

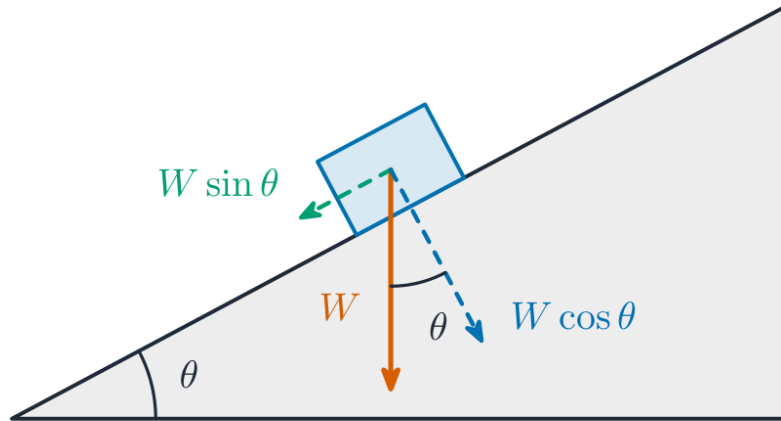
Exercise walk-through

1.6

Work, energy, power and efficiency (statements 17–22)

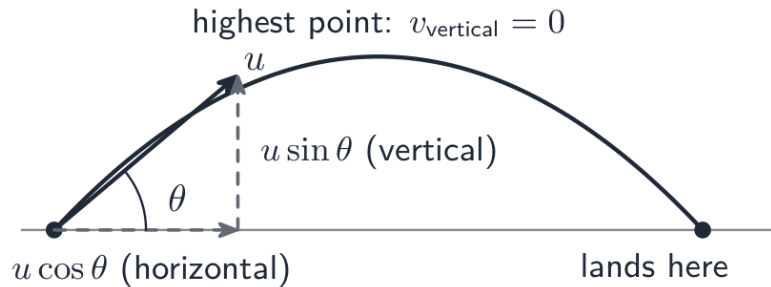
Pearson Edexcel · International A-Level · Physics

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 crane lifts a 250 kg load by 12 m. Calculate the gravitational potential energy gained. [2]

2.2 A 0.40 kg ball moves at 15 m s^{-1} . Calculate its kinetic energy. [2]

2.3 A motor transfers 800 J in 4.0 s. Calculate its power. [1]

Exercises 2.1·2.3

2.1 A crane lifts a 250 kg load by 12 m. Calculate the gravitational potential energy gained. [2]

$$\mathbf{2.1} \quad \Delta E_{\text{grav}} = mg\Delta h = 250 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 12 \text{ m} = 2.9 \times 10^4 \text{ J}.$$

2.2 A 0.40 kg ball moves at 15 m s⁻¹. Calculate its kinetic energy. [2]

$$\mathbf{2.2} \quad E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.40 \text{ kg} \times (15 \text{ m s}^{-1})^2 = 45 \text{ J}.$$

2.3 A motor transfers 800 J in 4.0 s. Calculate its power. [1]

$$\mathbf{2.3} \quad P = \frac{E}{t} = \frac{800 \text{ J}}{4.0 \text{ s}} = 200 \text{ W}.$$

Exercises 2.4·3.1

2.4 A 60 kg runner speeds up from 3.0 m s^{-1} to 6.0 m s^{-1} . Calculate the work done on

3 Exam-style questions

3.1 A braking force dissipates an average power of 40 kW over 3.0 s while a car moves 45 m. Which expression gives the braking force? [1]

☐

A $\frac{40 \times 10^3 \times 45}{3.0}$

B $\frac{40 \times 10^3 \times 3.0}{45}$

C $\frac{40 \times 10^3 \times 3.0}{45}$

D $\frac{40 \times 10^3}{45 \times 3.0}$

Exercises 2.4·3.1

2.4 A 60 kg runner speeds up from 3.0 m s^{-1} to 6.0 m s^{-1} . Calculate the work done on

3 Exam-style questions

2.4 $W = \Delta E_k$: E_k change $= \frac{1}{2}m(v^2 - u^2) = \frac{1}{2} \times 60 \text{ kg} \times (36 - 9.0) \text{ m}^2\text{s}^{-2} = 810 \text{ J}$.

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- ☐ **A** $\frac{40 \times 10^3 \times 45}{3.0}$
- B** $\frac{40 \times 10^3 \times 3.0}{45}$
- C** $\frac{40 \times 10^3 \times 3.0}{45}$
- D** $\frac{40 \times 10^3}{45 \times 3.0}$

3.1 B. Work dissipated = power $\times$ time, and force = work $\div$ distance. A multiplies by the distance; C and D invert the ratio.

Exercise 3.2

3.2 A ball is dropped and falls with air resistance. Which statement describes the fall at terminal velocity? [1]

☐

A gravitational energy becomes kinetic energy only

B gravitational energy becomes work done against air resistance only

C no energy is transferred

D kinetic energy becomes gravitational energy

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3.2 B. At terminal velocity the kinetic energy is constant, so the whole gravitational loss does work against air resistance. A forgets the drag; C violates conservation; D reverses the fall.

Exercise 3.3

3.3 A pump lifts 200 kg of water through 4.5 m every minute.

(a) Show that the useful power output of the pump is about 150 W. [3]

(b) The pump's electrical input power is 550 W. Calculate its efficiency. [2]

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(a) Show that the useful power output of the pump is about 150 W. [3]

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3.3 (a) $\Delta E_{\text{grav}} = mg\Delta h = 200 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 4.5 \text{ m} = 8.8 \times 10^3 \text{ J per minute};$
 $P = \frac{E}{t} = \frac{8.8 \times 10^3 \text{ J}}{60 \text{ s}} = 147 \text{ W} \approx 150 \text{ W}.$ (b) $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}} =$
 $\frac{147 \text{ W}}{550 \text{ W}} = 0.27.$

Exercise 3.4

3.4 A cyclist of total mass 85 kg freewheels down a hill, dropping 25 m vertically. Her speed rises from 4.0 m s^{-1} to 18 m s^{-1} .

(a) Calculate the loss of gravitational potential energy. [2]

(b) Calculate the gain in kinetic energy. [2]

(c) Account for the difference between your two answers. [2]

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(c) Account for the difference between your two answers. [2]

3.4 (a) $\Delta E_{\text{grav}} = mg\Delta h = 85 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 25 \text{ m} = 2.1 \times 10^4 \text{ J}$. (b) $\Delta E_k = \frac{1}{2}m(v^2 - u^2) = \frac{1}{2} \times 85 \text{ kg} \times (18^2 - 4.0^2) \text{ m}^2\text{s}^{-2} = 1.3 \times 10^4 \text{ J}$. (c) The remaining $8 \times 10^3 \text{ J}$ is work done against air resistance and friction – energy is conserved once every transfer is counted.