



Rewarding Learning

General Certificate of Secondary Education

Further Mathematics

Unit 2
Mechanics

[GFM21]

Assessment

MARK SCHEME

GCSE MATHEMATICS

General Marking Instructions

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.

Assessment Objectives

Below are the assessment objectives for GCSE Further Mathematics.

Use and apply standard techniques (AO1)

Candidates should be able to:

- accurately recall facts, terminology and definitions;
- use and interpret notation correctly; and
- accurately carry out routine procedures or set tasks requiring multi-step solutions.

Reason, interpret and communicate mathematically (AO2)

Candidates should be able to:

- make deductions, inferences and draw conclusions from mathematical information;
- construct chains of reasoning to achieve a given result;
- present arguments and proofs; and
- assess the validity of an argument and critically evaluate a given way of presenting information.

Solve problems within mathematics and in other contexts (AO3)

Candidates should be able to:

- translate problems in mathematical or non-mathematical contexts into a process or a series of mathematical processes;
- make and use connections between different parts of mathematics;
- interpret results in the context of the given problem;
- evaluate methods used and results obtained; and
- evaluate solutions to identify how they may have been affected by assumptions made.

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).

Additional guidance for teachers

These notes explain how the marks allocated in the published mark scheme are to be applied.

In the mark scheme, M indicates method marks and W indicates work marks. MW indicates a combined method and work mark. Work marks should not be awarded if the method is incorrect.

If a candidate misreads a question, eg copies a given equation incorrectly, deduct 1 mark and then FT (follow through), as long as the question is not made easier. However, work marks should not be awarded to answers which are inconsistent with the question, eg negative numbers of people.

If a correct answer in working is transferred incorrectly (or not at all) to the answer line, give BOD (benefit of doubt). However, if the incorrect answer is used in a subsequent section, penalise one mark in the subsequent section and treat the remaining work as a misread.

As a general rule, ignore work that is scored out.

However, if correct working is scored out, but subsequently used correctly, give BOD.

If incorrect working is not scored out but subsequently corrected, give BOD.

If more than one attempt at a question is made and none is scored out, mark the attempt that corresponds to the answer given in the answer line. If no answer is given in answer line, mark the worst attempt, unless the better attempt is clearly the one that is intended to be taken.

If incorrect or unnecessary working is given after a correct answer, ignore this if the correct answer is on the answer line. However, if a subsequent incorrect answer is given on the answer line deduct 1 mark.

Mark answers only in appropriate section. Allow forward marking if carried through into appropriate section, eg if working for part (ii) is given in part (i) and not repeated but used in part (ii), give appropriate marks in part (ii).

Do not allow backward marking, eg answer to part (ii) is given as answer to part (i) and no answer, or an incorrect answer, is given in part (ii).

All working must be shown, so answers with no working can get no marks, unless the working is trivial.

Answers should be exact where possible.

Unless specifically stated in the mark scheme, accept one or more dp (decimal places), or 3 significant figures, unless insufficient accuracy leads to very inaccurate or meaningless answer.

Ignore slight rounding errors, eg arising from calculations using values to 2 rather than 3 or more places. Accept 1.5 instead of 1.50 for an answer required to 2 dp. Ignore truncation error in the last digit unless a specific accuracy is required, eg 0.345 truncated to 0.34.

1. (i) **MW1** for resolving horizontally correctly and creating the equation;
W1 for solving the equation correctly;
- (ii) **MW1** for resolving vertically correctly and creating the equation – follow through for the angle found in part (i);
W1 for solving the equation correctly;
2. (i) **M1** for knowing to add **a** and **b**;
MW1 for simplifying the resultant. Accept $x\mathbf{i} + 2\mathbf{i} - 9\mathbf{j}$;
- (ii) **MW1** for knowing how to find the magnitude of a vector and putting it equal to 15;
MW1 for coming up with a quadratic equation;
W1 for solving the quadratic correctly;
3. (i) **M1** for the correct shape, ie. up, across and then down;
M1 for the correct labelling of the values on the velocity and time axis;
- (ii) **MW1** for the correct attempt of finding the area from $t=0$ to $t=10$ by adding a triangle to a rectangle or using a trapezium;
W1 for correctly calculating the area;
- (iii) **MW1** for subtracting the answer found in part (ii) from 100 correctly, allow follow through from their calculated area;
MW1 for setting up an equation in V set equal to the area found for the first mark;
W1 for solving their equation correctly;
- (iv) **M1** for a correct equation of motion with correct values substituted – allow follow through from value of V found in part (iii);
W1 for the correct deceleration calculated – follow through from the value of V calculated in part (iii) as long as the value of a is calculated as negative and the answer for deceleration given as positive;
4. (i) **MW1** for a correct equation of motion with correct values substituted;
W1 for the correct acceleration calculated;
- (ii) **MW1** for the correct use of $F=ma$ with the correct values substituted;
W1 for solving the resulting equation in T correctly;
- (iii) **MW1** for the difference in forces for the F of $F=ma$ and **MW1** for the $=ma$ of the formula, ie. 1 mark for the $T - Fr$ with the value of T found in part (ii) correctly substituted and the second mark for the $=7a$;
W1 for the correct solving of the resulting equation – allow follow through for an incorrect value of T calculated as long as the value of the frictional force is **less** than the value of T ;
5. (i) **MW1** for the arrow and label for the R force;
MW1 for the arrow and label for the Fr force;
- (ii) **MW1** for a correct of motion with correct values substituted;
W1 for the correct deceleration calculated – deceleration must be given as a positive number;
- (iii) **MW1** for the $-6g\sin 28^\circ - Fr$ and **M1** for the $=6(-6.4)$;
MW1 for the rearranging of the equation to lead to the value of Fr given;

- (iv) **MW1** for the $6g\sin 28^\circ - Fr$ and substituting in the value of Fr given in the previous part and **MW1** for the $=6a$;
W1 for the correct solving of the resulting equation – only follow through for this mark if the value of a calculated is less than 4.69;
- (v) **MW1** for a correct equation of motion with correct values substituted, following through from the value of a calculated in part (iv) as long as it is less than 4.69;
W1 for the correct final velocity calculated;
6. (i) **MW1** for any two forces correctly arrowed and labelled and **MW2** for all forces correctly arrowed and labelled;
 Note, the 30 g force must be acting at the point M;
- (ii) **MW1** for correctly equating vertically;
W1 for solving the resulting equation;
- (iii) **In this part of the question, algebra must be used with an unknown length used in setting up an equation;**
MW1 for a correct clockwise moment set up about a point and **MW1** for equating it with a correct anticlockwise moment set up about the same point;
W1 is for finding the unknown length;
MW1 for showing how the calculated length has led to the given length of the rod;
- The first three marks of this answer can be obtained on follow through from using an incorrect reaction calculated in part (i). The final mark can only be gained on follow through if it leads to the length of the rod being calculated as 1.6 m as asked to prove in the question.
- (iv) **MW1** for a correct clockwise moment set up about a point and **MW1** for equating it with a correct anticlockwise moment set up about the same point;
W1 for solving the resulting equation to find an unknown reaction;
MW1 for correctly equating vertically;
W1 for solving the equation to find the second reaction;

1 (i) Resolving along x -axis

$$28 \cos \theta = 14$$

$$\theta = 60$$

MW1

W1

(ii) Resolving along y -axis

$$P = 28 \sin 60^\circ$$

MW1

$$P = 24.25$$

W1

4

2 (i) Resultant of \mathbf{a} and $\mathbf{b} = \mathbf{a} + \mathbf{b}$

M1

$$= (x + 2)\mathbf{i} - 9\mathbf{j}$$

MW1

(ii) $\sqrt{(x + 2)^2 + (-9)^2} = 15$

MW1

$$(x + 2)^2 + 81 = 225$$

$$x^2 + 4x + 85 = 225$$

$$x^2 + 4x - 140 = 0$$

MW1

$$(x - 10)(x + 14) = 0$$

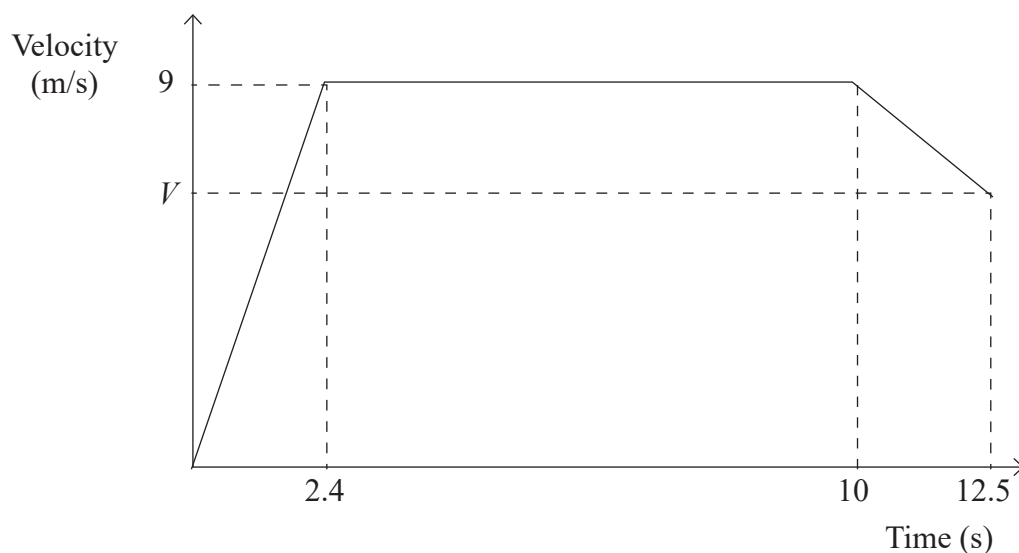
$$x = 10 \text{ or } -14$$

W1

| | | | |
|---|--------------------------|---|-----|
| [| Alternatively |] | |
| | $(x + 2)^2 = 144$ | | MW1 |
| | $x + 2 = \pm 12$ | | |
| | $x = 10 \text{ or } -14$ | | W1 |

5

3 (i)



M1 (shape)

M1 (labels & values)

(ii) Distance = area of triangle + rectangle

$$= \frac{1}{2} \times 9 \times 2.4 + 9 \times 7.6$$

$$= 79.2 \text{ m}$$

MW1

W1

Alternative solution

Distance = area of trapezium

$$= \frac{1}{2} (7.6 + 10) \times 9$$

$$= 79.2 \text{ m}$$

MW1

W1

(iii) Area of trapezium = $100 - 79.2 = 20.8$

MW1

$$\frac{1}{2} (9 + V) \times 2.5 = 20.8$$

MW1

$$V = 7.64$$

W1

(iv) $u = 9, v = 7.64, t = 2.5$

$$v = u + at$$

$$7.64 = 9 + 2.5a$$

M1

$$a = -0.544$$

$$\text{Deceleration} = 0.544 \text{ m/s}^2$$

W1

Alternative solution

$$\text{Deceleration} = \frac{9 - V}{12.5 - 10} = \frac{9 - 7.64}{2.5}$$

M1

$$= 0.544 \text{ m/s}^2$$

W1

4 (i) $u = 0, v = 4, t = 2$

$$v = u + at$$

$$4 = 0 + 2a$$

MW1

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

W1

AVAILABLE
MARKS

9

(ii) Using $F = ma$ on the 9 kg block

$$90 - T = 9a$$

$$90 - T = 18$$

$$T = 72 \text{ N}$$

MW1

W1

(iii) Using $F = ma$ on the 7 kg block

$$T - F_r = 7a$$

$$72 - F_r = 14$$

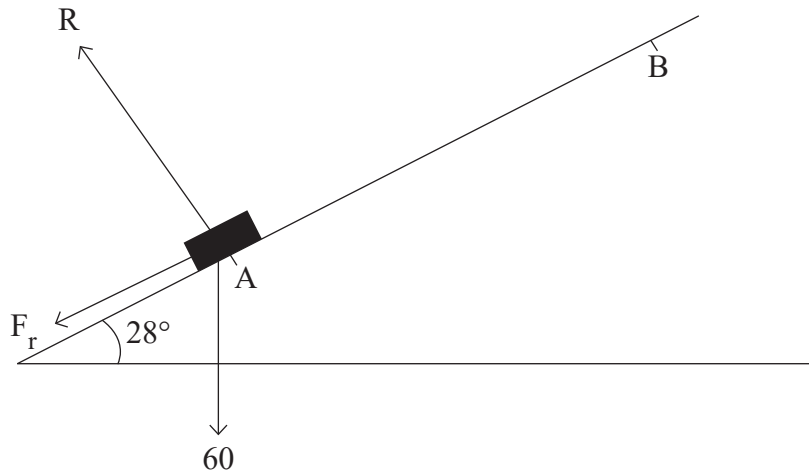
$$F_r = 58 \text{ N}$$

MW1 MW1

W1

7

5 (i)



MW1 MW1

(ii) $s = 1.25, u = 4, v = 0$

$$v^2 = u^2 + 2as$$

MW1

$$0 = 16 + 2.5a$$

$$a = -6.4 \text{ m/s}^2$$

$$\text{deceleration} = 6.4 \text{ m/s}^2$$

W1

(iii) Resolving parallel to slope and using $F = ma$ up the slope

$$-6g \sin 28^\circ - F_r = 6(-6.4)$$

MW1 M1

$$F_r = 38.4 - 60 \sin 28^\circ$$

MW1

$$F_r = 10.232 \rightarrow 10.23 \text{ N}$$

(iv) Resolving parallel to the slope and using $F = ma$ down the slope

$$6g \sin 28^\circ - F_r = 6a$$

$$6g \sin 28^\circ - 10.232 = 6a$$

MW1 MW1

$$a = 2.989 \rightarrow 2.99 \text{ m/s}^2$$

W1

(v) $a = 2.989$, $u = 0$, $s = 1.25$

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2 \times 2.989 \times 1.25$$

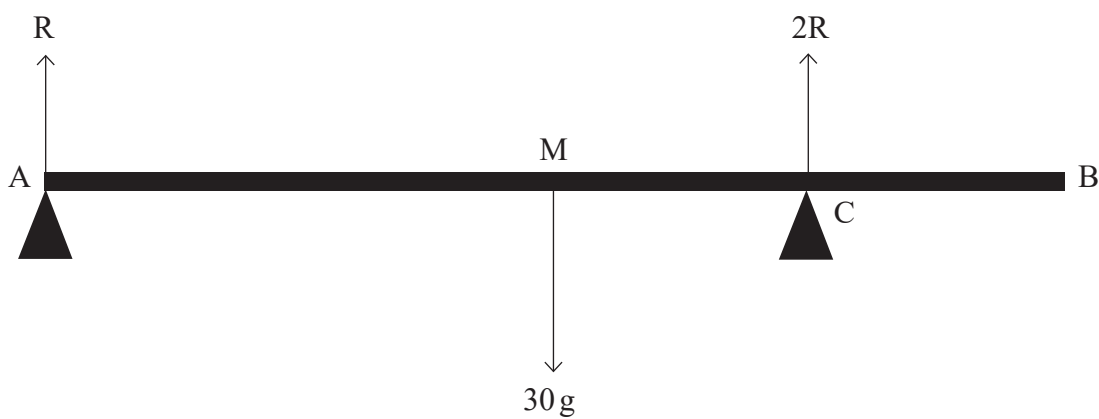
MW1

$$v = 2.73 \text{ m/s}$$

W1

12

6 (i)



MW2

(1 mark if 2 forces correct,
2 marks if all 3 correct)

(ii) Equating vertically

$$R + 2R = 300$$

MW1

$$\text{Reaction at A} = R = 100\text{N}$$

W1

(iii) Reaction at A = 100N, reaction at C = 200N

Let x = distance AM (= BM)

Taking moments about A

$$200 \times 1.2 = 300x$$

MW1 MW1

$$x = 0.8 \text{ m}$$

W1

$$AB = 2x = 1.6 \text{ m}$$

W1

Alternative 1

Taking moments about B

$$300x = 100 \times 2x + 200(2x - 1.2)$$

MW1 MW1

$$x = 0.8 \text{ m}$$

W1

$$AB = 2x = 1.6 \text{ m}$$

MW1

Alternative 2

Taking moments about M

$$100x = 200(1.2 - x)$$

MW1 MW1

$$x = 2.4 - 2x$$

$$x = 0.8$$

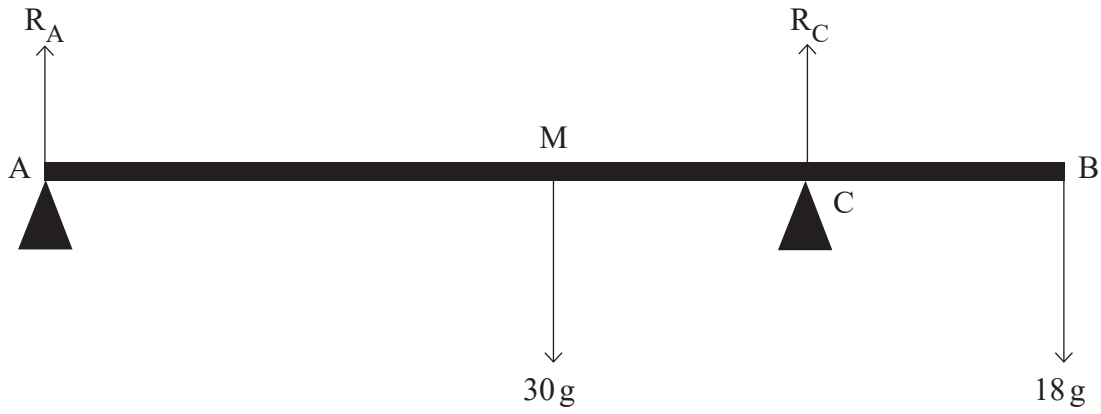
W1

$$AB = 2x = 1.6 \text{ m}$$

MW1

AVAILABLE
MARKS

(iv)



Taking moments about A

$$1.2 R_C = 300 \times 0.8 + 180 \times 1.6$$

MW1 MW1

$$R_C = 440 \text{ N}$$

W1

Equating vertically

$$R_A + 440 = 300 + 180$$

MW1

$$R_A = 40 \text{ N}$$

W1

Alternatively

Taking moments about C

$$1.2 R_A + 180 \times 0.4 = 300 \times 0.4$$

MW1 MW1

$$R_A = 40 \text{ N}$$

W1

Equating vertically

$$40 + R_C = 300 + 180$$

MW1

$$R_C = 440 \text{ N}$$

W1

Total

AVAILABLE
MARKS

13

50