

FREE SAMPLE

AQA GCSE Physics Comics · Topic 4.1 Energy, Chapter 2

One full lesson sequence, start to finish:

- Curious hook → Do now → Start of lesson (title, objectives, key words)
- Comic-style teaching pages with a green key-points box on every page
- Worked examples in the same 4 steps every time
- Hook answered → Essentials page
- Your turn questions, Challenge (3-star) questions, full answers
- Remember! summary page

The full PowerPoint versions are editable, with clickable contents and Back / Chapter buttons on every slide.

AQA PHYSICS COMIC

Energy Adventures

AQA GCSE Physics · Topic 4.1 Energy

Featuring the 8 energy stores:



Kinetic



Grav. potential



Elastic potential



Thermal



Chemical



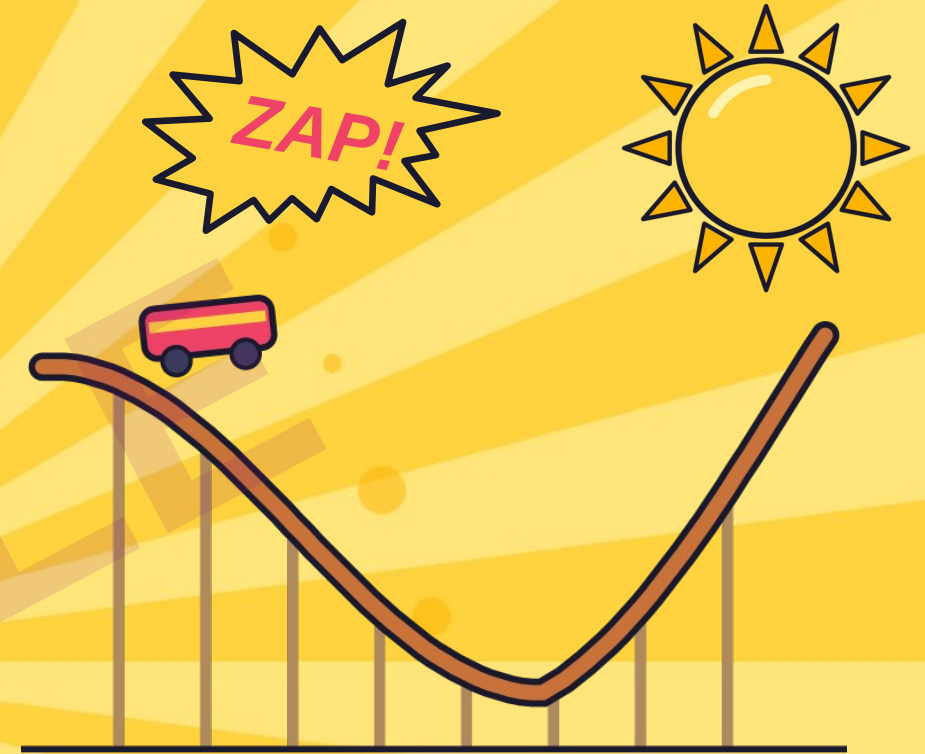
Magnetic



Electrostatic



Nuclear



CONTENTS — click a chapter

COMBINED + PHYSICS

= in Combined Science and Physics

PHYSICS ONLY

= triple Physics only (not Combined)

1 Energy stores and systems

Start →

Your turn

Answers

Remember!

2 Energy on the move

Start →

Your turn

Answers

Remember!

3 Heating things up

Start →

Your turn

Answers

Remember!

4 Power, waste and efficiency

some Physics only

Start →

Your turn

Answers

Remember!

5 Powering the planet

Start →

Your turn

Answers

Remember!

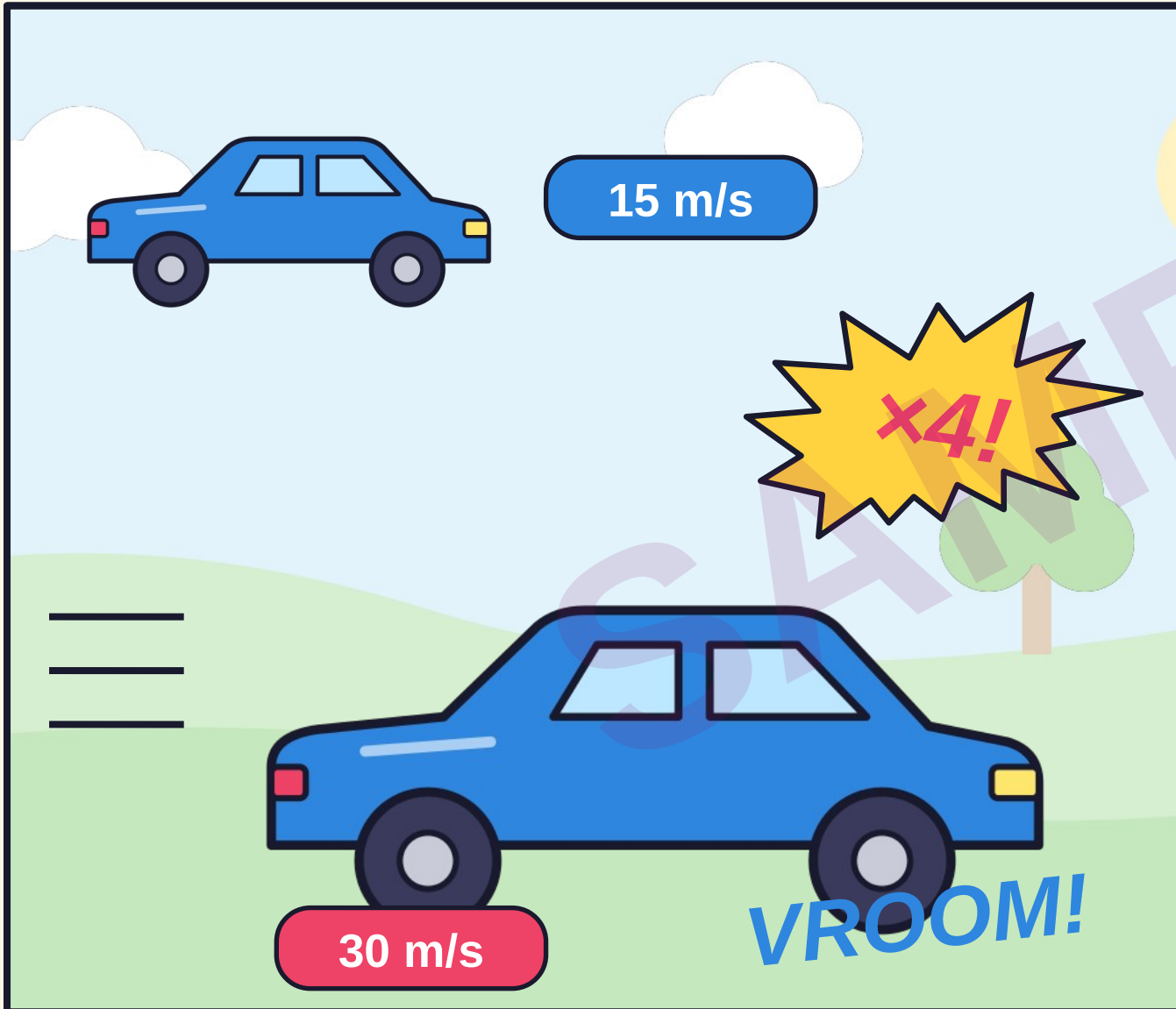
CHAPTER 2

Energy on the move

Calculating kinetic, elastic and gravitational potential energy



CURIOUS HOOK



A car **doubles** its speed. Why does it then have **4 times** as much kinetic energy, not 2 times?

Answered at the end of this sub-topic, on the HOOK ANSWERED page.

DO NOW — 5 minutes**D1**

What are the units of mass and of speed?

D2

What does **extension** mean for a spring?

D3

Calculate:

(a) 3^2

(b) $\frac{1}{2} \times 4 \times 3^2$

D4

A ball falls from a shelf. Which energy store **empties**, and which store **fills**?

DO NOW ANSWERS · START OF LESSON

D1

mass: kg
speed: m/s

D2

how much longer
the spring gets
when stretched

D3

(a) 9
(b) $\frac{1}{2} \times 4 \times 9 = 18$

D4

gravitational
potential empties;
kinetic fills

Start of lesson

- Title: Kinetic, gravitational and elastic potential energy
- Date: _____
- Today I will:
 - Calculate kinetic energy.
 - Calculate gravitational potential energy.
 - Calculate elastic potential energy.
- Key words: kinetic energy, gravitational field strength, spring constant, extension

Key words

- **kinetic energy**: energy in the kinetic store of a moving object.
- **gravitational field strength** (g): 9.8 N/kg on Earth.
- **spring constant** (k): how stiff a spring is, in N/m.
- **extension** (e): how much longer a spring is when stretched, in m.

The Mega Coaster



WHOOSH!

Kinetic

More **mass** or more **speed** means more E_k .

WORKED EXAMPLE

$$E_k = \frac{1}{2} m v^2$$

E_k = kinetic energy (J)

m = mass (kg)

v = speed (m/s)

Q: A rollercoaster car has mass 500 kg and moves at 12 m/s.
Calculate its E_k .

1. $E_k = \frac{1}{2} m v^2$
2. $E_k = \frac{1}{2} \times 500 \times 12^2$
3. $E_k = \frac{1}{2} \times 500 \times 144 = 36\,000$
4. Answer: 36 000 J

36 000 J!

Kinetic energy

- Moving objects have energy in their kinetic store.
- More mass or more speed means more kinetic energy.

$$E_k = \frac{1}{2} m v^2$$

- E_k in Joules (J), m in kg, v in m/s.

Double the speed = double the E_k ?

NO!

v is **squared**, so double the speed gives **4 ×** the E_k .

THINK DEEPER

Triple the speed. How many times more E_k ?

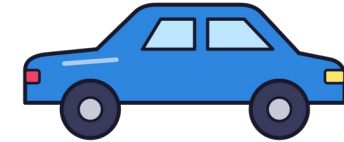
500 kg car

6 m/s → 9 000 J

↓ $v \times 2$

↓ $E_k \times 4$

12 m/s → 36 000 J



because $2^2 = 4$

REARRANGING EXAMPLE

$$E_k = \frac{1}{2} m v^2$$

Substitute first,
then rearrange
to find v .

Q: A 50 kg dodgem rider has 1600 J of kinetic energy. Calculate her speed.

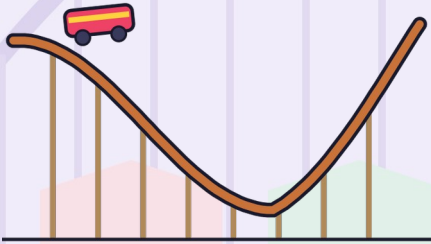
1. $E_k = \frac{1}{2} m v^2$
2. $1600 = \frac{1}{2} \times 50 \times v^2$
3. $v^2 = 1600 \div 25 = 64$, so $v = \sqrt{64}$
4. Answer: $v = 8$ m/s

$v = 8$ m/s!

Speed is squared

- Double the speed → 4 × the kinetic energy.
- Double the mass → only 2 × the kinetic energy.
- To find v : substitute first, then rearrange.

The big drop: 20 m



How **fast** will the car be at the bottom?

ZOOM!

Gravitational potential



Kinetic

$$E_p \text{ lost} = E_k \text{ gained}$$

THINK DEEPER

The mass cancels out. Does a heavier car go faster?

TWO STORES LINKED

$$E_p \text{ lost} = E_k \text{ gained}$$

$$m g h = \frac{1}{2} m v^2$$

starts from rest
 $m = 500 \text{ kg}$, $h = 20 \text{ m}$

Q: The 500 kg car rolls from rest down a 20 m drop. Calculate its speed at the bottom.

1. $E_p = m g h = 500 \times 9.8 \times 20 = 98\,000 \text{ J}$
2. $E_k = 98\,000 = \frac{1}{2} \times 500 \times v^2$
3. $v^2 = 98\,000 \div 250 = 392$, so $v = \sqrt{392}$
4. Answer: $v = 19.8 \text{ m/s}$

$$v \approx 19.8 \text{ m/s!}$$

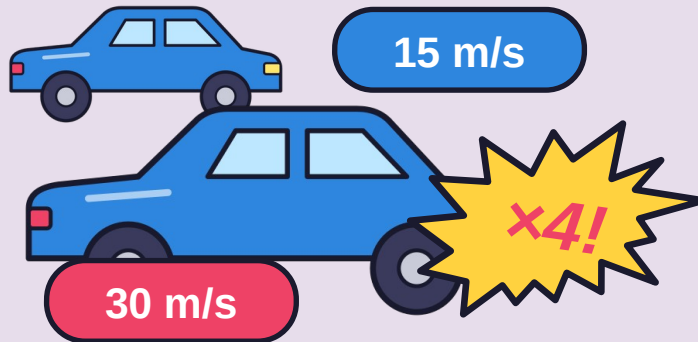
Linking two stores

- If no energy is dissipated by friction or air resistance:

$$E_p \text{ lost} = E_k \text{ gained}$$

- Find E_p first, then use $E_k = \frac{1}{2} m v^2$ to find v .

HOOK ANSWERED



A car **doubles** its speed. Why does it then have **4 times** as much kinetic energy, not 2 times?

The answer

- 1 $E_k = \frac{1}{2} m v^2$. The **speed is squared**, but the mass is not.
- 2 A 1000 kg car at 15 m/s: $E_k = \frac{1}{2} \times 1000 \times 15^2 = 112\,500 \text{ J}$.
- 3 The same car at 30 m/s: $E_k = \frac{1}{2} \times 1000 \times 30^2 = 450\,000 \text{ J}$.
- 4 $450\,000 \div 112\,500 = 4$. Double the speed: $2^2 = 2 \times 2 = 4$.

Stretch

The brakes must transfer 4 times as much energy.

In one sentence

- $E_k = \frac{1}{2} m v^2$: the speed is squared, so doubling the speed makes the kinetic energy $2 \times 2 = 4$ times bigger.

ESSENTIALS

✎ Must-know facts

- Moving objects have energy in their kinetic store.
- Raised objects have energy in their gravitational potential store.
- Stretched or squashed objects have elastic potential energy.
- Double the speed → 4 × the kinetic energy.
- Extension = stretched length – original length.
- $E_e = \frac{1}{2} k e^2$ only works up to the limit of proportionality.
- No friction: E_p lost = E_k gained.

✎ Equations and units

$$E_k = \frac{1}{2} m v^2$$

$$E_p = m g h$$

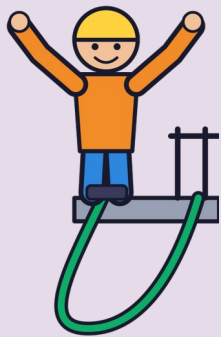
$$E_e = \frac{1}{2} k e^2$$

- Energy in Joules (J), mass in kg, speed in m/s.
- Height and extension in m.
- g in N/kg (9.8 N/kg on Earth), k in N/m.

YOUR TURN! Equation → substitute → calculate → answer with unit.

Q1

A 60 kg bungee jumper stands on a platform 45 m high. Calculate her E_p .



$g = 9.8 \text{ N/kg}$

Q2

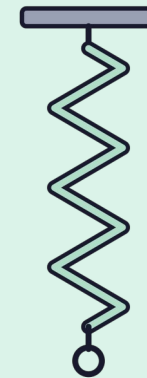
A 400 g ball is thrown at 5.0 m/s. Calculate its E_k .



Hint: grams → kg first!

Q3

A spring ($k = 80 \text{ N/m}$) is 20 cm long. It is stretched to 50 cm. Calculate E_e .



Hint: find e in metres first!

ANSWERS: how did you do?

Q1

$$E_p = m g h$$

1. $E_p = m g h$
2. $E_p = 60 \times 9.8 \times 45$
3. $E_p = 26\,460$
4. Answer: 26 460 J

26 460 J!

(about 26 000 J)

Q2

$$E_k = \frac{1}{2} m v^2$$

- $m = 400 \text{ g} = 0.4 \text{ kg}$
1. $E_k = \frac{1}{2} m v^2$
 2. $E_k = \frac{1}{2} \times 0.4 \times 5.0^2$
 3. $E_k = \frac{1}{2} \times 0.4 \times 25 = 5.0$
 4. Answer: 5.0 J

5.0 J!**Q3**

$$E_e = \frac{1}{2} k e^2$$

- $e = 50 - 20 = 30 \text{ cm} = 0.30 \text{ m}$
1. $E_e = \frac{1}{2} k e^2$
 2. $E_e = \frac{1}{2} \times 80 \times 0.30^2$
 3. $E_e = \frac{1}{2} \times 80 \times 0.09 = 3.6$
 4. Answer: 3.6 J

3.6 J!

CHALLENGE ★★ ★ Linking the stores

C1

★★★

[4 marks]

Linking $E_p \rightarrow E_k$. A 0.20 kg ball is dropped from a height of 5.0 m. Ignoring air resistance, calculate its speed just before it hits the ground.

C2

★★★

[4 marks]

Linking $E_e \rightarrow E_k$. A toy launcher's spring ($k = 800 \text{ N/m}$) is compressed by **5.0 cm**. It launches a 0.040 kg ball. All the elastic potential energy becomes kinetic energy. Calculate the launch speed.

C3

★★★

[4 marks]

By what factor?

- (a) The spring in C2 is compressed **twice** as far. By what factor does E_e change? By what factor does the launch speed change?
- (b) A rollercoaster drop is made **4 times** higher. By what factor does the speed at the bottom change?

C4

★★★

[5 marks]

A 70 kg skier starts from rest and drops through a vertical height of 30 m. At the bottom her speed is 20 m/s. Calculate the energy dissipated, and explain where it goes.

ANSWERS — Challenge ★★

C1

$$E_p \text{ lost} = 0.20 \times 9.8 \times 5.0 = 9.8 \text{ J (1)}$$

$$E_k \text{ gained} = 9.8 \text{ J (1)}$$

$$9.8 = \frac{1}{2} \times 0.20 \times v^2, \text{ so } v^2 = 98 \text{ (1)}$$

$$v = \sqrt{98}$$

$$\rightarrow 9.9 \text{ m/s (1)}$$

C2

$$e = 5.0 \text{ cm} = 0.050 \text{ m}$$

$$E_e = \frac{1}{2} \times 800 \times 0.050^2 = 1.0 \text{ J (1)}$$

$$E_k: 1.0 = \frac{1}{2} \times 0.040 \times v^2 \text{ (1)}$$

$$v^2 = 1.0 \div 0.020 = 50 \text{ (1)}$$

$$v = \sqrt{50}$$

$$\rightarrow 7.1 \text{ m/s (1)}$$

C3

(a) $E_e \propto e^2$, so $2^2 = 4 \times$ the energy (1).

E_k is $4 \times$ too. $E_k \propto v^2$, so v is $\sqrt{4} = 2 \times$ (1).

(b) $v^2 = 2 g h$, so $v \propto \sqrt{h}$ (1).

$\sqrt{4} = 2$: the speed **doubles** (1).

C4

$$E_p \text{ lost} = 70 \times 9.8 \times 30 = 20\,580 \text{ J (1)}$$

$$E_k \text{ gained} = \frac{1}{2} \times 70 \times 20^2 = 14\,000 \text{ J (1)}$$

$$\text{dissipated} = 20\,580 - 14\,000 \text{ (1)}$$

Work against friction and air resistance heats the skis, snow and air: **thermal store** of the surroundings (1).

$$\rightarrow 6580 \text{ J (about } 6600 \text{ J) (1)}$$

REMEMBER!

Energy on the move

Equations (all on the sheet)

$$E_k = \frac{1}{2} m v^2 \quad \text{kinetic}$$

$$E_p = m g h \quad \text{grav. potential}$$

$$E_e = \frac{1}{2} k e^2 \quad \text{elastic potential}$$

Units

- J, kg, m/s, m, N/kg, N/m
- $g = 9.8 \text{ N/kg}$ on Earth
- Convert: grams $\div 1000 \rightarrow$ kg; cm $\div 100 \rightarrow$ m

Key ideas

- Double the speed $\rightarrow 4\times$ the E_k (v is squared)
- Extension e = stretched length – original length
- $E_e = \frac{1}{2} k e^2$ works up to the **limit of proportionality**
- No friction: E_p lost = E_k gained

Method

- Equation $\rightarrow$ substitute $\rightarrow$ calculate $\rightarrow$ answer **with unit**

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