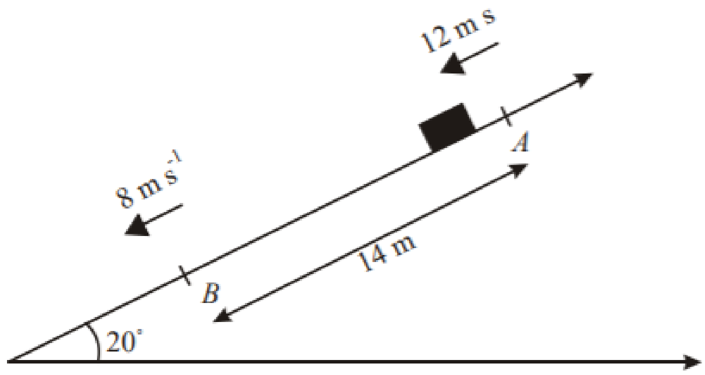
Further Maths A-Level Starter Activity

Topic: K.E and P.E (1)

Chapter Reference: Further Mechanics 1, Chapter 2

8 minutes

A package of mass 3.5 kg is sliding down a ramp. The package is modelled as a particle and the ramp as a rough plane inclined at an angle of 20° to the horizontal. The package slides down a line of greatest slope of the plane from a point *A* to a point *B*, where *AB* = 14 m. At *A* the package has speed 12 ms^{-1} and at *B* the package has speed 8 ms^{-1}, as shown in the diagram above.



Find the total energy lost by the package in travelling from *A* to *B*. **(5)**

Solutions

Change in K.E = $\frac{1}{2} \times 3.5\ (12^2 - 8^2)$ (= 140)	**B1**
Change in P.E = 3.5 x 9.8 x 14 sin 20	**M1**
Change in P.E = 164.238	**A1**
Change in energy = change in KE + change in PE	**M1**
Change in energy = 304J	**A1**

Topic: K.E and P.E (2)

Chapter Reference: Further Mechanics 1, Chapter 2

8 minutes

1. A brick of mass 3 kg slides in a straight line on a horizontal floor. The brick is modelled as a particle and the floor as a rough plane. The initial speed of the brick is 8 ms^{-1}. The brick is brought to rest after moving 12 m by the constant frictional force between the brick and the floor.

a. Calculate the kinetic energy lost by the brick in coming to rest, stating the units of your answer. **(2)**

b. Calculate the coefficient of friction between the brick and the floor **(4)**

Why risk it?! Draw a diagram

Solutions

1a.

K.E = $\frac{1}{2} \times 3 \times 8^2$	**B1**
= 96 J	**B1**

1b .

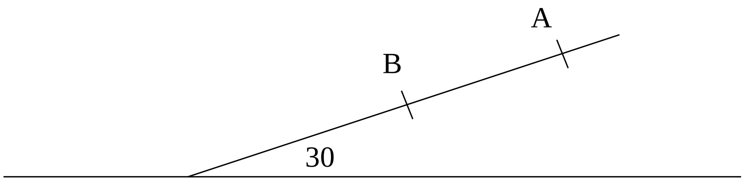
F = $\mu 3g$	**B1**
Using work energy principle	**M1**
$\mu 3g \times 12 = 96$	**A1**
μ = 0.27 (or 0.272)	**A1**

Topic: Conservation of Energy (3)

Chapter Reference: Further Mechanics 1, Chapter 2

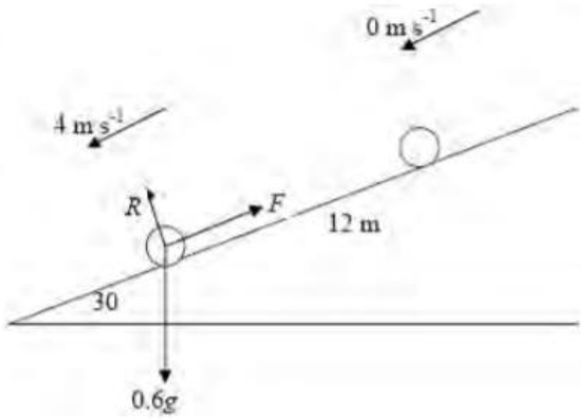
8 minutes

1. A particle P of mass 0.6 kg is released from rest at point A and slides down a line of greatest slope of a rough plane ending at point B. The plane is inclined at 30° to the horizontal. When P has moved 12 m, its speed is 4 ms^{-1}.



Given that friction is the only non-gravitational resistive force acting on P, find, the word done against friction as the speed of P increases from 0 ms^{-1} to 4 ms^{-1} **(4)**

<u>**Solutions**</u>



K.E. Gained = $\frac{1}{2}$ x 0.6 x 4^2	**M1**
P.E. Lost = 0.6 x g x (12 sin 30)	**M1**
Change in energy = P.E lost – K.E. gained = 0.6 x g x 12 sin 30 - $\frac{1}{2}$ x 0.6 x 4^2	**M1**
Work done against friction = 30 or 30.5J	**A1**

Topic: Work-Energy Principle (4)

Chapter Reference: Further Mechanics 1, Chapter 2

8 minutes

1. At a demolition site, bricks slide down a straight chute into a container. The chute is rough and is inclined at an angle of 30° to the horizontal. The distance travelled down the chute by each brick is 8 m. A brick of mass 3 kg is released from rest at the top of the chute. When it reaches the bottom of the chute, its speed is 5 ms^{-1}.

a. Find the potential energy lost by the brick in moving down the chute.

b. By using the work-energy principle, or otherwise, find the constant frictional force acting on the brick as it moves down the chute.

Why risk it?! Draw a diagram

Solutions

1a.

P.E Lost = 3 x g x 8 sin 30 = 3 x g x 8 x 0.5	**M1**
P.E Lost = 117.6 J	**A1**

1b.

K.E gained = $\frac{1}{2} \times 3 \times 5^2$	**M1**
K.E gained = = 37.5 J	**A1**
Work-energy: F x 8 = 117.6 – 37.5	**M1**
F = 10.0125 N	**A1**

Further Maths A-Level Starter Activity

Topic: Work-Energy Principle (5)

Chapter Reference: Further Mechanics 1, Chapter 2

10 minutes

1. A car of mass 1000 kg is moving along a straight horizontal road with a constant acceleration of f ms^{-2}. The resistance to motion is modelled as a constant force of magnitude 1200 N. When the car is travelling at 12 ms^{-1}, the power generated by the engine of the car is 24 kW.

a. Calculate the value of f. **(4)**

When the car is travelling at 14 ms^{-1} , the engine is switched off and the car comes to rest, without braking, in a distance of d metres. Assuming the same model for resistance,

b. Use the work-energy principle to calculate the value of d. **(3)**

c. Give a reason why the model used for the resistance to motion may not be realistic **(1)**

Why risk it?! Draw a diagram

Solutions

1a.

$T_r = \frac{2400}{12}$ (= 2000)	**M1**
Using Newton's second law	**M1**
$T_r - 1200 = 1000 \times f$	**A1**
$f = 0.08$	**A1**

1b.

Work energy principle	**M1**
$= \frac{1}{2} \times 1000 \times 14^2 = 1200d$	**A1**
$d = 81.666…. = 81.7$	**A1**

1c.

Resistances may vary with speed	**B1**

Topic: Power (6)

Chapter Reference: Further Mechanics 1, Chapter 2

10 minutes

1. A car of mass 1200 kg moves along a straight horizontal road. The resistance to motion of the car from non-gravitational forces is of constant magnitude 600 N. The car moves with constant speed and the engine of the car is working at a rate of 21 kW

a. Find the speed of the car **(3)**

The car moves up a hill inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{14}$. The car's engine continues to work at 21 kW, and the resistance to motion from nongravitational forces remains of magnitude 600 N.

b. Find the constant speed at which the car can move up the hill **(4)**

Why risk it?! Draw a diagram

Solutions

1a.

Driving force = $\frac{P}{v}$	**B1**
$\frac{21000}{v} = 600$	**M1**
v = 35 ms^{-1}	**A1**

1b.

$\frac{P}{v} = 600 + 1200 \times g \times \frac{1}{14}$	**M1**
$\frac{P}{v} = 1400\ N$	**A1**
$\frac{21000}{v} = 1440$ $v = \frac{21000}{1440}$	**M1**
v = 14.6 or 15 ms^{-1}	**A1**