

2.2 Forces and Free-Body Diagrams

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

KEY WORDS friction 摩擦力 • tension 张力 • free-body diagram 受力图 • net force 净力
• force 力

Objective

Build the skills to answer exam questions on **forces and free-body diagrams**.

You must be able to:

- identify the forces acting on an object (weight, normal, tension, friction, applied)
- draw a **free-body diagram** 受力图 showing each force as an arrow from the object
- find the **net force** 净力 by adding forces as vectors
- resolve forces into components on an inclined surface

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.

■ Identify every force

A book resting on a table feels two forces: its **weight** mg down and the **normal force** N up from the table. They balance, so the net force is zero.

■ Draw the free-body diagram

Represent the object as a dot and draw one arrow per force, pointing the way the force acts, longer for bigger. Only forces *on* the object appear — never forces it exerts on others.

■ Net force by components

Add forces as vectors. A box pulled right with 10 N while friction pulls left with 4 N:

$$F_{\text{net}} = 10 - 4 = 6 \text{ N to the right.}$$

■ Forces on an incline

On a slope of angle θ , gravity splits into $mg \sin \theta$ (down the slope) and $mg \cos \theta$ (into the slope, balanced by the normal force).

2 Practice

Now apply the methods above.

2.1 A book rests on a table. Name the two forces acting on it. [2]

2.2 A box is pushed right with 20 N; friction opposes with 8 N. Find the net force. [2]

2.3 On a free-body diagram, whose forces are shown — those on the object, or those the object exerts? [1]

2.4 A 2 kg block sits on a 30° incline. Find the component of gravity along the slope (use $g = 10 \text{ m s}^{-2}$). [2]

3 Exam-style questions

3.1 The net force on an object is the [1]

A	B
C	D

A largest single force

B vector sum of all forces on it

C sum of its weight and mass

D force it exerts on the ground

3.2 A free-body diagram should show [1]

A	B
C	D

A only the weight

B all forces acting on the object

C the object's velocity

D forces the object exerts on others

3.3 A 5 kg crate is pulled right by 30 N against 12 N of friction.

(a) Find the net force. [2]

(b) Find the acceleration. [1]

3.4 A 4 kg block rests on a 37° frictionless incline ($g = 10 \text{ m s}^{-2}$).

(a) Find the component of gravity along the slope. [2]

(b) Find the block's acceleration down the slope. [1]