Exercise walk-through

Power ▪ 3.5

eXercise

You must be able to

- use **power** 功率 as the rate of doing work: $P = \dfrac{W}{t}$
- use $P = Fv$ for a force moving at speed v
- state the unit of power (the watt, $1\ \text{W} = 1\ \text{J s}^{-1}$)
- compare machines by their power output

Method — Power is work per time

$$P = \frac{W}{t}.$$

Doing 600 J of work in 3 s gives $P = 600/3 = 200$ W.

Method — Power as force times speed

For a force F moving an object at steady speed v,

$$P = Fv.$$

A 50 N driving force at 4 m s^{-1} delivers $P = 50 \times 4 = 200$ W.

Method — The watt

One watt is one joule per second. A 100 W bulb uses 100 J every second.

Practice 2.1 ▪ 2 marks

A motor does 900 J of work in 3 s. Find its power.

Solution 2.1

Method: Power is work per time

Worked steps

$P = W/t = 900/3 = 300$ W M1 A1.

Practice 2.2 ▪ 2 marks

A 20 N force moves an object at 5 m s^{-1}. Find the power.

Solution 2.2

Method: Power as force times speed

Worked steps

$P = Fv = 20 \times 5 = 100$ W M1 A1.

Practice 2.3 ▪ 1 mark

State the unit of power and what it equals.

Solution 2.3

Worked steps

The watt; $1\ \mathrm{W} = 1\ \mathrm{J\ s^{-1}}$ B1.

Practice 2.4 ▪ 1 mark

Two motors do the same work; motor A takes less time. Which has the greater power?

Solution 2.4

Method: Power is work per time

Worked steps

Motor A (same work in less time means more power) B1.

Exam-style 3.1 ▪ 1 mark

Power is defined as

A force times distance

B the rate of doing work

C work times time

D energy times speed

Solution 3.1

A force times distance

B the rate of doing work ✓

C work times time

D energy times speed

Worked steps

B — power is the rate of doing work.

Exam-style 3.2 ▪ 1 mark

A car engine provides 3000 N of force at 20 m s^{-1}. Its power output is

A 150 W

B 6.0×10^4 W

C 3000 W

D 20 W

Solution 3.2

Method: Power as force times speed

A 150 W

B 6.0×10^4 W ✓

C 3000 W

D 20 W

Worked steps

B — $P = Fv = 3000 \times 20 = 6.0 \times 10^4$ W.

Exam-style 3.3 ▪ 1 mark

A crane lifts a 500 kg load at a steady 0.4 m s^{-1} ($g = 10$ m s^{-2}).
(a) Find the upward force needed.
(b) Find the power output of the crane.

Solution 3.3

Method: Power as force times speed

Worked steps

(a) $F = mg = 5000$ N B1. (b) $P = Fv = 5000 \times 0.4 = 2000$ W M1 A1.

Exam-style 3.4 ▪ 2 marks

A pump does $12\,000$ J of work in 40 s.
(a) Find its power.
(b) State how much energy it uses in one minute at this rate.

Solution 3.4

Method: Power is work per time

Worked steps

(a) $P = 12000/40 = 300$ W M1 A1. (b) $300 \times 60 = 18\,000$ J B1.