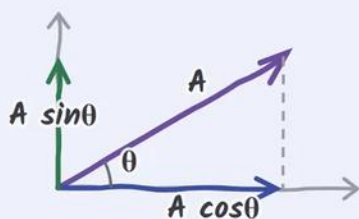


work in the scientific sense, the two mechanical energies, and the rate at which energy is used

What counts as work

- work is done only when a force moves its point of application, and it is force times displacement in the direction of the force
- so $W = F s \cos\theta$, where θ is the angle between the force and the displacement
- no displacement means no work, however tiring the effort. Pushing a wall that does not move is zero work in this sense
- force perpendicular to the motion does no work, since $\cos 90^\circ$ is zero. Carrying a bag horizontally does no work against gravity
- positive work when the force is along the motion, and negative work when it opposes, as friction does
- work is a scalar, measured in joules, and one joule is one newton acting through one metre



a force applied at an angle to the direction of travel, resolved into a part along the motion and a part across it: only the part along the motion does any work, which is where the cosine in the formula comes from

The relations of this chapter *

work done by a force at an angle

$$W = F s \cos\theta$$

kinetic energy of a moving body

$$K = \frac{1}{2} m v^2$$

potential energy at a height

$$U = m g h$$

the work energy theorem

$$W = K_f - K_i$$

power, the rate of doing work

$$P = \frac{W}{t}$$

and power in terms of speed

$$P = F v$$

kinetic energy depends on the SQUARE of the speed, so doubling the speed of a vehicle quadruples its kinetic energy and therefore the braking distance needed to stop it

The two mechanical energies

- kinetic energy is the energy a body has because it is moving, and it is always positive
- potential energy is the energy a body has because of its position, usually its height
- the work energy theorem: the net work done on a body equals its change in kinetic energy
- potential energy is measured from a chosen reference level, so only differences in it are meaningful
- the path does not matter for gravitational potential energy, only the change in height
- so lifting a box straight up or carrying it up a ramp needs the same work against gravity, though friction may add more on the ramp

