Science 10

Unit B: Energy flow in technological systems

Work and the joule

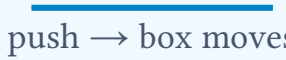
Work in joules

- You do work when you speed something up or move it against an opposing force.
- Energy change on a system equals work done on it: $\Delta E = W$.

$$W = F \times d$$

work (J) = force (N) × displacement (m) in direction of force

$\Delta E = W$ on system · $E_p = mgh$ · $E_k = \frac{1}{2}mv^2$



push ⟶ box moves

Force and distance

- Force, work, and energy share equations, and the units have to match before the numbers do.
- Work uses W = Fd, and the answer is in joules only when the units already match.
- The check mgh = ½mv² asks whether height lost shows up as speed gained.

Key terms

force

A push or pull that can change an object's motion or shape. (F)

work

Energy transferred when a force moves an object ($W = Fd \cos \theta$). (W)

gravitational potential energy

Energy associated with an object's position relative to a chosen reference level in a gravitational field. (E_p)

kinetic energy

Energy associated with an object's motion. (KE or E_k)

Key terms

joule

SI unit of energy and work (J).

Work and gravitational potential energy

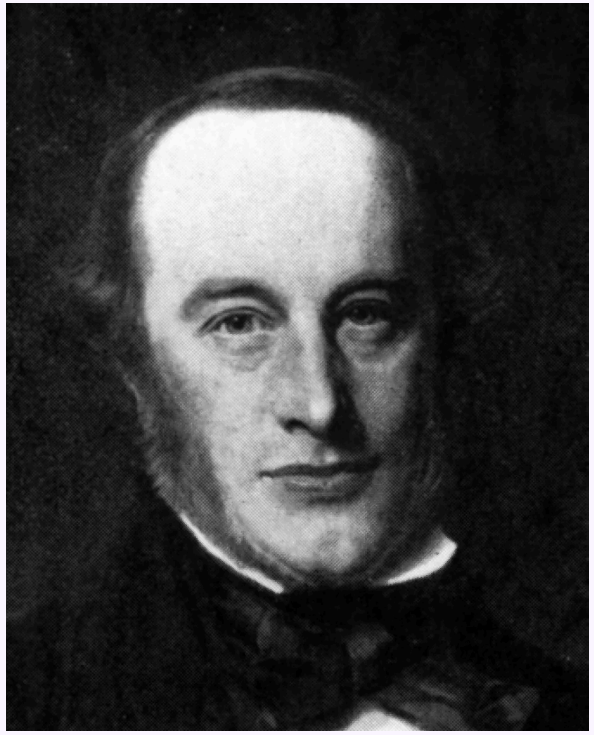
- Gravitational potential energy (E_p) is work done against gravity and is calculated with $E_p = mgh$.
- Mechanical work: $W = Fd$ when force and displacement align.
- Change in energy of a system equals work done on it.

Falling object

- From rest, gravitational potential energy lost over height h becomes kinetic energy gained when air resistance is ignored.
- The relationship $mgh = \frac{1}{2}mv^2$ asks whether height lost accounts for the speed gained.

The joule

- One joule is one newton-metre, which is also one kilogram metre squared per second squared.
- Energy and work use that same unit, so a work calculation can be compared with an energy change.



Practice set

- Calculate the gravitational potential energy of a 5 kg object on a 2 m shelf.
- Calculate the kinetic energy of a 3 kg object moving at 4 m/s.
- How much work is required to double the speed of an object that starts at rest?

Safety

Lab safety

- Keep feet and hands out of the path of a cart on a ramp.
- Clamp or brace the ramp before you measure its height.
- A rolling cart takes some of the energy as its own motion, which throws off the measurement.
- Stop the apparatus before you lean in to read a scale.

Work calculation

- Calculate work for 20 N over 3 m; compare to mgh for 2 kg raised 3 m (g ≈ 9.8 N/kg).
- A complete answer uses W = Fd with matching units and states the result in joules.

Work and energy retrieval check

- Calculate the work done by a constant 12 N force over 3.0 m in the force direction.
- Calculate gravitational potential energy gained by a 2.0 kg object raised 1.5 m.
- Explain why carrying a box horizontally at constant speed does no mechanical work on the box by the upward support force.

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