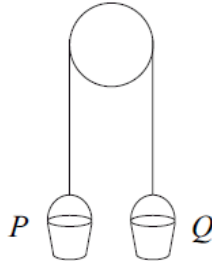


Mechanics 1 Newton's Laws Questions

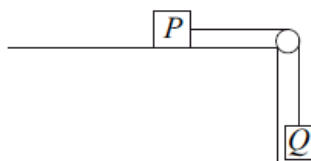
- 7 A builder ties two identical buckets, P and Q , to the ends of a light inextensible rope. He hangs the rope over a smooth beam so that the buckets hang in equilibrium, as shown in the diagram.



The buckets are each of mass 0.6 kg .

- (a) (i) State the magnitude of the tension in the rope. *(1 mark)*
- (ii) State the magnitude and direction of the force exerted on the beam by the rope. *(2 marks)*
- (b) The bucket Q is held at rest while a stone, of mass 0.2 kg , is placed inside it. The system is then released from rest and, in the subsequent motion, bucket Q moves vertically downwards with the stone inside.
- (i) By forming an equation of motion for each bucket, show that the magnitude of the tension in the rope during the motion is 6.72 newtons, correct to three significant figures. *(6 marks)*
- (ii) State the magnitude of the force exerted on the beam by the rope while the motion takes place. *(1 mark)*
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- 5 A small block P is attached to another small block Q by a light inextensible string. The block P rests on a rough horizontal surface and the string hangs over a smooth peg so that Q hangs freely, as shown in the diagram.



The block P has mass 0.4 kg and the coefficient of friction between P and the surface is 0.5 .

The block Q has mass 0.3 kg .

The system is released from rest and Q moves vertically downwards.

- (a) (i) Draw a diagram to show the forces acting on P . *(1 mark)*
- (ii) Show that the frictional force between P and the surface has magnitude 1.96 newtons . *(2 marks)*
- (b) By forming an equation of motion for each block, show that the magnitude of the acceleration of each block is 1.4 ms^{-2} . *(5 marks)*
- (c) Find the speed of the blocks after 3 seconds of motion. *(2 marks)*
- (d) After 3 seconds of motion, the string breaks. The blocks continue to move. Comment on how the speed of each block will change in the subsequent motion. For each block, give a reason for your answer. *(4 marks)*
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- 2 A lift rises vertically from rest with a constant acceleration.

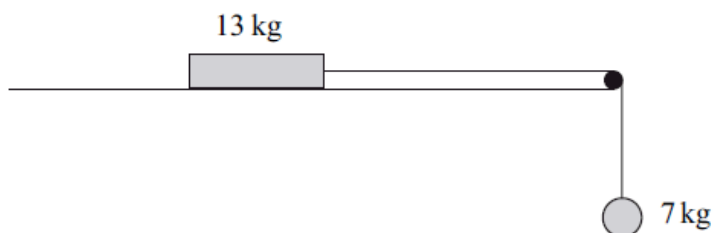
After 4 seconds , it is moving upwards with a velocity of 2 ms^{-1} .

It then moves with a constant velocity for 5 seconds .

The lift then slows down uniformly, coming to rest after it has been moving for a total of 12 seconds .

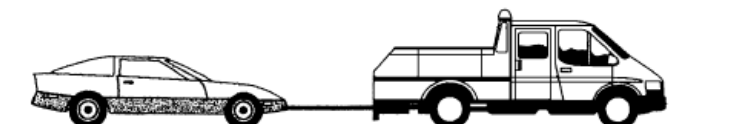
- (a) Sketch a velocity–time graph for the motion of the lift. *(4 marks)*
- (b) Calculate the total distance travelled by the lift. *(2 marks)*
- (c) The lift is raised by a single vertical cable. The mass of the lift is 300 kg . Find the maximum tension in the cable during this motion. *(4 marks)*
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- 4 The diagram shows a block, of mass 13 kg, on a rough horizontal surface. It is attached by a string that passes over a smooth peg to a sphere of mass 7 kg, as shown in the diagram.



The system is released from rest, and after 4 seconds the block and the sphere both have speed 6 m s^{-1} , and the block has **not** reached the peg.

- State **two** assumptions that you should make about the string in order to model the motion of the sphere and the block. *(2 marks)*
 - Show that the acceleration of the sphere is 1.5 m s^{-2} . *(2 marks)*
 - Find the tension in the string. *(3 marks)*
 - Find the coefficient of friction between the block and the surface. *(6 marks)*
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- 4 A car, of mass 1200 kg, is connected by a tow rope to a truck, of mass 2800 kg. The truck tows the car in a straight line along a horizontal road. Assume that the tow rope is horizontal. A horizontal driving force of magnitude 3000 N acts on the truck. A horizontal resistance force of magnitude 800 N acts on the car. The car and truck accelerate at 0.4 m s^{-2} .



- Find the tension in the tow rope. *(3 marks)*
- Show that the magnitude of the horizontal resistance force acting on the truck is 600 N. *(4 marks)*
- In fact, the tow rope is **not** horizontal. Assume that the resistance forces and the driving force are unchanged.

Is the tension in the tow rope greater or less than in part (a)?

Explain why.

(2 marks)
