Kinetic energy and the work-energy principle

Starter

1. Find the work done by a man in these situations:
   (a) He pushes a packing case of mass of 35 kg a horizontal distance of 5 m against a resistive force of 200 N. The mass starts and finishes at rest.
   (b) He is handed a packing case of mass 35 kg. He holds it stationary, at the same height for 20 seconds and then someone else takes it from him.

Notes

Kinetic energy is measured in joules when mass is in kg and speed is in m/s and is given by the formula:

$$\textit{Kinetic energy} = \frac{1}{2}mv^2$$

E.g.1. Find the kinetic energy of a rugby player of mass 90 kg running at 6 m/s.

Work-energy principle

If a constant force, F, acts on an object over a horizontal distance, s, the work done by the force is equal to the gain in kinetic energy of the object. So if the velocity changes from u to v:

$$\text{Work done} = \text{Change in kinetic energy}$$
$$Fs = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

E.g. 2 A car and driver have a total mass of 1000 kg. The car gains speed from 7 m/s to 13 m/s with constant acceleration over a horizontal distance of 200 m. Calculate the driving force.

Extended work-energy principle

The work done by the force acting on an object, less the work done against resistance, is equal to the gain in kinetic energy of the object.

WD by driving force — WD against resistance = Change in kinetic energy

E.g. 3 A car is initially travelling at 6 m/s and then accelerates at a constant to 11 m/s over 350 m. Given that the resistance forces for 500 N. Given that the mass of the car is 900 kg, find the driving force of the engine.

E.g. 4 A ball of mass 1.2 kg moving with initial speed 20 m/s comes to rest after travelling 30 metres across a horizontal surface. Find the work done against resisting forces, and hence calculate the mean resisting force.

Video: Kinetic energy
Video: Work-energy principle

Solutions to Starter and E.g.s

Exercise

p8 1B Qu 1-12

Summary

Kinetic energy $= \frac{1}{2}mv^2$

Work-energy principle for motion along a horizontal road: Work done = Change in kinetic energy

$$Fs = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Extended work-energy principle: WD by driving force − WD against resistance = Change in KE