



Rewarding Learning

General Certificate of Secondary Education

Centre Number

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Candidate Number

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# Further Mathematics

Unit 2 (With calculator)

Mechanics



[GFM21]

\*GFM21\*

Assessment

Assessment Level of Control:

Tick the relevant box (✓)

TIME

1 hour.

Controlled Conditions	
Other	

### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write outside the boxed area on each page.**

Complete in black ink only. **Do not write with a gel pen.**

All working **must** be clearly shown in the spaces provided. Marks may be awarded for partially correct solutions.

Where rounding is necessary give answers correct to **2 decimal places** unless stated otherwise.

Take  $g = 10 \text{ m/s}^2$  when required.

Answer **all six** questions.

### INFORMATION FOR CANDIDATES

The total mark for this paper is 50.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use a calculator.

The Formula Sheet is on page 2.

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\*20GFM2101\*

## FORMULA SHEET

### MECHANICS

Quadratic equations: If  $ax^2 + bx + c = 0$  ( $a \neq 0$ )

$$\text{then } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Vectors: Magnitude of  $x\mathbf{i} + y\mathbf{j}$  is given by  $\sqrt{x^2 + y^2}$

Angle between  $x\mathbf{i} + y\mathbf{j}$  and  $\mathbf{i}$  is given by  $\tan^{-1}\left(\frac{y}{x}\right)$

Uniform Acceleration:  $v = u + at$   $s = \frac{1}{2}(u + v)t$   
 $v^2 = u^2 + 2as$   $s = ut + \frac{1}{2}at^2$

where  $u$  is initial velocity  $t$  is time  
 $v$  is final velocity  $s$  is change in displacement  
 $a$  is acceleration

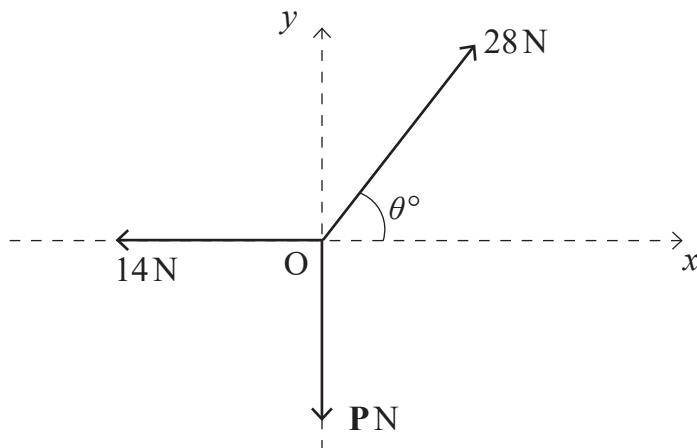
Newton's Second Law:  $F = ma$

where  $F$  is resultant force  $m$  is mass  
 $a$  is acceleration



1 A particle rests in equilibrium at a point O on a smooth, horizontal plane.

The particle is acted upon by three horizontal forces of magnitudes 14 N, 28 N and P N. The direction of each of these forces relative to the horizontal axes Ox and Oy is shown below.



The particle remains in equilibrium.

(i) Calculate the value of  $\theta$ .

Answer \_\_\_\_\_ [2]

(ii) Calculate the value of P.

Answer \_\_\_\_\_ [2]

[Turn over



2 Two forces **a** and **b** are defined by

$$\mathbf{a} = (2\mathbf{i} - 4\mathbf{j}) \text{ N} \quad \text{and} \quad \mathbf{b} = (x\mathbf{i} - 5\mathbf{j}) \text{ N}.$$

(i) Write down an expression for the resultant force of **a** and **b** in terms of **i** and **j**.

Answer \_\_\_\_\_ [2]

The **magnitude** of the resultant force of **a** and **b** is 15 N.

(ii) Calculate two possible values for  $x$ .

Answer  $x =$  \_\_\_\_\_ or \_\_\_\_\_ [3]





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**(Questions continue overleaf)**

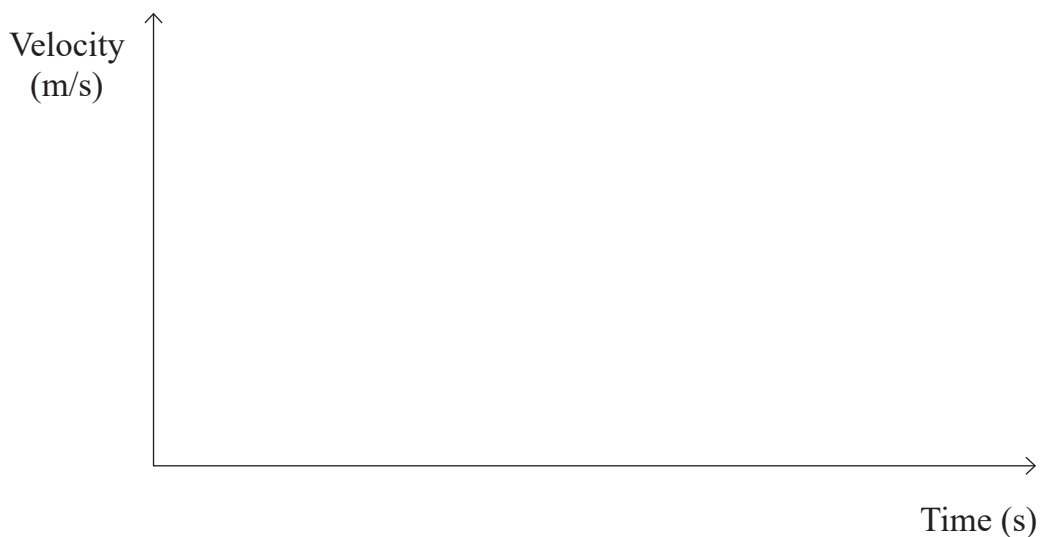
**[Turn over**

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\*20GFM2105\*

- 3 A sprinter running in a 100 m race took 12.5 seconds to complete the race.
- He accelerated uniformly from rest to a maximum velocity of 9 m/s in 2.4 seconds.
- He maintained this velocity for a further 7.6 seconds.
- He then decelerated uniformly to a final velocity of  $V$  m/s in the final 2.5 seconds.
- (i) Draw a velocity–time graph of the sprinter’s journey on the axes below.



[2]

Calculate

- (ii) the distance travelled in the first 10 seconds,

Answer \_\_\_\_\_ m [2]



(iii) the value of  $V$ ,

Answer \_\_\_\_\_ [3]

(iv) the sprinter's **deceleration** for the last part of the race.

Answer \_\_\_\_\_  $\text{m/s}^2$  [2]

[Turn over

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\*20GFM2107\*

- 4 A block of mass 7 kg is held at rest on a **rough**, horizontal roof. It is connected to a block of mass 9 kg by a light, inextensible string which passes over a smooth pulley attached to the end of the roof, as shown in the diagram below.



The 9 kg block hangs freely.

The blocks are released from rest and after 2 seconds they are both travelling at 4 m/s.

Calculate

- (i) the acceleration of the blocks,

Answer \_\_\_\_\_ m/s<sup>2</sup> [2]



(ii) the tension in the string,

Answer \_\_\_\_\_ N [2]

(iii) the force due to friction acting on the 7 kg block.

Answer \_\_\_\_\_ N [3]

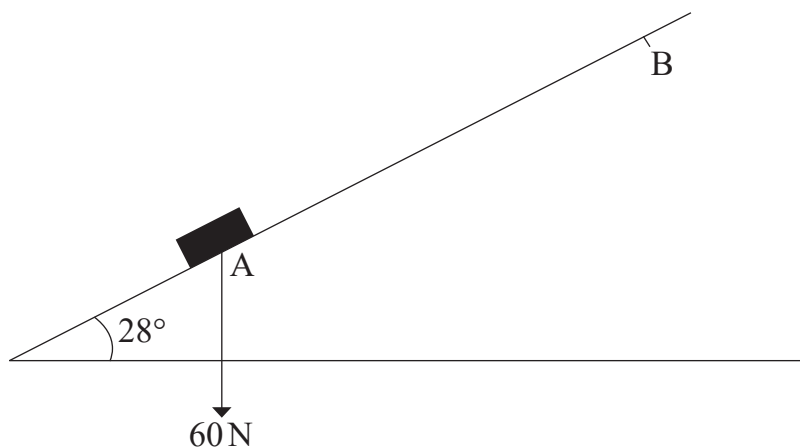
[Turn over

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\*20GFM2109\*

- 5 A block of mass 6 kg is held at the point A on a **rough** slope, which is inclined at an angle of  $28^\circ$  to the horizontal, as shown in the diagram below.



The block is projected **up** the slope from the point A at a speed of 4 m/s.

- (i) Mark, on the diagram above, the other two forces acting on the block. [2]

The block comes to rest at the point B, where the distance AB is 1.25 m.

- (ii) Calculate the **deceleration** of the block as it moves up the slope.

Answer \_\_\_\_\_ m/s<sup>2</sup> [2]



**(iii) Hence show that the force due to friction acting on the block is 10.23 N, correct to 2 decimal places.**

[3]

[Turn over

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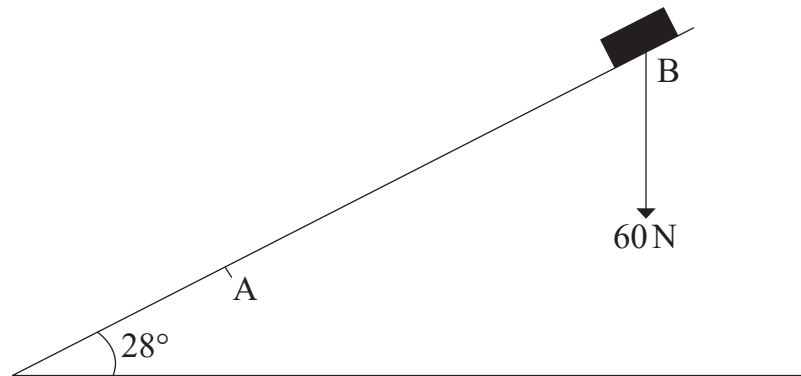
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From rest at B the block now slides **down** the slope.

The magnitude of the force due to friction remains unchanged.

Calculate

(iv) the new acceleration of the block,



Answer \_\_\_\_\_  $\text{m/s}^2$  [3]



(v) the speed of the block as it passes the point A.

Answer \_\_\_\_\_ m/s [2]

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[Turn over



\*20GFM2113\*

- 6 A uniform rod AB, of mass 30 kg, rests horizontally on two pivots, one at the end A and the other at the point C, as shown in the diagram below. The point M is the midpoint of the rod.



The distance AC is 1.2 m.

The reaction at the pivot C is twice the reaction at the pivot A.

- (i) Mark on the diagram above all the forces acting on the rod. [2]
- (ii) Calculate the reaction at the pivot A.

Answer \_\_\_\_\_ N [2]



(iii) Show that the length of the rod is 1.6 m.

[4]

[Turn over

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A mass of 18 kg is now attached to the end B of the rod.

- (iv) Calculate the new reactions at the pivots A and C, given that the rod remains horizontal and in equilibrium.

Answer Reaction at A = \_\_\_\_\_ N

Reaction at C = \_\_\_\_\_ N [5]

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Question Number	Marks
1	
2	
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<b>Total Marks</b>	
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Examiner Number

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