Exercise walk-through

Power ▪ 3.5

eXercise

You must be able to

- define **power** 功率 as $P = \dfrac{W}{\Delta t}$
- calculate **average power** 平均功率 from work done over a time interval
- relate **instantaneous power** to force and velocity, $P = Fv$
- use the SI unit **watt** 瓦特 and convert between energy and power

Method — Power is the rate of energy transfer

$P = \dfrac{W}{\Delta t}$, measured in watts ($1\ \text{W} = 1\ \text{J s}^{-1}$). A motor that does 600 J of work in 3.0 s delivers $P = 200$ W.

Method — Power from force and speed

For a force acting at speed v, $P = Fv$. A car engine providing 50 N of drive at 4.0 m s^{-1}: $P = 200$ W.

Method — Energy from power

$W = P\,\Delta t$. A 100 W bulb left on for 60 s uses 6000 J.

Practice 2.1 ▪ 1 mark

A crane does 9000 J of work in 6.0 s. Find its power.

Solution 2.1

Method: Power is the rate of energy transfer

Worked steps

$$P = \frac{W}{\Delta t} = \frac{9000}{6.0} = 1500 \text{ W}$$ B1.

Practice 2.2 ▪ 2 marks

A car engine pushes with 800 N at a steady 20 m s^{-1}. Find the power delivered.

Solution 2.2

Method: Power from force and speed

Worked steps

$P = Fv = 800 \times 20 = 16\,000$ W M1 A1.

Practice 2.3 ▪ 1 mark

A 60 W device runs for 120 s. Find the energy it uses.

Solution 2.3

Method: Energy from power

Worked steps

$W = P\,\Delta t = 60 \times 120 = 7200$ J (B1).

Exam-style 3.1 ▪ 1 mark

One watt is equal to

A 1 J

B 1 J s^{-1}

C 1 N

D 1 J s

Solution 3.1

A $1\ \mathrm{J}$

B $1\ \mathrm{J\,s^{-1}}$ ✓

C $1\ \mathrm{N}$

D $1\ \mathrm{J\,s}$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

A motor lifts a 200 N weight at a constant 0.50 m s^{-1}. Its power output is

A 100 W

B 200 W

C 400 W

D zero

Solution 3.2

Method: Power is the rate of energy transfer

A 100 W ✓

B 200 W

C 400 W

D zero

Worked steps

A — $P = Fv = 200 \times 0.50 = 100$ W.

Exam-style 3.3 ▪ 2 marks

A 500 kg lift rises 20 m at constant speed in 10 s (take $g = 10$ m s^{-2}).
(a) Find the work done against gravity.
(b) Find the power output of the motor.

Solution 3.3

Method: Power is the rate of energy transfer

Worked steps

(a) $W = mgh = 500 \times 10 \times 20 = 1.0 \times 10^5$ J M1 A1. (b) $P = \dfrac{1.0 \times 10^5}{10} = 1.0 \times 10^4$ W B1.