Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2019

Further Mathematics

Unit 2
Mechanics

[GFM21]

GFM21

TUESDAY 18 JUNE, AFTERNOON

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.
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 $\mathbf{g = 10\ m/s^2}$ 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.

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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 **(i)** Define a vector quantity. Include an example in your answer.

Definition _____

_____ [1]

Example _____ [1]

(ii) Define a scalar quantity. Include an example in your answer.

Definition _____

_____ [1]

Example _____ [1]

[Turn over

2 A body is initially at an origin O and is travelling with an initial velocity of $(-3\mathbf{i} + 2\mathbf{j})$ m/s.

It moves with a constant acceleration of $(4\mathbf{i} - 6\mathbf{j})$ m/s^2 for 4 seconds.

Calculate

(i) the displacement of the body from O, in vector form, after the 4 seconds,

Answer _____ m [3]

(ii) the **speed** of the body after the 4 seconds,

Answer _____ m/s [4]

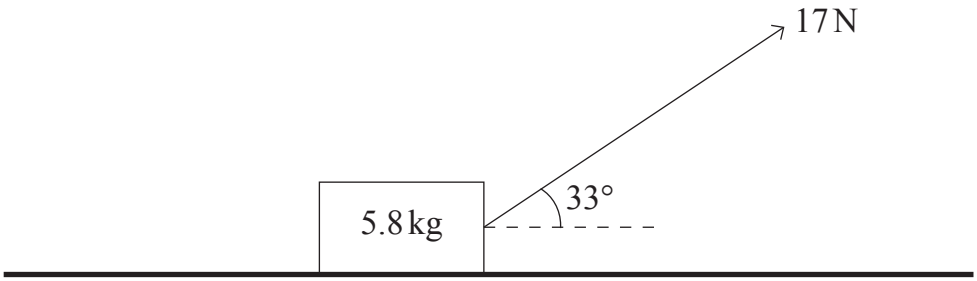
(iii) the angle the velocity makes with the positive x-axis after the 4 seconds.

Answer _____ ° [2]

[Turn over

3 A block of mass 5.8 kg is initially at rest on a smooth horizontal table.

The block is then pulled along the table by a string with a force of 17 N. The string makes an angle of 33° to the horizontal, as shown in the diagram below.



(i) Mark, on the diagram above, the other forces acting on the block. [1]

Calculate

(ii) the normal reaction between the block and the table,

Answer _____ N [4]

(iii) the acceleration of the block,

Answer _____ m/s^2 [3]

(iv) the speed v of the block after 5 seconds.

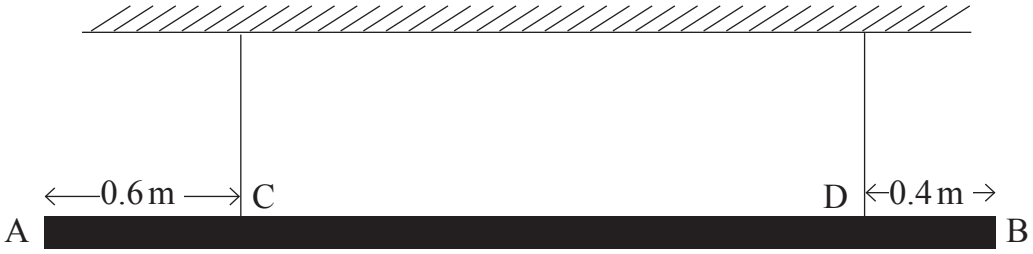
Answer _____ m/s [1]

[Turn over

4 A uniform rod AB has length 3.2 m and mass 4.6 kg.

It is suspended from a ceiling by two inextensible strings attached to points C and D on the rod.

The distance AC is 0.6 m and the distance DB is 0.4 m, as shown in the diagram below.



A mass of 6 kg is attached to the rod at the end A and a mass of 8 kg is attached to the rod at the 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 tensions in the strings at C and D.

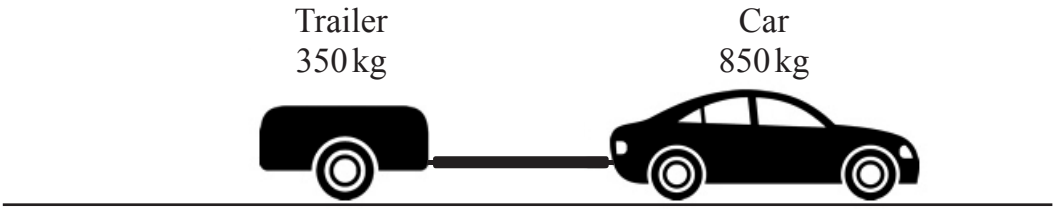
Answer Tension in string at C _____ N

Tension in string at D _____ N [6]

[Turn over

5 A car of mass 850 kg tows a trailer of mass 350 kg along a straight horizontal road.

The car and trailer are connected by a light horizontal towbar.



The resistance to motion of the car is 1.2 N per kg.

The resistance to motion of the trailer is 0.95 N per kg.

The car and trailer travel at a constant acceleration of 0.9 m/s^2

Calculate

(i) the tension in the towbar,

Answer _____ N [3]

(ii) the tractive force of the engine of the car.

Answer _____ N [3]

The car and trailer started from rest.

Eight seconds later the towbar breaks.

(iii) Calculate the speed of the car when the towbar breaks.

Answer _____ m/s [2]

[Turn over

(iv) Calculate the speed of the car 12 seconds after the towbar breaks, given that the tractive force of the car and the resistance to motion of the car remain unchanged.

Answer _____ m/s [5]

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(Questions continue overleaf)

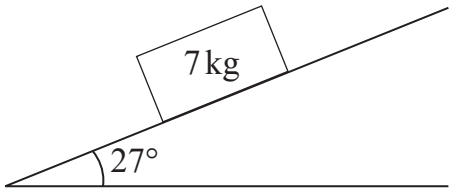
6 A block of mass 7kg lies on a rough surface inclined at an angle of 27° to the horizontal.

The force due to friction is 18.7 N.

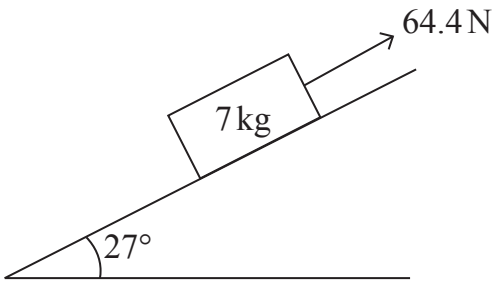
Which of the following options would produce the greatest acceleration of the block?

You must show working to support your answer.

Option A The block is allowed to slide down the slope.



Option B The block is pulled up the slope with a force of 64.4 N.



Answer Option _____ [7]

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

Examiner Number