The Law of Conservation of Energy (expanded)

Initial Energy = Final Energy

work done by engine +
initial GPE + initial KE = final GPE + final KE + w.d. against friction

Potential energy released/energy going in	=	Potential energy stored/energy going out

Consider the energy it has at the beginning - I tend to think of this as the energy it has in the bank (a bit like money).

Some of this energy is 'spent' in various ways - it is either spent and converted into another type of energy - or it is spent on having to overcome friction/resistance. Some energy is not spent, but is instead increased (e.g. the KE may increase if it gets faster because GPE is converted to KE)

If there is a force/engine doing work, then there is more energy 'in the bank' to be converted. This is why it is on the LHS of the equation.

A box of mass kg is projected from point A across a rough horizontal floor with speed $4ms^{-1}$. The box moves in a straight line across the floor and comes to rest at point B. The coefficient of friction between the box and the floor is 0.5

a) calculate the kinetic energy lost by the box

b) write down the work done against friction

c) calculate the distance AB

Ex 2C Q2, 4, 5, 6

A smooth plane is inclined at 30° to the horizontal. A particle of mass 0.5kg slides down a line of greatest slope of the plane. The particle starts from rest at point A and passes point B with a speed $6ms^{-1}$. Find the distance AB.

A particle of mass 2kg is projected with speed $8ms^{-1}$ up a line of greatest slope of a rough plane inclined at 45° to the horizontal. The coefficient of friction between the particle and the plane is 0.4. Calculate the distance the particle travels up the plane before coming to instantaneous rest.

A skier moving downhill passes point A on a ski run at $6ms^{-1}$. After descending 50m vertically the run begins to ascend. When the skier has ascended 25m to point B her speed is $4ms^{-1}$. The skier and her skis have a combined mass of 55kg. The total distance she travels from A to B is 1400m. The non-gravitational resistances to motion are constant and have a total magnitude of 12N.
Calculate the work done by the skier.

Ex 2C Q10-19

2.

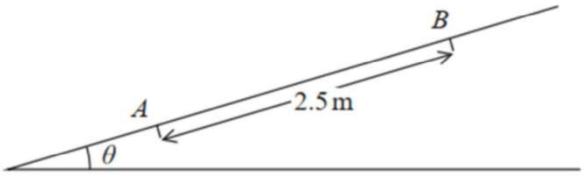

Figure 1

Figure 1 shows a ramp inclined at an angle θ to the horizontal, where $\sin\theta = \dfrac{2}{7}$

A parcel of mass 4 kg is projected, with speed $5\,\text{m}\,\text{s}^{-1}$, from a point A on the ramp.
The parcel moves up a line of greatest slope of the ramp and first comes to instantaneous rest at the point B, where $AB = 2.5$ m.
The parcel is modelled as a particle.

The total resistance to the motion of the parcel from non-gravitational forces is modelled as a constant force of magnitude R newtons.

(a) Use the work-energy principle to show that $R = 8.8$

(4)

After coming to instantaneous rest at B, the parcel slides back down the ramp. The total resistance to the motion of the particle is modelled as a constant force of magnitude 8.8 N.

(b) Find the speed of the parcel at the instant it returns to A.

(3)

(c) Suggest two improvements that could be made to the model.

(2)

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Edexcel M2 June 2007 Q4

Two particles *A* and *B*, of mass *m* and 2*m* respectively, are attached to the ends of a light inextensible string. The particle *A* lies on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The string passes over a small light smooth pulley *P* fixed at the top of the plane. The particle *B* hangs freely below *P*, as shown in Figure 2. The particles are released from rest with the string taut and the section of the string from *A* to *P* parallel to a line of greatest slope of the plane. The coefficient of friction between *A* and the plane is $\frac{5}{8}$. When each particle has moved a distance *h*, *B* has not reached the ground and *A* has not reached *P*.

(*a*) Find an expression for the potential energy lost by the system when each particle has moved a distance *h*.

(2)

When each particle has moved a distance *h*, they are moving with speed *v*. Using the work-energy principle,

(*b*) find an expression for v^2, giving your answer in the form *kgh*, where *k* is a number.

(5)

Extension: If B starts *s* meters above the ground Find an expression, in terms of for the total distance travelled by A before it first comes to rest.

4. (a)	PE lost $= 2mgh - mgh\sin\alpha$ $(= 7mgh/5)$	M1 A1 (2)
(b)	Normal reaction $R = mg\cos\alpha$ $(= 4mg/5)$	B1
	Work-energy: $\frac{1}{2}mv^2 + \frac{1}{2}2mv^2 = \frac{7mgh}{5} - \frac{5}{8}\cdot\frac{4mg}{5}h$	M1 A2,1,0
	$\Rightarrow \frac{3}{2}mv^2 = \frac{9mgh}{10} \Rightarrow v^2 = \frac{3}{5}gh$	A1 (5)

Answer to Extension:

Let extra distance = x

$\Rightarrow \frac{1}{2}mv^2 = mgx + F_r x$

$\Rightarrow \frac{1}{2}m\frac{3}{5}gs = mgx\frac{3}{5} + \frac{5}{8}mg\frac{4}{5}x$

$\Rightarrow \frac{3}{10}s = \frac{11}{10}x$

$\Rightarrow x = \frac{3s}{11}$

$\Rightarrow$ Total distance $= \frac{14s}{11}$