

GCSE / IGCSE Physics – Energy

GCSE / IGCSE (Edexcel / Cambridge style) · Total marks: 42 · Answers on the last page

This worksheet covers energy stores, work, power, efficiency and specific heat capacity. A calculator is allowed throughout; take $g = 9.8 \text{ N/kg}$ unless stated otherwise, and use $c_{\text{water}} = 4200 \text{ J/kg}^\circ\text{C}$.

Section A – Work, Power and Energy Stores

1. A crane lifts a 250 kg load through a vertical height of 12 m. Calculate the work done against gravity. [3]
2. A force of 60 N pushes a box a distance of 8 m across a floor. Calculate the work done by the force. [2]
3. Define "power" and state its unit. [2]
4. An electric motor transfers 4500 J of energy in 15 s. Calculate its power output. [2]

Section B – Efficiency and Specific Heat Capacity (Exam-style)

5. An electric kettle has a power input of 2000 W. In one minute of use, 96 000 J of energy is usefully transferred to heat the water, and the rest is wasted as heat to the surroundings.
 - (a) Calculate the total energy input to the kettle in one minute.
 - (b) Calculate the efficiency of the kettle, giving your answer as a percentage. [4]
6. 0.5 kg of water is heated from 20°C to 80°C using an immersion heater.
 - (a) Calculate the energy required to heat the water.
 - (b) The heater has a power rating of 1000 W and is 100% efficient. Calculate how long it takes to heat the water. [5]
7. Explain, in terms of energy stores and transfers, what happens to the kinetic energy of a car as its brakes are applied and it comes to rest. [3]
8. A ball of mass 0.2 kg is dropped from a height of 5 m. Calculate its speed just before hitting the ground, assuming all the gravitational potential energy is transferred to kinetic energy and air resistance is negligible. [4]

Section C – Extended / Challenge

9. A hydroelectric power station has a reservoir 40 m above its turbines. Water flows through the turbines at a rate of 50 000 kg per second.
 - (a) Calculate the maximum power that could be generated, assuming 100% efficiency.
 - (b) The station actually generates 15 MW of electrical power. Calculate its efficiency. [5]
10. A cyclist and bike have a total mass of 80 kg. The cyclist accelerates from rest to 6 m s^{-1} .
 - (a) Calculate the kinetic energy gained.
 - (b) If the cyclist's legs do 1800 J of work to reach this speed, calculate the efficiency of energy transfer to kinetic energy. [5]
11. A 2 kW immersion heater raises the temperature of 10 kg of water by 15°C, with no energy losses.

Calculate the time taken, giving your answer in minutes. [4]

12. A pendulum bob of mass 0.3 kg swings from a height of 0.2 m above its lowest point. Assuming no air resistance, calculate its maximum speed at the lowest point. [3]

Answers

Check your working against these. If an answer does not match, try the question again before looking for the method.

1. $W = mgh = 250 \times 9.8 \times 12 = 29\,400 \text{ J} = 29.4 \text{ kJ}$.
2. $W = Fd = 60 \times 8 = 480 \text{ J}$.
3. Power is the rate of transfer of energy (energy transferred per unit time). Its unit is the watt (W), equal to 1 J/s.
4. $P = \frac{E}{t} = \frac{4500}{15} = 300 \text{ W}$.
5. (a) $E = Pt = 2000 \times 60 = 120\,000 \text{ J}$.
(b) Efficiency = $\frac{96\,000}{120\,000} \times 100 = 80\%$.
6. (a) $Q = mc\Delta T = 0.5 \times 4200 \times 60 = 126\,000 \text{ J}$.
(b) $t = \frac{Q}{P} = \frac{126\,000}{1000} = 126 \text{ s}$.
7. The kinetic energy store of the car is transferred, mainly by work done against friction, to the thermal energy stores of the brakes and surroundings (and to the surroundings by heating); the total energy is conserved, but it becomes increasingly dissipated/spread out and less useful.
8. $mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 5} = \sqrt{98} = 9.9 \text{ m s}^{-1}$ (2 s.f.).
9. (a) $P = \frac{mgh}{t} = 50\,000 \times 9.8 \times 40 = 19\,600\,000 \text{ W} = 19.6 \text{ MW}$.
(b) Efficiency = $\frac{15}{19.6} \times 100 = 76.5\%$ (3 s.f.).
10. (a) $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 80 \times 6^2 = 1440 \text{ J}$.
(b) Efficiency = $\frac{1440}{1800} \times 100 = 80\%$.
11. $Q = mc\Delta T = 10 \times 4200 \times 15 = 630\,000 \text{ J}$. $t = \frac{Q}{P} = \frac{630\,000}{2000} = 315 \text{ s} = 5.25 \text{ minutes}$.
12. $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 0.2} = \sqrt{3.92} = 1.98 \text{ m s}^{-1}$ (3 s.f.). (Mass is not needed since it cancels.)

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