FORCES – POWER

OBJECTIVES

- Know how to calculate the formula for power, using calculations with work done and time
- Understand some ‘real world’ applications for power, including its relation to fuel consumption

SUCCESS CRITERIA

- Successfully carry out stepping practical and calculate power used
- Correctly answer 7 questions on power

Draw a simple car and annotate it with as many facts and information as possible from what we've learnt over the last few weeks. Use a whole page. Examples added to get you started:

You must have at least 10 facts but aim for 15!

Speed = distance/time

Breaking distance depends on road conditions

Forces acting on moving car are air-resistance, thrust.....[finish this sentence].....

WHICH IS MOST POWERFUL?

Power is the rate at which work is done. A more powerful engine therefore does work (i.e. transfers energy) faster than a less powerful engine.

Both these planes are about the same mass but the jet has more powerful engines.

This means that chemical energy in the fuel can be transferred to kinetic energy faster so it will have greater acceleration and a higher top speed.

HOW IS POWER CALCULATED?

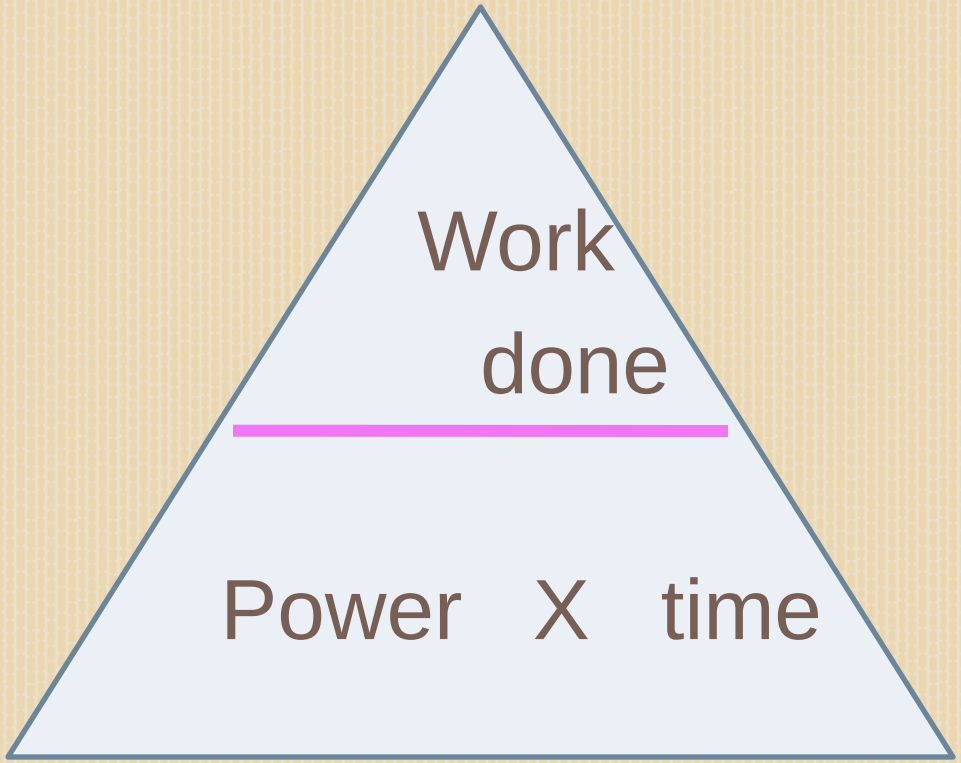
The power exerted by an object can be calculated using one of two equations:

$$\textbf{power} = \frac{\textbf{work done}}{\textbf{time taken}}$$

- Work done is measured in **joules** (**J**).
- Time is measured in **seconds** (**s**).
- Power is measured in **watts** (**W**).

Remember that work done = energy transferred.

CAN YOU GUESS WHAT THE TRIANGLE WILL BE?



CALCULATING POWER QUESTION 1

A lawnmower engine does 10 kJ of work in 10 seconds. What is the power of the engine?

$$\text{power} = \frac{\text{work done}}{\text{time}}$$

= 10,000 / 10

= **1,000 W** = **1 kW**

CALCULATING POWER QUESTION 2

A car transfers 12 mJ of energy in 2 minutes. What is the power of the car?

$$\text{power} = \frac{\text{work done}}{\text{time}} = \frac{\text{energy transfer}}{\text{time}}$$

= 12,000,000 / 120

= **100,000 W** = **100 kW**

QUESTION 3 – CALCULATING WORK DONE

A car has a power of 100kW. How much work does it do in 15 seconds?

Work done = power X time

= 100,000 X 15

= 1,500,000J
= 1.5mJ

SO, JUST TO MAKE IT CLEAR....

We've covered two equations for work done in this lesson and last lesson:

1) Work done = force X distance moved

2) Work done = power X time

HOW IS POWER RELATED TO FUEL CONSUMPTION?

Which plane will consume fuel the fastest?

The jet plane will have a higher fuel consumption than the propeller plane because its engines are more powerful.

A higher-powered engine will consume fuel more quickly than a lower-powered engine because it transfers energy at a faster rate. More work will be done in the same time.

WHY IS FUEL CONSUMPTION IMPORTANT?

In what situations might fuel consumption be an important consideration?

When buying a car, its fuel consumption (measured in miles per gallon – mpg) is an important factor to think about. This is because cars with a higher fuel consumption are:

- More expensive to run due to increased need to refuel, as well as higher road taxes
- More polluting due to higher carbon dioxide emissions – the higher the emissions, the greater the road tax.

What factors might affect the fuel consumption of a car?

FACTORS AFFECTING FUEL CONSUMPTION

All car manufacturers publish data on the fuel consumption on their cars, usually for two different speeds (e.g. urban and motorway).

These figures are, however, based on ideal driving conditions and are unlikely to be achieved in real-world driving.

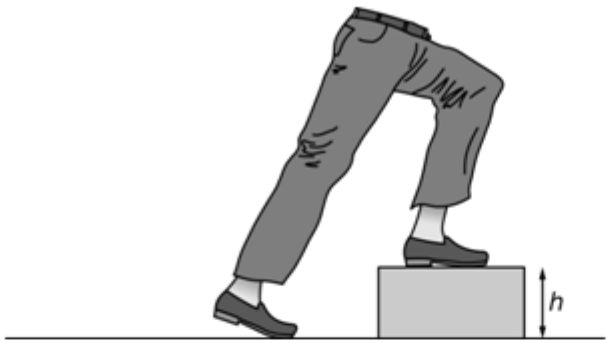
The fuel consumption of a specific car will vary with factors including:

- its speed, and the amount of harsh acceleration and braking
- the number of passengers and amount of luggage it is carrying
- the quality of the road surface.

PRACTICAL – CALCULATING YOUR OWN WORK DONE AND POWER

You will need:

- step (about 20–30 cm high)
- stop clock
- metre rule
- weighing scales



Work done = force X distance moved

Power = work done / time

Method

1 Find your mass using the weighing scales.

2 Measure the height of the step, *h*.

3 Do as many 'step-ups' as you can in 30 seconds while your partner measures the time. (You must start with both feet on the ground and then step up onto the step with one foot after the other, so that both feet are on the step. Do not jump up!) **Care! Make sure the step is firmly in place.**

4 Calculate the work you have done in one step up (= your weight (in N) × *h* (in m)).

5 Calculate the work you have done in 30 seconds.

6 Calculate your personal power by dividing the work done (in J) by 30 (s).

7 Repeat with roles reversed.

Do the practical one pair at a time

While you're waiting to do the practical and after you are finished – carry on with the questions on your work sheet.

Questions:

5) A kettle does 22 kj of work to boil water in 100 seconds. What is the power rating of the kettle?

p=wd/t = 220,000/100 = 2,200W = 2.2kW

6) A motorbike engine does 4.8mJ of work in 1 minute. What is the power of the engine?

p=wd/t = 4,800,000/60 = 80,000W = 80kW

7) A train with a power rating of 1mW does 7,200mJ of work during a journey. How long does the journey take?

time = work done/power = $\frac{7,200,000,000}{1,000,000}$

= 7,200 seconds = 2 hours

pp.186-189 in book – Q1-11

Worksheet P3d 6 – Power

1

motor	work done (in J)	time taken (in s)	power (in W)
A	450	30	**15**
B	**4500**	90	50
C	600	**16.7**	36
D	**10 500**	70	150
E	5000	250	**20**

3) **16s**
4) **8m**

WRITE DOWN THESE KEY WORDS AND THE CORRECT DEFINITION IN YOUR BOOKS

word	definition
1 work	A The force on an object due to the Earth's gravitational pull.
2 speed	B This is caused by putting waste into the environment.
3 weight	C This is a force that tries to stop touching surfaces from moving.
4 power	D This is done when a force moves.
5 energy	E This is another name for our surroundings.
6 pollution	F The distance travelled by a moving object in a second.
7 friction	G This is the rate of doing work.
8 environment	H This is needed in order to do work.

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