

Combined science - Physics - Key stage 4 - Energy

# Multi-step calculations - HT only - worksheet

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# Exam style questions



# Q1.

A microwave is rated at 900 W. How long would it take to raise the temperature of 500 g of water from 20 °C to 100 °C? Specific heat capacity of water = 4200 J/kg °C

Time = ..... s

[5]



## Q2.

A weightlifter performs a bench press with a bar of mass of 105 kg. Each repetition lifts the bar 0.7 m. They can perform 12 repetitions in 30 seconds. What is the total power of the weightlifter's arms? ( $g = 9.8 \text{ N/kg}$ )

Power = ..... W **[5]**



# Answers



# Q1.

A microwave is rated at 900 W. How long would it take to raise the temperature of 500 g of water from 20 °C to 100 °C? Specific heat capacity of water = 4200 J/kg °C

$$\Delta E = mc \Delta\theta$$

$$100 - 20 = 80$$

$$\Delta E = 0.5 \times 4200 \times 80$$

$$\Delta E = 168\,000 \text{ J}$$

1

1

$$P = E/t$$

$$900 = 168\,000 / t$$

$$t = 186.666666666666 \text{ s}$$

$$t = 187 \text{ s}$$

1

1

1

An answer that rounds to 187 s earns 5 marks

Time = ..... s

[5]



## Q2.

A weightlifter performs a bench press with a bar of mass of 105 kg. Each repetition lifts the bar 0.7 m. They can perform 12 repetitions in 30 seconds. What is the total power of the weightlifter's arms? ( $g = 9.8 \text{ N/kg}$ )

$$\text{GPE} = mgh$$

$$\text{GPE} = 105 \times 9.8 \times 0.7$$

$$\text{GPE} = 720.3 \text{ J}$$

1

1

$$P = E/t$$

$$P = 12 \times (720.3) / 30$$

$$P = 288.12$$

$$P = 288 \text{ W}$$

1

1

1

An answer that rounds to 288 W earns 5 marks

Power = ..... W **[5]**



# In lesson questions



## Worked example

A 12 kg block is suspended by a crane at a height of 30 m. The cable supporting it snaps and the block falls to the ground. Calculate the temperature rise of the 50 kg of concrete below on impact. Assume the transfer is 100 % efficient,  $g = 9.8$  N/kg and specific heat capacity of concrete is  $1000$  J/kg °C.

Temperature rise = ..... °C **[5]**



## Worked example 2

A fighter jet of mass 20 000 kg lands on an aircraft carrier with a velocity of 80 m/s. The arresting wire of the carrier has a spring constant of 2 kN/m and brings the aircraft to a stop. How much does the wire extend by?

Extension = ..... m **[5]**



# Independent practice

1. A motor raises a 400 kg elevator by 25 m in 15 s. It has a power rating of 9000 W. Calculate the efficiency of the motor. **[5]**
2. A ball of mass 0.5 kg is kicked with an initial velocity of 20 m/s into a net. The net has a spring constant of 400 N/m. What is the extension of the net? **[5]**
3. A 350 g stone is dropped from a height of 8 m. What is its speed at impact with the floor? **[5]**
4. A 40 kg bungee jumper falls through a height of 12 m before the bungee cord starts to extend. If the bungee cord reaches maximum extension when the jumper has fallen through a total height of 58 m, what is the spring constant of the cord? ( $g = 10 \text{ N/kg}$ ) **[5]**



# Independent practice

1. A 3 kg ball is dropped from a tower. Its velocity at impact with the ground is 25 m/s. What height was the ball dropped from? ( $g = 9.8 \text{ N/kg}$ )
2. A 25 % efficient motor lifts a 2 kg block 18 m in 45 s. What is the power of the motor?
3. A photovoltaic cell has an efficiency of 35 % and has sides 50 cm long. If the total power output is  $300 \text{ W/m}^2$ , what is the input power?
4. A power station produces 500 MW of electricity. If this is converted at 80 % efficiency to heating water, how many kilograms of water can be heated from  $20 \text{ }^\circ\text{C}$  to  $50 \text{ }^\circ\text{C}$  every second?

