AP PHYSICS C: MECHANICS • EXERCISE SHEET

3.5 Power

Name: _____ Class: _____ Date: _____ **Total: 15 marks**

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: $P = \dfrac{W}{t}$
- use $P = Fv$ for a force moving at speed v
- state the unit of power (the watt, 1 W = 1 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 $P = 600/3 = 200$ 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 $P = 50 \times 4 = 200$ 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

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

- **A** 150 W
- **B** 6.0×10^4 W
- **C** 3000 W
- **D** 20 W

3.3 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. [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]

4 Go further

You are ready for more on this subtopic:

- work through the interactive **3.5 Power** lesson on the **Learn** page;
- read the **Work, Energy, and Power** section of the AP Physics C: Mechanics handout on the **Know** page for the full explanation and worked diagrams.

Solutions

2.1 $P = W/t = 900/3 = 300$ W.

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

2.3 The watt; 1 W = 1 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 —$P = Fv = 3000 \times 20 = 6.0 \times 10^4$ W.

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

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