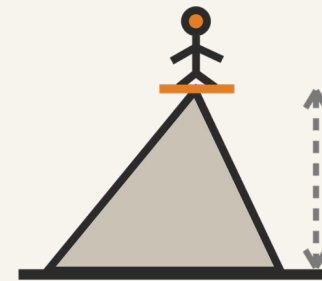
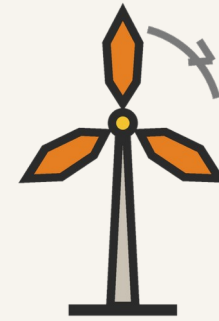


Power and Formula Choice

Energy every second — and how to spot which formula a question wants.

National 5 Engineering Science



LEARNING INTENTION

To calculate power using $P = E \div t$, and to choose the correct energy formula from the data the question gives you.

Daily Review

SHOW ME BOARDS

- 1 State the law of conservation of energy.
- 2 A motor runs at 9 V drawing 4 A for 20 s. Calculate E_e .
- 3 Water is heated from 20 °C to 70 °C. What is ΔT ?
- 4 $m = 2 \text{ kg}$, $\Delta T = 10 \text{ °C}$, $c = 4180$ — calculate E_h .
- 5 Change 4 minutes into seconds.

By the end of this lesson...

- 1 I can state $P = E \div t$ and say what a watt means.
- 2 I can rearrange it to $E = P t$ and to $t = E \div P$.
- 3 I can change kilowatts into watts and minutes into seconds.
- 4 I can pick the right formula by matching the symbols in the question.

Power — Energy Every Second

Power tells you how much energy a system transfers each second.

$$P = E \div t$$

P

power (W)

E

energy (J)

t

time (s)

1 watt means 1 joule transferred every second.

Worked Example – Motor

A motor transfers 18 000 J of energy in 30 seconds.
Calculate the power of the motor.

$$E = 18\,000\text{ J}$$

$$t = 30\text{ s}$$

$$P = ?$$

$$P = E \div t$$

$$P = 18\,000 \div 30$$

$$\underline{P = 600\text{ W}}$$

Rearranging the Power Formula

Same formula, three jobs – the question tells you which quantity is missing.

$$P = E \div t$$

You are given the energy and the time. The answer is in watts (W).

$$E = P t$$

You are given the power and the time. The answer is in joules (J).

$$t = E \div P$$

You are given the energy and the power. The answer is in seconds (s).

Booklet rule: rearrange to $E = P t$ or $t = E \div P$ as needed.

Worked Example – Fan

A 400 W fan is switched on for 3 minutes.
Calculate the energy transferred.

$$P = 400 \text{ W}$$

$$t = 3 \text{ min} = 180 \text{ s}$$

$$E = ?$$

$$P = E \div t$$

$$E = P t$$

$$E = 400 \times 180$$

$$\underline{E = 72\,000 \text{ J}}$$

Show Me — Power Calculations

SHOW ME BOARDS

- 1 Write the formula for power.
- 2 State the unit of power.
- 3 2 000 J in 10 s — calculate the power.
- 4 A 60 W lamp runs for 20 s. Calculate the energy transferred.
- 5 A 500 W motor transfers 5 000 J. How long did it run for?

Show Me — More Power

SHOW ME BOARDS

EXTRA PRACTICE

- 1 State the unit of energy and the unit of power.
- 2 3 000 J in 60 s — calculate the power.
- 3 Change 1.5 kW into watts.
- 4 A 100 W heater runs for 30 s. Calculate the energy transferred.
- 5 A 250 W pump transfers 2 500 J. Calculate the time it ran for.

Task 1 – Power

Three calculations in your jotter, SQA layout every time.
Question 2 gives you the power – rearrange to find the energy.

Question 3 gives you the power and the energy – find the time.

Booklet – “TRY THIS: Power”

Watch Out – Energy or Power?

THE MISTAKE

- “It transfers 2 000 J, so the power is 2 000 W”
- “A 1.5 kW heater, so $P = 1.5$ ”
- “Joules and watts are both energy”

THE CORRECT ANSWER

- Only if it took 1 second. Divide by the time.
- 1.5 kW = 1 500 W. Convert before you substitute.
- Joules are energy. Watts are joules per second.

Checkpoint

- 1 Write the formula for power and give the unit of the answer.
- 2 A motor transfers 12 000 J in 40 s. Calculate the power.
- 3 What + why: a heater is labelled 1.5 kW. What does that tell you?

PERIOD 2 STARTS HERE

Choosing the Right Formula

Six formulae. The question tells you which one it wants.

Choosing the Right Formula

Read the symbols the question gives you – they point straight at the formula.

What the question gives you	Formula	Unit of the answer
a force and a distance	$E_w = F d$	joules (J)
a mass and a speed	$E_k = \frac{1}{2} m v^2$	joules (J)
a mass and a height	$E_p = m g h$	joules (J)
a voltage, a current and a time	$E_e = V I t$	joules (J)
a mass, a ΔT and a value of c	$E_h = c m \Delta T$	joules (J)
an energy and a time	$P = E \div t$	watts (W)

Show Me – Which Formula?

SHOW ME BOARDS

- 1 A force of 60 N moves a crate 4 m. Which formula?
- 2 A 3 kg drone flies at 6 m/s. Which formula?
- 3 A crane lifts 90 kg through 5 m. Which formula?
- 4 A lamp runs at 12 V and 2 A for 30 s. Which formula?
- 5 A motor transfers 9 000 J in 15 s. Which formula?

Show Me — Which Formula Again?

SHOW ME BOARDS

EXTRA PRACTICE

- 1 2 kg of water is heated by $30\text{ }^{\circ}\text{C}$. Which formula?
- 2 A 750 W pump runs for 2 minutes. Which formula?
- 3 A 1 200 kg van travels at 20 m/s . Which formula?
- 4 A robot arm pushes with 15 N over 0.8 m. Which formula?
- 5 A battery gives 6 V and 0.5 A for 1 minute. Which formula?

Task 2 – Energy Equations

Twelve mixed questions – every formula in this booklet.

1-3 work done · 4-6 kinetic and potential energy

7-10 electrical and heat energy · 11-12 power

Marks are printed beside each question – 38 in total.

Booklet – “PRACTICE: Energy Equations”

Exam Practice — Past Papers

SQP Q17(b)(ii) — lift motor, find the time (3)
Rearranging $E_e = V I t$ is the same skill as $t = E \div P$
Next lesson: 2022 Q14(d) — power inside an efficiency question

Find the relationship in the data booklet

LOOKING AHEAD

Efficiency

Every real machine wastes part of its input. How do we score it?

Plenary – Prove Your I Can... Statements

SHOW ME BOARDS

- 1 Write the formula for power.
- 2 What does 1 watt mean, in joules and seconds?
- 3 Rearrange $P = E \div t$ to make E the subject.
- 4 Change 1.2 kW into watts.
- 5 A 40 W bulb runs for 60 s. Calculate the energy transferred.

Plenary – More Quick Checks

SHOW ME BOARDS

EXTRA PRACTICE

- 1 State the unit of power.
- 2 Rearrange $P = E \div t$ to make t the subject.
- 3 Change 3 minutes into seconds.
- 4 A 200 W motor runs for 15 s. Calculate the energy transferred.
- 5 Which formula uses V , I and t ?

Extension – If You Finish Early

- 1 A 400 W motor runs for 6 s. Calculate the energy transferred.
- 2 All of that energy becomes E_k in a 12 kg trolley. Find its speed.
- 3 What + why: 1 kW and 2 kW heaters both supply 60 kJ. Which is quicker?

Extension — More Challenges

EXTRA PRACTICE

- 1 A 250 W conveyor runs for 12 s. Calculate the energy transferred.
- 2 All of that energy becomes E_k in a 60 kg box. Find its speed.
- 3 A 2.5 kW heater runs for 2 minutes. Give the energy in kJ.

Extension – Unit Conversions

- 1 Change 0.75 kW into watts.
- 2 A 0.5 kW lamp runs for 6 minutes. Give the energy in kJ.
- 3 A machine transfers 1.2 MJ in 10 minutes. Calculate the power.

Extension — More Conversions

EXTRA PRACTICE

- 1 Change 2 400 W into kilowatts.
- 2 A 3 kW oven runs for 5 minutes. Give the energy in MJ.
- 3 A motor transfers 54 kJ in 1.5 minutes. Calculate the power.