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2D Vectors & NII 1ii

A Level
P P P

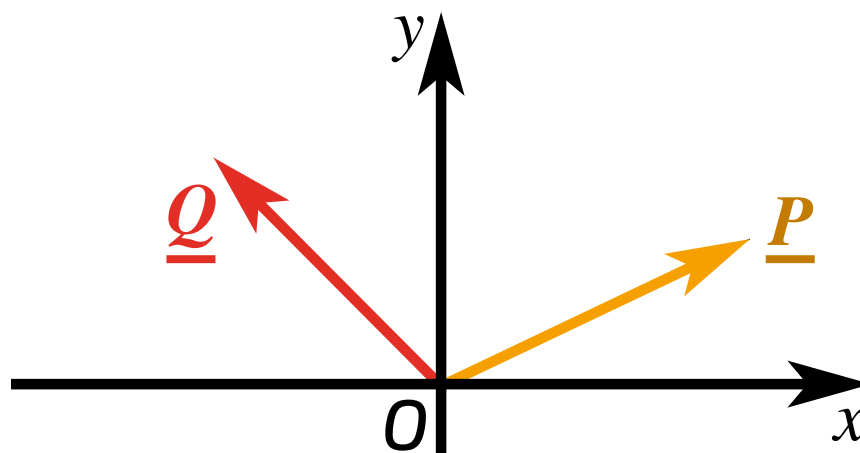


Figure 1: Two horizontal forces \underline{P} and \underline{Q} acting at the origin.

Two horizontal forces \underline{P} and \underline{Q} act at the origin O as shown in **Figure 1**.

The components of \underline{P} in the x - and y -directions are 14 N and 5 N respectively.

The components of \underline{Q} in the x - and y -directions are -9 N and 7 N respectively.

Part A Resultant force components

Write down the x -component of the resultant of \underline{P} and \underline{Q} .

Write down the y -component of the resultant of \underline{P} and \underline{Q} .

Part B Resultant force magnitude and angle

Find the magnitude of the resultant force.

Find the angle the resultant makes with the positive x -axis to 3 significant figures.

Part C Acceleration

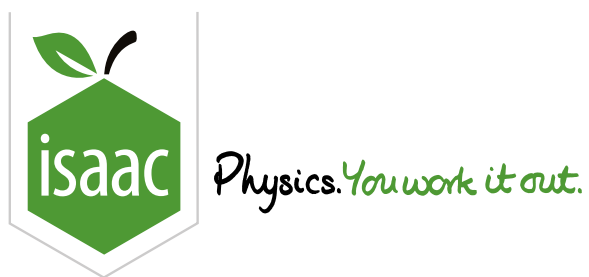
The two forces \underline{P} and \underline{Q} act on a particle of mass 0.2 kg.

Express the acceleration of the particle using the unit vectors \underline{i} and \underline{j} .

$$\underline{a} = \text{ } \underline{i} + \text{ } \underline{j}$$

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2D Vectors & NII 2ii

A Level

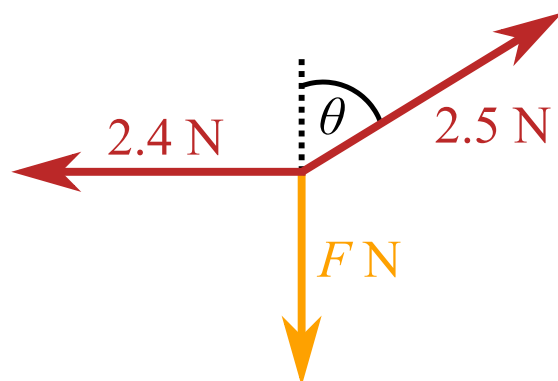


Figure 1: Diagram showing three forces acting on a particle.

A particle rests on a smooth horizontal surface. Three horizontal forces of magnitudes 2.5 N, F N and 2.4 N act on the particle on bearings θ , 180° and 270° respectively. The particle is in equilibrium.

Part A Vector notation

The 2.5 N force may be written in the form $(p\mathbf{i} + q\mathbf{j})\text{N}$. Write down the value of p .

Part B Finding F

Hence, find F .

Part C Finding θ

Find θ to 3 significant figures.

Part D Acceleration

The 2.4 N force suddenly ceases to act on the particle, which has mass 0.2 kg.

Find the magnitude of the acceleration of the particle.

$$|\underline{a}| = \boxed{}$$

Find the direction of the acceleration of the particle. Give your answer in the form of a bearing, to the nearest degree.

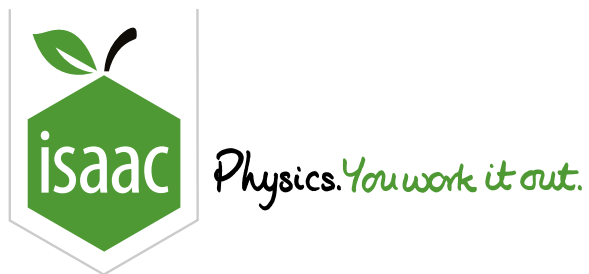
$$\boxed{}^\circ$$

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Friction 2i

A Level



A particle of mass 2 kg is propelled in a straight line across a rough surface with an initial velocity $\underline{u} = (12\underline{i} + 9\underline{j}) \text{ m s}^{-1}$. It comes to rest in 3 seconds.

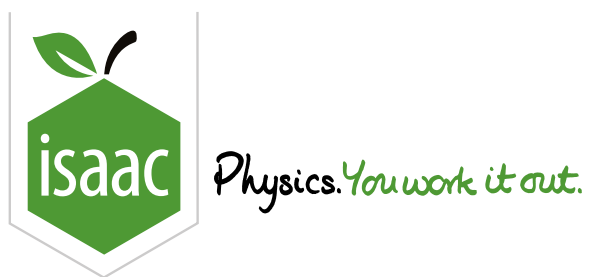
Assuming that the frictional force is constant throughout the motion and no other forces are acting, what is the magnitude of the frictional force?

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Friction 1ii

A Level

A block of mass 4 kg is in equilibrium on a rough surface under the influence of a horizontal force, X , of 11.8 N .

Part A Diagram

In addition to X there are three other forces on the block. Each of these forces is a different type. Choose the three types from the list below.

- ☐ Electrostatic
- ☐ Friction
- ☐ Magnetic
- ☐ Normal reaction
- ☐ Tension
- ☐ Weight

Part B Ratio of forces

Find the ratio of the frictional force, F , to the normal reaction, R . Give your answer to one decimal place.

Part C Finding M

A different block, of mass M , is placed on the same surface. A force of 16.8 N is applied in place of force X . Again the system is in equilibrium.

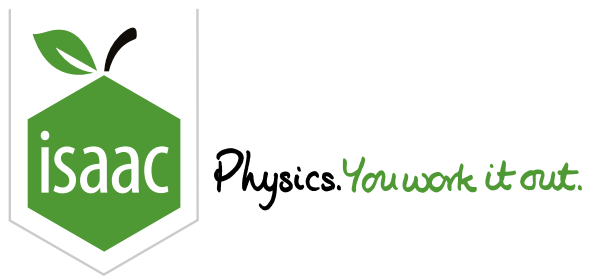
Assuming the same ratio applies to the frictional and normal forces, find the value of M to 3 significant figures.

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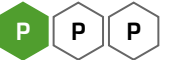
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Newton's Laws 2i

A Level

A trailer of mass 500 kg is attached to a car of mass 1250 kg by a light rigid horizontal tow-bar. The car and trailer are travelling along a horizontal straight road. The resistance to motion of the trailer is 400 N and the resistance to motion of the car is 900 N. Find both the tension in the tow-bar and the driving force of the car in each of the following cases.

Part A Driving force 1

The car and trailer are travelling at constant speed.

What is the driving force?

Part B Tension 1

What is the tension in the tow-bar?

Part C Driving force 2

The car and trailer have acceleration 0.6 m s^{-2} .

What is the driving force of the car? Give your answer to 4 significant figures.

Part D Tension 2

What is the tension in the tow-bar?

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Normal Reaction 2i

A Level

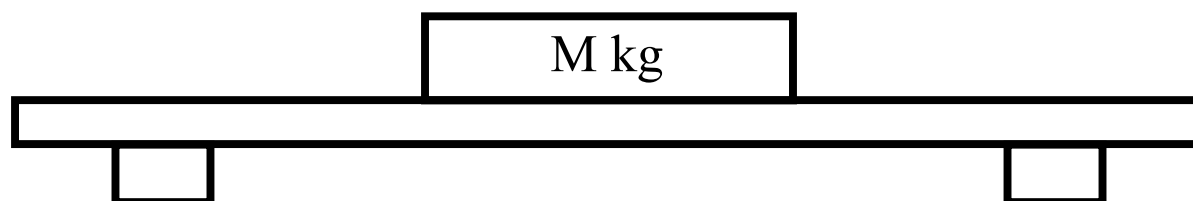


Figure 1: Diagram showing a block of mass M kg on a platform which is raised by a hoist.

A box of mass M kg is loaded onto a platform which can be raised by a hoist. The platform, which consists of 2 vertical supports and a horizontal plate, has a total mass of 30 kg. Before the hoist is attached, the box and platform are on horizontal ground and the thrust in each support is 350 N.

Part A Mass of box

Find the mass of the box to 3 significant figures.

Part B Normal reaction 1

The platform is now connected to the hoist cable, raised slowly by a short distance so that it leaves the ground, and brought to a halt.

Find the normal reaction on the box in this stationary position to 3 significant figures.

Part C Tension

Find the tension in the hoist cable.

Part D Normal reaction 2

The hoist suddenly jerks the platform upwards, with an initial acceleration of 1.5 m s^{-2} .

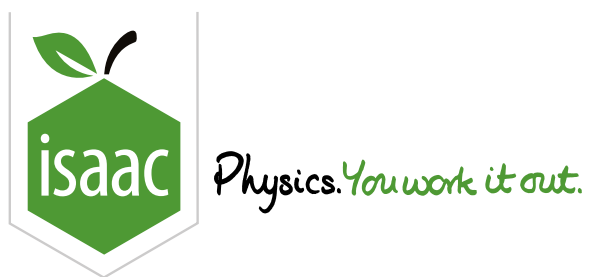
Find the normal reaction on the box to 3 significant figures.

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Analysing Systems and Forces 2i

A Level
P P P

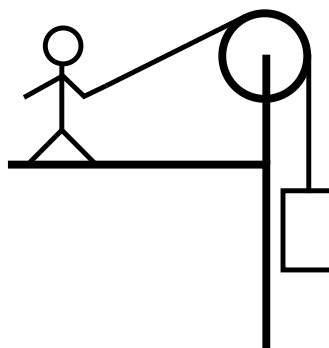


Figure 1: Man preparing to lower a box down a cliff.

A man is preparing to lower a box down a cliff. He sets up a fixed pulley with a rope as shown in **Figure 1**. He pulls on the rope with a force $-(100\hat{i} + 75\hat{j})$ N and the box settles into a stationary position with the rope between the box and pulley vertical.

Part A Force in rope

The force **on the man's hand from the rope** can be written as

$$\underline{\mathbf{F}} = \begin{pmatrix} F_1 \\ F_2 \end{pmatrix}$$

Find F_1 and F_2 .

$F_1 =$

$F_2 =$

Part B Magnitude of tension

What is the magnitude of the tension in the rope?

Part C Assumptions

In order to model the system mathematically, it is necessary to make assumptions. From the list below choose one assumption you need to make about the pulley and two assumptions about the rope.

- The pulley is .
- The rope is and .

Items:

inextensible

light

slack

smooth

Part D Force diagrams

Choose the correct labels for the diagrams below, which show the forces in the rope at the pulley, and the forces on the box.

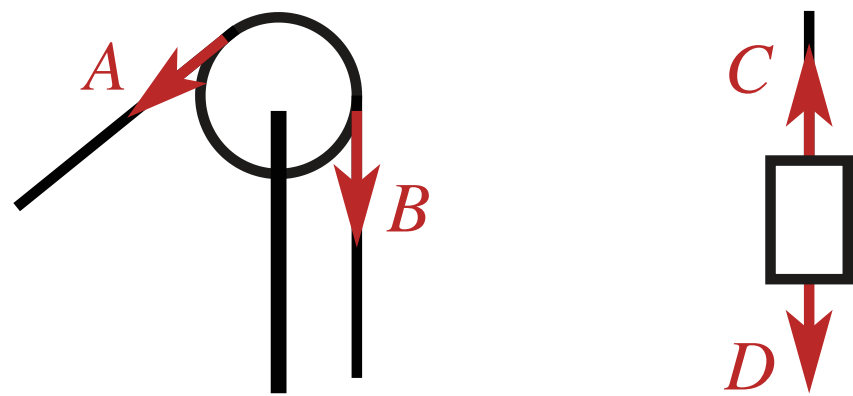


Figure 2: Force diagrams showing the forces in the rope at the pulley, and the forces on the box.

Force A:

Force B:

Force C:

Force D:

Items:

- Tension, 75 N
- Tension, 100 N
- Tension, 125 N
- Weight, mg

Part E Mass of box

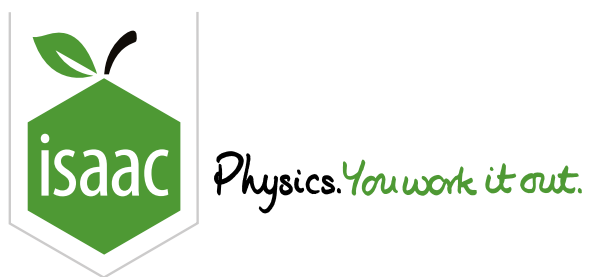
Find the mass of the box to 3 significant figures.

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Analysing Systems and Forces 1i

A Level
P P P

A small, smooth pulley is suspended from a fixed point by a light chain. A light inextensible string passes over the pulley. Particles P and Q, of masses 0.30 kg and m respectively, are attached to the opposite ends of the string. The particles are released from rest at a height of 0.20 m above horizontal ground with the string taut; the portions of the string not in contact with the pulley are vertical. P strikes the ground with speed 1.4 m s^{-1} . Subsequently P remains on the ground and Q does not reach the pulley.

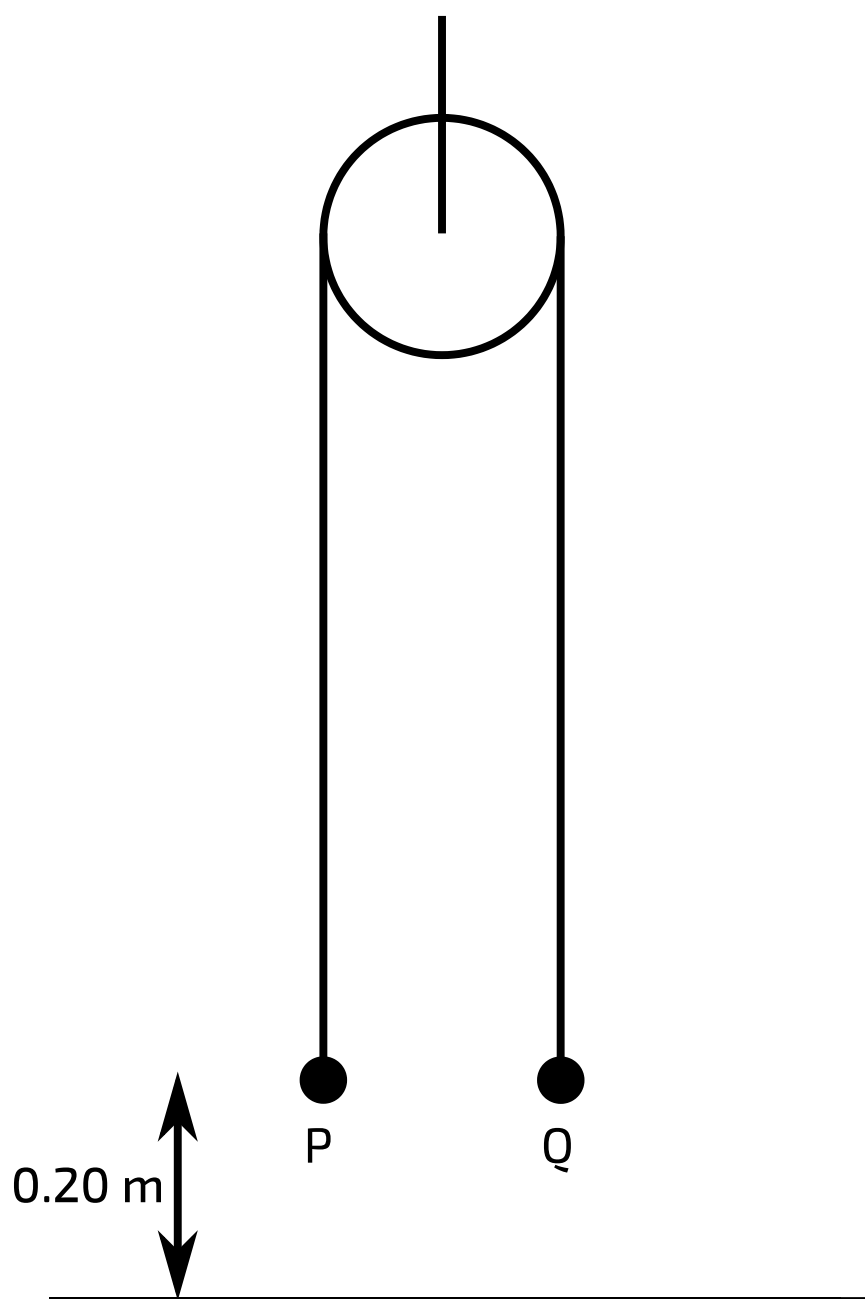


Figure 1: Diagram showing string with P and Q on either end passing over a pulley.

Part A Acceleration of P

Calculate the acceleration of P while it is in motion to 2 significant figures.

Part B Tension in the string

Calculate the tension in the string to 2 significant figures.

Part C Mass of Q

Find the mass of Q.

Part D Height of Q

Calculate the greatest height of Q above the ground.

Part E Tension in the chain

It is given that the mass of the pulley is 0.50 kg.

State the magnitude of the tension in the chain which supports the pulley when **P is in motion**. Give your answer to 2 significant figures.

Part F Tension when Q moving upwards

State the magnitude of the tension in the chain which supports the pulley when **P is at rest on the ground and Q is moving upwards**. Give your answer to 2 significant figures.

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