

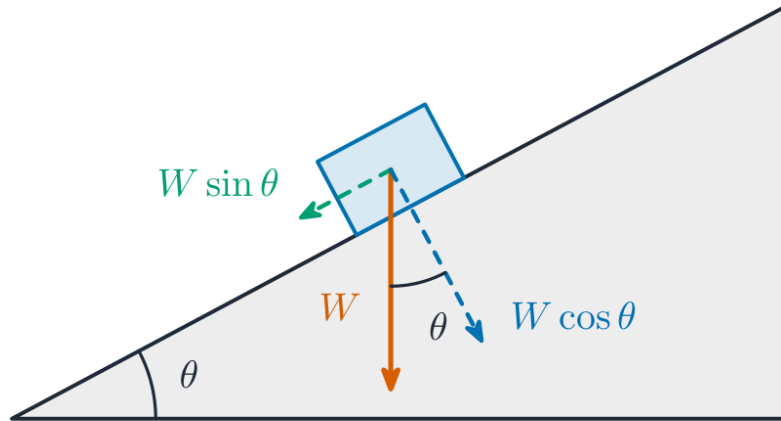
Exercise walk-through

1.5

Moments and equilibrium (statements 15–16)

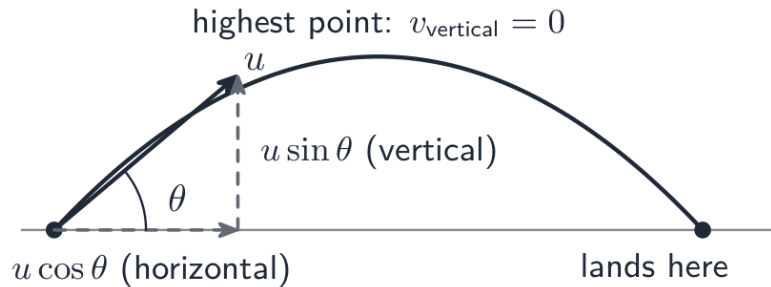
Pearson Edexcel · International A-Level · Physics

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 2.1·2.3

2.1 A force of 25 N acts perpendicular to a spanner 0.30 m from the pivot. Calculate the moment. [1]

2.2 The same force now acts at 50° to the spanner at the same point. Calculate the new moment. [2]

2.3 State the two conditions for an extended body to be in equilibrium. [2]

Exercises 2.1·2.3

2.1 A force of 25 N acts perpendicular to a spanner 0.30 m from the pivot. Calculate the moment. [1]

2.1 $\text{moment} = Fx = 25 \text{ N} \times 0.30 \text{ m} = 7.5 \text{ N m}.$

2.2 The same force now acts at 50° to the spanner at the same point. Calculate the new moment. [2]

2.2 Only the perpendicular component turns the spanner: $\text{moment} = F \sin \theta \times x = 25 \text{ N} \times \sin 50^\circ \times 0.30 \text{ m} = 5.7 \text{ N m}.$

2.3 State the two conditions for an extended body to be in equilibrium. [2]

2.3 Resultant force is zero and resultant moment about any point is zero.

Exercises 2.4·3.1

2.4 A uniform beam of weight 40 N and length 4.0 m balances on a pivot at its centre. A child of weight 300 N sits 1.5 m to the right of the pivot. Where must a second child of weight 400 N sit to balance the beam? [3]

3.1 Two children of equal weight sit on a see-saw at equal distances from the support. Which row describes the resultant force and the resultant moment on the beam? [1]

☐

A zero – zero

B zero – anticlockwise

C downwards – zero

D downwards – anticlockwise

Exercises 2.4·3.1

2.4 A uniform beam of weight 40 N and length 4.0 m balances on a pivot at its centre. A child of weight 300 N sits 1.5 m to the right of the pivot. Where must a second child of weight 400 N sit to balance the beam? [3]

2.4 The beam's weight acts at the pivot, so it has no moment. $300 \text{ N} \times 1.5 \text{ m} = 400 \text{ N} \times x$, so $x = \frac{450 \text{ N m}}{400 \text{ N}} = 1.1 \text{ m}$ to the left of the pivot.

3.1 Two children of equal weight sit on a see-saw at equal distances from the support. Which row describes the resultant force and the resultant moment on the beam? [1]

- ☐ **A** zero – zero
B zero – anticlockwise
C downwards – zero
D downwards – anticlockwise

3.1 A. Equal weights give zero resultant moment about the support, and the support's upward force balances both weights, so the resultant force is also zero. B and D keep a turning effect that symmetry removes; C forgets the support force.

Exercise 3.2

3.2 A door handle is fitted 0.80 m from the hinges. Which change reduces the force needed to open the door? [1]

☐

A pushing nearer the hinges

B pushing at a smaller angle to the door

C pushing perpendicular to the door at the handle

D pushing with the same force at half the distance

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3.2 C. For a fixed force, the moment is greatest when the force is perpendicular and the distance is greatest. A and D shrink the distance; B shrinks the perpendicular component.

Exercise 3.3

3.3 A uniform metre rule of weight 1.2 N is suspended from a string at its 50 cm mark. A dish is hung at the 20 cm mark.

(a) State the principle of moments. [1]

(b) The rule balances horizontally with a dish of total weight 1.8 N at the 20 cm mark and a counterweight at the 85 cm mark. Calculate the weight of the counterweight. [3]

(c) The string is moved to the 60 cm mark. Explain, without further calculation, whether the rule can still balance with the dish at 20 cm and the counterweight at 85 cm . [2]

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Full solution 3.3

3.3 (a) In equilibrium, the total clockwise moment equals the total anticlockwise moment.

(b) About the string: the dish acts at 0.30 m; the counterweight at 0.35 m; the rule's

weight has no moment. $1.8 \text{ N} \times 0.30 \text{ m} = W \times 0.35 \text{ m}$, so $W = \frac{0.54 \text{ N m}}{0.35 \text{ m}} = 1.5 \text{ N}$. (c)

No: moving the string to 60 cm shortens the counterweight's distance to 0.25 m, so its moment falls below the dish's moment, and the rule tips towards the dish.