

## 2.2 Forces and Free-Body Diagrams

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ **Total: 11 marks**

**KEY WORDS** force 力 • friction 摩擦力 • free-body diagram 受力图 • tension 张力  
• weight 重力

### Objective

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

**You must be able to:**

- describe a **force** 力 as a push or pull, measured in **newtons** 牛顿
- distinguish **contact forces** 接触力 (normal, friction) from **long-range forces** 长程力 (gravity)
- draw a **free-body diagram** 受力图 showing every force on one object as a labelled arrow
- find the **net force** 合力 by adding the force vectors

### 1 Worked examples

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

#### ■ What goes on a free-body diagram

Only the forces acting **on** the chosen object: weight ( $mg$ , down), normal force ( $F_N$ , perpendicular to the surface), friction ( $f$ , along the surface), tension ( $T$ , along a rope), and any applied push. Never draw a "motion" arrow.

#### ■ Net force

Add the force components. A box pulled +10 N to the right against 4 N of friction:  $F_{net} = 10 - 4 = 6$  N to the right.

#### ■ Types of force

**Contact:** normal, friction, tension, applied push. **Long-range (field):** gravity (and, later, electric and magnetic).

### 2 Practice

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

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**2.2** State whether each is a contact or a long-range force: (a) weight, (b) friction, (c) normal force, (d) the gravitational pull of the Moon. [2]

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**2.3** A crate is pushed to the right with 25 N while 9.0 N of friction acts. Find the net horizontal force. [1]

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**2.4** A lamp of weight 15 N hangs in equilibrium from a single cord. State the tension in the cord. [1]

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### 3 Exam-style questions

**3.1** Which force is a long-range (field) force? [1]

|   |   |
|---|---|
| A | B |
| C | D |

**A** the normal force

**B** friction

**C** gravity

**D** tension

**3.2** On a free-body diagram of a sliding box, which arrow should **not** appear? [1]

|   |   |
|---|---|
| A | B |
| C | D |

**A** weight

**B** normal force

**C** friction

**D** the box's velocity

**3.3** A 2.0 kg sign hangs at rest from two vertical cords, each with tension  $T$  (take  $g = 10 \text{ m s}^{-2}$ ).

(a) List the forces on the sign (a free-body diagram in words). [1]

(b) Find the tension in each cord. [2]