

Name _____

Class _____

Date _____

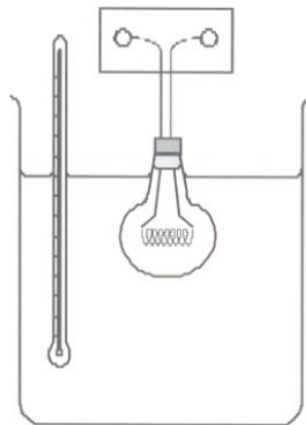
By the end of this worksheet I can...

- ☐ calculate efficiency using $\eta = E_{\text{out}} \div E_{\text{in}}$
- ☐ give efficiency as a percentage
- ☐ complete an energy audit
- ☐ work backwards from an efficiency to find an input or a time

I DO**Key ideas and worked example** Read this first **$\eta = E_{\text{out}} \div E_{\text{in}}$ (or $P_{\text{out}} \div P_{\text{in}}$)**Efficiency = useful energy out $\div$ total energy in

- η has no units and is never more than 1
- Multiply by 100 to give a percentage

An **energy audit** lists every energy going into and out of a system. Energy can't be destroyed, so **total energy in = useful energy out + energy wasted** (usually heat and sound).



Estimating the efficiency of a filament bulb: the heat it gives out warms the water.

An electric lift rated 110 V, 30 A raises a 700 kg load 20 m in 2 minutes.

Example Calculate the percentage efficiency of the lift.

Worked answer set out every step like this

$$t = 2 \times 60 = 120 \text{ s}$$

$$E_{\text{in}} = VIt = 110 \times 30 \times 120 = 396\,000 \text{ J}$$

$$E_{\text{out}} = mgh = 700 \times 9.8 \times 20 = 137\,200 \text{ J}$$

$$\eta = 137\,200 \div 396\,000 = 0.346$$

Efficiency = 34.6% (35%)

Why marks are not awarded

- ✗ Giving an efficiency bigger than 1 (100%): the fraction is upside down

WE DO

Guided practice Follow the steps to help you

A 12 V bulb draws 5 A and is placed in 0.5 litres of water for 10 minutes. The water warms from 18 °C to 30 °C.

1 Calculate the efficiency of the bulb as a light source. (4 marks)

Steps

1. Energy in: $E_e = VIt$ with $t = 600$ s
2. Heat out: $E_h = cm\Delta T = 4180 \times 0.5 \times 12$
3. Useful light energy = energy in – heat out
4. Efficiency = light energy ÷ energy in $\times 100$

YOU DO

On your own Give answers to two significant figures. Show your working.

2 Water in a hydroelectric station falls 500 m at a rate of 5000 kg per second. The energy transfer is 65% efficient. Calculate the useful energy produced each second.

3 A geothermal power plant pumps 100 litres of water into the ground at 10 °C. It comes out as steam at 240 °C.

a) Calculate the heat energy absorbed by the water.

b) For every 15 MJ of heat from the ground the plant produces 5.34 MJ of electricity. Calculate its efficiency.

4 A deep fat fryer uses 2 kJ of electrical energy each second. It heats 1.5 kg of oil ($c = 2400 \text{ J/kg K}$) from 20°C to 80°C in 6 minutes. Calculate the efficiency of the fryer. (4 marks)

5 A heater on a 240 V supply draws 8 A and is 75% efficient. How long will it take to heat 1.5 litres of water from 20°C to 90°C ? (4 marks)

6 An electric motor drives a ski tow. The table shows the energy passing through each stage.

Stage	Energy in (kJ)	Energy out (kJ)	Energy lost (kJ)
Motor	15	13.5	
Gearbox	13.5	10.8	
Winding mechanism	10.8	9.1	

a) Complete the energy lost column.

b) Calculate the total energy lost.

c) Complete the sentence: "Because the is always greater than the the efficiency will always be less than 100%."

d) Calculate the efficiency of the ski tow.

7 A coffee machine heats 0.14 kg of water from 18 °C to 89 °C in 16 seconds. The element runs from 230 V and draws 22 A.

a) Calculate the electrical energy supplied.

b) Calculate the heat energy transferred to the water.

c) Calculate the efficiency of the machine.

Check and reflect

Mark your answers with the answer sheet. Which “I can” statement above still needs work? Look back at the notes for that topic on the site.
