

4.5 Energy, work and power

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS power 功率 • work done 功 • kinetic 动能 • potential energy 势能 • mass 质量

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 $g = 10 \text{ m s}^{-2}$.

You must be able to:

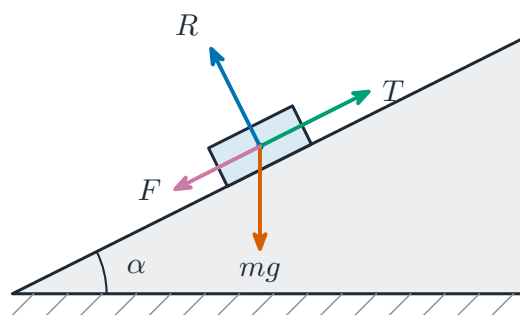
- calculate work $W = Fd \cos \theta$, $\text{KE} = \frac{1}{2}mv^2$, $\text{PE} = mgh$
- use the work–energy principle (work done = change in energy)
- use $P = Fv$ for power

1 Worked examples

■ Energy & power



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



Work and energy on an inclined plane

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

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]

Solutions

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

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

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

3.2 (a) $\Delta\text{KE} = \frac{1}{2}(1200)(20^2 - 10^2) = 600(400 - 100) = 600(300) = 180000 \text{ J}.$

(b) $\text{work by engine} = \Delta\text{KE} + \text{work against resistance} = 180000 + 400(150); = 180000 + 60000 = 240000 \text{ J}.$

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