

QQQ – Mechanics Year 2 – Chapter 5 – Resolving Forces & Friction (Version 2)

Total Marks: 24

(24 = Platinum, 22 = Gold, 19 = Silver, 16 = Bronze)

1.

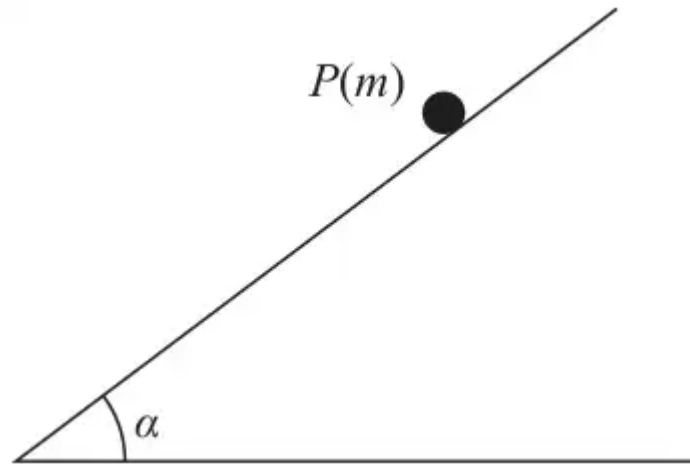


Figure 3

A particle P of mass m is held at rest at a point on a rough inclined plane, as shown in Figure 3.

It is given that

- the plane is inclined to the horizontal at an angle α , where $\tan \alpha = \frac{5}{12}$
- the coefficient of friction between P and the plane is μ , where $\mu < \frac{5}{12}$

The particle P is released from rest and slides down the plane.

Air resistance is modelled as being negligible.

Using the model,

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

(b) show that, as P slides down the plane, the acceleration of P down the plane is

$$\frac{1}{13}g(5 - 12\mu)$$

(4)

(c) State what would happen to P if it is released from rest but $\mu \geq \frac{5}{12}$ (1)

(Total 7 marks)

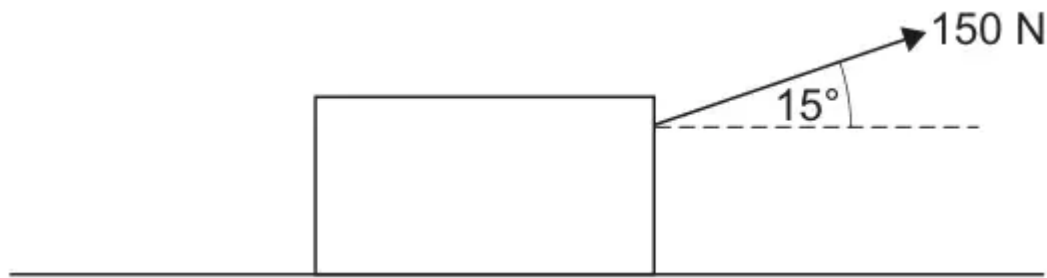
2. In this question use $g = 9.8 \text{ m s}^{-2}$

A boy attempts to move a wooden crate of mass 20 kg along horizontal ground. The coefficient of friction between the crate and the ground is 0.85

- (a) The boy applies a horizontal force of 150 N. Show that the crate remains stationary.

[3 marks]

- (b) Instead, the boy uses a handle to pull the crate forward. He exerts a force of 150 N, at an angle of 15° above the horizontal, as shown in the diagram.



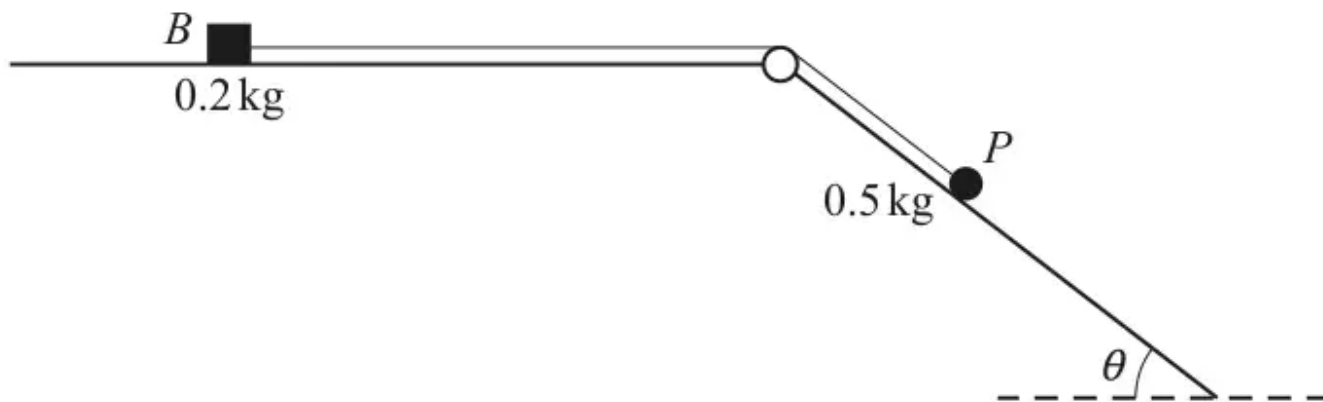
Determine whether the crate remains stationary.

Fully justify your answer.

[5 marks]

(Total 8 marks)

3.



The diagram shows a small block B , of mass 0.2 kg , and a particle P , of mass 0.5 kg , which are attached to the ends of a light inextensible string. The string is taut and passes over a small smooth pulley fixed at the intersection of a horizontal surface and an inclined plane.

The block can move on the horizontal surface, which is rough. The particle can move on the inclined plane, which is smooth and which makes an angle of θ with the horizontal where $\tan \theta = \frac{3}{4}$.

The system is released from rest. In the first 0.4 seconds of the motion P moves 0.3 m down the plane and B does not reach the pulley.

- (a) Find the tension in the string during the first 0.4 seconds of the motion. [4]
- (b) Calculate the coefficient of friction between B and the horizontal surface. [5]

(Total 9 marks)