Pearson Edexcel

Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Mathematics

9MA0 (Applied) (Public release version)

Resource Set 1: Topic 8

Forces and Newton’s Laws

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an optional part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1 A rough plane is inclined to the horizontal at an angle α , where $\tan\alpha = \frac{3}{4}$

A brick P of mass m is placed on the plane.

The coefficient of friction between P and the plane is μ

Brick P is in equilibrium and on the point of sliding down the plane.

Brick P is modelled as a particle.

Using the model,

(*a*) find, in terms of m and g, the magnitude of the normal reaction of the plane on brick P **(2)**

(*b*) show that $\mu = \frac{3}{4}$ **(4)**

For parts (c) and (d), you are not required to do any further calculations.

Brick P is now removed from the plane and a much heavier brick Q is placed on the plane.

The coefficient of friction between Q and the plane is also $\frac{3}{4}$

(*c*) Explain briefly why brick Q will remain at rest on the plane. **(1)**

Brick Q is now projected with speed 0.5 m s^{-1} down a line of greatest slope of the plane.

Brick Q is modelled as a particle.

Using the model,

(*d*) describe the motion of brick Q, giving a reason for your answer. **(2)**

(Total for Question 1 is 9 marks)

2. A rough plane is inclined to the horizontal at an angle α, where $\tan \alpha = \frac{3}{4}$

A particle of mass m is placed on the plane and then projected up a line of greatest slope of the plane.

The coefficient of friction between the particle and the plane is μ.

The particle moves up the plane with a constant deceleration of $\frac{4}{5}g$

(*a*) Find the value of μ.

(6)

The particle comes to rest at the point A on the plane.

(*b*) Determine whether the particle will remain at A, carefully justifying your answer.

(2)

(Total for Question 2 is 8 marks)

3.

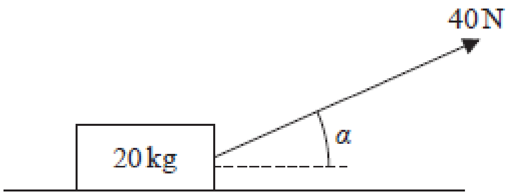

Figure 1

A wooden crate of mass 20 kg is pulled in a straight line along a rough horizontal floor using a handle attached to the crate.

The handle is inclined at an angle α to the floor, as shown in Figure 1, where $\tan \alpha = \frac{3}{4}$.

The tension in the handle is 40 N. The coefficient of friction between the crate and the floor is 0.14. The crate is modelled as a particle and the handle is modelled as a light rod.

Using the model,

(a) find the acceleration of the crate.

(6)

The crate is now pushed along the same floor using the handle. The handle is again inclined at the same angle α to the floor, and the thrust in the handle is 40 N as shown in Figure 2 below.

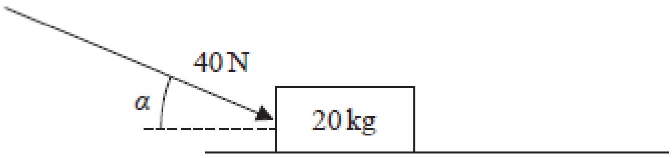

Figure 2

(b) Explain briefly why the acceleration of the crate would now be less than the acceleration of the crate found in part (a).

(2)

(Total for Question 3 is 8 marks)

4.

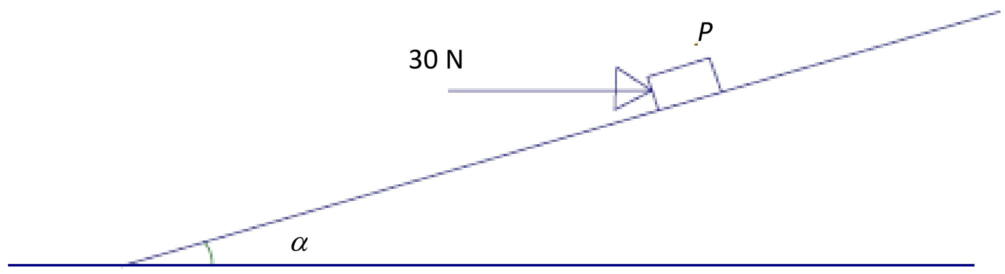

Figure 3

A package P of weight 20 N is moving up an inclined plane under the action of a horizontal force of magnitude 30 N, as shown in Figure 3. The force is acting in a vertical plane through a line of greatest slope of the plane. The coefficient of friction between P and the plane is μ.
The plane is inclined at angle α to the horizontal, where $\tan \alpha = \frac{5}{12}$.

Package P is modelled as a particle.

(a) Find the magnitude of the normal reaction of the plane on P.

(2)

(b) Find the range of possible values of μ.

(4)

The horizontal force is now removed and P continues to slide up the plane until P comes to instantaneous rest. Package P then slides back down the plane.

Given that $\mu = \frac{1}{3}$,

(c) find the acceleration of P as it slides down the plane.

(5)

(Total for Question 4 is 11 marks)

5.

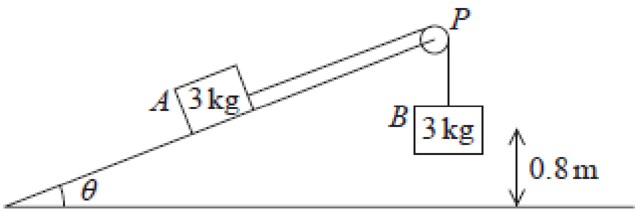

Figure 3

Two packages A and B, each of mass 3 kg, are attached to the ends of a rope. Initially A is held at rest on a smooth fixed plane that is inclined at angle θ to the horizontal ground, where $\sin\theta = \frac{2}{7}$.

The rope passes over a pulley, P, fixed at the top of the plane. The pulley is modelled as small and smooth. The part of the string from A to P is parallel to a line of greatest slope of the plane. Package B hangs freely below P, as shown in Figure 3.

The packages are released from rest with the string taut and A moves up the plane. In this model, the packages are modelled as particles and the rope as a light inextensible string. The magnitude of the tension in the string immediately after the packages are released is T newtons.

(a) Find the value of T.

(6)

At the instant when the packages are released from rest, B is 0.8 m above the ground and A is at the point C on the plane. When B reaches the ground, B is immediately brought to rest by the impact with the ground. In the subsequent motion, A does not reach P and comes to instantaneous rest at the point D on the plane.

(b) Find the distance CD.

(5)

(c) State two limitations of the model that could affect the reliability of your answers.

(2)

(Total for Question 5 is 13 marks)

6.

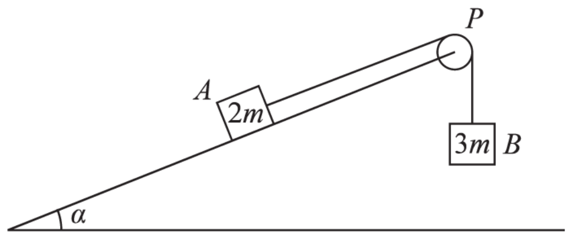

Figure 1

Two blocks, A and B, of masses $2m$ and $3m$ respectively, are attached to the ends of a light string.

Initially A is held at rest on a fixed rough plane.

The plane is inclined at angle a to the horizontal ground, where $\tan \alpha = \frac{5}{12}$

The string passes over a small smooth pulley, P, fixed at the top of the plane.

The part of the string from A to P is parallel to a line of greatest slope of the plane.
Block B hangs freely below P, as shown in Figure 1.

The coefficient of friction between A and the plane is $\frac{2}{3}$

The blocks are released from rest with the string taut and A moves up the plane.

The tension in the string immediately after the blocks are released is T.

The blocks are modelled as particles and the string is modelled as being inextensible.

(a) Show that $T = \frac{12mg}{5}$

(8)

After B reaches the ground, A continues to move up the plane until it comes to rest before reaching P.

(b) Determine whether A will remain at rest, carefully justifying your answer.

(2)

(c) Suggest two refinements to the model that would make it more realistic.

(2)

(Total for Question 6 is 12 marks)