

3.5 Power

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS power 功率 • work 功

Objective

Build the skills to answer exam questions on **power**.

You must be able to:

- use **power** 功率 as the rate of doing work: $P = \frac{W}{t}$
- 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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Power is work per time

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

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

■ 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 $P = 50 \times 4 = 200 \text{ W}$.

■ The watt

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

2 Practice

Now apply the methods above.

2.1 A motor does 900 J of work in 3 s. Find its power. [2]

2.2 A 20 N force moves an object at 5 m s^{-1} . Find the power. [2]

2.3 State the unit of power and what it equals. [1]

2.4 Two motors do the same work; motor A takes less time. Which has the greater power? [1]

3 Exam-style questions

3.1 Power is defined as [1]

- **A** force times distance
 - **B** the rate of doing work
 - **C** work times time
 - **D** energy times speed
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3.2 A car engine provides 3000 N of force at 20 m s^{-1} . Its power output is [1]

- **A** 150 W
 - **B** $6.0 \times 10^4 \text{ W}$
 - **C** 3000 W
 - **D** 20 W
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3.3 A crane lifts a 500 kg load at a steady 0.4 m s^{-1} ($g = 10 \text{ m s}^{-2}$).

(a) Find the upward force needed. [1]

- (b) Find the power output of the crane. [2]

3.4 A pump does 12 000 J of work in 40 s.

- (a) Find its power. [2]
(b) State how much energy it uses in one minute at this rate. [1]

Solutions

2.1 $P = W/t = 900/3 = 300 \text{ W}$.

2.2 $P = Fv = 20 \times 5 = 100 \text{ W}$.

2.3 The watt; $1 \text{ W} = 1 \text{ J s}^{-1}$.

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

3.1 B — power is the rate of doing work.

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

3.3 (a) $F = mg = 5000 \text{ N}$. (b) $P = Fv = 5000 \times 0.4 = 2000 \text{ W}$.

3.4 (a) $P = 12000/40 = 300 \text{ W}$. (b) $300 \times 60 = 18\,000 \text{ J}$.