

Exercise walk-through

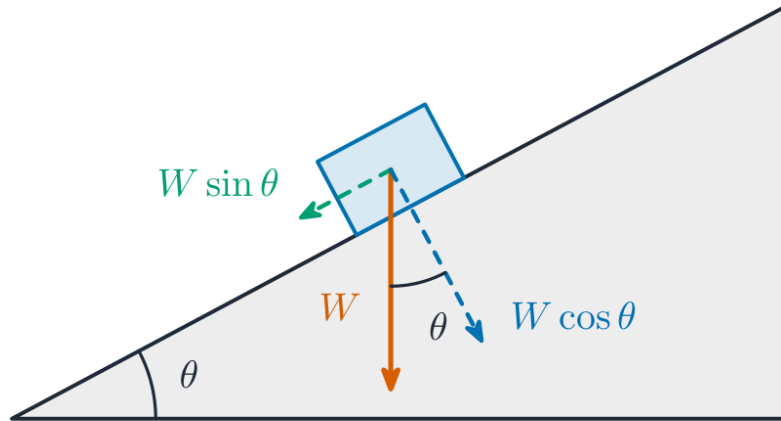
# 1.1

## Motion graphs and uniform acceleration (statements 1–3)

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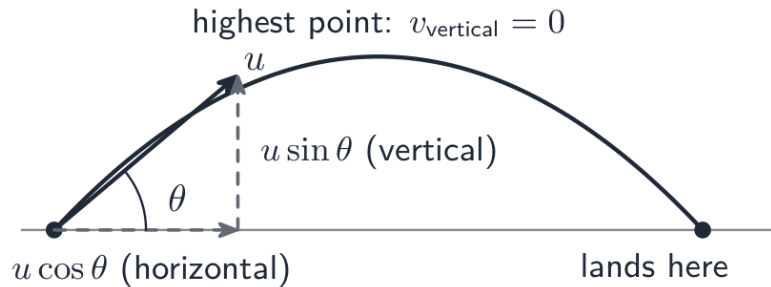
Pearson Edexcel · International A-Level · Physics

## Resolve from the marked angle



- Draw a right triangle: the adjacent component uses cosine, the opposite uses sine.
- For a slope at angle  $\theta$ :  
 $W_{\parallel} = W \sin \theta$ ,  $W_{\perp} = W \cos \theta$ .
- 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.

## Exercise 2.1

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**2.1** State what is represented by (a) the gradient of a velocity–time graph; (b) the area between the line and the time axis on a velocity–time graph. [2]

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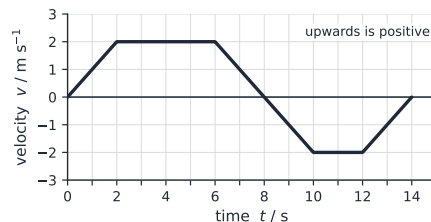
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**2.1** (a) acceleration (b) displacement. *Distance needs the sizes of the areas; displacement uses their signs.*

## Exercise 2.2

2.2 The velocity–time graph shows a lift that goes up, comes back down, and passes its starting floor. Upwards is positive.



- (a) Calculate the acceleration of the lift between  $t = 0$  and  $t = 2.0$  s. [1]

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- (b) Calculate the displacement of the lift between  $t = 6.0$  s and  $t = 12.0$  s. [2]

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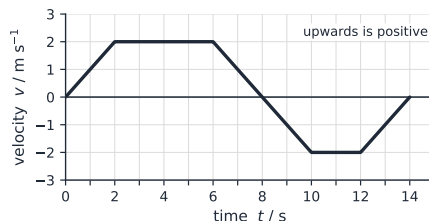
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- (c) Calculate the total distance travelled by the lift in the 14 s. (*Hint: for distance, every area counts as positive.*) [2]

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**2.2** (a)  $a = \frac{\Delta v}{\Delta t} = \frac{2.0 \text{ m s}^{-1} - 0}{2.0 \text{ s}} = 1.0 \text{ m s}^{-2}$ . (b) Areas:  $t = 6\text{--}8$  s:  $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = +2.0 \text{ m}$ ;  $t = 8\text{--}10$  s:  $\frac{1}{2} \times 2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -2.0 \text{ m}$ ;  $t = 10\text{--}12$  s:  $2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -4.0 \text{ m}$ . Displacement =  $2.0 - 2.0 - 4.0 = -4.0 \text{ m}$ . (c) Distance =  $|+2.0| + |-2.0| + |-4.0|$  plus the  $0\text{--}6$  s area  $\frac{1}{2}(4.0 + 6.0) \text{ s} \times 2.0 \text{ m s}^{-1} = 10 \text{ m}$  and the  $12\text{--}14$  s triangle  $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = 2.0 \text{ m}$ : total  $10 + 2.0 + 2.0 + 4.0 + 2.0 = 20 \text{ m}$ .

## Full solution 2.2

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**2.2** (a)  $a = \frac{\Delta v}{\Delta t} = \frac{2.0 \text{ m s}^{-1} - 0}{2.0 \text{ s}} = 1.0 \text{ m s}^{-2}$ . (b) Areas:  $t = 6\text{--}8 \text{ s}$ :  $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = +2.0 \text{ m}$ ;  $t = 8\text{--}10 \text{ s}$ :  $\frac{1}{2} \times 2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -2.0 \text{ m}$ ;  $t = 10\text{--}12 \text{ s}$ :  $2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -4.0 \text{ m}$ . Displacement =  $2.0 - 2.0 - 4.0 = -4.0 \text{ m}$ . (c) Distance =  $|+2.0| + |-2.0| + |-4.0|$  plus the  $0\text{--}6 \text{ s}$  area  $\frac{1}{2}(4.0 + 6.0) \text{ s} \times 2.0 \text{ m s}^{-1} = 10 \text{ m}$  and the  $12\text{--}14 \text{ s}$  triangle  $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = 2.0 \text{ m}$ : total  $10 + 2.0 + 2.0 + 4.0 + 2.0 = 20 \text{ m}$ .

## Exercises 2.3·2.4

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**2.3** A ball is dropped from rest and hits the ground after 0.55 s.

(a) Use  $s = ut + \frac{1}{2}at^2$  to show that the drop height is about 1.5 m. [2]

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(b) State one reason why a measured time from a handheld stopwatch could make the calculated  $g$  too small, and one improvement. [2]

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**2.4** A car accelerates uniformly from  $8.0 \text{ m s}^{-1}$  to  $20 \text{ m s}^{-1}$  over 96 m. Calculate its

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**2.3** (a)  $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 9.81 \text{ m s}^{-2} \times (0.55 \text{ s})^2 = 1.5 \text{ m}$ . (b) Reaction time makes

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**2.4** No time is given, so  $v^2 = u^2 + 2as$ .  $a = \frac{v^2 - u^2}{2s} = \frac{(20 \text{ m s}^{-1})^2 - (8.0 \text{ m s}^{-1})^2}{2 \times 96 \text{ m}} = \frac{336}{192} \text{ m s}^{-2} = 1.8 \text{ m s}^{-2}$ .

## Exercise 3.1

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**3.1** An object moves with constant non-zero acceleration. Which row describes its displacement–time graph and its velocity–time graph? [1]

☐

**A** both graphs are straight lines

**B** the displacement–time graph is curved; the velocity–time graph is a straight sloped line

**C** both graphs are curved

**D** the displacement–time graph is a straight sloped line; the velocity–time graph is curved

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**3.1 B.** Constant acceleration makes velocity change linearly (straight sloped velocity–time line) while displacement follows  $s = ut + \frac{1}{2}at^2$  (curved). A is wrong because a straight displacement–time line means constant velocity; C and D mismatch the pair.

## Exercise 3.2

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**3.2** A train's velocity–time graph is a straight line from  $3.0 \text{ m s}^{-1}$  at  $t = 0$  to  $9.0 \text{ m s}^{-1}$  at  $t = 4.0 \text{ s}$ . What is the displacement in those  $4.0 \text{ s}$ ? [1]

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**A** 12 m

**B** 24 m

**C** 36 m

**D** 48 m

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**3.2 B.** The area is a trapezium:  $s = \frac{(u+v)}{2}t = \frac{3.0+9.0}{2} \text{ m s}^{-1} \times 4.0 \text{ s} = 24 \text{ m}$ . A uses only  $u$ ; C multiplies  $u \times t$ ; D doubles correctly counted halves

## Exercise 3.3

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**3.3** In an experiment to determine  $g$ , a student plots  $s$  on the  $y$ -axis for a falling object.

(a) State what should be plotted on the  $x$ -axis to give a straight line through the origin, and how the gradient gives  $g$ . [2]

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(b) The student's  $s$  against  $t^2$  line has a small fixed vertical intercept but the expected gradient. Suggest a distance-measurement error that could cause this and state the effect on  $g$  calculated from the gradient. [2]

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**3.3** (a) Plot  $t^2$  on the  $x$ -axis;  $s = \frac{1}{2}gt^2$ , so the gradient equals  $g/2$  and  $g = 2 \times \text{gradient}$ .

(b) A fixed offset in the distance reading adds the same amount to every  $s$ ; it changes the vertical intercept but not the gradient, so  $g = 2 \times \text{gradient}$  is unchanged.

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**3.4** A skydiver leaves an aeroplane with zero vertical velocity. In the first 1.4 s she falls 9.2 m. Air resistance can be ignored if her mean acceleration is greater than  $0.95g$ . Deduce whether air resistance can be ignored. [4]

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**3.4**  $s = ut + \frac{1}{2}at^2$  with  $u = 0$ :  $a = \frac{2s}{t^2} = \frac{2 \times 9.2 \text{ m}}{(1.4 \text{ s})^2} = 9.4 \text{ m s}^{-2}$ . Compare:  $\frac{9.4}{9.81} = 0.96 > 0.95$ ; since the calculated acceleration exceeds  $0.95g$ , air resistance **can** be ignored.