5.2.1 Work and energy

When a force is used to move an object, work is done. Work is measured in joules (*J*) and represents the energy transferred in doing the moving.

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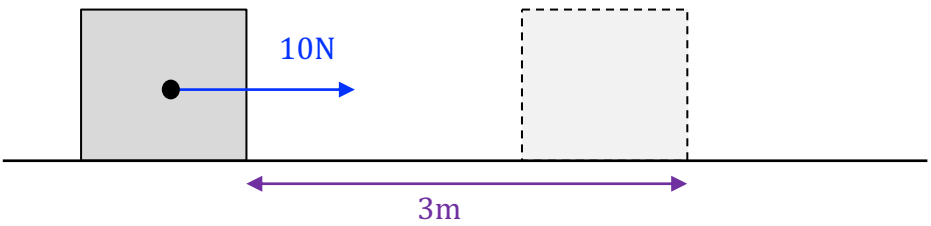
work done (W) = force x (distance moved in the direction of the force)

(1) Looking at the equation (above), what is an alternative unit for work?

Worked example:



A constant force of 10N is used to move a block for a distance of 3m.

The work done:

$$W = 10 \times 3$$
$$= 30J$$

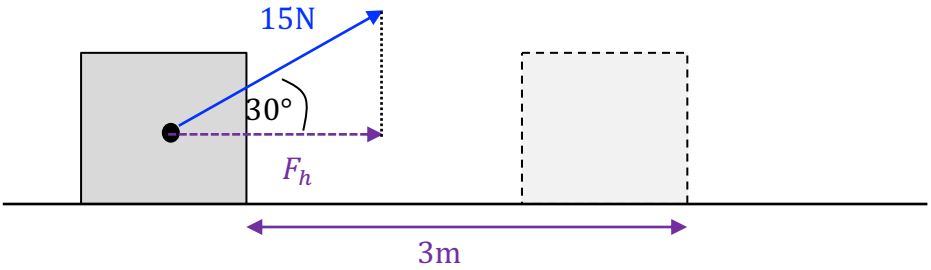
(2) If someone is pushing the block (above), where is the energy coming from?

In the process of pushing the block (above), energy is being transferred. If there is friction between the block and the surface, then the energy is being transferred (dissipated) as thermal energy in the surroundings.

(3) If there is no friction or air resistance (in the situation above), what store of energy is increasing?

Sometimes the applied force is not in the direction of the movement.

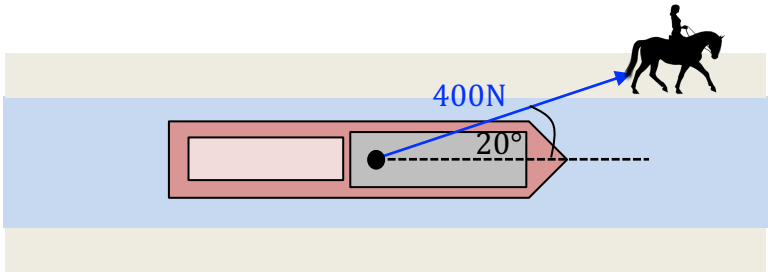
Worked example:



In this case, a force of 15N, acting at an angle of 30 degrees, is used to move the block horizontally. To calculate the work done we need to use the horizontal component (F_h) of the force, because this is the force component that is moving the block horizontally. [If you are not familiar with resolving vectors, see section 5.1.1.]

$$W = F_h \times 3$$
$$= (15 \times \cos 30°) \times 3$$
$$= 39J$$

(4) A horse is used to pull a barge along a canal, with a rope at an angle of 20 degrees. What work is done, if the horse pulls the barge for a distance of 1km?



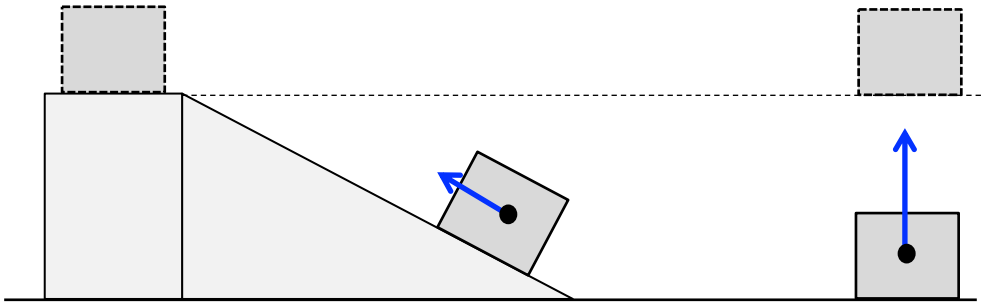
In the case of something being lifted up, the work done (W) to lift the object is equal to the gravitational potential energy gained by the object:

$$W = m \times g \times \Delta h$$

Where m=mass, g=gravitational field strength (=9.8N/kg), Δh=height lifted.

(5) What work would be required to lift a 1000kg car by 10m?

Work is only done against a resisting force. In the case of raising objects, work is done against gravity. In the absence of friction work can only be done in the vertical plane. Consider the following:



A block is pushed up a frictionless ramp and raised to the height shown. Another identical block is lifted up directly to this height.

(6) In which situation is the most work done? Why?