

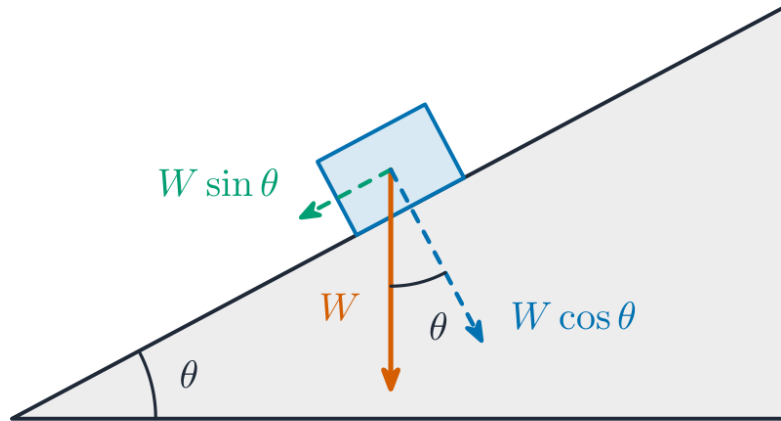
Exercise walk-through

1.2

Vectors, resolution and projectile motion (statements 4–7)

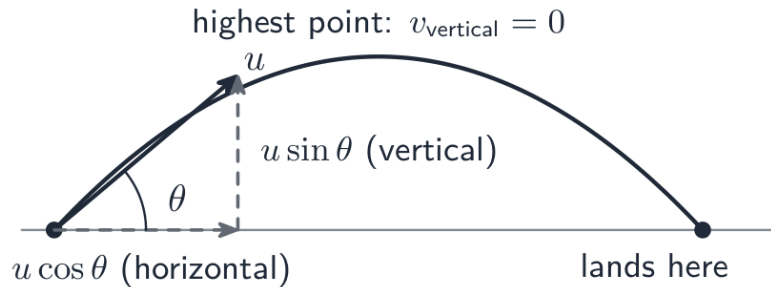
Pearson Edexcel · International A-Level · Physics

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 Sort into scalars and vectors: speed, velocity, work, weight, distance, momentum, displacement, energy. [2]

2.2 A force of 60 N acts at 25° to the horizontal. Calculate its horizontal and vertical components. [2]

2.3 Two perpendicular forces act on a point: 30 N north and 40 N east. Calculate the magnitude of the resultant and its angle to north. [3]

Exercises 2.1·2.3

2.1 Sort into scalars and vectors: speed, velocity, work, weight, distance, momentum, displacement, energy. [2]

2.1 Scalars: speed, work, distance, energy. Vectors: velocity, weight, momentum, displacement.

2.2 A force of 60 N acts at 25° to the horizontal. Calculate its horizontal and vertical components. [2]

2.2 Horizontal: $F_h = F \cos \theta = 60 \text{ N} \times \cos 25^\circ = 54 \text{ N}$. Vertical: $F_v = F \sin \theta = 60 \text{ N} \times \sin 25^\circ = 25 \text{ N}$.

2.3 Two perpendicular forces act on a point: 30 N north and 40 N east. Calculate the magnitude of the resultant and its angle to north. [3]

2.3 $R = \sqrt{F_x^2 + F_y^2} = \sqrt{30^2 + 40^2} \text{ N} = 50 \text{ N}$; $\tan \theta = \frac{40}{30}$ so $\theta = 53^\circ$ east of north.

Exercise 2.4

2.4 A picture hangs from a hook by a wire. The wire pulls the picture with two tensions T_1 and T_2 and the picture has weight W .

(a) Write the vector equation that shows the picture is in equilibrium. [1]

(b) Explain what a scale drawing of the three forces must look like. [2]

Exercise 2.4

2.4 A picture hangs from a hook by a wire. The wire pulls the picture with two tensions T_1 and T_2 and the picture has weight W .

(a) Write the vector equation that shows the picture is in equilibrium. [1]

(b) Explain what a scale drawing of the three forces must look like. [2]

2.4

(a) $\vec{W} + \vec{T}_1 + \vec{T}_2 = \vec{0}$. (b) Drawn nose to tail, the three force arrows form a **closed triangle**; any side's length gives its force on the chosen scale.

Exercises 2.5·3.1

2.5 Two coins leave the edge of the same bench: coin P slides off at 1.0 m s^{-1} , coin Q is flicked off at 4.0 m s^{-1} . Explain why both coins land at the same time, and say which lands further from the bench. [2]

3 Exam-style questions

3.1 A boat is pulled north by 420 N and east by 160 N. Which expression gives the magnitude of the resultant force? [1]

☐

A $\sqrt{420^2} + \sqrt{160^2}$

B $420 + 160$

C $\sqrt{420^2 + 160^2}$

D $\sqrt{420^2 - 160^2}$

Exercises 2.5·3.1

2.5 Two coins leave the edge of the same bench: coin P slides off at 1.0 m s^{-1} , coin Q is flicked off at 4.0 m s^{-1} . Explain why both coins land at the same time, and say which lands further from the bench. [2]

3 Exam-style questions

2.5 Both coins have the same initial vertical velocity (zero) and fall the same height under g , and the vertical motion is independent of the horizontal motion – so the times are equal; coin Q travels further because its horizontal velocity is larger for the same time.

3.1 A boat is pulled north by 420 N and east by 160 N. Which expression gives the magnitude of the resultant force? [1]

- ☐ **A** $\sqrt{420^2} + \sqrt{160^2}$
B $420 + 160$
C $\sqrt{420^2 + 160^2}$
D $\sqrt{420^2 - 160^2}$

3.1 C. The forces are perpendicular, so the resultant is the hypotenuse. A adds the roots separately; B adds without squaring; D subtracts the squares.

Exercise 3.2

3.2 A stone is thrown horizontally from a cliff at the same moment as a second stone is dropped from the same height. Ignore air resistance. Which statement is correct? [1]

☐

A the thrown stone lands first because it moves faster

B the dropped stone lands first because it travels less far

C both land together because their vertical motions are identical

D both land together because their masses are equal

Exercise 3.2

3.2 A stone is thrown horizontally from a cliff at the same moment as a second stone is dropped from the same height. Ignore air resistance. Which statement is correct? [1]

☐

A the thrown stone lands first because it moves faster

B the dropped stone lands first because it travels less far

C both land together because their vertical motions are identical

D both land together because their masses are equal

3.2 C. The vertical motion decides the landing time and is identical for both stones. A and B confuse horizontal speed with vertical fall; D names mass, which does not appear in free fall.

Exercise 3.3

3.3 Traffic lights of weight W hang from the middle of a wire. Each half of the wire is at angle θ to the horizontal, with tension T in each half.

(a) Resolve each tension vertically and show that $W = 2T \sin \theta$. [2]

(b) The wire is tightened so that θ gets smaller. Explain what happens to the tension needed to support the same weight. [2]

Exercise 3.3

3.3 Traffic lights of weight W hang from the middle of a wire. Each half of the wire is at angle θ to the horizontal, with tension T in each half.

(a) Resolve each tension vertically and show that $W = 2T \sin \theta$. [2]

(b) The wire is tightened so that θ gets smaller. Explain what happens to the tension needed to support the same weight. [2]

3.3 (a) Each wire half pulls up with $T \sin \theta$; equilibrium gives $W = T \sin \theta + T \sin \theta = 2T \sin \theta$. (b) $T = \frac{W}{2 \sin \theta}$: as θ gets smaller, $\sin \theta$ gets smaller, so the tension must **increase** for the same weight.

Exercise 3.4

3.4 A launcher fires a ball at 25 m s^{-1} at 40° above the horizontal from ground level.

(a) Show that the vertical component of the launch velocity is about 16 m s^{-1} . [1]

(b) Calculate the time the ball spends in the air. [3]

(c) Calculate the horizontal distance travelled before landing. [2]

(d) The launch speed stays the same but the angle increases. Explain why the horizontal distance can decrease even though the ball stays in the air longer. [2]

Exercise 3.4

3.4 A launcher fires a ball at 25 m s^{-1} at 40° above the horizontal from ground level.

(a) Show that the vertical component of the launch velocity is about 16 m s^{-1} . [1]

(b) Calculate the time the ball spends in the air. [3]

(c) Calculate the horizontal distance travelled before landing. [2]

(d) The launch speed stays the same but the angle increases. Explain why the horizontal distance can decrease even though the ball stays in the air longer. [2]

3.4 (a) $u_v = u \sin \theta = 25 \text{ m s}^{-1} \times \sin 40^\circ = 16.1 \text{ m s}^{-1} \approx 16 \text{ m s}^{-1}$. (b) Known: $u_v = 16.1 \text{ m s}^{-1}$, and at landing $v_v = -16.1 \text{ m s}^{-1}$ (same level). Use $v = u + at$:

$$t = \frac{v_v - u_v}{-g} = \frac{-16.1 \text{ m s}^{-1} - 16.1 \text{ m s}^{-1}}{-9.81 \text{ m s}^{-2}} = 3.3 \text{ s (M1, A1)}$$

Full solution 3.4

3.4 (a) $u_v = u \sin \theta = 25 \text{ m s}^{-1} \times \sin 40^\circ = 16.1 \text{ m s}^{-1} \approx 16 \text{ m s}^{-1}$. (b) Known: $u_v = 16.1 \text{ m s}^{-1}$, and at landing $v_v = -16.1 \text{ m s}^{-1}$ (same level). Use $v = u + at$:

$$t = \frac{v_v - u_v}{-g} = \frac{-16.1 \text{ m s}^{-1} - 16.1 \text{ m s}^{-1}}{-9.81 \text{ m s}^{-2}} = 3.3 \text{ s (M1, A1)}$$

(c) $u_h = u \cos \theta = 25 \text{ m s}^{-1} \times \cos 40^\circ = 19.2 \text{ m s}^{-1}$; $s_h = u_h \times t = 19.2 \text{ m s}^{-1} \times 3.3 \text{ s} = 63 \text{ m}$.

(d) A larger angle raises u_v , so the flight is longer, but it lowers u_h ; since distance = $u_h \times t$, the smaller horizontal speed can win, and the distance falls.