

Using $F=ma$ without Kinematics

Question Paper 1

Level	A Level
Subject	Maths
Exam Board	AQA
Module	Mechanics 1
Topic	Newton's Law of motion
Sub Topic	Using $F=ma$ without kinematics
Booklet	Question Paper - 1

Time Allowed: 56 minutes

Score: /46

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

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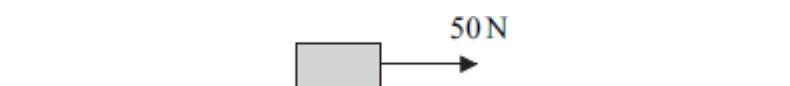
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Q1. Three forces act on a particle. These forces are $(9\mathbf{i} - 3\mathbf{j})$ newtons, $(5\mathbf{i} - 8\mathbf{j})$ newtons and $(-7\mathbf{i} + 3\mathbf{j})$ newtons. The vectors \mathbf{i} and \mathbf{j} are perpendicular unit vectors.

- (a) Find the resultant of these forces. (2)
- (b) Find the magnitude of the resultant force. (2)
- (c) Given that the particle has mass 5 kg, find the magnitude of the acceleration of the particle. (2)
- (d) Find the angle between the resultant force and the unit vector \mathbf{i} . (3)

(Total 9 marks)

Q2. A block, of mass 4 kg, is made to move in a straight line on a rough horizontal surface by a horizontal force of 50 newtons, as shown in the diagram.



Assume that there is no air resistance acting on the block.

- (a) Draw a diagram to show all the forces acting on the block. (1)
- (b) Find the magnitude of the normal reaction force acting on the block. (1)
- (c) The acceleration of the block is 3 m s^{-2} . Find the magnitude of the friction force acting on the block. (3)

(d) Find the coefficient of friction between the block and the surface. (2)

(e) Explain how and why your answer to part (d) would change if you assumed that air resistance did act on the block. (2)

(Total 9 marks)

Q3. A small train at an amusement park consists of an engine and two carriages connected to each other by light horizontal rods, as shown in the diagram.



The engine has mass 2000 kg and each carriage has mass 500 kg.

The train moves along a straight horizontal track. A resistance force of magnitude 400 newtons acts on the engine, and resistance forces of magnitude 300 newtons act on each carriage. The train is accelerating at 0.5 m s^{-2} .

(a) Draw a diagram to show the **horizontal** forces acting on Carriage 2. (1)

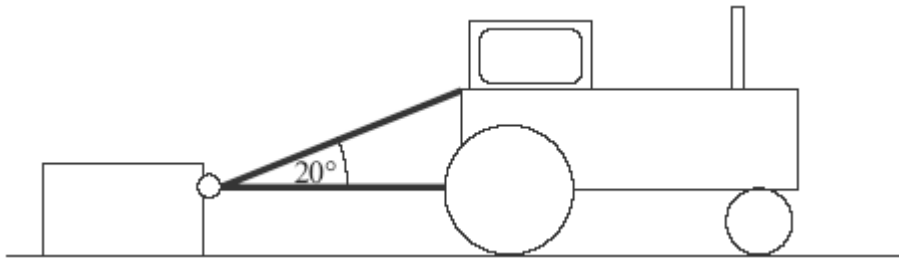
(b) Show that the magnitude of the force that the rod exerts on Carriage 2 is 550 newtons. (2)

(c) Find the magnitude of the force that the rod attached to the engine exerts on Carriage 1. (3)

(d) A forward driving force of magnitude P newtons acts on the engine. Find P . (3)

(Total 9 marks)

- Q4.** A crate, of mass 200 kg, is initially at rest on a rough horizontal surface. A smooth ring is attached to the crate. A light inextensible rope is passed through the ring, and each end of the rope is attached to a tractor. The lower part of the rope is horizontal and the upper part is at an angle of 20° to the horizontal, as shown in the diagram.



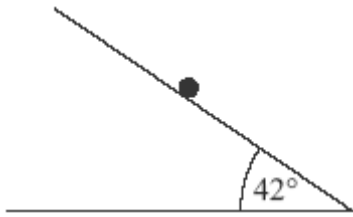
When the tractor moves forward, the crate accelerates at 0.3 m s^{-2} . The coefficient of friction between the crate and the surface is 0.4.

Assume that the tension, T newtons, is the same in both parts of the rope.

- (a) Draw and label a diagram to show the forces acting on the crate. (2)
- (b) Express the normal reaction between the surface and the crate in terms of T . (3)
- (c) Find T . (5)

(Total 10 marks)

- Q5.** A particle, of mass m kg, is at rest on a rough plane which is inclined at an angle of 42° to the horizontal, as shown in the diagram.



The friction force acting on the particle has magnitude 30 newtons.

- (a) Draw and label a diagram to show all the forces acting on the particle. (1)
- (b) Find m . (3)
- (c) Find the magnitude of the normal reaction force acting on the particle. (2)
- (d) Given that the particle is on the point of sliding down the plane, find the coefficient of friction between the particle and the plane. (3)

(Total 9 marks)