Rewarding Learning

General Certificate of Secondary Education
January 2015

Further Mathematics

Unit 2

Mechanics and Statistics

[GMF21]

MONDAY 19 JANUARY, 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).

Section A

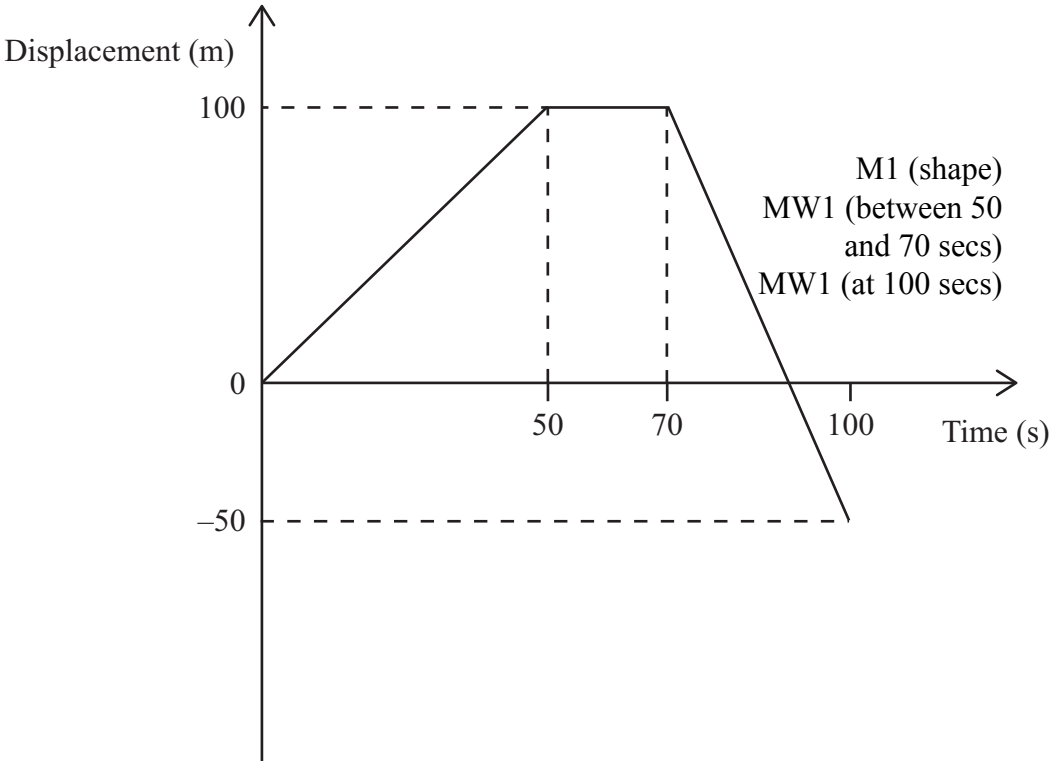
Mechanics

AVAILABLE MARKS

1 **(i)** Speed $= \sqrt{4^2 + (-3)^2} = 5\,\text{m/s}$ M1 W1

(ii) Position vector $= (2\mathbf{i} + \mathbf{j}) + 5(4\mathbf{i} - 3\mathbf{j})$ M1 M1
$= (22\mathbf{i} - 14\mathbf{j})\text{m}$ W1 5

2 **(i)**



(ii) Total distance $= 2 \times 50 + 5 \times 30$
$= 250\,\text{m}$ MW1

(iii) Starts running at 70 s

Reaches starting point after $\frac{100}{5} = 20\,\text{s}$ MW1

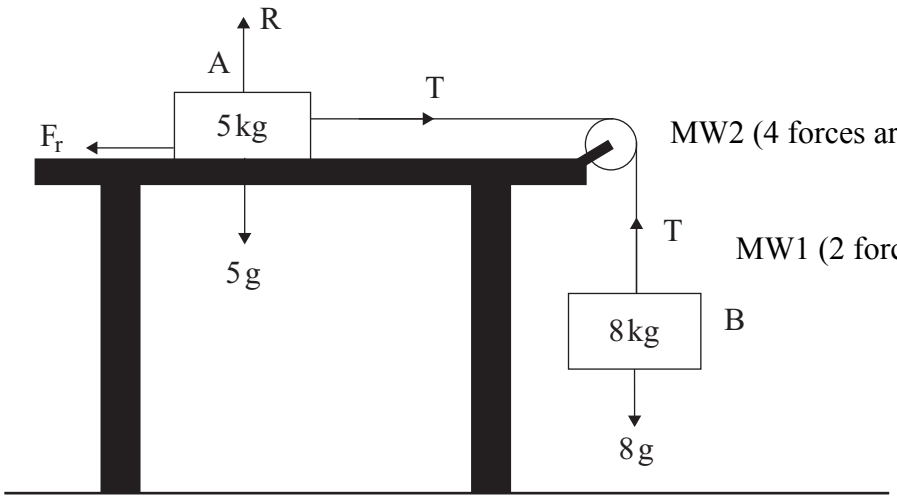
$\therefore$ Time to arrive back at starting point

$= 70\,\text{s} + 20\,\text{s} = 90\,\text{s}$ MW1 6

		AVAILABLE MARKS
3	**(i)** $u = 45, v = 55, t = \frac{1}{2}$	
	$v = u + at$	
	$55 = 45 + \frac{1}{2}a$ M1	
	$a = 20\,\text{km/h}^2$ W1	
	(ii) $s = \frac{1}{2}(u + v)t$	
	$= \frac{1}{2}(45 + 55)\frac{1}{2}$ M1	
	$= 25\,\text{km}$ W1	
	Alternative solution	
	$s = ut + \frac{1}{2}at^2$	
	$= 45 \times \frac{1}{2} + \frac{1}{2} \times 20 \times \frac{1}{4}$ M1	
	$= \frac{45}{2} + \frac{5}{2} = 25\,\text{km}$ W1	
	(iii) $u = 55, v = 0, s = 11$	
	$v^2 = u^2 + 2as$	
	$0 = 55^2 + 2a \times 11$ M1	
	$22a = -3025$	
	$a = -137.5\,\text{km/h}^2$	
	So deceleration $= 137.5\,\text{km/h}^2$ W1	
	(iv) $s = \frac{1}{2}(u + v)t$	
	$11 = \frac{1}{2}(55 + 0)t$ M1	
	$t = 0.4\,\text{h}$	
	$t = 24$ minutes W1	8
	Alternative solution	
	$v = u + at$	
	$0 = 55 - 137.5\,t$ M1	
	$t = 0.4$ h	
	$t = 24$ minutes W1	

AVAILABLE MARKS

4 **(i)**



MW2 (4 forces around A)

MW1 (2 forces at B)

(ii) $s = 1.6, u = 0, t = 0.8$

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

$1.6 = \frac{1}{2} a \times 0.8^2$ MW1

$a = \frac{3.2}{0.64} = 5\,\text{m/s}^2$ W1

(iii) At block B

$8\,g - T = 8a$ MW1

$80 - 40 = T$

$T = 40\,N$ W1

(iv) At block A

Resolve vertically:

$R = 5\,g = 50\,N$ MW1

Resolve horizontally

$T - F_r = 5a$

$F_r = 40 - 25$

$F_r = 15\,N$ MW1

$F_r = \mu R$

$\mu = \frac{15}{50} = 0.3$ MW1 10

AVAILABLE MARKS

5 **(i)**

Take moments about C:

$15\,g \times 1 = 2.5 \times R_D$ MW1

$R_D = \frac{150}{2.5} = 60\,N$ W1

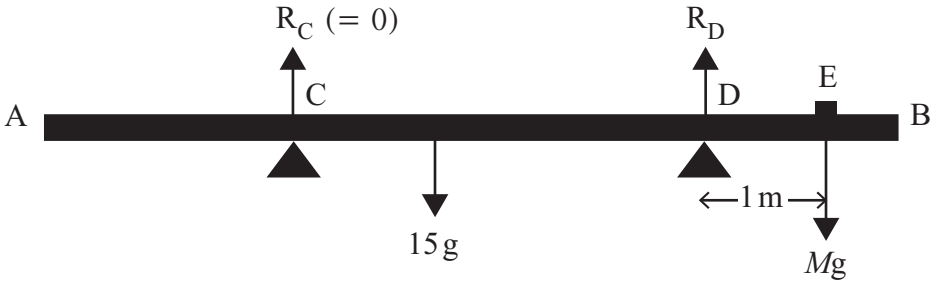
(ii) Resolve vertically:

$R_C + R_D = 15g$

$R_C = 150 - 60 = 90\,N$ MW1

(iii) When on point of tilting, $R_C = 0\,N$ M1

(iv)



Take moments about D:

$1.5 \times 15\,g = 1 \times Mg$ MW1

$M = 22.5$ W1

(v)

Take moments about C:

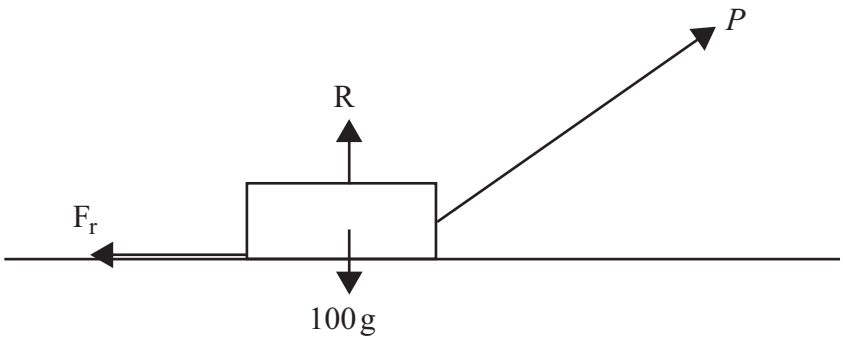
$15\,g \times 1 = 22.5\,g \times (2 - x)$ MW1 MW1

$150 = 450 - 225x$

$x = \frac{4}{3}$ MW1 9

		AVAILABLE MARKS

6 **(i)**



Resolve horizontally:

$F_r = P \cos 35°$

$= 500 \cos 35°$ MW1

$= 409.58\text{N} \rightarrow 410\text{N}$ W1

(ii) Resolve vertically:

$R + P \sin 35° = 100\,g$

$R = 1000 - 600 \sin 35°$ MW1

$= 655.85\text{N} \rightarrow 656\text{N}$ W1

(iii) Resolve horizontally:

$F_r = P \cos 35°$

$= 600 \cos 35°$

$= 491.49\text{N}$ MW1

$F_r = \mu R$

$\mu = \frac{F_r}{R} = \frac{491.49}{655.85}$ MW1

$= 0.749 \rightarrow 0.75$ W1

(iv) Resolve vertically:

$R + P \sin 35° = 100\,g$

$R = 1000 - 700 \sin 35°$ MW1

$= 598.496\text{N}$

$\rightarrow 598\text{N}$ (3 s.f.) W1

(v) Resolve horizontally and apply $F = ma$

$P \cos 35° - F_r = 100a$

$100a = 700 \cos 35° - 0.749 \times 598.5$ M1 W1

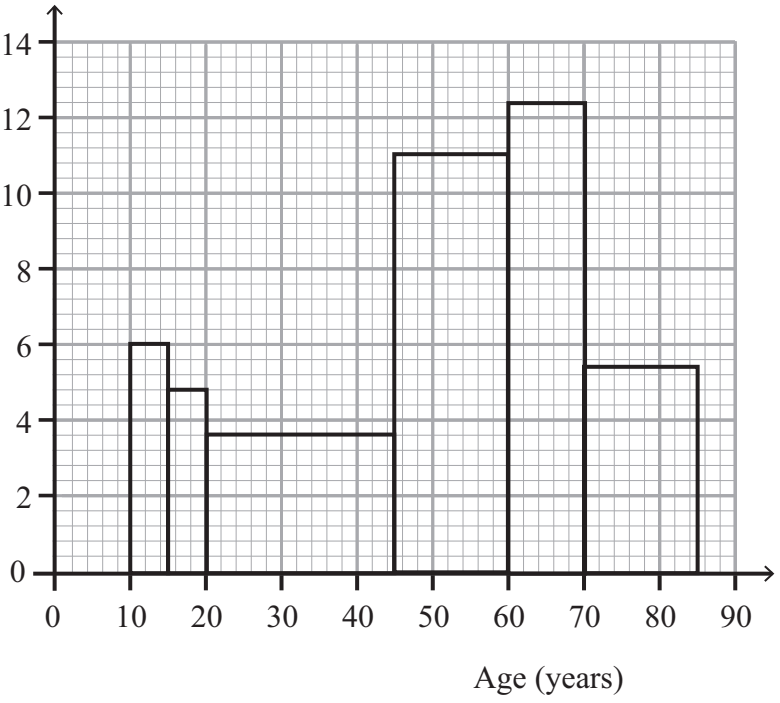
$a = 1.251$

$\rightarrow 1.25\,\text{m/s}^2$ W1 12

Section B

Statistics

			AVAILABLE MARKS
7	**(i)** The mean increases	M1	
	(ii) The standard deviation decreases	M1	2
8	Number of patients = 525		
	Median class is $3 < t \leqslant 4$	M1	
	$\text{Median} = 3 + \frac{\frac{525}{2} - 237}{202} \times 1$	M2	
	$= 3.13$ hours	W1	4
9	Frequency densities are		
	6 4.8 3.6 11 12.4 5.4	M1 W1	



MW1 (axes)
MW1 (widths)
MW1 (heights)

5

				AVAILABLE MARKS
10	**(i)**	Ratio of girls = 2 : 4 : 1		
		So number of girls = 16 : 32 : 8	MW1	
		Total number of musicians = 34 + 56 = 90	MW1	
		So P (girl in hotel) $= \frac{8}{90}$		
		$= \frac{4}{45}$	MW1	
	(ii)	Number who went to beach = 90 × 0.6 = 54	MW1	
		Number of boys = 54 – 32	M1	
		= 22	W1	
	(iii)	Number of boys sightseeing $= \frac{34 - 22}{2}$		
		= 6	MW1	
		P(both boys sightseeing) $= \frac{6}{90} \times \frac{5}{89}$	M1 MW1	
		$= \frac{1}{267}$	W1	10

AVAILABLE MARKS

11 **(i)**

Ranks (weeks)	3	1.5	7.5	9	1.5	6	4	10	5	7.5
Ranks (mass)	7	10	6	3	8.5	2	8.5	4	5	1

MW1
MW1

Alternatively

Ranks (weeks)	8	9.5	3.5	2	9.5	5	7	1	6	3.5
Ranks (mass)	4	1	5	8	2.5	9	2.5	7	6	10

MW1
MW1

(ii)

d^2	16	72.25	2.25	36	49	16	20.25	36	0	42.25

$\sum d^2 = 290$ M1 W1

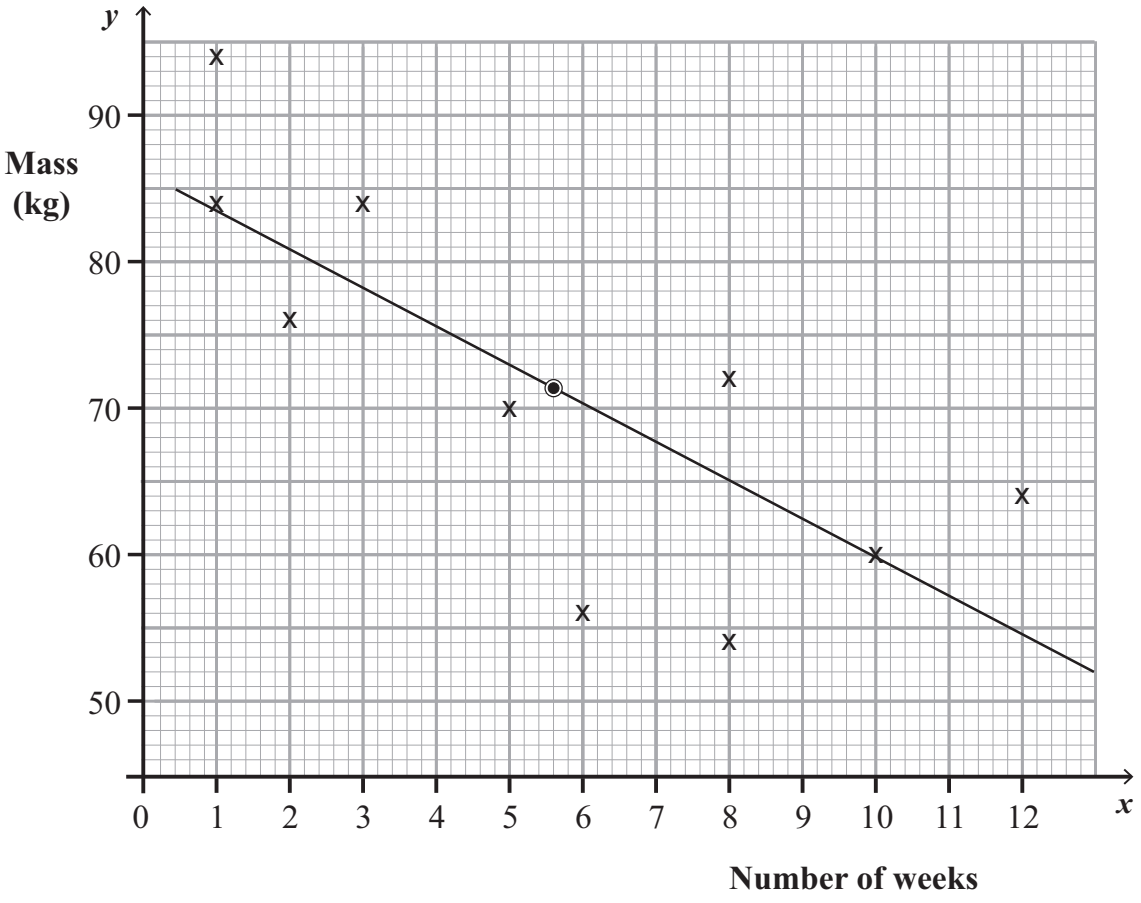
$r = 1 - \frac{6 \times 290}{10 \times 99}$ M1

$= -0.76$ W1

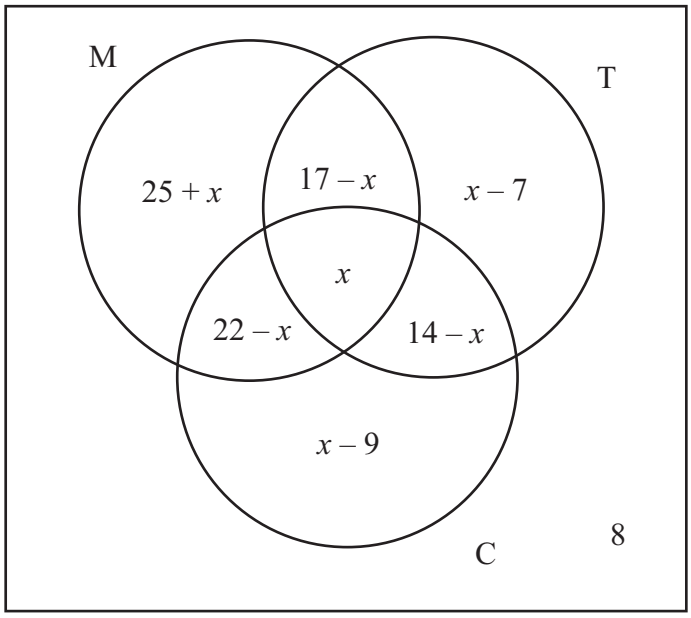
(iii) negative correlation M1

(iv) mean number of weeks = 5.6
mean mass = 71.4 kg MW1

(v)



M1 (through means)
W1 (slope)

			AVAILABLE MARKS
(vi)	$m = \frac{54.5 - 83.5}{12 - 1} = -2.64$	MW1	
	Passes through means		
	So $71.4 = -2.64(5.6) + c$	MW1	
	$\therefore c = 86.18$		
	$\therefore y = -2.64x + 86.18$	W1	13
12 **(i)**		M1 W2	
	So $64 + (x - 7) + (14 - x) + (x - 9) + 8 = 80$		
	$x + 70 = 80$		
	$x = 10$	MW1	
(ii)	P(only coffee machine) $= \frac{x - 9}{80} = \frac{1}{80}$	M1 W1	6
13 **(i)**	$P(<200) = \frac{1}{2}$	MW1	
(ii)	$P(>255) = \frac{1}{4}$	MW1	
(iii)	$P(>255 \mid >115) = \frac{P(>255)}{P(>115)} = \frac{\frac{1}{4}}{\frac{3}{4}} = \frac{1}{3}$	M2 W1	
(iv)	$P(>115) \times P(>115) = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$	M1 W1	
(v)	$P(>255)\ P(<255) + P(<255)\ P(>255)$		
	$= \frac{1}{4} \times \frac{3}{4} + \frac{3}{4} \times \frac{1}{4}$	MW1 MW1	
	$= \frac{3}{8}$	W1	10
		Total	**100**