Lesson 4

A-Level Applied Mathematics
Mechanics : Dynamics II : Year 2

4.1 Acceleration on a Slope

Example

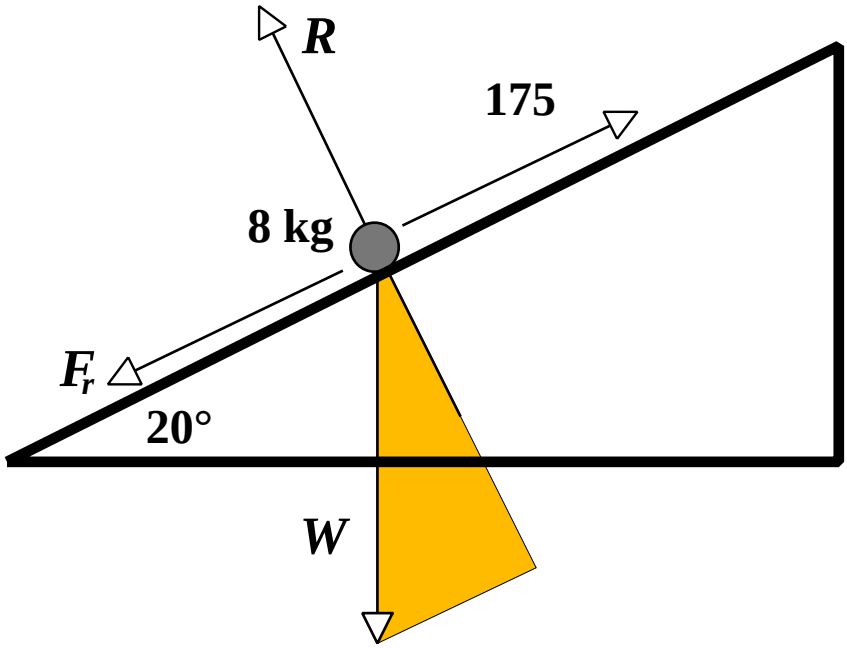
An 8 kg rocket is being launched up a rough slope by engines thrusting with 175 N.
The slope is inclined at an angle of 20° to the horizontal.
The coefficient of friction between box and slope is 0.6.

(i) Resolve the force associated with the 8 kg mass into two component parts, one parallel to the slope, the other perpendicular to the slope.

(ii) What is the magnitude of the normal reaction between box and slope ?

(iii) What is the magnitude of the friction force opposing motion ?

(iv) Find the constant acceleration of the box up the slope.



4.2 Exercise

Question 1

A car of mass 980 kg is being driven up an inclined road.
It's engine is generating a driving force of 8 kN.
The road makes an angle of 27° to the horizontal.
The coefficient of friction between car and road is 0.4.

(i) Resolve the force associated with the 980 kg mass into two component parts, one parallel to the road, the other perpendicular to the road.

(ii) What is the magnitude of the normal reaction between car and road ?

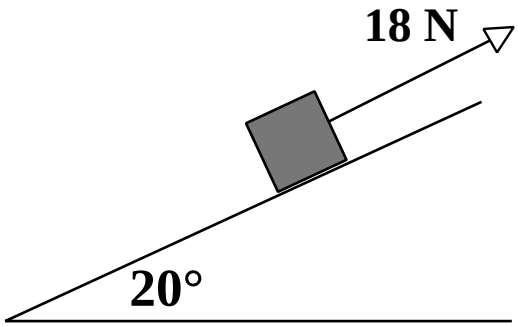
(iii) What is the magnitude of the friction force opposing motion ?

(iv) Find the constant acceleration of the car up the inclined road.

HINT : Draw a good sized diagram.

Question 2

M1 examination question from June 2005



A box of mass 2 kg is pulled up a rough plane by means of a light rope.
The plane is inclined at an angle of 20° to the horizontal.
The rope is parallel to a line of greatest slope of the plane.
The tension in the rope is 18 N.
The coefficient of friction between the box and the plane is 0.6.
By modelling the box as a particle, find

(a) the normal reaction on the box,

[3 marks]

(b) the acceleration of the box.

[5 marks]

Question 3

A 2 kg crate is being hauled DOWN a very rough slope by a light rope pulling with a force of 20 N parallel to the plane.

The slope is inclined at an angle of 18° to the horizontal.

The coefficient of friction between crate and slope is 0.85.

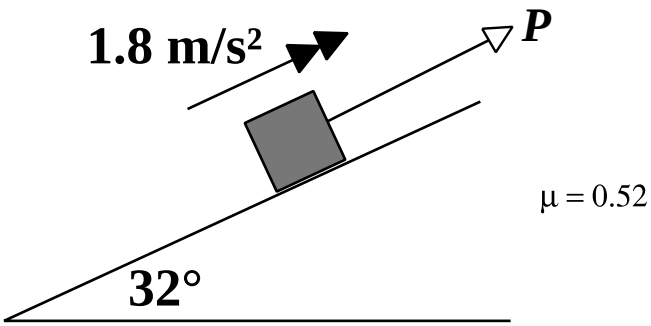
(i) Resolve the force associated with the 2 kg mass into two component parts, one parallel to the slope, the other perpendicular to the slope.

(ii) What is the magnitude of the normal reaction between crate and slope ?

(iii) What is the magnitude of the friction force opposing motion ?
Also, does this friction force act up or down the slope ?

(iv) Find the constant acceleration of the crate down the slope.

Question 4



A box of mass 12 kg is moving with constant accelerating of 1.8 m s^{-2} up a rough slope inclined at 32° to the horizontal.

For the system, μ = 0.52, and the pulling rope is light and parallel to the plane.

(i) Resolve the force associated with the 12 kg mass into two component parts, one parallel to the slope, the other perpendicular to the slope.

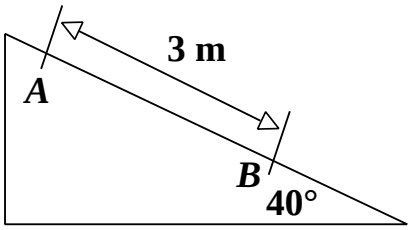
(ii) What is the magnitude of the normal reaction between box and slope ?

(iii) What is the magnitude of the friction force opposing motion ?

(iv) Calculate the tension in the pulling rope, *P*.

Question 5

A-Level Examination Question from June 2014, M1, Q2



A rough plane is inclined at 40° to the horizontal. Two points *A* and *B* are 3 metres apart and lie on a line of greatest slope of the inclined plane, with *A* above *B*, as shown. A particle *P* of mass *m* kg is held at rest on the plane at *A*.

The coefficient of friction between *P* and the plane is 0.5. The particle is released.

(a) Find the acceleration of *P* down the plane.

[5 marks]

(b) Find the speed of *P* at *B*

[2 marks]