Power and efficiency

Worked solutions

GCSE science calculations

This topic online

1 A kettle transfers 264 000 J of energy in 120 s.

Calculate the power of the kettle. (2 marks)

Power = energy transferred ÷ time

P = 264000 ÷ 120

P = 2200 W

2200 W

2 An electric motor is supplied with 500 J of energy. It transfers 400 J of this usefully to kinetic energy.

Calculate the efficiency of the motor. Give your answer as a decimal. (2 marks)

Efficiency = useful output energy transfer ÷ total input energy transfer

efficiency = 400 ÷ 500

efficiency = 0.8

0.8

3 A crane on a building site does 36 000 J of work lifting a pallet of bricks. The lift takes 20 s.

Calculate the power of the crane. (2 marks)

Power = work done ÷ time

P = 36000 ÷ 20

P = 1800 W

1800 W

4 Mei heats her lunch in a microwave oven. The microwave transfers 54 kJ of energy in 1 minute.

Calculate the power of the microwave oven in watts. (3 marks)

Power = energy transferred ÷ time

54 kJ = 54000 J

1 minute = 60 s

P = 54000 ÷ 60

P = 900 W

900 W

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5 Gabriel uses a hairdryer for 5 minutes. In this time it transfers 495 kJ of energy.

Calculate the power of the hairdryer in watts. (3 marks)

Power = energy transferred ÷ time

495 kJ = 495000 J

5 minutes = 5 × 60 = 300 s

P = 495000 ÷ 300

P = 1650 W

1650 W

6 The motor of an e-scooter has a total power input of 0.5 kW. Its useful power output is 410 W.

Calculate the efficiency of the motor as a percentage. (3 marks)

Efficiency = useful power output ÷ total power input

0.5 kW = 500 W

efficiency = 410 ÷ 500

efficiency = 0.82

0.82 × 100 = 82%

82%

7 A 1200 W electric heater is used to warm a garden office. It transfers 360 000 J of energy.

Calculate how long the heater was switched on. Give your answer in seconds. (3 marks)

Power = energy transferred ÷ time

1200 = 360000 ÷ t

t = 360000 ÷ 1200

t = 300 s

300 s

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8 A gas boiler has an efficiency of 92%. In one minute it is supplied with 80 000 J of energy from the gas.

Calculate the useful energy transferred to the water in the central heating in this minute. (3 marks)

Efficiency = useful output energy transfer ÷ total input energy transfer

92% = 0.92

0.92 = useful ÷ 80000

useful = 0.92 × 80000

useful = 73600 J

73600 J

9 An electric drill has an efficiency of 0.75. The drill transfers 600 J of energy usefully as it drills a hole in a wall.

Calculate the total energy supplied to the drill. (3 marks)

Efficiency = useful output energy transfer ÷ total input energy transfer

0.75 = 600 ÷ total input

total input = 600 ÷ 0.75

total input = 800 J

800 J

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10 A lift in a block of flats raises a total mass of 750 kg through a height of 12 m in 15 s.
The total power input to the lift motor is 7.5 kW. Gravitational field strength = 9.8 N/kg
Calculate the efficiency of the lift system as a percentage. Give your answer to 2 significant figures.
Show your working.

(4 marks)

Useful energy = gravitational potential energy gained

Gravitational potential energy = mass × gravitational field strength × height

$E_p = 750 \times 9.8 \times 12$

$E_p = 88200\ J$

Power = energy transferred ÷ time

useful power = 88200 ÷ 15

useful power = 5880 W

Efficiency = useful power output ÷ total power input

7.5 kW = 7500 W

efficiency = 5880 ÷ 7500

efficiency = 0.784

0.784 × 100 = 78.4%

Round to 2 significant figures

78%

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11 Ravi boils water in a 2.4 kW kettle. The kettle is switched on for 3 minutes. The efficiency of the kettle is 0.85.

Calculate the energy wasted by the kettle. Give your answer in standard form to 2 significant figures. Show your working.

(4 marks)

Total input energy = power x time

2.4 kW = 2400 W

3 minutes = 180 s

$E = 2400 \times 180$

$E = 432000$ J

Efficiency = useful output energy transfer ÷ total input energy transfer

useful = 0.85×432000

useful = 367200 J

Wasted energy = total input - useful output

wasted = $432000 - 367200$

wasted = 64800 J

Standard form, 2 significant figures

6.5×10^4 J

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12 Chloe is choosing between two vacuum cleaners.

Vacuum cleaner	Total power input in W	Useful power output in W
A	1600	1040
B	900	630

a. Calculate the efficiency of vacuum cleaner A as a percentage.

b. Calculate the efficiency of vacuum cleaner B as a percentage.

c. Which vacuum cleaner is more efficient, A or B? Show your working.

(5 marks)

a)

Efficiency = useful power output ÷ total power input

efficiency = 1040 ÷ 1600

efficiency = 0.65

0.65 x 100 = 65%

65%

b)

efficiency = 630 ÷ 900

efficiency = 0.7

0.7 x 100 = 70%

70%

c)

70% > 65%

B

13 Lucy uses a blender for 20 s. In this time it transfers 3600 J of energy usefully to the kinetic energy store of the blades. It wastes 2400 J of energy by heating and sound.

Calculate the efficiency of the blender as a percentage.

(3 marks)

Total input energy = useful energy + wasted energy. The 20 s is not needed

total input = 3600 + 2400 = 6000 J

Efficiency = useful output energy transfer ÷ total input energy transfer

efficiency = 3600 ÷ 6000

efficiency = 0.6

0.6 x 100 = 60%

60%

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