Applications of Dynamic Friction

Question Paper 2

Level	A Level
Subject	Maths
Exam Board	AQA
Module	Mechanics 1
Topic	Newton's Laws of motion
Sub Topic	Applications of dynamic friction
Booklet	Question Paper - 2

Time Allowed: **59 minutes**

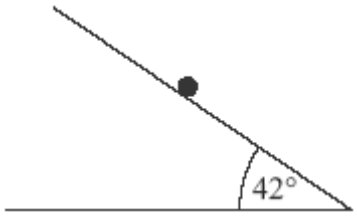
Score: **/49**

Percentage: **/100**

Grade Boundaries:

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

Q1. 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)

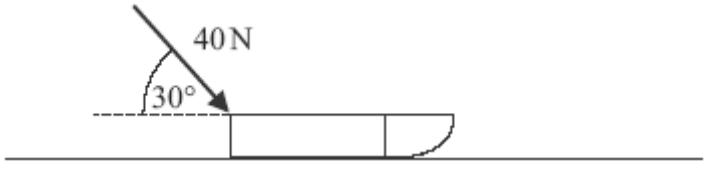
(c) Find the magnitude of the normal reaction force acting on the particle.

(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)

Q2. A sledge of mass 8 kg is at rest on a rough horizontal surface. A child tries to move the sledge by pushing it with a pole, as shown in the diagram, but the sledge **does not move**. The pole is at an angle of 30° to the horizontal and exerts a force of 40 newtons on the sledge.



Model the sledge as a particle.

(a) Draw a diagram to show the four forces acting on the sledge.

(1)

(b) Show that the normal reaction force between the sledge and the surface has magnitude 98.4 N.

(3)

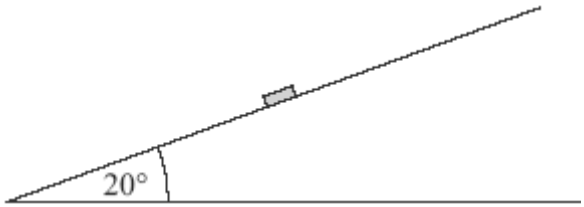
(c) Find the magnitude of the friction force that acts on the sledge.

(2)

(d) Find the least possible value of the coefficient of friction between the sledge and the surface.

(3)
(Total 9 marks)

Q3. A puck, of mass 0.2 kg, is placed on a slope inclined at 20° above the horizontal, as shown in the diagram.



The puck is hit so that initially it moves with a velocity of 4 m s^{-1} directly up the slope.

(a) A simple model assumes that the surface of the slope is smooth.

(i) Show that the acceleration of the puck up the slope is –3.35 m s^{-2}, correct to three significant figures.

(3)

(ii) Find the distance that the puck will travel before it comes to rest.

(3)

(iii) What will happen to the puck after it comes to rest?

Explain why.

(2)

(b) A revised model assumes that the surface is rough and that the coefficient of friction between the puck and the surface is 0.5.

(i) Show that the magnitude of the friction force acting on the puck during this motion is 0.921 N, correct to three significant figures.

(3)

(ii) Find the acceleration of the puck up the slope.

(3)

(iii) What will happen to the puck after it comes to rest in this case?

Explain why.

(2)
(Total 16 marks)

Q4. A box, of mass 3 kg, is placed on a slope inclined at an angle of 30° to the horizontal. The box slides down the slope. Assume that air resistance can be ignored.

(a) A simple model assumes that the slope is smooth.

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

(1)

(ii) Show that the acceleration of the box is 4.9 m s^{-2}.

(2)

(b) A revised model assumes that the slope is rough. The box slides down the slope from rest, travelling 5 metres in 2 seconds.

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

(2)

(ii) Find the magnitude of the friction force acting on the box.

(3)

(iii) Find the coefficient of friction between the box and the slope.

(5)

(iv) In reality, air resistance affects the motion of the box. Explain how its acceleration would change if you took this into account.

(2)
(Total 15 marks)