Work done by a force (single)

Starter

1. Prove that $2n + 1 < 2^n$ for all integers $n > 3$.

Notes

A force is required to move an object. Work done is the amount of energy required to move the object.

- Forces that promote movement are called propulsive forces (e.g. tension, tractive).
- Forces that resist movement are called resistive forces (e.g. friction, air resistance).

Work can be done by both propulsive and resistive forces as an object moves.

Formula for work done

Work done = force × distance $= Fs$

Work done is measured in joules (J) when force is measured in Newtons and distance is measured in metres. So 1 J $\equiv 1$Nm

E.g. 1 A car of mass 1200 kg travels 5 km at a constant speed along a road against resistive force of constant friction and air resistance force of 800 N and 500 N respectively. Calculate the work done by the engine.

Working: Since the car moves at a constant speed the work done by the engine equals the work down against the resistive forces
Work done $= (800 + 500) \times 5000 = 6500$ kJ

E.g. 2 A gardener moves a wheelbarrow 30 metres along a level, straight path. The work done by the gardener is 120 J, and the barrow is initially and finally at rest. Calculate the average force resisting the motion.

Work done against gravity

Work done against/by gravity = weight × height gained/lost

E.g. 3 A weightlifter raises a mass of 120 kg from the ground to above her head — a distance of 2 m. Calculate the work done against gravity. Assume $g = 9.8$. Give your answer to the nearest J.

Working: WD $= 120 \times 9.8 \times 2 = 2352$ J

E.g. 4 A man of mass 85 kg climbs 2 m up a ladder which is inclined at $70°$ to the horizontal. Calculate the work done against gravity. Give your answer to the nearest J.

Video: Work done by a force (horizontal plane)
Video: Work done by a force (vertical plane)

Solutions to Starter and E.g.s

Exercise

p5 1A Qu 1-8

Summary

Work done = force × distance $= Fs$
Work done against/by gravity = weight × height $= mgh$