A-Level Starter Activity

Jethwa Maths

Topic: Friction on a Horizontal Surface

Chapter Reference: Mechanics 2, Chapter 5

8 minutes

1.

Two particles P and Q, of mass 2 kg and 3 kg respectively, are joined by a light inextensible string. Initially the particles are at rest on a rough horizontal plane with the string taut. A constant force F of magnitude 30 N is applied to Q in the direction PQ, as shown in Figure 4. The force is applied for 3 s and during this time Q travels a distance of 6 m. The coefficient of friction between each particle and the plane is μ. The acceleration of the system is $1\frac{1}{3}$ ms^{-2} Find,

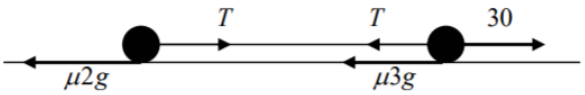
a. The value of μ **(3)**

b. The tension in the string **(3)**

c. State how in your calculation you have used the information that the string is inextensible **(1)**

Solutions

1a.



Applying Newton's Second Law for System,	**M1**
$30 - \mu 5g = 5(1\frac{1}{3})$	**M1**
$\mu = \frac{10}{21}$ (0.48)	**M1**

1b.

Applying Newton's Second Law for P	**M1**
$T - \frac{14}{3g} \times 2g = 2 \times \frac{4}{3}$	**M1**
$T = 12$N	**M1**

1c.

The acceleration of P and Q is the same.	**M1**

A-Level Starter Activity

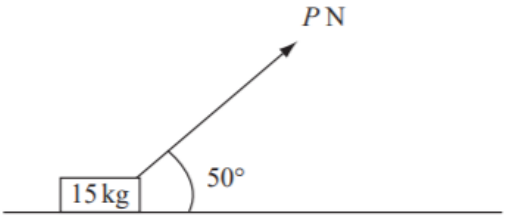
Jethwa Maths

Topic: Forces and Friction

Chapter Reference: Mechanics 2, Chapter 5

7 minutes

1.



A small box of mass 15 kg rests on a rough horizontal plane. The coefficient of friction between the box and the plane is 0.2 . A force of magnitude P newtons is applied to the box at 50° to the horizontal, as shown in Figure 1. The box is on the point of sliding along the plane. Find the value of P, giving your answer to 2 significant figures. **(7)**

Solutions

1.

Resolving horizontally,	**M1**
F = P cos 50	**M1**
$F = \mu R$ F = 0.2R	**M1**
Resolving vertically,	**M1**
P sin 50 + R = 15g	**M1**
Eliminating R, solving for P,	**M1**
P = 37 N	**M1**

A-Level Starter Activity

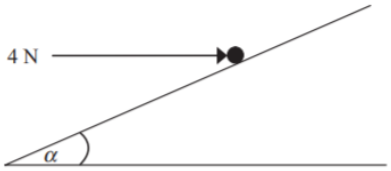
Jethwa Maths

Topic: Forces and Friction 2

Chapter Reference: Mechanics 2, Chapter 5

7 minutes

1.



A particle of weight W newtons is held in equilibrium on a rough inclined plane by a horizontal force of magnitude 4 N. The force acts in a vertical plane containing a line of greatest slope of the inclined plane. The plane is inclined to the horizontal at an angle α where $\tan \alpha = \frac{3}{4}$ as shown in the figure.

The coefficient of friction between the particle and the plane is $\frac{1}{2}$. Given that the particle is on the point of sliding down the plane,

Find the value of W. **(8)**

Solutions

1a.

Resolving perpendicular	**M1**
$R = 4 \sin \alpha + W \cos \alpha$	**M1**
Resolving parallel to the plane,	**M1**
$4 \cos \alpha + F = W \sin \alpha$	**M1**
$F = \mu R$ $F = 0.5R$	**M1**
$\cos \alpha = 0.8$ $\sin \alpha = 0.6$	**M1**
Solving simultaneously, $R = 4(0.6) + W(0.8)$ $4(0.8) + F = W(0.6)$	**M1**
$W = 22$N	**M1**

A-Level Starter Activity

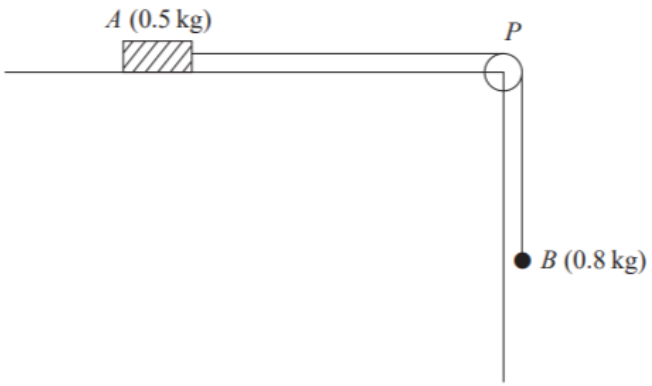
Jahwa Maths

Topic: Friction (Horizontal Table)

Chapter Reference: Mechanics 2, Chapter 5

8 minutes

1.



A block of wood A of mass 0.5 kg rests on a rough horizontal table and is attached to one end of a light inextensible string. The string passes over a small smooth pulley P fixed at the edge of the table. The other end of the string is attached to a ball B of mass 0.8 kg which hangs freely below the pulley, as shown in the figure. The coefficient of friction between A and the table is μ. The system is released from rest with the string taut. After release, B descends a distance of 0.4 m in 0.5 s. The acceleration of the system in 3.2 ms^{-2}. Modelling A and B as particles, calculate,

a. The tension in the string **(4)**

b. The value of μ **(5)**

c. State how in your calculations you have used the information that the string is inextensible. **(1)**

Solutions

1a.

Applying Newton's Second law to B,	**M1**
$F = ma$ $0.8g - T = 0.8 \times 3.2$	**M1**
$T = 0.8g - (0.8 \times 3.2)$ (This step can be implied)	**M1**
$T = 5.28$ N	**M1**

1b.

Applying Newton's Second law to A,	**M1**
$T - F = 0.5a$ $F = 5.28 - 0.5a$	**M1**
Also, $F = \mu R$ $F = 0.5\mu g$	**M1**
Equating 'F' $5.28 - 0.5a = 0.5\mu g$	
$\mu = 0.75$	

1c.

A and B have the same acceleration	**M1**

A-Level Starter Activity

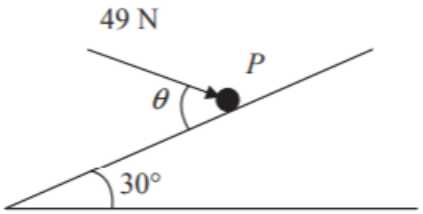
Jethwa Maths

Topic: Resolving on Inclined Planes

Chapter Reference: Mechanics 2, Chapter 5

8 minutes

1. A particle P of mass 6 kg lies on the surface of a smooth plane. The plane is inclined at an angle of 30^o to the horizontal. The particle is held in equilibrium by a force of magnitude 49 N, acting at an angle to the plane, as shown in the figure. The force acts in a vertical plane through a line of greatest slope of the plane.



a. Show that $\cos\theta = \frac{3}{5}$ **(3)**

b. Find the normal reaction between P and the plane. **(4)**

Solutions

1a.

Resolving parallel to the plane	**M1**
$49 \cos \theta = 6g \sin 30$	**M1**
$\cos \theta = \frac{3}{5}$	**M1**

1b.

Resolving perpendicular to the plane	**M1**
$R = 6g \cos 30 + 49 \sin \theta$	**M1**
$\sin \theta = \frac{4}{5}$	**M1**
$R = 90.1$	**M1**

A-Level Starter Activity

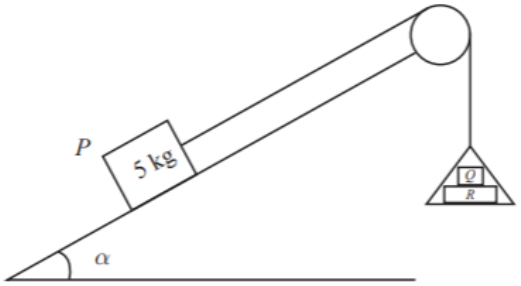
Jahwa Maths

Topic: Inclined Plane with Scale Pan

Chapter Reference: Mechanics 2, Chapter 5

8 minutes

1.



One end of a light inextensible string is attached to a block P of mass 5 kg. The block P is held at rest on a smooth fixed plane which is inclined to the horizontal at an angle α, where $\sin\alpha = \frac{3}{5}$. The string lies along a line of greatest slope of the plane and passes over a smooth light pulley which is fixed at the top of the plane. The other end of the string is attached to a light scale pan which carries two blocks Q and R, with block Q on top of block R, as shown in Figure 3. The mass of block Q is 5 kg and the mass of block R is 10 kg. The scale pan hangs at rest and the system is released from rest. By modelling the blocks as particles, ignoring air resistance and assuming the motion is uninterrupted.

Find the acceleration of the scale pan and the tension in the string. **(8)**

Solutions

1.

Applying Newton's Second Law to P	**M1**
$T - 5g \sin \alpha = 5a$	**M1**
Applying Newton's Second Law to Scale Pan	**M1**
$15g - T = 15a$	**M1**
Solving for a	**M1**
$a = 0.6g$ ms^{-2}	**M1**
Solving for T	**M1**
$T = 6g$ ms^{-2}	**M1**

A-Level Starter Activity

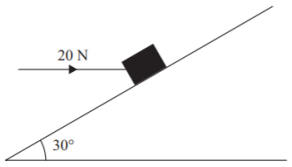
Jethwa Maths

Topic: Inclined Planes

Chapter Reference: Mechanics 2, Chapter 5

4 minutes

1.



A box of mass 5 kg lies on a rough plane inclined at 30° to the horizontal. The box is held in equilibrium by a horizontal force of magnitude 20 N, as shown in Figure 2. The force acts in a vertical plane containing a line of greatest slope of the inclined plane. The box is in equilibrium and on the point of moving down the plane. The box is modelled as a particle.

Find the magnitude of the normal reaction of the plane on the box **(3)**

Solutions

1.

Resolving perpendicular to the plane	**M1**
$R = 20 \cos 60 + 5g \cos 30$	**M1**
$= 52.4$ N	**M1**