4.2 Work power and resources

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

Objective

Build the skills to answer exam questions on **work, power and energy resources** 、 : work done $W = Fd$, gravitational potential energy and kinetic energy, power, and generating electricity from renewable and non-renewable resources.

You must be able to:

- calculate work done, gravitational potential energy and kinetic energy
- calculate power as the rate of energy transfer
- use conservation of energy to find speeds and heights
- evaluate energy resources for generating electricity

1 Key knowledge and worked examples

Work and energy

idea	equation or rule
work done	$W = F \times d$ (unit J)
gravitational potential energy	$GPE = m \times g \times h$, with $g = 10$ N/kg
kinetic energy	$KE = \frac{1}{2} \times m \times v^2$
power	$P = W \div t$ (unit W = J/s)
energy resources	non-renewable: coal, oil, gas, nuclear; renewable: wind, water, solar, geothermal

Worked example 1: kinetic energy. Find the kinetic energy of a 2.0 kg ball moving at 3.0 m/s.

1. Known: $m = 2.0$ kg; $v = 3.0$ m/s.
2. Rule: $KE = \frac{1}{2}mv^2$.
3. Numbers: $0.5 \times 2.0 \times 9.0$.
4. Result: 9.0 **J**.

Worked example 2: power. A motor does 1200 J of work in 4.0 s. Find its power.

1. Known: $W = 1200$ J; $t = 4.0$ s.
2. Rule: $P = W \div t$.
3. Numbers: $1200 \div 4.0$.
4. Result: 300 **W**.

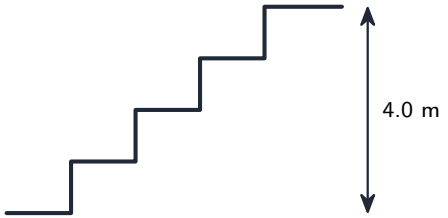
Answer shapes: when something falls, the GPE it loses becomes KE (if there are no losses).

2 Practice

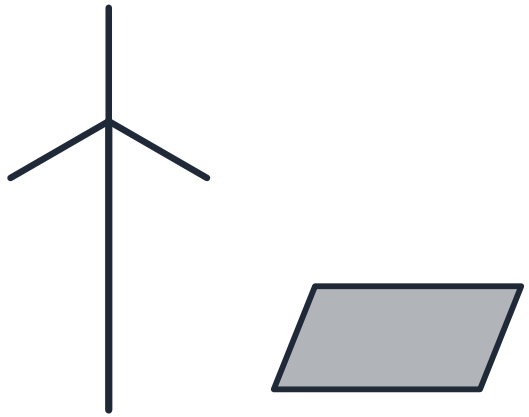
2.1 A student pushes a box with a force of 40 N for 3.0 m. Calculate the work done. [2]



2.2 A 50 kg student climbs 4.0 m up some stairs. Calculate the gravitational potential energy gained. [2]

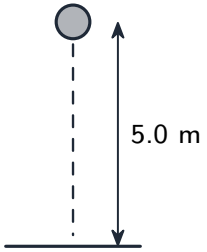


2.3 Name **two** renewable energy resources, and give **one** disadvantage of one of them. [2]

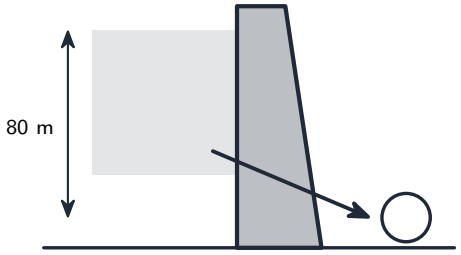


3 Exam-style questions

3.1 A 0.50 kg ball is dropped from a height of 5.0 m. Use energy to calculate its speed just before it hits the ground. Ignore air resistance. [3]



3.2 At a hydroelectric power station, 2000 kg of water falls through a height of 80 m every second and turns turbines.



(a) Calculate the gravitational potential energy lost by the water each second. [2]

(b) The station is 75% efficient. Calculate its electrical power output. [3]

(c) Calculate the speed of the water at the bottom, ignoring energy losses. [3]

(d) Evaluate hydroelectric power compared with a gas-fired power station for a country with high mountains and plenty of rain. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- 40×3.0
- **120** J

2.2

- $50 \times 10 \times 4.0$
- **2000** J

2.3

- two of: wind, solar, hydroelectric, tidal, waves, geothermal
- a correct disadvantage, e.g. wind and solar are not reliable; dams flood valleys

3.1

- GPE lost $= 0.50 \times 10 \times 5.0 = 25$ J
- $25 = \frac{1}{2} \times 0.50 \times v^2$, so $v^2 = 100$
- $v =$ **10** m/s

3.2

(a) $2000 \times 10 \times 80 =$ **1 600 000** J

(b) useful energy each second $= 0.75 \times 1\,600\,000 = 1\,200\,000$ J; power = **1.2** MW

(c) $\frac{1}{2}v^2 = gh$, so $v^2 = 2 \times 10 \times 80 = 1600$; $v =$ **40** m/s

(d) points to include:

- hydroelectric is renewable; rain refills the reservoir, which suits this country (App)
- it releases no carbon dioxide when running; gas releases carbon dioxide, a greenhouse gas (K)
- hydroelectric can start up quickly and store energy in the reservoir (An)
- but a dam is very expensive to build and floods valleys, destroying habitats and homes (K)
- gas stations are cheaper to build, but gas is non-renewable and its price can change (An)
- judgement: hydroelectric is the better long-term choice here, despite the cost of building (An)

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.