

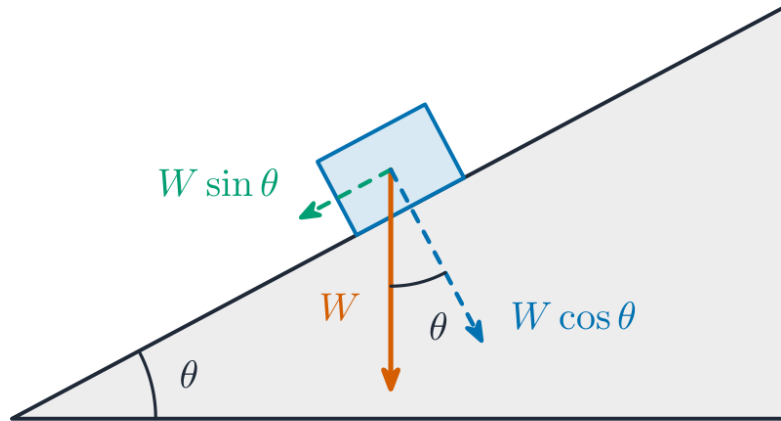
Exercise walk-through

1.3

Forces, Newton's laws and free-body diagrams (statements 8–12, core practical 1)

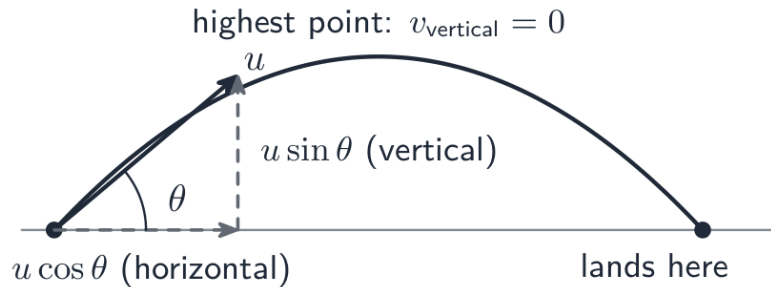
Pearson Edexcel · International A-Level · Physics

Resolve from the marked angle



- Draw a right triangle: the adjacent component uses cosine, the opposite uses sine.
- For a slope at angle θ :
 $W_{\parallel} = W \sin \theta$, $W_{\perp} = W \cos \theta$.
- Combine perpendicular components with Pythagoras and give a direction.

One projectile, two motions



- Neglect drag: horizontal acceleration is zero; vertical acceleration is $-g$ upward-positive.
- $u_h = u \cos \theta$, $u_v = u \sin \theta$; time links the two directions.
- At the highest point only the vertical velocity is zero.

Core practical 3: Young modulus of a wire

- Measure original length; measure diameter at several positions and orientations with a micrometer.
- Add loads in steps; measure extensions and plot stress against strain in the proportional region.
- Use the gradient for E ; repeat/unload to check elastic behaviour and control zero errors.

Exercises 2.1·2.2

2.1 A ball hangs from a string. (a) Draw the free-body diagram of the ball. (b) State the third-law partner of the string's upward pull on the ball. [3]

2.2 A lift of mass 800 kg accelerates upwards at 1.2 m s^{-2} .

(a) Calculate the resultant force on the lift. [1]

(b) Calculate the tension in the cable. (*Hint: weight acts down, tension up.*) [3]

Exercises 2.1·2.2

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2.1 (a) Two arrows from the ball's centre: weight downwards, tension upwards, equal lengths. (b) The ball's downward pull on the string, equal and opposite, acting on the **string**.

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(a) Calculate the resultant force on the lift. [1]

(b) Calculate the tension in the cable. (*Hint: weight acts down, tension up.*) [3]

2.2 (a) $\sum F = ma = 800 \text{ kg} \times 1.2 \text{ m s}^{-2} = 960 \text{ N}$. (b) Up positive: $T - W = ma$.

Exercises 2.3·2.4

2.3 A book rests on a table. A student says: “The weight and the normal contact force are equal and opposite, so they are a Newton’s-third-law pair.” Explain the mistake. [2]

2.4 Two carts push apart on a frictionless track. Cart A pushes cart B to the right with 15 N. State the force on cart A: magnitude, direction, and which law you used. [2]

Exercises 2.3·2.4

2.3 A book rests on a table. A student says: “The weight and the normal contact force are equal and opposite, so they are a Newton’s-third-law pair.” Explain the mistake. [2]

2.3 Both forces act on the **same body** (the book); a third-law pair acts on different bodies – the partners are the Earth’s pull on the book / the book’s pull on the Earth, and the table’s push on the book / the book’s push on the table.

2.4 Two carts push apart on a frictionless track. Cart A pushes cart B to the right with 15 N. State the force on cart A: magnitude, direction, and which law you used. [2]

2.4 15 N to the **left**, by Newton’s third law – B pushes A back with an equal and opposite force.

Exercise 3.1

3.1 A person sits on a chair. The forces on the person are weight and the normal contact force from the chair. Why are these **not** a Newton's-third-law pair? [1]

☐

A the chair is stationary

B the forces act in opposite directions

C the forces act on the same object

D the forces have the same magnitude

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3.1 C. A third-law pair acts on different objects; these two both act on the person. B and D describe properties a third-law pair also has; A is irrelevant.

Exercise 3.2

3.2 A coin and a feather are dropped together in air. Which statement is correct? [1]

☐

A the coin's initial acceleration is greater than the feather's

B the feather's initial acceleration is greater than the coin's

C their initial accelerations are equal, and they reach the same terminal velocity

D their initial accelerations are equal, and the coin reaches a greater terminal velocity

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3.2 D. At release the only force is weight, so both start with acceleration g . Drag grows with speed and balances the weight sooner for the light feather, so the coin's terminal velocity is greater. C fails on terminal velocity; A and B fail on the initial acceleration.

Exercise 3.3

3.3 A skydiver jumps from an aeroplane and falls vertically.

(a) Explain why the skydiver's acceleration decreases as her speed increases. [2]

(b) She opens her parachute. Explain, in terms of the forces, why she decelerates at first and why the deceleration then decreases until she reaches a new terminal velocity. [4]

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3.3 (a) Weight is constant but drag increases with speed, so the resultant force – and by $\sum F = ma$ the acceleration – decreases. (b) On opening, drag becomes greater than weight, so the resultant force is upwards and she decelerates. As her speed falls, the drag falls, so the resultant upwards force – and the deceleration – decreases, until drag equals weight again and the velocity is constant.

Exercise 3.4

3.4 A crate of weight 950 N hangs from a helicopter by a cable. The helicopter rises so that the crate accelerates upwards at 0.80 m s^{-2} .

(a) Calculate the mass of the crate. [1]

(b) Calculate the tension in the cable. [3]

(c) The crate now descends at a **constant** velocity. State the tension in the cable, with a reason. [2]

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(b) Calculate the tension in the cable. [3]

(c) The crate now descends at a **constant** velocity. State the tension in the cable, with a reason. [2]

3.4 (a) $m = \frac{W}{g} = \frac{950 \text{ N}}{9.81 \text{ N kg}^{-1}} = 96.8 \text{ kg}$. (b) Up positive: $T - W = ma$. $T = ma + W = 96.8 \text{ kg} \times 0.80 \text{ m s}^{-2} + 950 \text{ N} = 77 \text{ N} + 950 \text{ N} = 1030 \text{ N}$. (c) $T = 950 \text{ N}$ – constant velocity means zero acceleration, so zero resultant force (Newton's first law).

Full solution 3.4

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