A-LEVEL MATHEMATICS • EXERCISE SHEET

4.5 Energy, work and power

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

Objective

Build the skills to answer exam questions on **energy, work and power** 能量、功与功率—**work done** 功, **kinetic** 动能 and **potential energy** 势能, the **work–energy** principle, and **power** 功率 $P = Fv$. Take $g = 10$ m s^{-2}.

You must be able to:

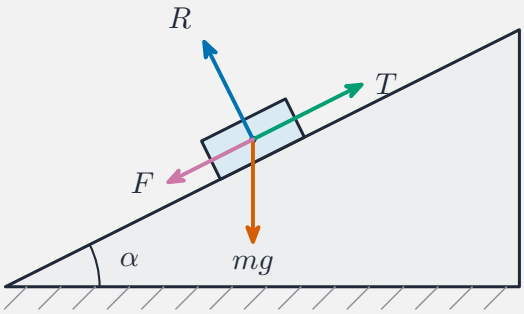
- calculate work $W = Fd\cos\theta$, KE $= \frac{1}{2}mv^2$, PE $= mgh$
- use the work–energy principle (work done = change in energy)
- use $P = Fv$ for power

1 Worked examples

Energy & power

A roller coaster trades potential energy for kinetic energy as it rises and falls

Image: source



Work and energy on an inclined plane

Engine 12 kW, speed 20 m s^{-1} on the level: $P = Fv \Rightarrow F = \dfrac{12000}{20} = 600$ N.

Work–energy: (driving force work) − (resistance work) = change in KE.

2 Practice

2.1 Find the kinetic energy of a 2 kg body moving at 6 m s^{-1}. [2]

2.2 A force of 50 N moves a body 4 m in its own direction. Find the work done. [1]

3 Exam-style questions

3.1 A 1500 W motor raises a load at constant speed. In 10 s it does work of: [1]

- **A** 150 J
- **B** 1500 J
- **C** 15000 J
- **D** 150000 J

3.2 A car of mass 1200 kg accelerates from 10 m s^{-1} to 20 m s^{-1} on a level road.

(a) Find the increase in kinetic energy. [3]

(b) If a constant resistance of 400 N acts over the 150 m taken, find the total work done by the engine. [3]

3.3 A cyclist and bicycle of total mass 90 kg freewheel from rest down a slope, dropping a vertical height of 20 m. Resistances do 9000 J of work.

(a) Using energy, find the speed at the bottom. [4]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **4.5 Energy, work and power** past-paper sheet in the Library, or try these in **Practice mode**:

- 9709/41 N25 —Q1 (work–energy)
- 9709/41 N25 —Q4 (power)
- 9709/42 N25 —Q3 (energy)

Solutions

2.1 KE $= \frac{1}{2}mv^2 = \frac{1}{2}(2)(36) = 36$ J.

2.2 $W = Fd = 50 \times 4 = 200$ J.

3.1 C. work = power $\times$ time $= 1500 \times 10 = 15000$ J.

3.2 (a) ΔKE $= \frac{1}{2}(1200)(20^2 - 10^2) = 600(400 - 100) = 600(300) = 180000$ J.
(b) work by engine = ΔKE+ work against resistance $= 180000 + 400(150)$; $= 180000 + 60000 = 240000$ J.

3.3 (a) energy: mgh − (resistance work) $= \frac{1}{2}mv^2$; $90(10)(20) - 9000 = \frac{1}{2}(90)v^2$; $18000 - 9000 = 45v^2 \Rightarrow v^2 = 200$; $v = 14.1$ m s^{-1}.