AP PHYSICS C: MECHANICS • EXERCISE SHEET

3.2 Work

Name: _____ Class: _____ Date: _____ **Total: 14 marks**

KEY WORDS work 功 • work-energy theorem 功能定理 • normal force 法向力 • kinetic energy 动能

Objective

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

You must be able to:

- calculate **work** 功: $W = Fd\cos\theta$
- explain that only the force component along the displacement does work
- state that a perpendicular force does zero work
- apply the **work-energy theorem** 功能定理: $W_{net} = \Delta K$

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.

■ **Work done by a force**

$$W = Fd\cos\theta,$$

where θ is the angle between the force and the displacement. A 10 N force pulling a box 3 m in its own direction ($\theta = 0$) does $W = 10 \times 3 = 30$ J.

■ **Angled and perpendicular forces**

At an angle θ, only $F\cos\theta$ does work. If $\theta = 90°$, $\cos 90° = 0$, so the force does **no work** – like the normal force on a sliding box, or gravity on a horizontal path.

■ **Work-energy theorem**

The net work equals the change in kinetic energy:

$$W_{net} = \Delta K = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2.$$

2 Practice

Now apply the methods above.

2.1 A 20 N force pushes a crate 4 m in its own direction. Find the work done. [2]

2.2 State the work done by a force acting perpendicular to the motion. [1]

2.3 A 50 N force acts at 60° to a 2 m displacement. Find the work done. [2]

2.4 State what the net work done on an object equals. [1]

3 Exam-style questions

3.1 The work done by a force perpendicular to the displacement is [1]

- **A** maximum
- **B** zero
- **C** negative
- **D** equal to Fd

3.2 The work-energy theorem states that the net work equals the change in [1]

- **A** momentum
- **B** kinetic energy
- **C** mass
- **D** velocity

3.3 A 30 N force drags a sled 5 m at 37° above the horizontal.

(a) Find the work done by the force. [2]

(b) State why the vertical component does no work here. [1]

3.4 A 2 kg block speeds up from 3 m s^{-1} to 5 m s^{-1}.

(a) Find the change in kinetic energy. [2]

(b) State the net work done on it. [1]

Solutions

2.1 $W = Fd\cos 0 = 20 \times 4 = 80$ J.

2.2 Zero.

2.3 $W = 50 \times 2 \times \cos 60° = 50$ J.

2.4 The change in its kinetic energy.

3.1 B — $\cos 90° = 0$, so no work.

3.2 B — net work equals the change in kinetic energy.

3.3 (a) $W = 30 \times 5 \times \cos 37° = 120$ J. (b) The vertical component is perpendicular to the horizontal displacement.

3.4 (a) $\Delta K = \frac{1}{2}(2)(5^2 - 3^2) = 16$ J. (b) 16 J.