GCSE PHYSICS · TEACHING DECK

Energy Part 1

Complete deck — Stores, kinetic, gravitational and elastic energy, review

AQA 8463 | Edexcel 1PH0 | OCR J249 / J250

Four decks in one — stores and transfers, KE and GPE, elastic energy, then review



GCSE PHYSICS · TEACHING DECK

Energy Stores & Changes

Deck 1 of 4 — Systems, transfers & how to describe them

AQA 8463 | Edexcel 1PH0 | OCR J249 / J250

The bedrock of the whole topic — every energy question starts with naming a store correctly



Where we're going — 4 decks

YOU ARE HERE

1

Systems, transfers & how to describe them

All tiers

2

Kinetic & gravitational potential energy

All tiers

3

Elastic potential energy & bringing it together

Higher stretch

4

Quick recap & multi-step challenges

Review

A rare split-free topic — Part 1 is common to every tier, board and course (Combined and Separate). There is almost nothing to withhold from anyone here.

STARTER *~1 min*



"Clap your hands. You just made a sound — but energy is never made from nothing. Trace it back: where was that energy a moment before?"

Push toward: sound ← movement ← muscles ← food.

Tutor: *This is the whole deck's big idea — energy is never created, only stored, and it moves between stores.*

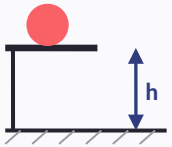
THEIR IDEAS

Systems & the eight energy stores

- A system is an object or group of objects you choose to study — e.g. a kettle and the water in it, or a ball and the Earth.
- Energy is never created or destroyed. It is stored, and it moves (transfers) between stores when a system changes.
- **The eight energy stores (learn all eight): kinetic, gravitational potential, elastic potential, thermal / internal, chemical, nuclear, electrostatic, magnetic.**
- Describe energy by where it is stored — not “light energy” or “sound energy”. Those are ways energy is transferred, not stores.



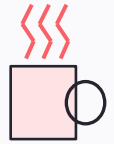
Kinetic
a moving car or ball



Gravitational potential
a book on a high shelf



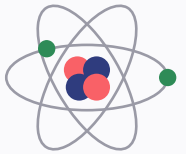
Elastic potential
a stretched spring or band



Thermal / internal
a hot cup of tea



Chemical
food, fuel, a battery



Nuclear
inside atomic nuclei



Electrostatic
separated + and – charges



Magnetic
magnets and iron

Where marks are lost: vague names (“heat energy” not “thermal store”); confusing a store with a transfer; forgetting chemical, nuclear, electrostatic and magnetic.

WORKED EXAMPLE

Tutor models the method — answer comes last

A stretched catapult holds a stone. Name the main store now, and just after release as the stone flies up.

METHOD

- The elastic potential store is full while the catapult is stretched.
- On release it empties into the kinetic store.
- As the stone rises, energy shifts to the gravitational potential store.

WORK IT THROUGH

Answer: Elastic potential (stretched) → kinetic (on release) → gravitational potential (as it rises).

Mark scheme: *1 for elastic potential · 1 for kinetic · 1 for gravitational potential.*

YOUR TURN — PART 1

Systems & the eight energy stores — answers on the next slide.

1 Define “system” in one sentence.

2 Name the store filling up: a car speeding up; a book lifted onto a shelf; a stretched elastic band.

3 For a cooling cup of tea, which store empties?

4 Why is “sound energy” not one of the eight stores?

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 1

Tutor reveal

1

A system is an object or group of objects being studied.

2

Kinetic · gravitational potential · elastic potential.

3

The tea's thermal store empties.

4

Sound is a way energy is transferred (by radiation), not a store where energy sits.

STARTER *~1 min*



"A ball bounces, but each bounce is a little lower than the last. Where is the energy at the top of a bounce, at the bottom — and where does the missing energy go?"

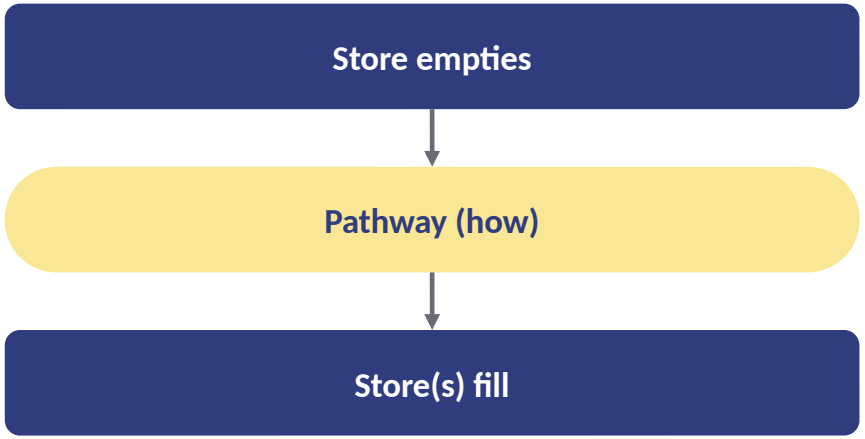
Push toward: GPE ⇄ KE each bounce, with a little energy dissipated (heating + sound) every time it hits the ground.

Tutor: *Sets up the "describe the energy changes" question type — core marks on every board.*

THEIR IDEAS

Four pathways, five situations to describe

- Energy transfers between stores by four pathways: mechanically (a force does work), electrically (a moving charge does work), by heating (a temperature difference), and by radiation (e.g. light, sound, infrared).
- **To answer "describe the energy changes": name the store that empties → the pathway → the store(s) that fill.**
- Five situations to know: projected upwards; hits an obstacle; accelerated by a force; vehicle braking; kettle boiling.



The shape of every "describe the energy changes" answer.

THE FOUR PATHWAYS

Mechanically
a force does work

Electrically
a moving charge does work

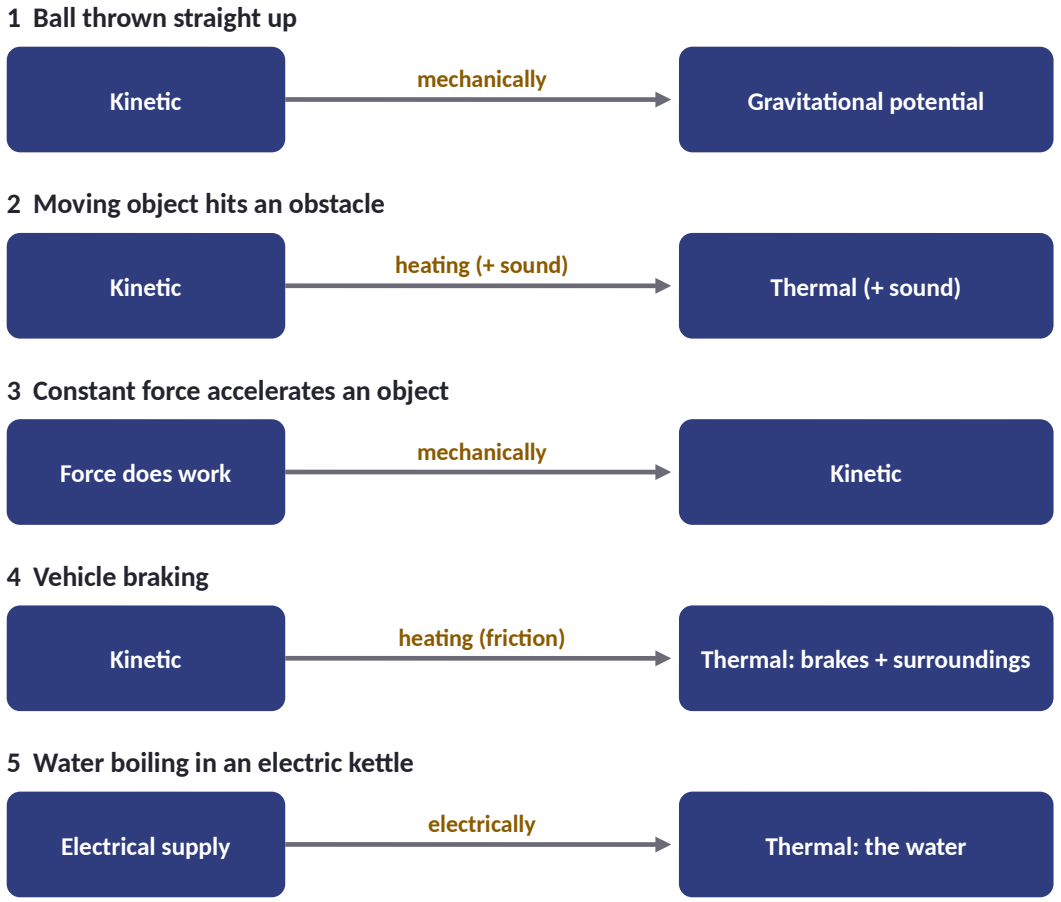
By heating
a temperature difference

By radiation
light, sound, infrared

Where marks are lost: "kinetic pathway" or "heat store" (pathway = how, store = where); saying energy is "used up" or "lost" instead of transferred.

The five situations, store by store

- Always write the chain in order: store that empties → pathway → store that fills.
- Where the “extra” energy goes matters: in 2 and 4 it is dissipated — transferred by heating to the thermal store of the surroundings (and some to sound). It is never “used up”.
- Use exact names: “thermal store”, “kinetic store”, “gravitational potential store” — not “heat”, “movement” or “height energy”.



Where marks are lost: naming only the store that fills and forgetting the one that empties (or vice versa).

WORKED EXAMPLE

Tutor models the method — answer comes last

A car brakes to a stop. Describe the energy transfer.

METHOD

- The kinetic store of the car empties.
- Energy is transferred by heating (friction in the brakes) to the thermal store of the brakes and the surroundings.

WORK IT THROUGH

Answer: Kinetic store empties → transferred by heating (friction) → thermal store of the brakes and surroundings fills.

Mark scheme: *1 for kinetic store empties · 1 for by heating (friction) · 1 for thermal store of the brakes / surroundings.*

YOUR TURN — PART 2

Transfer pathways & describing the changes — answers on the next slide.

1 State the four transfer pathways.

2 Describe the main energy changes when a ball is thrown straight up (ignore air resistance).

3 Describe the energy changes when a kettle boils water.

4 A wind-up toy runs across the floor. Name the store that empties and the pathway.

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 2

Tutor reveal

1

Mechanically, electrically, by heating, by radiation.

2

Kinetic store empties → gravitational potential store fills (then reverses on the way down).

3

Energy supplied electrically → thermal store of the water fills.

4

Elastic potential store of the wound spring empties → transferred mechanically to the kinetic store.

EXAM PRACTICE — SET A

Energy stores and transfers · 12 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q1 *Stores & transfers · table* **[6 marks]**

The table shows the energy stores involved in three situations.

Situation	Store that empties	Store that fills
A stretched catapult fires a stone	*elastic potential*	*kinetic*
(i) A student lifts a book onto a shelf		
(ii) A skateboard coasts to a stop		
(iii) A ball falls off a table		

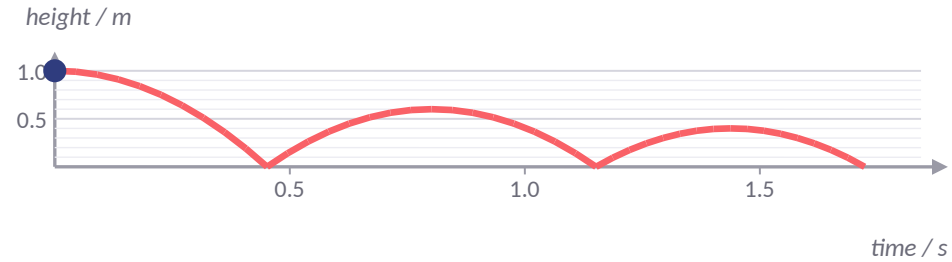
(a) Complete rows (i), (ii) and (iii) of the table. **[3]**

(b) Name the pathway that transfers energy to the surroundings in row (ii). **[1]**

(c) A student says: "The skateboard's energy has been used up." Explain why this is wrong. **[2]**

Q2 *Graph · describe & explain* **[6 marks]**

A student drops a ball. The graph shows its height as it bounces.



(a) Use the graph to find the height lost by the first peak. **[1]**

(b) Name the energy store that is greatest at each peak. **[1]**

(c) Describe the energy changes from release to the first impact. **[2]**

(d) Explain why each bounce is lower than the one before. **[2]**

MARK SCHEME — SET A

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q1

[6 marks]

B1 (i) chemical (store of the student) → gravitational potential

B1 (ii) kinetic → thermal

B1 (iii) gravitational potential → kinetic

Each row needs BOTH stores correct. Accept "internal" for thermal. "Heat energy", "movement energy": no credit.

B1 (b) by heating (accept "heating by friction")

B1 (c) energy is not used up / destroyed — the total stays the same (conserved)

B1 it is transferred (dissipated) by heating to the thermal store of the surroundings (wheels, road, air)

Do not accept "lost" or "wasted" on their own.

Answer: (a) chemical → gravitational potential; kinetic → thermal; gravitational potential → kinetic

Q2

[6 marks]

B1 (a) 1.0 − 0.6 = 0.4 m (allow 0.38–0.42)

B1 (b) gravitational potential (store)

B1 (c) gravitational potential store empties

B1 kinetic store fills (transferred mechanically, by the force of gravity)

B1 (d) on each impact some energy is dissipated / transferred by heating (and sound) to the thermal store of the ball, floor and surroundings

B1 so less energy is left in the kinetic store after the bounce, so less is transferred to the gravitational potential store at the top

Do not accept "energy is lost" or "used up" without saying where it goes.

Answer: (a) 0.4 m (b) gravitational potential

EXAM PRACTICE — 6-MARK QUESTION

Levels-based · 6 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q3 *Extended response · levels* **[6 marks]**

*A child winds up a clockwork toy car, places it on the floor and lets go. The car speeds across the floor and gradually slows to a stop. Describe the energy transfers that take place, from the child winding up the toy until the car stops. Name each store and each pathway you use.

MARK SCHEME — 6-MARK QUESTION

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q3

[6 marks]

Level 3 (5–6) a complete, linked sequence covering winding, release AND slowing, naming stores and pathways correctly, with the energy ending in the thermal store of the surroundings.

Level 2 (3–4) most of the sequence, or the whole sequence with a store / pathway missing or misnamed (e.g. “heat”).

Level 1 (1–2) isolated correct stores or transfers, no clear sequence.

Indicative content: chemical store of the child’s muscles empties; energy transferred mechanically (work done winding) to the elastic potential store of the spring; on release the elastic potential store empties, transferred mechanically to the kinetic store of the car; friction between wheels / floor and air resistance: kinetic store empties, energy transferred by heating to the thermal store of the wheels, floor and air (dissipated); some energy transferred by sound (radiation); total energy conserved — none used up.

Max 6 marks

Answer: **Levels-based: see descriptors**

Watch out — and what to remember

IN A NUTSHELL

- Energy is stored, never created or destroyed.
- Learn all eight stores — describe by where it's stored, not by the transfer.
- Every “describe the changes” answer: store empties → pathway → store fills.

COMMON SLIP-UPS

Calling a transfer a store

“Sound energy” and “light energy” are pathways (radiation), not stores. Only the eight named stores count.

Forgetting the less obvious stores

Chemical, nuclear, electrostatic and magnetic are the ones students miss under pressure — drill all eight, not just kinetic and GPE.

Saying energy is “used up”

Energy is never lost or used up — always name where it goes and by which pathway.

NEXT Deck 2 — Kinetic & gravitational potential energy

GCSE PHYSICS · TEACHING DECK

Energy Stores & Changes

Deck 2 of 4 — Kinetic & gravitational potential energy

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The two most-tested calculations in the whole topic — drill selecting and rearranging the equation



Where we're going — 4 decks



1

Systems, transfers & how to describe them

All tiers

YOU ARE HERE

2

Kinetic & gravitational potential energy

All tiers

3

Elastic potential energy & bringing it together

Higher stretch

4

Quick recap & multi-step challenges

Review

Still all tiers, all boards — Foundation and Higher take these two equations at the same pace, just go steady on the rearranging.

STARTER *~1 min*



"Two cars at the same speed, one twice the mass — which has more kinetic energy, and how many times more? Now same mass but one at twice the speed — how many times more?"

Push toward: Mass doubles → KE doubles. Speed doubles → KE is four times bigger, because speed is squared.

Tutor: *Draws out the key idea before the formal equation: speed is squared, mass isn't.*

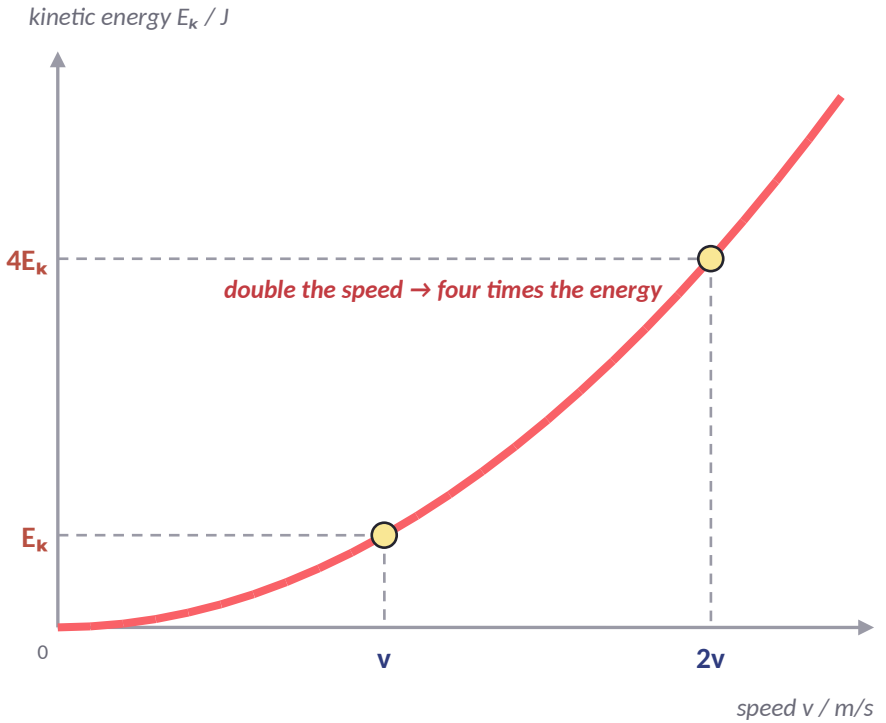
THEIR IDEAS

Kinetic energy — $E_k = ½ m v^2$

- Kinetic energy is the energy in the store of a moving object.
- $E_k = ½ m v^2$, where E_k = kinetic energy (J), m = mass (kg), v = speed (m/s).
- Speed is squared, so doubling the speed gives four times the kinetic energy — this is why stopping distances grow so quickly.
- Rearranged for speed: $v = \sqrt{(2E_k \div m)}$.

$E_k = ½ m v^2$

J = 0.5 × kg × (m/s)² · rearranged for speed: $v = \sqrt{(2E_k \div m)}$



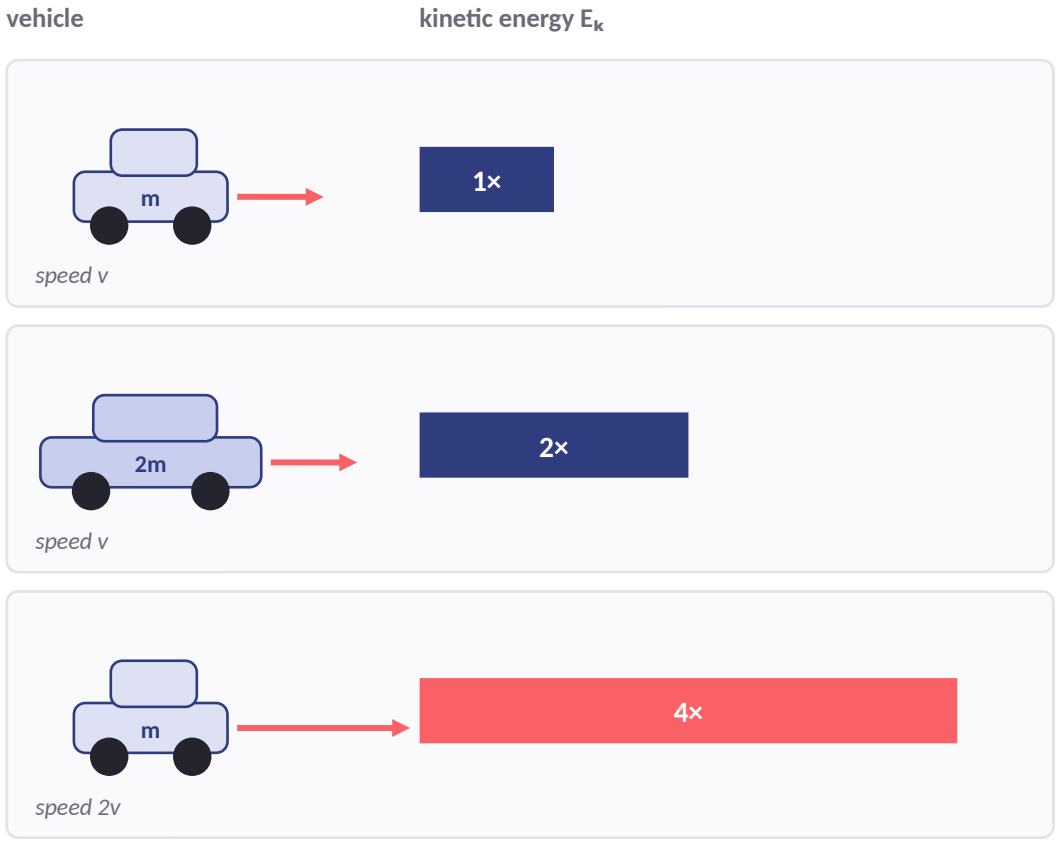
Doubling v quadruples E_k — it's squared in the equation.

A formula triangle can't rearrange a squared term — practise rearranging directly.

Where marks are lost: forgetting to square the speed (square only v, not ½mv); dropping the ½; forgetting to square-root at the end when finding v.

Mass or speed: which matters more?

- Double the mass → double the kinetic energy (E_k is directly proportional to m).
- Double the speed → four times the kinetic energy (E_k is proportional to v^2). Treble the speed → nine times.
- **Rearranging: $E_k = ½ m v^2$ → $v^2 = 2E_k ÷ m$ → $v = √(2E_k ÷ m)$. Mass: $m = 2E_k ÷ v^2$.**
- Convert first: speed in m/s (km/h ÷ 3.6), mass in kg (g ÷ 1000, tonnes × 1000).



Double the mass → ×2. Double the speed → ×4.

$$v = √(2E_k ÷ m)$$

m/s = √(J ÷ kg) · square-root as the very last step

Where marks are lost: converting km/h and g after substituting; squaring the whole of ½mv; reading "×4" as "×2".

WORKED EXAMPLE

Tutor models the method — answer comes last

A 1200 kg car travels at 20 m/s. Find its kinetic energy.

METHOD

- Write the equation: $E_k = ½ m v^2$
- Substitute: $E_k = ½ \times 1200 \times 20^2$
- Square the speed first: $20^2 = 400$, then multiply through.

WORK IT THROUGH

Answer: $E_k = ½ \times 1200 \times 400 = 240\,000$ J (240 kJ).

Mark scheme: *1 for equation · 1 for substitution (squared speed) · 1 for 240 000 J.*

WORKED EXAMPLE — FINDING SPEED

Rearrange first — then square-root last

A 0.40 kg football has 20 J of kinetic energy. Find its speed.

METHOD

- Write the equation: $E_k = \frac{1}{2} m v^2$
- Rearrange for v^2: $v^2 = 2E_k \div m = (2 \times 20) \div 0.40$
- Calculate $v^2 = 40 \div 0.40 = 100$, then take the square root.

WORK IT THROUGH

Answer: $v = \sqrt{100} = 10$ m/s.

Mark scheme: *1 for rearranging · 1 for substituting ($v^2 = 100$) · 1 for v = 10 m/s.*

YOUR TURN — PART 1

Kinetic energy ($E_k = ½ m v^2$) — answers on the next slide.

1 State the kinetic energy equation with units.

2 A 0.15 kg ball moves at 12 m/s. Calculate its kinetic energy.

3 A 70 kg runner has 1260 J of kinetic energy. Calculate their speed.

4 A car doubles its speed. By what factor does its kinetic energy change?

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 1

Tutor reveal

1

$E_k = \frac{1}{2} m v^2$ (J, kg, m/s).

2

$\frac{1}{2} \times 0.15 \times 12^2 = 0.075 \times 144 = 10.8$ J.

3

$v = \sqrt{(2 \times 1260 \div 70)} = \sqrt{36} = 6$ m/s.

4

×4 (energy is proportional to speed^2).

STARTER *~1 min*



"Why does a dropped brick hurt far more from a second-floor window than from a chair?"

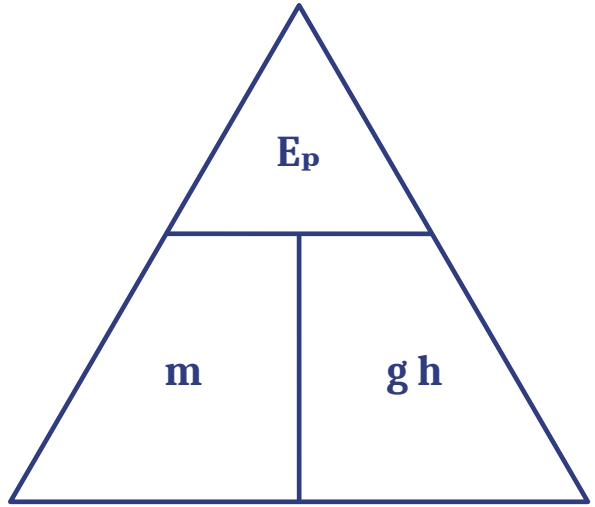
Push toward: Raising something stores more gravitational potential energy — more height, more energy to release.

Tutor: *Straightforward once the value of g is clear — this is the gentler of the two calculations in this deck.*

THEIR IDEAS

Gravitational potential energy — $E_p = m\ g\ h$

- Gravitational potential energy is the energy in the store of an object raised in a gravitational field.
- E_p = m g h, where E_p = gravitational potential energy (J), m = mass (kg), g = gravitational field strength (N/kg), h = height (m). Edexcel writes this ΔGPE = m g Δh — the same equation.
- On Earth g ≈ 9.8 N/kg. Some questions use 10 N/kg — always use the value given. Only the change in height matters.



Cover the quantity you want: $m = E_p \div (g\ h)$; $h = E_p \div (m\ g)$.

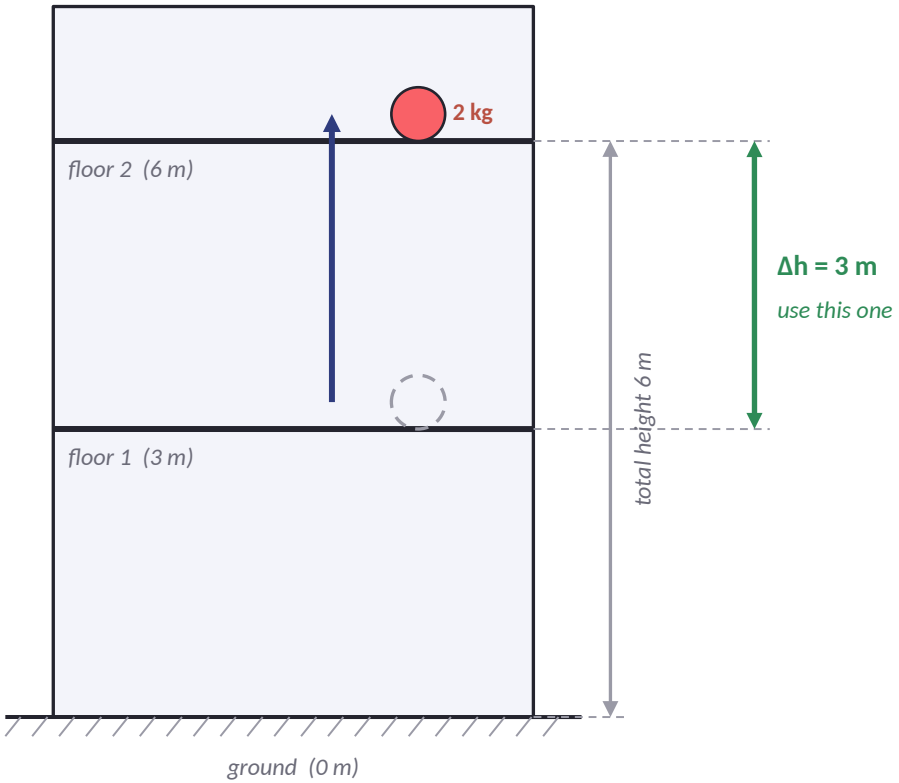
$E_p = m\ g\ h$

J = kg × N/kg × m · g ≈ 9.8 N/kg (or 10 N/kg if the question says so)

Where marks are lost: using the wrong g; using the total height instead of the change in height; mixing up mass (kg) and weight (N).

Change in height, weight and the value of g

- Only the CHANGE in height counts: a ball lifted from floor 1 (3 m) to floor 2 (6 m) gains E_p for Δh = 3 m, not 6 m.
- Weight W = m g (N). So E_p = W × h — the work done lifting the object through the height.
- **Mass is in kg, weight is in N. If the question gives a weight, divide by g to get the mass — or use E_p = W × h directly.**
- Edexcel: ΔGPE = m g Δh. AQA / OCR: E_p = m g h. Same equation — and g = 9.8 or 10 N/kg, whichever the question states.



Raising the 2 kg ball from floor 1 to floor 2: E_p = m g Δh = 2 × 10 × 3 = 60 J

Where marks are lost: using 6 m instead of 3 m; converting cm to m after multiplying; writing the answer in N instead of J.

WORKED EXAMPLE

Tutor models the method — answer comes last

Lift a 3 kg bag 1.5 m onto a shelf (g = 9.8). GPE gained?

METHOD

- Write the equation: $E_p = m\ g\ h$
- Substitute: $E_p = 3 \times 9.8 \times 1.5$

WORK IT THROUGH

Answer: $E_p = 3 \times 9.8 \times 1.5 = 44.1$ J.

Mark scheme: *1 for equation · 1 for substitution · 1 for 44.1 J.*

WORKED EXAMPLE — FINDING HEIGHT

Rearrange for h, then substitute

A 0.20 kg ball gains 3.0 J of gravitational potential energy (g = 10 N/kg). How high was it raised?

METHOD

- Write the equation: $E_p = m\ g\ h$
- Rearrange for h: $h = E_p \div (m\ g)$
- Substitute: $h = 3.0 \div (0.20 \times 10) = 3.0 \div 2.0$

WORK IT THROUGH

Answer: h = 1.5 m.

Mark scheme: *1 for rearranging · 1 for substitution · 1 for 1.5 m.*

YOUR TURN — PART 2

Gravitational potential energy ($E_p = m\,g\,h$) — answers on the next slide.

1 State the GPE equation with units.

2 A 60 kg climber ascends 20 m (g = 9.8). GPE gained?

3 A 0.5 kg ball gains 24.5 J of GPE. How high was it raised (g = 9.8)?

4 Using g = 10, find the GPE of a 2 kg mass 5 m up.

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 2

Tutor reveal

1

$E_p = m\ g\ h$ (J, kg, N/kg, m).

2

60 × 9.8 × 20 = 11 760 J.

3

h = 24.5 ÷ (0.5 × 9.8) = 5 m.

4

2 × 10 × 5 = 100 J.

EXAM PRACTICE — SET A

Kinetic energy · 15 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q1 *Calculation · multi-step* **[8 marks]**

A car of mass 800 kg is travelling at 90 km/h along a motorway.

(a) Show that 90 km/h is the same as 25 m/s. [1]

(b) Calculate the kinetic energy of the car. [3]

(c) The car slows to 45 km/h. Explain why its kinetic energy is not half of the value in (b). [2]

(d) The car brakes to rest. State the store the energy is transferred to and the pathway. [2]

Q2 *Data table · calculation* **[7 marks]**

A student measures the speed of a 0.50 kg trolley and calculates its kinetic energy.

speed / m/s	1.0	2.0	3.0	4.0
kinetic energy / J	0.25	1.0		4.0

(a) Calculate the kinetic energy of the trolley at 3.0 m/s. [2]

(b) The student says: “Kinetic energy is directly proportional to speed.” Use the table to show that this is wrong. [2]

(c) Calculate the speed of the trolley when its kinetic energy is 8.0 J. Give your answer to 2 significant figures. [3]

MARK SCHEME — SET A

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q1

[8 marks]

B1 (a) 90 × 1000 = 90 000 m in 3600 s; 90 000 ÷ 3600 = 25 m/s

M1 (b) $E_k = \frac{1}{2} m v^2$

M1 $\frac{1}{2} \times 800 \times 25^2$ (= 400 × 625)

A1 250 000 J (2.5×10^5 J) — allow 250 kJ

B1 (c) E_k is proportional to v^2 (speed is squared)

B1 speed halves so E_k falls to one quarter (¼), not one half

B1 (d) thermal store of the brakes (and surroundings)

B1 by heating (friction)

Answer: (a) 25 m/s (b) 250 000 J

Q2

[7 marks]

M1 (a) $\frac{1}{2} \times 0.50 \times 3.0^2$

A1 2.25 J

B1 (b) speed doubles (2.0 → 4.0 m/s) but E_k increases from 1.0 to 4.0 J

B1 ×4, not ×2 — E_k is proportional to v^2, so not directly proportional to speed

M1 (c) $v^2 = 2E_k \div m = (2 \times 8.0) \div 0.50$

M1 $v^2 = 32$ then $v = \sqrt{32}$

A1 5.7 m/s (5.657… to 2 s.f.)

If the square root is omitted (v = 32): M1 M1 only.

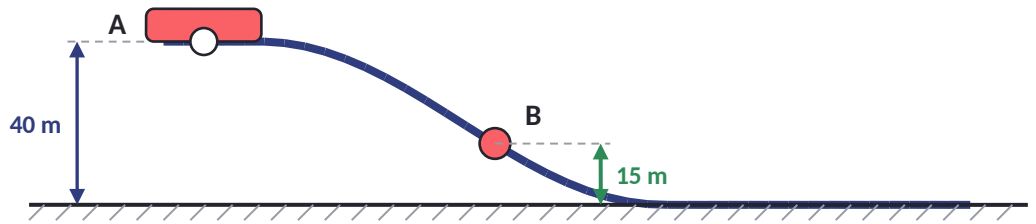
Answer: (a) 2.25 J (c) 5.7 m/s

EXAM PRACTICE — SET B

Gravitational potential energy · 14 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q3 *Diagram · chained calculation* **[8 marks]**

A 500 kg roller-coaster car is released from rest at A. g = 10 N/kg.



(a) Calculate the gravitational potential energy of the car at A. [2]

(b) Calculate the energy transferred from the GPE store from A to B. [3]

(c) All this energy becomes kinetic energy. Calculate the speed at B. [3]

Q4 *Calculation · unit conversion* **[6 marks]**

A student of mass 60 kg climbs a staircase of 25 steps. Each step is 20 cm high. g = 10 N/kg.

(a) Show that the student climbs a height of 5.0 m. [1]

(b) Calculate the gravitational potential energy gained by the student. [2]

(c) The student now carries a 6.0 kg bag up the same stairs. Calculate the extra gravitational potential energy gained. [2]

(d) A box is lifted to twice the height. Its gravitational potential energy: A halves B stays the same C doubles D quadruples [1]

MARK SCHEME — SET B

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q3

[8 marks]

M1 (a) $E_p = m\,g\,h = 500 \times 10 \times 40$

A1 200 000 J (2.0×10^5 J)

M1 (b) uses the CHANGE in height: $\Delta h = 40 - 15 = 25$ m

M1 $\Delta E_p = 500 \times 10 \times 25$

A1 125 000 J (using 15 m gives 75 000 J: max 1 mark)

M1 (c) $\frac{1}{2} \times 500 \times v^2 = 125\,000$ (ECF from (b))

M1 $v^2 = 2 \times 125\,000 \div 500 = 500$

A1 v = 22 m/s (22.4… to 2 s.f.)

Answer: (a) 200 000 J (b) 125 000 J (c) 22 m/s

Q4

[6 marks]

B1 (a) 25 × 20 = 500 cm = 5.0 m (conversion must be shown)

M1 (b) $E_p = m\,g\,h = 60 \times 10 \times 5.0$

A1 3000 J (3.0×10^3 J)

M1 (c) $6.0 \times 10 \times 5.0$

A1 300 J (not 3300 J: the question asks for the EXTRA)

B1 (d) C (doubles) — E_p is directly proportional to h

Allow ECF in (b) from a wrong height in (a).

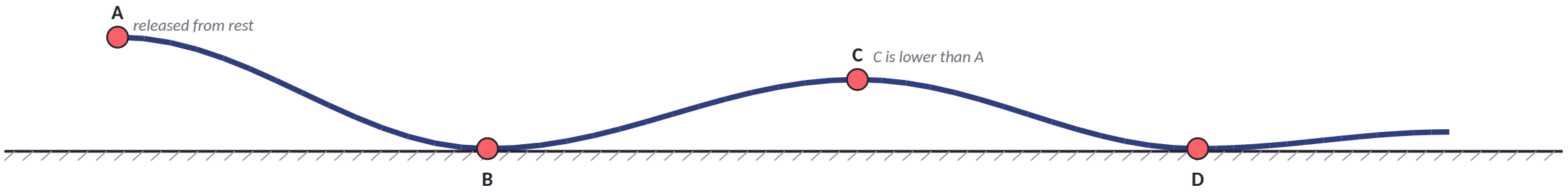
Answer: (b) 3000 J (c) 300 J (d) C

EXAM PRACTICE — 6-MARK QUESTION

Levels-based · 6 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q5 *Extended response · levels* **[6 marks]**

*A roller-coaster car is pulled to the top of the first hill at A and released from rest. It runs down to B, up to the top of a lower hill at C, and then down to D. Describe the energy transfers as the car moves from A to D, and explain why the car cannot reach the height of A at C.



MARK SCHEME — 6-MARK QUESTION

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q5

[6 marks]

Level 3 (5–6) a clear, linked description of A→B, B→C and C→D using correct store names, AND a correct explanation of why C is lower than A (dissipation to the thermal store).

Level 2 (3–4) describes most transfers correctly, or explains the lower hill but with a missing / vague link (e.g. “friction” with no store named).

Level 1 (1–2) isolated correct statements (e.g. “GPE turns to KE”) with no sequence.

Indicative content: at A the car has maximum gravitational potential energy, no kinetic energy; A→B gravitational potential store empties and kinetic store fills (mechanically); at B kinetic store is maximum, GPE minimum; B→C kinetic store empties, GPE store fills; at C car is momentarily slow, GPE less than at A; C→D GPE empties, KE fills again. Friction and air resistance mean some energy is transferred by heating to the thermal store of the track, wheels and air (and some by sound) — dissipated — so the car has less energy than at A and cannot climb back to the same height.

Max 6 marks

Answer: **Levels-based: see descriptors**

Watch out — and what to remember

IN A NUTSHELL

- $E_k = ½ m v^2$ — speed is squared, don't drop the ½.
- $E_p = m g h$ — always check which g the question gives you.
- Rearrange directly for the squared equation; the triangle only helps for GPE.

COMMON SLIP-UPS

Squaring the wrong thing

In $E_k = ½ m v^2$, only v is squared — square it before multiplying by ½ and m, not the whole expression.

Forgetting to square-root

Rearranging for speed needs a final square-root step: $v = \sqrt{(2E_k \div m)}$, not just $2E_k \div m$.

Total height vs change in height

GPE only cares about the change in height — not the object's height above the ground at the start or the total drop of a multi-stage fall.

NEXT Deck 3 — Elastic potential energy & bringing it together →

GCSE PHYSICS · TEACHING DECK

Energy Stores & Changes

Deck 3 of 4 — Elastic potential energy & bringing it together

AQA 8463 | Edexcel 1PH0 | OCR J249 / J250

Mirrors kinetic energy — then links every equation so far into one falling-object idea



Where we're going — 4 decks



1

Systems, transfers & how to describe them

All tiers

2

Kinetic & gravitational potential energy

All tiers

YOU ARE HERE

3

Elastic potential energy & bringing it together

Higher stretch

4

Quick recap & multi-step challenges

Review

All tiers again — but the second chunk carries a Higher stretch flag: rearranging m g h = ½ m v² to v = √(2 g h).

STARTER *~1 min*

"As you stretch a spring, what fills up? And what happens the instant you let go?"

Push toward: The elastic potential store fills as you stretch it; releasing empties it into the kinetic store.

Tutor: *Links storing energy to releasing it — sets up the equation as the natural next step.*

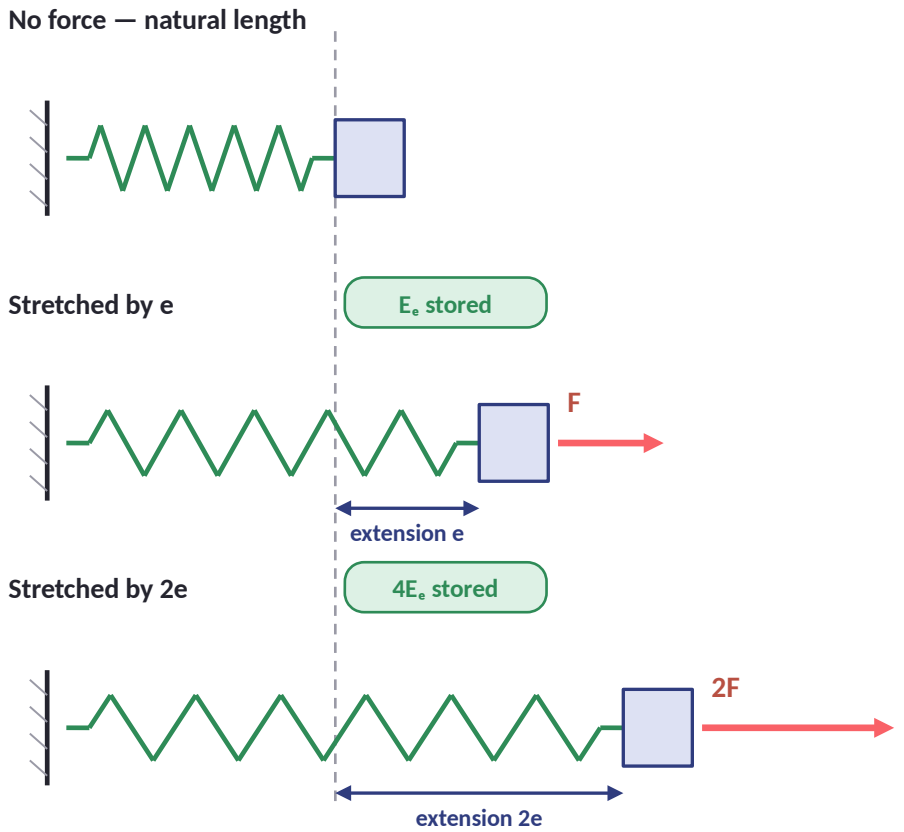
THEIR IDEAS

Elastic potential energy — $E_e = ½ k e^2$

- Elastic potential energy is the energy stored in a stretched or squashed spring (or other elastic object).
- $E_e = ½ k e^2$ (EPE in J = 0.5 × spring constant k in N/m × (extension e in m)^2), provided the limit of proportionality is not exceeded. Edexcel writes $½ k x^2$.
- Extension is squared, so — like kinetic energy — doubling the stretch quadruples the stored energy.

$E_e = ½ k e^2$

J = 0.5 × N/m × m^2 · valid only up to the limit of proportionality



extension = stretched length − natural length. Double e → four times E^e.

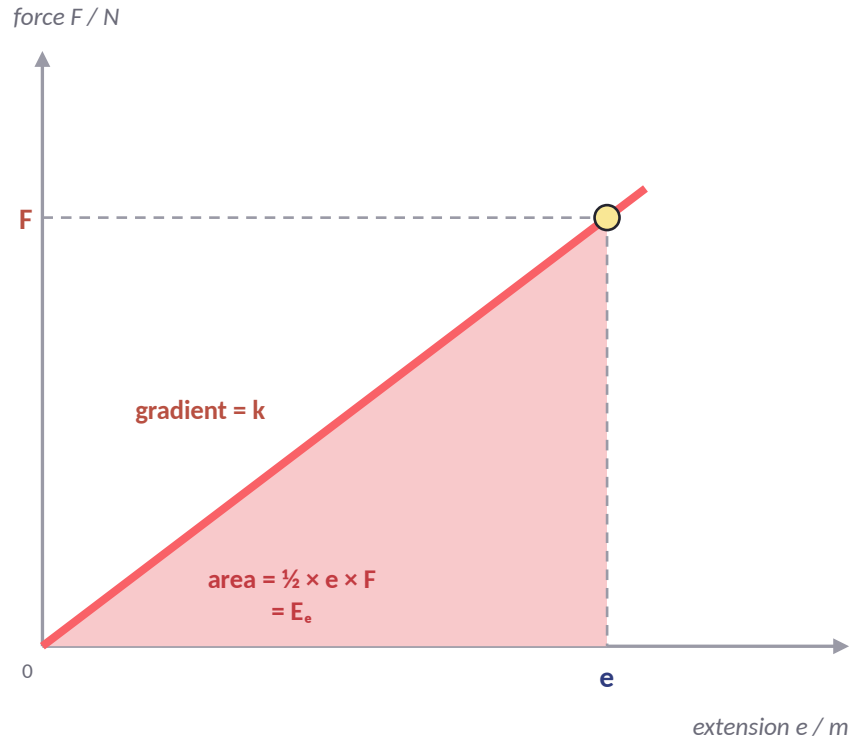
Where marks are lost: missing the condition ("provided the limit of proportionality is not exceeded"); squaring k instead of e; using total length instead of extension.

Force, extension and the energy stored

- Extension e = stretched length − natural length. Convert cm to m before substituting.
- Up to the limit of proportionality, F = k e: the graph of force against extension is a straight line through the origin, and its gradient is the spring constant k (N/m).
- **The area under the line is the energy stored: ½ × e × F = ½ × e × (k e) = ½ k e².**
- Rearranged: $k = 2E_e \div e^2$ and $e = \sqrt{(2E_e \div k)}$.

$$k = 2E_e \div e^2$$

N/m = J ÷ m² · rearranged for extension: $e = \sqrt{(2E_e \div k)}$



Straight line = F = k e (up to the limit of proportionality). Area under it = energy stored.

Where marks are lost: forgetting to square e when finding k; using the whole spring length; dropping the 2 in the rearrangement.

WORKED EXAMPLE

Tutor models the method — answer comes last

A spring (k = 200 N/m) is stretched 0.10 m. EPE stored?

METHOD

- Choose the equation from the sheet: $E_e = ½ k e^2$ (extension in m).
- Substitute: $E_e = ½ \times 200 \times 0.10^2$
- Square the extension first: $0.10^2 = 0.01$, then multiply through.

WORK IT THROUGH

Answer: $E_e = ½ \times 200 \times 0.01 = 1.0$ J.

Mark scheme: *M1 substitution ½ × 200 × 0.10² · A1 1.0 J. A bare correct answer scores 2/2; there is no mark for just writing the equation.*

Every calculation, every board: the same six moves

1 Convert

cm → m, g → kg, minutes → s. The #1 mark-loser in every examiner report.

2 Choose

Pick the equation from the sheet. No marks for just writing it down (from 2028).

3 Substitute

Numbers into the equation as printed: this earns the first mark.

4 Rearrange

Then evaluate. Square e or v; square-root LAST for speed.

5 Answer + unit

Correct answer with no working = full marks (except “Show that”).

6 Check

Sense check and s.f. A 900 J toy spring is a unit slip.

What it costs: unconverted unit or power-of-ten slip = usually −1 mark · correct number from the wrong equation = 0 · substituting into a wrongly rearranged equation = 0 · rounding wrongly (0.173 for 0.174) = −1 · “Show that”: must show more s.f. than the value given.

YOUR TURN — PART 1

Elastic potential energy ($E_e = \frac{1}{2} k e^2$) — answers on the next slide.

1 A spring (k = 120 N/m) is stretched by 5.0 cm. Choose the right equation from the sheet and calculate the energy stored.

2 A spring (k = 50 N/m) is compressed 0.20 m. Energy stored?

3 A spring stores 0.9 J when stretched 0.30 m. Find its spring constant.

4 If the extension of a spring doubles, what happens to the stored energy?

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 1

Tutor reveal

1

$E_e = \frac{1}{2} k e^2$ with e = 0.050 m: $\frac{1}{2} \times 120 \times 0.050^2 = 0.15$ J. (Using 5.0 unconverted gives 1500 J: an examiner would give 1 mark at most.)

2

$\frac{1}{2} \times 50 \times 0.20^2 = 25 \times 0.04 = 1.0$ J.

3

$k = 2E \div e^2 = 1.8 \div 0.09 = 20$ N/m.

4

It becomes four times bigger (×4).

YOUR TURN — PRACTICAL SKILLS

Practical skills — the spring experiment — answers on the next slide.

1 A ruler is marked in millimetres. What is its resolution?

2 Repeat readings of one extension: 8.0 cm, 8.1 cm, 9.4 cm, 7.9 cm. Find the mean extension.

3 A different student, with different equipment, gets the same results. Are the results repeatable or reproducible?

4 Suggest how to reduce parallax error when reading the ruler. (“Be careful” scores 0.)

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PRACTICAL SKILLS

Tutor reveal

1

1 mm (the smallest change the instrument can show).

2

9.4 cm is an anomaly, so ignore it: (8.0 + 8.1 + 7.9) ÷ 3 = 8.0 cm.

3

Reproducible (different person / equipment). Repeatable = same person, same equipment, same results.

4

Read the ruler at eye level, perpendicular to the scale, or fix a pointer to the bottom of the spring.

STARTER *~1 min*



"A ball dropped from a height speeds up as it falls. Which store empties, which fills — and if we ignore air resistance, are the two amounts equal?"

Push toward: GPE store empties as the KE store fills — with no air resistance, the amounts are exactly equal.

Tutor: *Bridges directly from Deck 2's GPE equation into today's big idea: conservation across a falling object.*

THEIR IDEAS

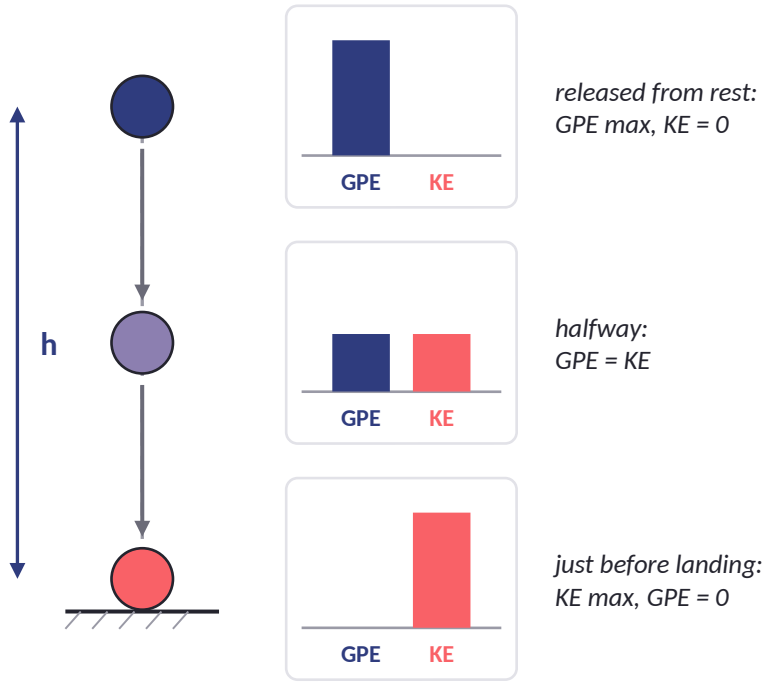
Conservation of energy: GPE lost = KE gained

HIGHER STRETCH — rearranging m g h = ½ m v² to v = √(2 g h) is where Higher students are pushed.

- When a system changes, energy shifts store to store. Ignoring friction and air resistance, energy is conserved: GPE lost = KE gained.
- **That links the two equations: m g h = ½ m v². The mass cancels, giving v = √(2 g h) — handy for "how fast does it land?"**
- In reality some energy is dissipated — transferred by heating to the thermal store of the surroundings by friction and air resistance.

$$m\,g\,h = \tfrac{1}{2}\,m\,v^2 \rightarrow v = \sqrt{(2\,g\,h)}$$

Mass cancels from both sides — this only works because both equations contain m

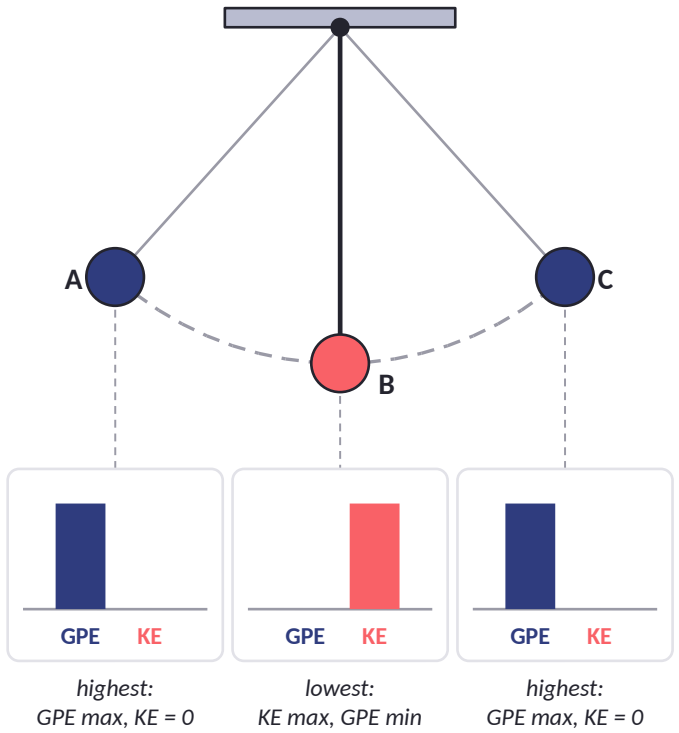


GPE lost = KE gained (no air resistance)

Where marks are lost: forgetting to state "assuming no air resistance"; not cancelling mass and getting stuck; treating dissipated energy as destroyed rather than transferred.

Swings and bounces: energy moving between stores

- A pendulum: at the highest points the gravitational potential store is full and the kinetic store is empty; at the lowest point it is the other way round.
- Total energy stays the same (ignoring dissipation) — the bars just change shape: GPE + KE = constant.
- Real pendulums slow down: air resistance and friction at the pivot dissipate energy by heating to the thermal store of the surroundings, so each swing is a little lower.

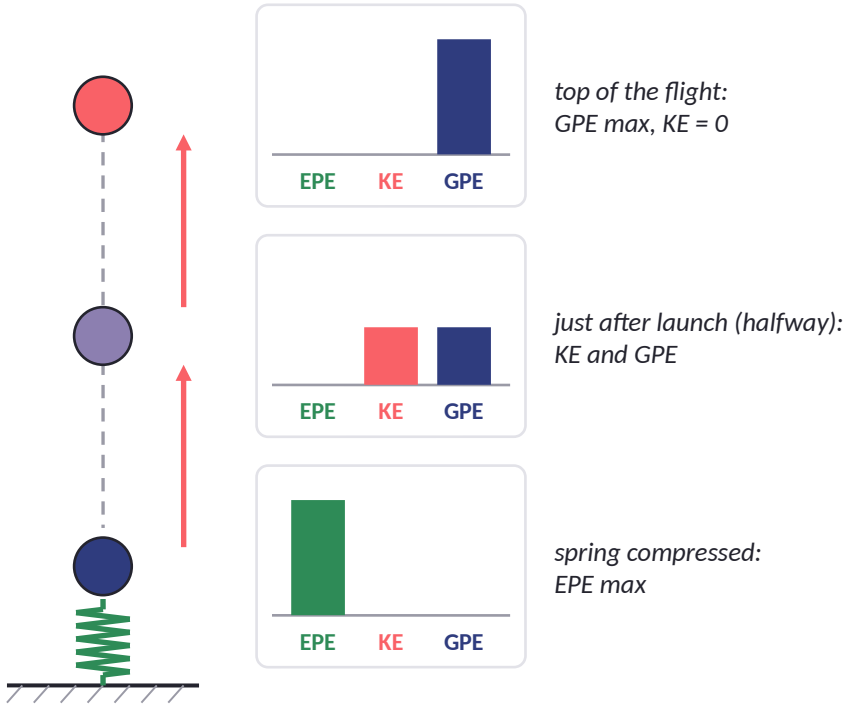


each swing a little energy is dissipated to the thermal store of the air and pivot, so the swing dies away

Where marks are lost: saying energy is "lost"; swapping which store is full at the top and the bottom; forgetting the thermal store of the surroundings.

Chaining the stores: spring → kinetic → gravitational

- A spring launches a ball upwards: elastic potential store empties → kinetic store → gravitational potential store at the top.
- **With no losses, set the energies equal: ½ k e² = m g h (everything the spring stored ends up as GPE).**
- Method: (1) find E_e from ½ k e²; (2) write E_e = m g h; (3) rearrange h = E_e ÷ (m g). Keep the intermediate energy in joules.



½ k e² = ½ m v² = m g h (no losses)

Where marks are lost: skipping the intermediate energy; using cm instead of m for the compression; forgetting that some energy is dissipated in a real launch, so the real height is less.

“Explain why it doesn’t go as high / as fast as predicted”

Examiners give one mark per linked step. “Friction” or “energy is lost” on its own scores nothing.

1. **Name the force:** Air resistance (and friction) act on the moving object.

2. **Work is done:** Work is done against these forces as the object moves.

3. **Say where the energy goes:** Energy is dissipated: transferred by heating to the thermal store of the object and the surroundings.

4. **Link to the answer:** So less energy reaches the kinetic (or gravitational potential) store → lower speed (or height).

WHERE THIS COMES UP

- Spring launcher: lower height
- Falling ball: lower landing speed
- Pendulum: swing dies away
- Bungee: doesn’t return to the platform
- Braking: kinetic → thermal store of the brakes

AQA 2023 2H Q3.5 (braking energy): only 4% scored full marks: most wrote “friction” with no energy transfer.

WORKED EXAMPLE

Tutor models the method — answer comes last

A 2 kg ball is dropped from 5 m (g = 9.8, no air resistance). Find its speed as it lands.

METHOD

- GPE lost = m g h = 2 × 9.8 × 5 = 98 J.
- By conservation of energy, this all becomes KE: ½ m v² = 98.
- Rearrange for v: v = √(2 × 98 ÷ 2).

WORK IT THROUGH

Answer: v = √98 ≈ 9.9 m/s. (Or straight from v = √(2 g h) = √(2 × 9.8 × 5) ≈ 9.9 m/s.)

Mark scheme: *M1 GPE = 2 × 9.8 × 5 = 98 J · M1 98 = ½ × 2 × v² · A1 9.9 m/s. Forgetting the square root (98 m/s) scores 2/3.*

YOUR TURN — PART 2

Bringing the stores together — answers on the next slide.

1 State what “energy is conserved” means for a closed system.

2 A 0.5 kg ball falls 1.8 m (g = 9.8, no air resistance). Find its landing speed.

3 Air resistance is NOT ignored. Explain why the ball lands slower than your answer to question 2.

4 A pendulum swings. Describe how the stores change from the highest point to the lowest.

Working space is squared on purpose — students calculate, tutor annotates.

ANSWERS — PART 2

Tutor reveal

1

The total energy stays the same — it only moves between stores, none is created or destroyed.

2

$v = \sqrt{(2 \times 9.8 \times 1.8)} = \sqrt{35.28} \approx 5.9$ m/s.

3

Work is done against air resistance, so some energy is dissipated to the thermal store of the air. Less energy reaches the kinetic store, so the speed is lower.

4

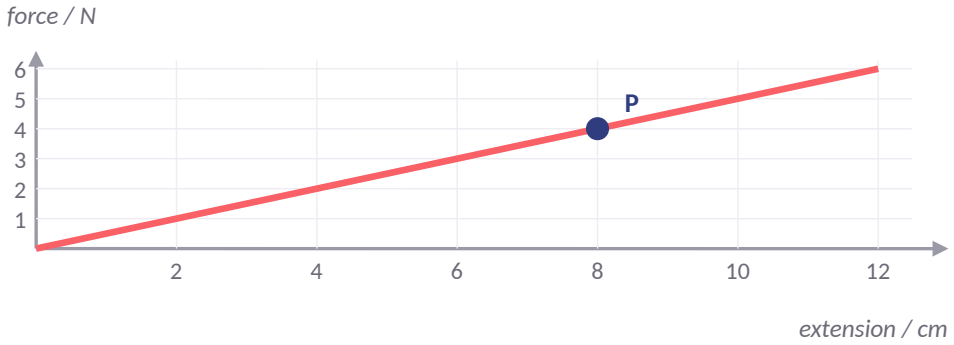
At the top: full GPE, zero KE; falling: GPE → KE; at the bottom: maximum KE, minimum GPE — then it reverses.

EXAM PRACTICE — SET A

Elastic potential energy · 15 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q1 *AQA-style · graph · calculation* **[7 marks]**

A student hangs masses from a spring. The spring obeys Hooke's law over the whole range shown.



(a) Use point P to calculate the spring constant in N/m. [3]

(b) Calculate the energy stored in the spring at point P. [2]

(c) The extension is doubled. State what happens to the stored energy and explain why. [2]

Q2 *Edexcel-style · Show that · chained* **[8 marks]**

A toy launcher uses a spring (spring constant 600 N/m) to fire a ball of mass 12 g straight up. The spring is compressed by 4.0 cm. g = 10 N/kg.

(a) Show that the elastic potential energy stored in the compressed spring is about 0.5 J. [3]

(b) All of this energy is transferred to the ball's gravitational potential store. Calculate the maximum height reached. [3]

(c) The ball actually rises less high than this. Explain why. [2]

MARK SCHEME — SET A

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q1

[7 marks]

B1 (a) reads F = 4.0 N at e = 8.0 cm and converts e = 0.080 m

M1 k = F ÷ e = 4.0 ÷ 0.080

A1 50 N/m (any valid point on the line)

M1 (b) $E_e = ½ k e^2 = ½ \times 50 \times 0.080^2$ (ECF k)

A1 0.16 J

B1 (c) four times bigger (×4)

B1 because E_e is proportional to e^2 (extension is squared)

Unit marks: k in N/m, E_e in J. Using 8.0 (cm) unconverted gives 6.25 N/cm: max 2.

Answer: **(a) 50 N/m (b) 0.16 J**

Q2

[8 marks]

B1 (a) 4.0 cm = 0.040 m

M1 $E_e = ½ k e^2 = ½ \times 600 \times 0.040^2$

A1 0.48 J seen (must be to more s.f. than 0.5; working back from 0.5 J scores 0)

B1 (b) 12 g = 0.012 kg

M1 h = E_e ÷ (m g) = 0.48 ÷ (0.012 × 10) (ECF; allow 0.5 J giving 4.2 m)

A1 4.0 m

B1 (c) work done against air resistance / friction in the launcher

B1 energy dissipated to the thermal store of the surroundings, so less reaches the gravitational potential store

Unit traps: 4.0 cm unconverted → 4800 J: max 1 in (a). 12 g unconverted → 0.004 m: max 2 in (b).

Answer: **(a) 0.48 J (b) 4.0 m (accept 4.2 m from 0.5 J)**

EXAM PRACTICE — SET B

OCR-style: multiple choice traps + estimate · 7 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q3 *OCR-style · multiple choice* **[3 marks]**

Choose one answer for each part. Each part is worth 1 mark.

(a) A spring (k = 200 N/m) is stretched by 3.0 cm. Energy stored? [1]

A 0.09 J B 0.18 J C 3.0 J D 900 J

(b) A 0.20 kg ball falls 5.0 m from rest, no air resistance (g = 10 N/kg). Speed at the ground? [1]

A 5.0 m/s B 10 m/s C 50 m/s D 100 m/s

(c) The extension of a spring is trebled. The energy stored becomes: [1]

A ×3 B ×6 C ×9 D ×27

Q4 *OCR-style · estimate · 1 s.f.* **[4 marks]**

A student walks up a flight of stairs about 3 m high. g = 10 N/kg.

(a) Estimate the gravitational potential energy the student gains. Give your answer to 1 significant figure. [3]

(b) Explain why your answer can only be an estimate. [1]

MARK SCHEME — SET B

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q3

[3 marks]

B1 (a) A: 0.09 J

Trap answers: B forgot the ½; C forgot to square; D left 3.0 cm in cm

B1 (b) B: 10 m/s ($v = \sqrt{(2\,g\,h)} = \sqrt{100}$)

Trap answer: D forgot the square root; mass not needed

B1 (c) C: ×9 (energy ∝ e^2)

Answer: (a) A (b) B (c) C

Q4

[4 marks]

B1 (a) sensible mass for a student: 50–80 kg

M1 $E_p = m\,g\,h$ = (their mass) × 10 × 3

A1 answer to 1 s.f. in the range 2000 J (e.g. 60 kg → 1800 J → 2000 J)

B1 (b) the mass and height are typical / approximate values, not measured

Reject a mass below 30 kg or above 150 kg (examiners report estimates from 6 kg to 600 000 kg)

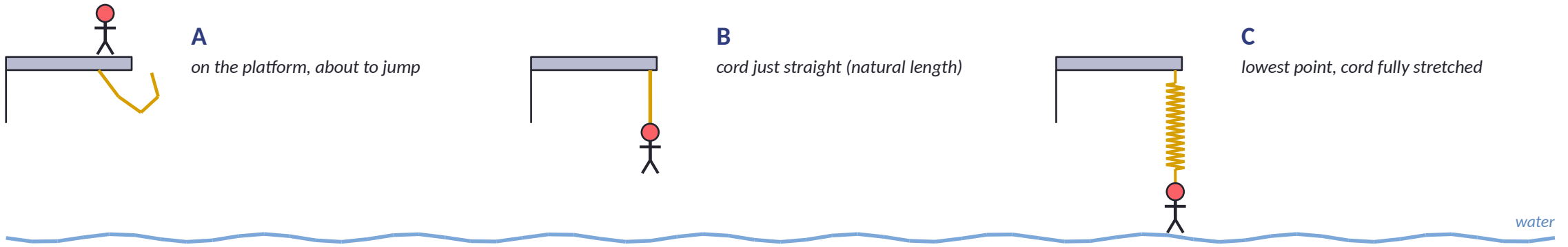
Answer: (a) about 2000 J (1 s.f.)

EXAM PRACTICE — 6-MARK QUESTION

Levels-based · 6 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q5 *AQA-style · extended response · levels* **[6 marks]**

*A bungee jumper steps off a platform. The jumper falls, the elastic cord becomes taut and stretches, and the jumper reaches the lowest point C before being pulled back up. Describe the energy transfers between A, B and C, and explain why the jumper does not return to the height of the platform.



MARK SCHEME — 6-MARK QUESTION

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q5

[6 marks]

Level 3 (5–6) a complete, linked description of A→B and B→C using correct store names, including both the elastic potential store and dissipation to the thermal store, with an explanation for the lower return height.

Level 2 (3–4) most transfers described with correct stores, or the dissipation point made but one section of the fall missing.

Level 1 (1–2) isolated correct stores (e.g. “GPE becomes KE”) with no sequence.

Capping: no mention of the elastic potential store → max Level 2. Energy “lost” with no destination → cannot reach Level 3.

Indicative content: A→B (cord slack): gravitational potential store empties, kinetic store fills (mechanically). B→C (cord stretching): kinetic store AND gravitational potential store empty; elastic potential store of the cord fills; at C kinetic energy is zero momentarily and the elastic potential store is greatest. On the way back the elastic potential store empties into kinetic and gravitational potential. Air resistance and internal friction in the cord dissipate energy by heating to the thermal store of the air and cord, so the jumper has less energy and does not return to the platform height.

Max 6 marks

Answer: **Levels-based: see descriptors**

Rejected vs credited: say it the way the mark scheme does

✕ REJECTED	✓ CREDITED
~~energy is lost / used up~~	energy is dissipated to the thermal store of the surroundings
~~friction (on its own)~~	work done against friction transfers energy to the thermal store
~~potential energy (no type)~~	elastic potential energy / gravitational potential energy
~~the length of the spring~~	extension = stretched length − original length
~~heat energy~~	thermal energy store / transferred by heating
~~v = 36 (from $v^2 = 36$)~~	v = √36 = 6.0 m/s: square-root last

Taken from AQA, Edexcel and OCR examiner reports: each phrase on the left has cost students marks.

Watch out — and what to remember

IN A NUTSHELL

- $E_e = ½ k e^2$ — squared, so rearrange directly, same as E_k.
- GPE lost = KE gained (no air resistance) links every equation from Part 1.
- $v = \sqrt{(2 g h)}$ is the mass-cancels shortcut for a falling object's landing speed.

COMMON SLIP-UPS

Dropping the limit-of-proportionality condition

$E_e = ½ k e^2$ only holds up to the limit of proportionality — always state this when asked when the equation applies.

Getting stuck on the mass cancelling

In $m g h = ½ m v^2$, both sides have one m — cancel it early rather than trying to substitute a mass you don't need.

Writing “energy is lost”

Examiners reject “lost” with no destination. Write: dissipated (transferred by heating) to the thermal store of the surroundings.

NEXT Deck 4 — Quick recap & multi-step challenges →

GCSE PHYSICS · TEACHING DECK

Energy Stores & Changes

Deck 4 of 4 — Quick recap & multi-step challenges

AQA 8463 | Edexcel 1PH0 | OCR J249 / J250

Whole-topic exit questions, then three chained questions the way real exam papers ask them



Where we're going — 4 decks



1

Systems, transfers & how to describe them

All tiers

2

Kinetic & gravitational potential energy

All tiers

3

Elastic potential energy & bringing it together

Higher stretch

YOU ARE HERE

4

Quick recap & multi-step challenges

Review

A consolidation deck — no new content. Use it as an exit ticket, or save it for the start of the next session as a warm-up.

QUICK RECAP

Whole-topic exit questions — cover Decks 1–3. Answers on the next slide.

1 Name the eight energy stores.

2 A 1500 kg car travels at 10 m/s. Calculate its kinetic energy.

3 A 4 kg mass is lifted 3 m (g = 9.8). Calculate the GPE gained.

4 Describe the energy transfer when a moving car brakes to a stop.

ANSWERS — PART 1

Tutor reveal

1

Kinetic, gravitational potential, elastic potential, thermal, chemical, nuclear, electrostatic, magnetic.

2

½ × 1500 × 10^2 = 75 000 J (75 kJ).

3

4 × 9.8 × 3 = 117.6 J.

4

Kinetic store empties → by heating (friction in the brakes) → thermal store of the brakes and surroundings.

CHALLENGE 1

① *Easy*

A 0.5 kg ball is raised 2 m (g = 9.8) and then dropped. Ignoring air resistance, find its speed as it lands.

METHOD

- GPE gained = m g h = 0.5 × 9.8 × 2 = 9.8 J, all converted to KE.
- Rearrange ½ m v^2 = 9.8 for v.

WORK IT THROUGH

Answer: v = √(2 × 9.8 ÷ 0.5) = √39.2 ≈ 6.3 m/s. (Or v = √(2 g h) = √(2 × 9.8 × 2).)

Mark scheme: *1 for GPE = 9.8 J · 1 for ½mv^2 = 9.8 · 1 for v ≈ 6.3 m/s.*

CHALLENGE 2

② *Medium*

A 1200 kg car travelling at 20 m/s brakes to rest. All its kinetic energy transfers to the thermal store of the brakes. Find the energy transferred and name the pathway.

METHOD

- Write the equation: $E_k = ½\ m\ v^2$
- Substitute: $E_k = ½ \times 1200 \times 20^2 = 600 \times 400$.

WORK IT THROUGH

Answer: E_k = 240 000 J (240 kJ), transferred by heating (friction) to the thermal store of the brakes and surroundings.

Mark scheme: *1 for equation · 1 for substitution · 1 for 240 000 J · 1 for the pathway: by heating.*

CHALLENGE 3

③ *Hard*

A spring (k = 800 N/m) is compressed 0.05 m and launches a 0.02 kg ball straight up. Assuming all the elastic energy becomes GPE, find the maximum height (g = 9.8).

METHOD

- Find the elastic energy: $E_e = ½ \times 800 \times 0.05^2 = 400 \times 0.0025$.
- At the top all of it is GPE: m g h = E_e.
- Rearrange for h: h = E_e ÷ (m g).

WORK IT THROUGH

Answer: E_e = 1.0 J, so h = 1.0 ÷ (0.02 × 9.8) = 1.0 ÷ 0.196 ≈ 5.1 m.

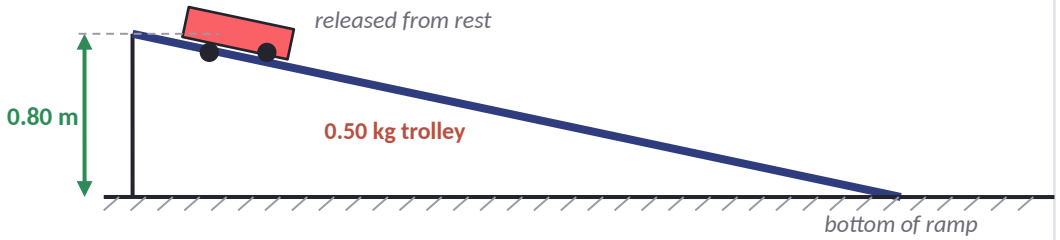
Mark scheme: *1 for E^e = 1.0 J · 1 for m g h = E^e · 1 for rearranging · 1 for h ≈ 5.1 m.*

EXAM PRACTICE — SET A

Chained calculations · 16 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q1 *Diagram · chained calculation* **[8 marks]**

A trolley of mass 0.50 kg is released from rest at the top of a ramp. g = 10 N/kg.



(a) Calculate the GPE lost by the trolley at the bottom of the ramp. [2]

(b) Calculate the speed at the bottom if no energy is dissipated. [3]

(c) The measured speed is 3.6 m/s. Calculate the energy dissipated. [3]

Q2 *Chained calculation · unit conversion* **[8 marks]**

A spring-loaded toy (spring constant 400 N/m) is compressed by 5.0 cm and fires a 10 g ball. All of the elastic energy is transferred to the kinetic store of the ball. g = 10 N/kg.

(a) Calculate the elastic potential energy stored in the spring. [3]

(b) Calculate the speed at which the ball leaves the toy. [3]

(c) The ball is now fired vertically upwards at this speed. Calculate the maximum height it reaches, ignoring air resistance. [2]

MARK SCHEME — SET A

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q1

[8 marks]

M1 (a) $E_p = m\,g\,h = 0.50 \times 10 \times 0.80$

A1 4.0 J

M1 (b) $\frac{1}{2}\,m\,v^2 = E_p$ (ECF from (a))

M1 $v^2 = 2 \times 4.0 \div 0.50 = 16$

A1 4.0 m/s

M1 (c) $E_k = \frac{1}{2} \times 0.50 \times 3.6^2 = 3.24$ J

M1 energy dissipated = 4.0 − 3.24 (ECF)

A1 0.76 J (transferred by heating to the thermal store of the ramp, trolley and surroundings)

Answer: (a) 4.0 J (b) 4.0 m/s (c) 0.76 J

Q2

[8 marks]

B1 (a) 5.0 cm = 0.050 m

M1 $E_e = \frac{1}{2}\,k\,e^2 = \frac{1}{2} \times 400 \times 0.050^2$

A1 0.50 J

B1 (b) 10 g = 0.010 kg

M1 $v^2 = 2E_k \div m = 2 \times 0.50 \div 0.010 = 100$ (ECF from (a))

A1 10 m/s

M1 (c) m g h = 0.50 (all KE → GPE) so h = 0.50 ÷ (0.010 × 10)

A1 5.0 m

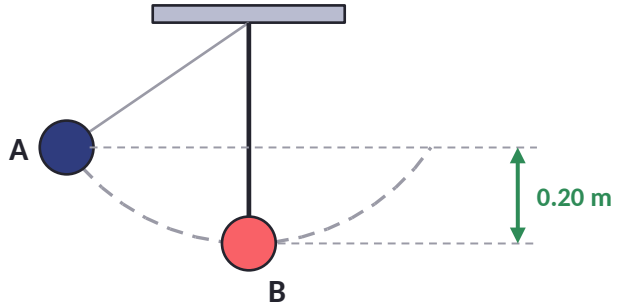
Answer: (a) 0.50 J (b) 10 m/s (c) 5.0 m

EXAM PRACTICE — 6-MARK QUESTION

Levels-based · 6 marks in total · marks shown in [brackets] · mark scheme on the next slide

Q3 *Extended response · levels · uses data* **[6 marks]**

*A pendulum bob of mass 0.050 kg is pulled aside and released from rest at A, which is 0.20 m above the lowest point B (g = 10 N/kg). Describe the energy transfers as the bob swings from A to B and up the other side, and explain why the swing gradually dies away. Use calculations to find the gravitational potential energy at A and the speed at B if no energy were dissipated.



A: released from rest
B: lowest point of the swing
bob of mass 0.050 kg

MARK SCHEME — 6-MARK QUESTION

Tutor reveal · M = method, A = accuracy, B = independent mark, ECF = error carried forward

Q3

[6 marks]

Level 3 (5–6) correct transfers A→B→other side with stores named, the dissipation explanation, AND both calculations (GPE = 0.10 J, v = 2.0 m/s) used to support the answer.

Level 2 (3–4) transfers and one of dissipation or the calculations done well, or both partly.

Level 1 (1–2) isolated points, e.g. “GPE becomes KE”, or one correct calculation only.

Indicative content: at A, GPE = m g h = 0.050 × 10 × 0.20 = 0.10 J and KE = 0; A→B gravitational potential store empties, kinetic store fills; at B all 0.10 J is kinetic, so v = √(2 × 0.10 ÷ 0.050) = 2.0 m/s (or v = √(2 g h)); B→the other side, kinetic empties and GPE fills again. Air resistance and friction at the pivot dissipate energy by heating to the thermal store of the air and surroundings on every swing, so the bob reaches a lower height each time until it stops.

Max 6 marks

Answer: **Levels-based: GPE = 0.10 J, v = 2.0 m/s**

Watch out — and what to remember

IN A NUTSHELL

- All three equations rearrange the same way — write it, substitute, then solve line by line.
- Chained questions are just single steps stitched together — find the intermediate value first.
- Method marks are awarded even when the final answer is wrong — insist on every line of working.

COMMON SLIP-UPS

Rushing straight to a final answer

On a multi-step question, write down each intermediate result (e.g. the energy, before the height) — it's where most of the marks sit.

Losing track of units mid-chain

Carry units through every line, especially when a result from one equation feeds into another.

Skipping the assumption

“Ignoring air resistance” or “all the energy converts” should be stated, not just used silently.

NEXT Part 2 — Heating, power, efficiency & energy resources →