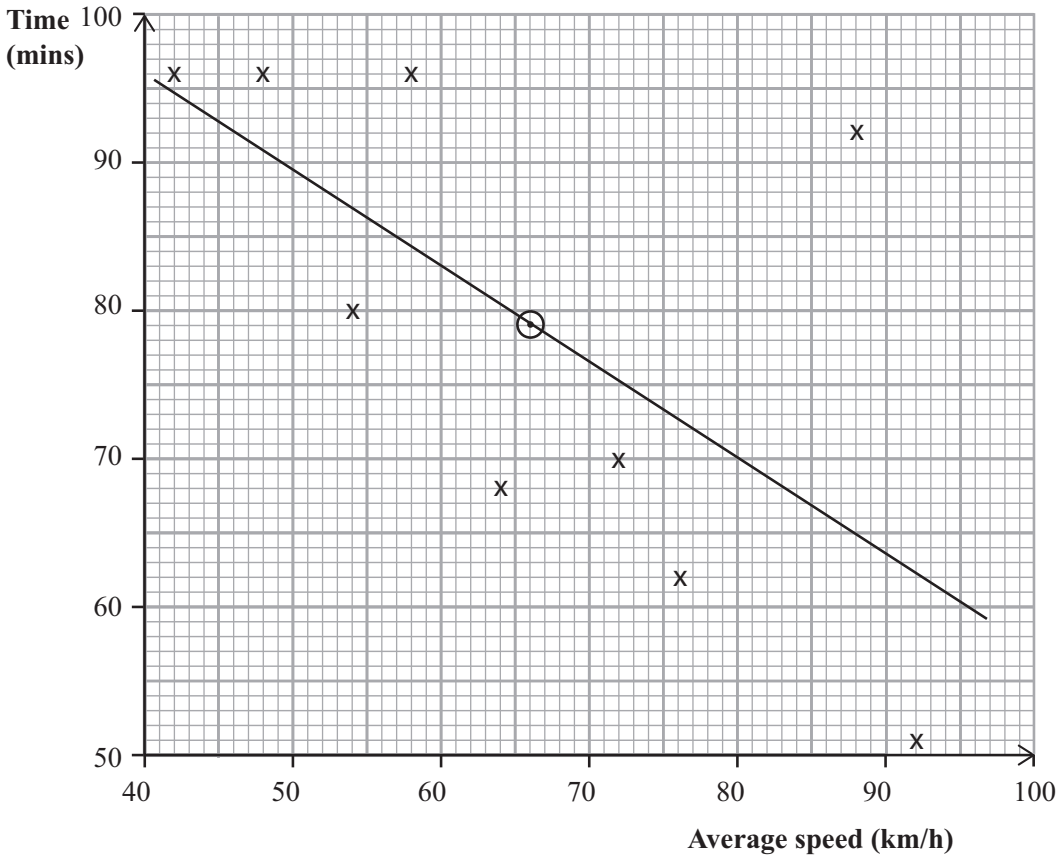
(ii) Negative correlation M1

(iii) mean of average speeds $= \frac{594}{9} = 66$ km/h

mean of times $= \frac{711}{9} = 79$ mins MW1

AVAILABLE MARKS

(iv)

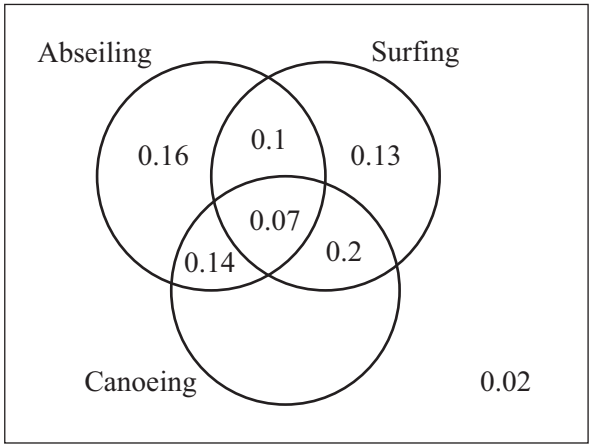


MW1 (through means)
MW1 (slope)

AVAILABLE MARKS

(v) Frank – he has to travel much further to work than the rest. M1 11

13 (i)



MW1 (0.07)

MW1 (0.1, 0.14, 0.2)

MW1 (0.16, 0.13, 0.02)

(ii) $1 - (0.16 + 0.1 + 0.14 + 0.07 + 0.13 + 0.2 + 0.02)$ M1

$= 1 - 0.82 = 0.18$ W1

(iii) P(not abseiling) = 0.13 + 0.2 + 0.18 + 0.02

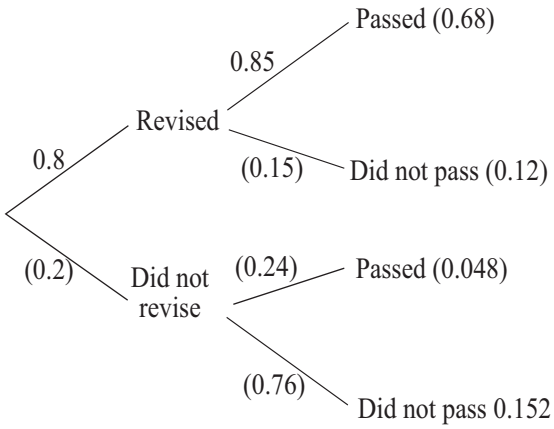
$= 0.53$

P(surfing and not abseiling) = 0.13 + 0.2

$= 0.33$ MW1

P(surfing|not abseiling) $= \frac{0.33}{0.53} = 0.62$ MW1 7

14



(i) $P = 0.8 \times 0.85 = 0.68$ MW1

(ii) $0.2\ p = 0.152$ MW1

$p = 0.76$ W1

(iii) P (Did not revise and passed) $= 0.2 \times 0.24 = 0.048$ MW1

P (passed) = 0.68 + 0.048 = 0.728 MW1

No. of candidates passed $= 125 \times 0.728 = 91$ MW1 6

AVAILABLE MARKS

			AVAILABLE MARKS
15	**(i)** $P(\text{shop}\mid\text{granny}) = \dfrac{P(\text{shop and granny})}{P(\text{granny})}$		
	$0.4 = \dfrac{P(\text{shop and granny})}{0.55}$	M1	
	So $P(\text{shop and granny}) = 0.4 \times 0.55 = 0.22$	W1	
	(ii) $P(\text{granny}\mid\text{shop}) = \dfrac{P(\text{shop and granny})}{P(\text{shop})}$		
	$0.88 = \dfrac{0.22}{P(\text{shop})}$	M1	
	$P(\text{shop}) = \dfrac{0.22}{0.88} = 0.25$	W1	
	(iii) P (shop or granny) = P (shop) + P (granny) – P (shop and granny)		
	$= 0.25 + 0.55 - 0.22$	M1	
	$= 0.58$	W1	6
		Total	**100**