

3.2 Work

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS work 功 • angle 角度 • energy 能量 • joules 焦耳

Objective

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

You must be able to:

- define **work** 功 as $W = Fd \cos \theta$
- explain how the **angle** 角度 between force and displacement makes work positive, negative, or zero
- calculate the work done by a constant force
- find the work done by a variable force from the **area** under a force-position graph

1 Worked examples

Study these first. Each one shows the method for a question type used later.

■ The work formula

$W = Fd \cos \theta$, where θ is the angle between the force and the displacement. Work is a scalar, measured in joules.

■ The sign of work

- $\theta < 90^\circ \rightarrow$ **positive** work (energy added)
- $\theta = 90^\circ \rightarrow$ **zero** work (e.g. the normal force on a box sliding along a flat floor)
- $\theta > 90^\circ \rightarrow$ **negative** work (e.g. friction opposing motion)

■ Variable force

The work done by a changing force is the **area under the force-versus-position graph**.

2 Practice

2.1 A 30 N force pushes a box 4.0 m in the direction of the force. Find the work done.[1]

2.2 State the work done by the normal force on a box sliding along a flat floor, and why. [2]

2.3 A 50 N force drags a crate 10 m at 37° above the horizontal ($\cos 37^\circ \approx 0.80$). Find the work done. [2]

2.4 A force-position graph is a rectangle 10 N tall and 3.0 m wide. Find the work done.[1]

3 Exam-style questions

3.1 The work done by a force is zero when the angle between the force and the displacement is [1]

- | | |
|---|---|
| A | B |
| C | D |
- A 0°
B 45°
C 90°
D 180°

3.2 Friction acting on a sliding object does [1]

- | | |
|---|---|
| A | B |
| C | D |
- A positive work
B negative work
C zero work
D undefined work

3.3 A child pulls a sled with a 40 N force at 30° above the horizontal for 20 m ($\cos 30^\circ \approx 0.87$).

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

(b) Explain why the vertical component of the pull does no work here. [1]