Exercise walk-through

Forces and Free-Body Diagrams ▪ 2.2

eXercise

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

Method — 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.

Method — 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.

Method — Types of force

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

Practice 2.1 ▪ 2 marks

A book rests on a table. Name the two forces acting on it and their directions.

Solution 2.1

Method: What goes on a free-body diagram

Worked steps

weight, acting downward; and the normal force from the table, acting upward B1 B1.

Practice 2.2 ▪ 2 marks

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.

Solution 2.2

Method: Types of force

Worked steps

(a) long-range; (b) contact; (c) contact; (d) long-range B1 B1 *for any two correct, for all four.*

Practice 2.3 ▪ 1 mark

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

Solution 2.3

Method: Net force

Worked steps

$25 - 9.0 = 16$ N to the right (B1).

Practice 2.4 ▪ 1 mark

A lamp of weight 15 N hangs in equilibrium from a single cord. State the tension in the cord.

Solution 2.4

Method: What goes on a free-body diagram

Worked steps

15 N (equal to the weight, since it is in equilibrium) B1.

Exam-style 3.1 ▪ 1 mark

Which force is a long-range (field) force?

A the normal force

B friction

C gravity

D tension

Solution 3.1

Method: Types of force

A the normal force

B friction

C gravity ✓

D tension

Worked steps

C.

Exam-style 3.2 ▪ 1 mark

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

A weight

B normal force

C friction

D the box's velocity

Solution 3.2

Method: What goes on a free-body diagram

A weight

B normal force

C friction

D the box's velocity ✓

Worked steps

D.

Exam-style 3.3 ▪ 1 mark

A 2.0 kg sign hangs at rest from two vertical cords, each with tension T (take $g = 10$ m s^{-2}).
(a) List the forces on the sign (a free-body diagram in words).
(b) Find the tension in each cord.

Solution 3.3

Method: What goes on a free-body diagram

Worked steps

(a) weight mg downward; two tension forces T upward **B1**. (b) $2T = mg = 20$ N, so $T = 10$ N **M1** **A1**.