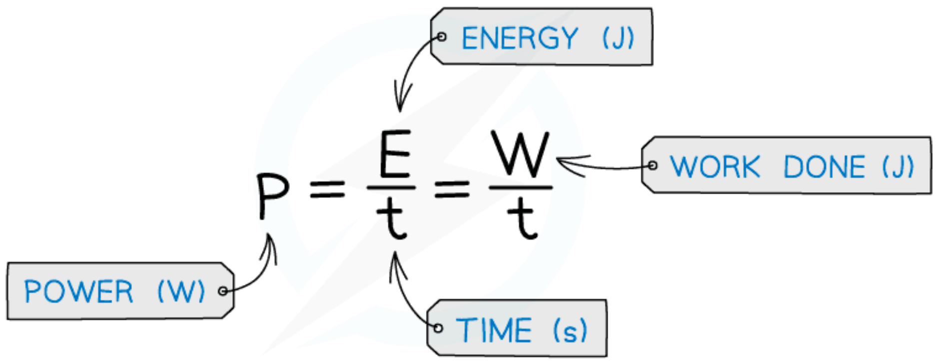
Power

- The power of a machine is the **rate at which it transfers energy**
- Since work done is equal to the energy transferred, power can also be defined as the rate of doing work or **the work done per unit time**
- The SI unit for power is **Watts (W)** where **1 W** = **1 J s^{-1}**



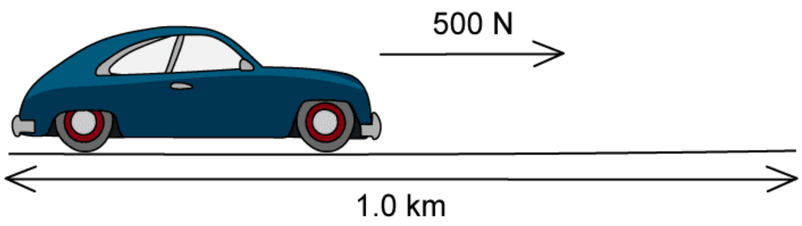
Power is the rate of change of work

- You may be familiar with labels on lightbulbs which indicate their power such as 60 W or 100 W. These tell you about an energy transferred by an electrical current rather than by a force doing work

Solving Problems Involving Power

Worked example

A car engine exerts the following force for 1.0 km in 200 s.



What is the average power developed by the engine?

STEP 1

EQUATION FOR POWER

$$\text{POWER} = \frac{\text{WORK DONE}}{\text{TIME}}$$

STEP 2

CALCULATE WORK DONE

$$W = F \times d$$

$$= 500\text{ N} \times 1.0 \times 10^{3}\text{ m}$$

$$= 5 \times 10^{5}\text{ J}$$

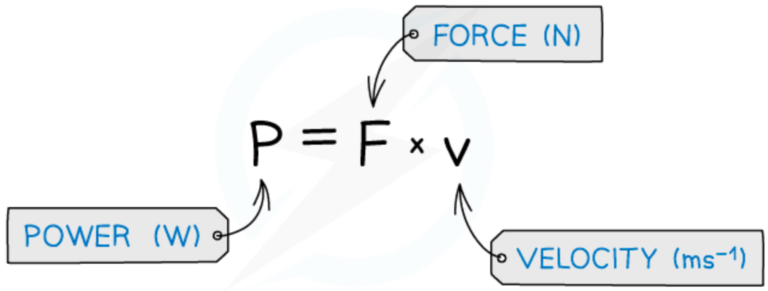
STEP 3

SUBSTITUTE VALUES INTO POWER EQUATION

$$\text{POWER} = \frac{5 \times 10^{5}\text{ J}}{200\text{ s}} = 2500\text{ W} = 2.5\text{ kW}$$

Derivation of P=F*v

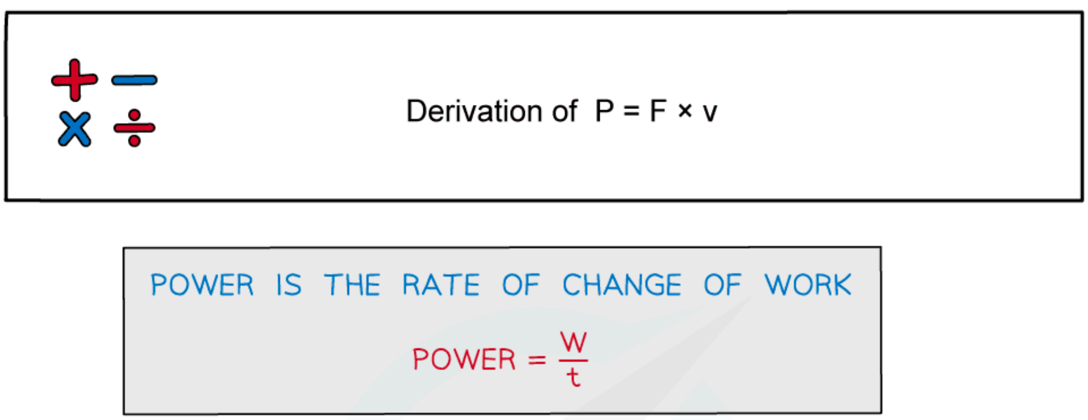
- Moving power is defined by the equation:

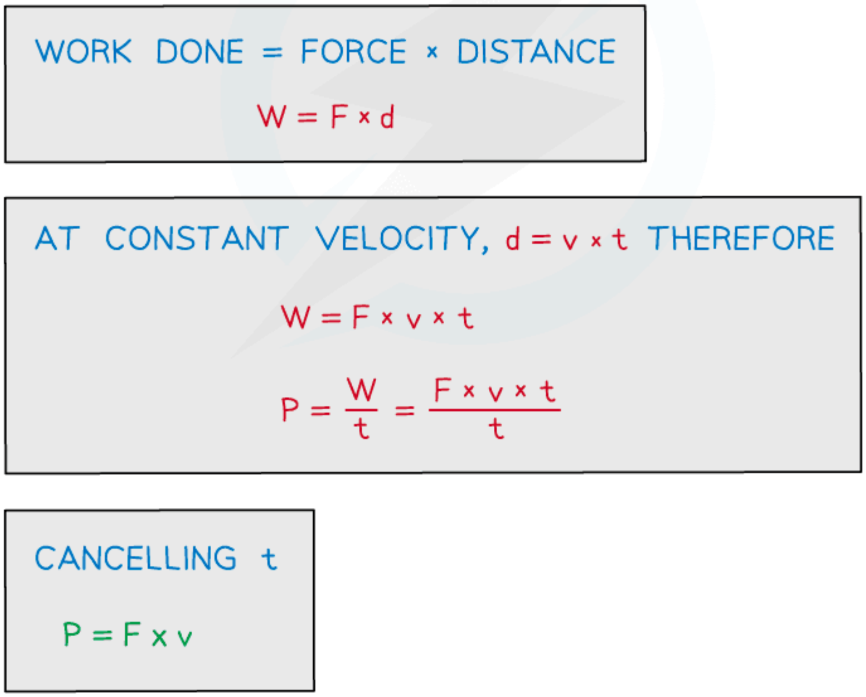


- This equation is only relevant where a **constant force** moves a body at **constant velocity**. Power is required in order to produce an acceleration
- The force must be applied in the **same** direction as the velocity

Derivation

- The derivation for this equation is shown below:

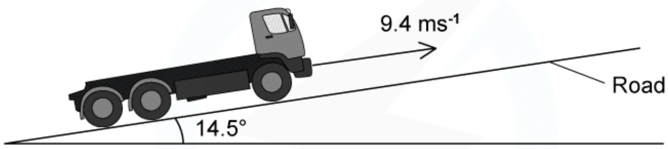




Derivation of P = F × v

Worked example

A lorry moves up a road that is inclined at 14.5° to the horizontal.



The lorry has mass 3500 kg and is travelling at a constant speed of 9.4 ms^{-1}. The force due to air resistance is negligible.

Calculate the useful power from the engine to move the lorry up the road.

STEP 1

EQUATION FOR POWER

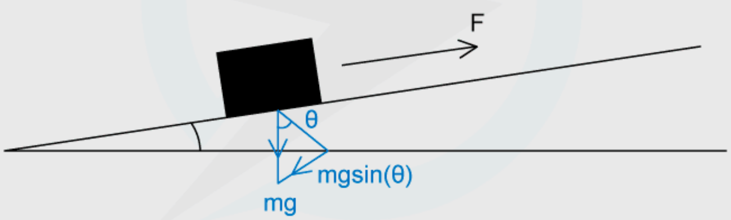
$P = F \times v$

STEP 2

CALCULATE THE FORCE

THE FORCE NEEDED TO MOVE THE LORRY UP THE ROAD IS THAT WHICH OVERCOMES THE COMPONENT OF ITS WEIGHT ACTING DOWN THE SLOPE

$F = mg \sin\theta = 3500 \times 9.81 \times \sin(14.5) = 8596.8 \text{ N}$



STEP 3

SUBSTITUTE INTO POWER EQUATION

$P = 8\,596.8 \times 9.4 = 80\,809.9 \text{ W} = 81\,000 \text{ W} = 81 \text{ kW}$ (2.s.f.)