Using F=ma without Kinematics

Question Paper 5

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 - 5

Time Allowed: **59 minutes**

Score: **/50**

Percentage: **/100**

Grade Boundaries:

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

Q1. A van accelerates uniformly from rest on a straight horizontal road. After it has travelled 80 metres, its speed is 20 m s^{-1}.

(a) (i) Find the time taken for the van to travel the 80 metres.

(2)

(ii) Show that the acceleration of the van is 2.5 m s^{-2}.

(2)

(b) The mass of the van is 1200 kg. The force produced by its engine has magnitude F newtons and acts on the van in its direction of motion.

(i) Find F, if there is no resistance to motion.

(2)

(ii) Find F, if there is a constant resistance force of 400 N.

(2)

(Total 8 marks)

Q2. A child travels down a slide at a **constant speed**. Model the slide as a rough plane inclined at an angle of 40° to the horizontal. Model the child as a particle of mass 20 kg and assume that there is no air resistance as the child moves.

(a) (i) Draw a diagram to show the forces acting on the child.

(1)

(ii) Show that the magnitude of the normal reaction force acting on the child is approximately 150 N.

(2)

(iii) Find the magnitude of the friction force acting on the child and show that the coefficient of friction between the child and the slide is 0.84, correct to two significant figures.

(4)

(b) In reality, air resistance acts on the child as she slides at a constant speed. How would this affect the value of the coefficient of friction that you calculated in part (a)(iii)?

(1)

(Total 8 marks)

Q3. A particle moves with constant acceleration in a horizontal plane. The unit vectors **i** and **j** are perpendicular and lie in the plane. At time $t = 0$, the particle is at rest at the origin. At time $t = 4$ seconds, the position vector of the particle is $(-16\mathbf{i} + 16\mathbf{j})$ metres.

(a) Show that the acceleration of the particle is $(-2\mathbf{i} + 2\mathbf{j})$ m s^{-2}.

(4)

(b) Find the speed of the particle when $t = 5$.

(4)

(c) The mass of the particle is 3 kg. Two horizontal forces **P** and **Q** act on the particle. If $\mathbf{P} = 20\mathbf{i} - 10\mathbf{j}$, find **Q**.

(4)

(Total 12 marks)

Q4. A car is travelling along a straight horizontal road. When the car is at a distance of 48 metres from a set of traffic lights, it is travelling at 20 m s^{-1}. The car slows down uniformly so that it has a speed of 4 m s^{-1} as it passes the traffic lights.

(a) Show that the acceleration of the car is -4 m s^{-2}.

(2)

(b) How far past the traffic lights does the car travel before it stops?

(3)

(c) Calculate the total time that it takes the car to stop.

(2)

(d) The car has mass 1100 kg. As the car slows down, it experiences a resistance force that has a constant magnitude of 200 newtons, and a force due to the brakes of magnitude F newtons.

Find F.

(3)
(Total 10 marks)

Q5. A particle, of mass 2 kg, is set into motion up a rough slope inclined at 40° to the horizontal.
The coefficient of friction between the particle and the slope is 0.3 . Assume that there is no air resistance acting on the particle.

(a) Find the magnitude of the friction force that acts on the particle.

(3)

(b) Find the acceleration of the particle as it moves up the slope.

(3)
(Total 6 marks)

Q6. A lift has mass 800 kg. A vertical cable is attached to the lift. Model the lift as a particle.

(a) Show that the tension in the cable is 8000 N, when the lift is accelerating upwards at 0.2 m s^{-2}.

(3)

(b) Find the tension in the cable when the lift is accelerating downwards at 0.2 m s^{-2}.

(2)

(c) Write down the tension in the cable when the lift is travelling at a constant speed.

(1)
(Total 6 marks)