Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2025

Further Mathematics

Unit 2 **(With calculator)**
Mechanics

[GFM21]

GFM21

MONDAY 2 JUNE, MORNING

TIME

1 hour.

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 or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Questions which require drawing can be completed using an HB pencil.
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 $\mathbf{g = 10\ m/s^2}$ 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.

15900

FORMULA SHEET

MECHANICS

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

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

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 $\tan^{-1}\left(\dfrac{y}{x}\right)$

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

$v^2 = u^2 + 2as$ $\quad s = ut + \frac{1}{2}at^2$

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

Newton's Second Law: $F = ma$

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

1 Identify each of the measures below as either a **vector** quantity or a **scalar** quantity.

An example has been given for you.

Time _____

Weight _____

Acceleration Vector

Mass _____

Velocity _____

Distance _____

Tension _____

[2]

[Turn over

2 (Throughout this question, **i** and **j** denote unit vectors parallel to a set of standard x–y axes.)

A body is acted upon by three forces **p**, **q** and **r**, where

$$\mathbf{p} = (x\mathbf{i} - y\mathbf{j})\,\text{N}, \qquad \mathbf{q} = (2y\mathbf{i} - 3x\mathbf{j})\,\text{N} \qquad \text{and} \qquad \mathbf{r} = (22\mathbf{i} + 24\mathbf{j})\,\text{N}$$

(i) Given that $2\mathbf{p} - 3\mathbf{q} = \mathbf{r}$, calculate the values of x and y.

Answer $x =$ _____ , $y =$ _____ [5]

The forces **p** and **q** are removed and replaced by a force **w**, where

$$\mathbf{w} = (-6\mathbf{i} + 6\mathbf{j})\,\text{N}$$

Calculate

(ii) the **magnitude** of the vector $\mathbf{r} + \mathbf{w}$,

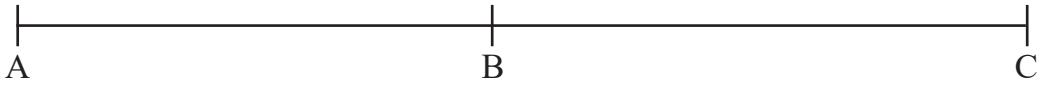
Answer _____ N [3]

(iii) the angle the vector $\mathbf{r} + \mathbf{w}$ makes with the positive x-axis.

Answer _____° [2]

[Turn over

3 Points A, B and C all lie on the same straight line as shown below.



The distance AC is 200 m.

A particle moves with constant acceleration and passes point A with a velocity of U m/s.

After 10 seconds, the particle passes through point C travelling at a velocity of 30 m/s.

Calculate

(i) the value of U,

Answer _____ [2]

(ii) the acceleration of the particle from A to C.

Answer _____ m/s^2 [2]

The particle passes point B with a velocity of 22 m/s.

Calculate

(iii) the time the particle takes to travel from A to B,

Answer _____ s [2]

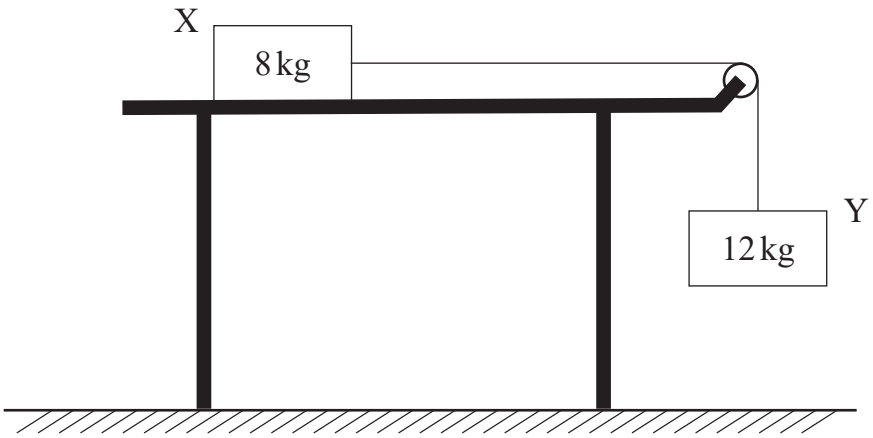
(iv) the distance from B to C.

Answer _____ m [3]

[Turn over

4 Two blocks, X and Y, of masses 8 kg and 12 kg respectively, are connected by a light, inextensible string that passes over a smooth pulley.

Block X is held at rest on a **rough**, horizontal table, and block Y hangs vertically above the ground, as shown in the diagram below.



(i) Mark, on the diagram above, all the forces acting on the blocks. [2]

The blocks are released from rest.

The force due to friction acting on block X is 30 N.

(ii) Calculate the acceleration of the blocks.

Answer _____ m/s^2 [6]

(iii) Calculate the tension in the string.

Answer _____ N [2]

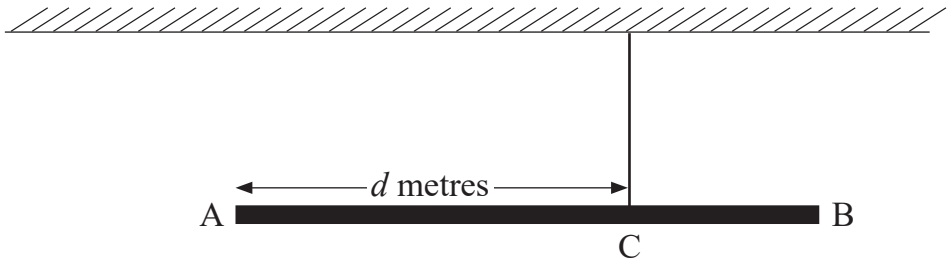
(iv) Calculate the magnitude of the resultant force exerted by the **string on the pulley**.

Answer _____ N [2]

[Turn over

5 A uniform rod AB, of length 10 m and mass 13 kg, is attached to a fixed point on a ceiling by a light, inextensible string.

The string is attached to the point C on the rod where the distance AC = d metres ($d > 5$), as shown in the diagram below.



A mass of 6 kg is attached at end A.

A mass of 21 kg is attached at end B.

The rod remains horizontal and in equilibrium.

(i) Mark, on the diagram above, all the forces acting on the rod. [2]

(ii) Calculate the tension in the string.

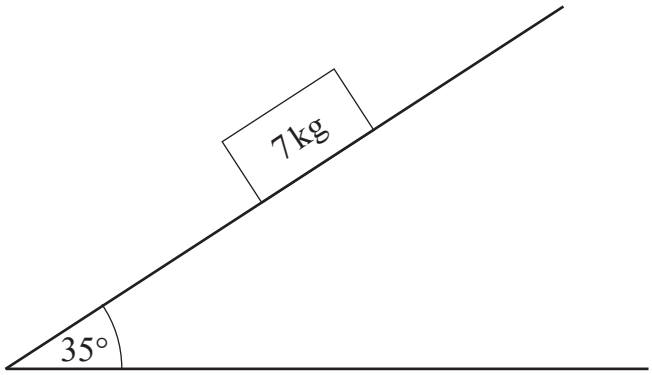
Answer _____ N [1]

(iii) Calculate the value of d.

Answer _____ [4]

[Turn over

6 A box of mass 7 kg lies at rest on a **rough** slope, which is inclined at an angle of 35° to the horizontal, as shown in the diagram below.



The box is released from rest and begins to slide down the slope.

(i) Mark, on the diagram above, all the forces acting on the box. [2]

(ii) Calculate the normal reaction between the box and the slope.

Answer _____ N [2]

The force due to friction is 4.8 N per kg of mass.

Calculate

(iii) the acceleration of the box as it slides down the slope,

Answer _____ m/s^2 [4]

(iv) the speed of the box when it has travelled 1.3 m down the slope.

Answer _____ m/s [2]

THIS IS THE END OF THE QUESTION PAPER

BLANK PAGE

DO NOT WRITE ON THIS PAGE

BLANK PAGE

DO NOT WRITE ON THIS PAGE

DO NOT WRITE ON THIS PAGE

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
Total Marks	

Examiner Number