1.4 Power

Power is a measure of how quickly work is done, or how quickly energy is transferred. (We talk about power being the "rate" of doing work, or the "rate" of energy transfer.)

For example, a car transfers chemical energy (in petrol) to kinetic energy. A powerful car does this very quickly. When comparing performance cars, we often compare how quickly they go from 0-60 miles per hour. The engine does work to accelerate the car.

The power of a device can be calculated using the following equation:

$$P = \frac{\Delta E}{\Delta t}$$

where ΔE=energy transferred, Δt=time taken to transfer the energy

The unit for power is the watt (*W*).

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

(2) An Audi TT car goes from 0-60mph in 3.7s. What is its kinetic energy when it is travelling at 60mph (=27m/s)? The car has a mass = 1300kg. (Hint: $k.e. = 0.5 \times m \times v^2$)

(3) Assuming the Audi is 100% efficient in transferring chemical energy in the petrol to kinetic energy, what is the power of the engine? (Hint: Use the equation for power, the kinetic energy you calculated, above, and the time taken.)

When a force is used to move an object, work is done:

$$work\ done = force \times distance\ moved\ in\ the\ direction\ of\ the\ force$$

The unit for work done is the joule (*J*).

(4) For the Audi TT, above, the driving force from the engine is 9500N. The car travels a distance of 50m in the time it takes to reach 60mph. What work is done by the engine in this time? (Hint: Use the equation for work done.)

As discussed, above, power is the rate of doing work:

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

where ΔW=amount of work done in joules, Δt=time taken to do the work in seconds.

(5) Considering that the work done by the Audi's engine, to reach 60mph, is done in 3.7s, what is the power of the engine? (Hint: Use the equation above, the work done calculated, above, and the time taken.)

When an object is lifted up, work is done. A force (=weight) is required to lift the object. The distance moved is the height the object is lifted through.

$$W = weight \times height$$
$$\therefore W = mass \times g \times height$$

where g=gravitational field strength (=9.8N/kg)

(6) A student (mass=60kg) climbs 15m up a flight of stairs. What is the work done by the student?

(7) The student in the previous question climbs the stairs in 12 seconds. What is the power of the student?

(8) There is a transfer of energy from chemical energy in the student's muscles to gravitational potential energy as the student climbs higher. What is the gain in gravitational potential energy of the student. (Hint: $\Delta g.p.e. = m \times g \times \Delta h$)

(9) Compare your answers from question (6) and (8). What do you notice?