

Covering teacher guide

Kinetic and gravitational potential energy

Start here / subject briefing

Before this lesson: Consolidation after kinetic/GPE equations, SI units and simple rearrangement have been taught. Both courses and tiers follow the same tasks. No spring, work-done or power calculations are required.

Moving objects have kinetic energy: at fixed mass it grows with speed squared. Lifting changes the gravitational potential energy of the load-Earth system: it depends on vertical rise, not cable length or path. A time change alone does not change mgh . Convert mass to kg first. When energy and mass are given, rearrange for speed squared and then take its positive square root. Use the g supplied in each question.

Words and symbols you will need

Term	Plain-English meaning
E_k , kinetic energy	Energy associated with motion, in joules (J).
GPE change, mgh	Gravitational potential energy gained/lost with vertical height change h , in J.
m and v	Total moving mass in kg; speed in m/s. v^2 means speed multiplied by itself.
g and h	Gravitational field strength in N/kg, and vertical height change in m.
Square root	The positive number which multiplies by itself to give v^2 ; required for speed.

Help pupils choose a method

1. Identify motion or a vertical change; write the matching equation.
2. Convert grams to kilograms. Use the question's g and its vertical rise where needed.
3. Substitute or rearrange with brackets; distinguish a squared speed from the final speed.
4. State the unit and check the physical meaning or comparison.

Use the supplied model - pupil page 2

Pupil page 2 gives all three models. Football speed is squared to give 10 J. The box uses its stated 9.8 N/kg and gains 78.4 J. In the separate trolley example $v^2=9$, so speed is 3 m/s, not 9. Worksheet lifts use their explicitly stated 10 N/kg.

Football: $E_k=0.5 \times 0.80 \times 5.0^2=10$ J. Box: GPE increase $=2.0 \times 9.8 \times 4.0=78.4$ J (78 J to two significant figures). Different trolley: $v^2=2E_k/m=2 \times 18/4.0=9.0$ m²/s², so $v=3.0$ m/s. Square a given speed before multiplying; take a positive square root when the unknown is speed. The box model uses its supplied 9.8, while later worksheet lifts explicitly supply 10.

If pupils are still stuck

Use the matching Say/Ask/Expect route and fresh named retry within its replacement time. If still insecure, help label the given quantities, units and equation, record the precise remaining error, and return it to the usual teacher. Do not extend today's lesson for the next-lesson retry.

Turn to teacher page 2 for the timed run sheet. Keep this guide separate from the pupil booklet.

Run the lesson from this page

Kinetic and gravitational potential energy

Print the complete 8-page pupil booklet, one per pupil, stapled in order. Double-sided printing is fine.

Read teacher page 1, then use the timed run sheet on page 2. Keep the 10-page teacher guide separate from pupil copies.

Pupils need pens, a ruler and a calculator. Reading, data and figures are supplied. No login, pupil devices or practical apparatus are required.

Min	Pupil page / Q	Read aloud / check	Next action and answer key
0-5	1 / 1-3	Start from memory; check all three responses at 5 minutes.	If insecure A uses first 2 reading minutes. Answers: teacher page 3. Coaching: page 7.
5-15	2 / reading	Read equations, units and complete models.	Check A if used; emphasise square versus square root and supplied g.
15-20	3 / 4	Choose a letter and justify both factors; stop.	If insecure B replaces 9-10, not the comparisons that use 5-7. Answers: teacher page 3. Coaching: page 8.
20-30	4 / 5-10	Calculate trolley energies and compare the tests.	If B was used complete 5-8 only; leave 9-10 blank. Answers: teacher page 4.
30-33	5 / 11	Find vertical rise independently and explain cable length.	If insecure C replaces 13-14. Answers: teacher page 4. Coaching: page 9.
33-45	6-7 / 12-17	Use the lift and ramp figures with $g=10 \text{ N/kg}$.	If C was used complete 12 and 15-17; leave 13-14 blank. Answers: teacher page 5.
45-55	8 / 18	Share practice answers; correct and explain one method.	Keep the exit answers hidden. Answers: teacher page 5.
55-60	8 / 19	Cover earlier pages; complete the fresh exit independently.	Collect all pages. D is next lesson only. Answers: teacher page 6. Coaching: page 10.

Estimated 60 minutes. Practice is 10 minutes, a 3-minute mid-check and 12 minutes. A uses reading time; B replaces 9-10; C replaces 13-14; D is next lesson only. Timings not classroom-trialled.

Entry and hinge - pupil pages 1 and 3

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

1. (pupil p1) $750/1000=0.750$ kg.
2. (pupil p1) Gravitational potential energy store of the load-Earth system. Not kinetic or just “potential”.
3. (pupil p1) $E_k=0.5 \times 2.0 \times 3.0^2=9.0$ J.
4. (pupil p3) D: E_k becomes 4 times as large because $(2v)^2=4v^2$. GPE increase becomes 2 times as large because h is not squared. Each comparison holds the other quantities fixed.

Try again A - pupil page 1

Only if directed. Use the first 2 reading minutes, then continue on page 2.

(a) 1.200 kg. (b) Gravitational potential energy. (c) $0.5 \times 4.0 \times 2.0^2=8.0$ J.

Try again B - pupil page 3

Only if directed. Complete B instead of questions 9-10 on page 4. Then answer questions 5-8 only on that page.

Kinetic energy $\times 9$ because $(3v)^2=9v^2$; GPE increase $\times 3$ because h appears once. Other quantities stay fixed.

Kinetic-energy practice and height check

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

5. (pupil p4) $E_k = 0.5 \times 20 \times 0.50^2 = 2.5 \text{ J}$.

6. (pupil p4) $E_k = 0.5 \times 20 \times 1.0^2 = 10 \text{ J}$.

7. (pupil p4) $E_k = 0.5 \times 40 \times 1.0^2 = 20 \text{ J}$.

8. (pupil p4) At fixed mass, doubling speed quadruples E_k : 2.5 to 10 J, because speed is squared. At fixed speed, doubling mass doubles E_k : 10 to 20 J. Identify which quantity stays fixed.

9. (pupil p4) $v^2 = 2E_k/m = 2 \times 24/48 = 1.0 \text{ m}^2/\text{s}^2$. Take the positive square root: $v = 1.0 \text{ m/s}$.

10. (pupil p4) $800 \text{ g} = 0.800 \text{ kg}$. $E_k = 0.5 \times 0.800 \times 2.0^2 = 1.6 \text{ J}$.

11. (pupil p5) $h = 180/(6.0 \times 10) = 3.0 \text{ m}$. The required height is the vertical rise of the load; the cable length is not that change. State the equation and unit.

Try again C - pupil page 5

Only if directed. Complete C instead of questions 13-14 on page 6. Then do questions 12 and 15-17.

$h = 400/(8.0 \times 10) = 5.0 \text{ m}$. The load rises vertically 5.0 m; cable length is not the height change.

Lift, ramp and review

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

12. (pupil p6) $GPE\ increase = mgh = 24 \times 10 \times 2.5 = 600\ J$. Use the vertical rise of 2.5 m.

13. (pupil p6) $h = GPE\ increase / (mg) = 360 / (24 \times 10) = 1.5\ m$.

14. (pupil p6) h is the change in vertical height of the load, 2.5 m, not the cable length. Cable length alone does not give its rise.

15. (pupil p6) The gains are equal: 600 J each. Mass, g and vertical rise are the same; time is not a factor in mgh. No power calculation is asked for.

16. (pupil p7) Use the 0.80 m vertical drop, not the 2.0 m distance along the ramp. GPE change depends on vertical height change.

17. (pupil p7) $GPE\ decrease = 2.0 \times 10 \times 0.80 = 16\ J$.

18. (pupil p8) Accept a correction with reasoning, such as square speed, convert grams, take the square root or use vertical rise. All-correct route: m, g and vertical drop are unchanged in mgh; ramp path length is not h.

Independent exit and next-lesson follow-up

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

19. (pupil p8) (a) $m=0.600\text{ kg}$; $v^2=2\times 10.8/0.600=36\text{ m}^2/\text{s}^2$, $v=6.0\text{ m/s}$. (b) $h=200/(5.0\times 10)=4.0\text{ m}$. (c) $4\times 10.8=43.2\text{ J}$, because speed is squared. Accept equivalent correct working and sensible rounding.

Try again D - next lesson - pupil page 8

Leave this today. Your usual teacher may direct it next lesson.

(a) $m=0.400\text{ kg}$; $v^2=2\times 3.2/0.400=16$; $v=4.0\text{ m/s}$. (b) $h=90/(3.0\times 10)=3.0\text{ m}$. (c) New $E_k=3.2/4=0.80\text{ J}$: halving speed quarters kinetic energy.

Collect and follow up

Collect every named booklet with working/corrections. Record who needs help with conversion, squared speed/square root, or vertical rise and who needs Try again D next lesson.

Source provenance - for the usual teacher

Pupil question	Original worksheet part / page
5	WS-06 Q2(a) / source p1
6	WS-06 Q2(b) / source p1
7	WS-06 Q2(c) / source p2
8	WS-06 Q2(e) / source p2
9	WS-06 Q2(g) / source p2
10	WS-06 Q2(h) / source p2
12	WS-06 Q3(a) / source p3
13	WS-06 Q3(c) / source p3
14	WS-06 Q3(e) / source p4
15	WS-06 Q3(f) / source p4
16	WS-06 Q5(a) / source p5
17	WS-06 Q5(b) / source p6

Selected practice is reformatted from the maintained PhysicsUK worksheet. Required context is included; unassigned parts are omitted.

[Source worksheet](#) | [Maintained solutions](#) | [Revision notes](#)

Source Q2(e) refers to pupil 5-7 and Q3(e) to pupil 12. Both figures and all contexts are embedded. Note models are selected from section 1 and the GPE example under section 4; the added square-root model is original. Supplied g differs explicitly between the note model (9.8) and worksheet tasks (10).

Check 1: Entry

Question 1, Question 2, Question 3

Look for: Q1 0.750 kg; Q2 gravitational potential; Q3 9.0 J with squared speed.

If secure: Continue to page 2 reading and models.

If: Mass remains 750 or uses an incorrect conversion.

Likely issue: Grams have not been converted to kilograms.

Say: The equation expects kilograms. One kilogram contains 1000 grams, so divide the number of grams by 1000 before calculating.

Ask: For question 1, how many kilograms is 750 grams?

Expect: 0.750 kg; it is less than one kilogram.

Next: Use page 2's equations/units, then complete Try again A on page 1 in the first 2 reading minutes.

Pupil page 2, conversions row.

If: Gives 3 J or 18 J for question 3, or names the wrong store for lifting.

Likely issue: The squared speed, factor one-half or choice of store needs checking.

Say: Motion uses kinetic energy with half the mass times speed squared. Lifting between stationary positions increases gravitational potential energy; it does not leave extra kinetic energy.

Ask: In question 3, what is 3^2 and then $0.5 \times 2 \times 9$? Which store increases in question 2?

Expect: 9, then 9 J; gravitational potential energy increases in the lift.

Next: Use page 2's equations/units, then complete Try again A on page 1 in the first 2 reading minutes.

Pupil page 2, equation choices and worked models.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 2: Hinge

Question 4

Look for: D with kinetic $\times 4$ from speed squared and GPE $\times 2$ from unsquared height.

If secure: Continue to questions 5-10.

If: A: doubles both energies.

Likely issue: The kinetic-energy dependence on speed has been treated as linear.

Say: Only speed is squared in the kinetic equation. Doubling it multiplies that squared factor by four; doubling a height multiplies mgh by two.

Ask: In question 4, what is $(2v)^2$ compared with v^2 ?

Expect: $4v^2$, so kinetic energy is four times as large at fixed mass.

Next: Use page 2's equation comparison, then complete Try again B on page 3 instead of questions 9-10; complete 5-8 on page 4.

Pupil page 2, squared-speed row.

If: B: quadruples both energies.

Likely issue: The square rule has been applied to height.

Say: The height appears once in mgh . With m and g fixed, twice the vertical rise gives twice the GPE increase.

Ask: In question 4, compare $mg(2h)$ with mgh .

Expect: $mg(2h)=2mgh$, so GPE increase doubles.

Next: Use page 2's equation comparison, then complete Try again B on page 3 instead of questions 9-10; complete 5-8 on page 4.

Pupil page 2, GPE row.

If: C, or D without a reason.

Likely issue: The two relationships may be swapped or the letter guessed.

Say: Match each change to its own equation before choosing factors. A correct letter needs a reason for both quantities.

Ask: Point to the squared variable in E_k and the height variable in mgh ; which factor follows for each?

Expect: v is squared: $\times 4$. h is not: $\times 2$.

Next: Use page 2's equation comparison, then complete Try again B on page 3 instead of questions 9-10; complete 5-8 on page 4.

Pupil page 2, two-equation comparison.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 3: Mid Practice

Question 11

Look for: $h=3.0$ m from $180/(6 \times 10)$, and cable length is not vertical rise.

If secure: Continue to questions 12-17 using the supplied figures.

If: Multiplies by mg or gives 30 m/1800 m.

Likely issue: The rearrangement or division by both m and g is insecure.

Say: The GPE change is mg multiplied by height. To recover height, divide the energy by the full product mg, with brackets around that denominator.

Ask: For question 11, what is mg, then $180/(6 \times 10)$?

Expect: $mg=60$ N; height= 3.0 m.

Next: Use page 2's height rearrangement, then complete Try again C on page 5 instead of 13-14; complete 12 and 15-17.

Pupil page 2, height-unknown row.

If: Uses 5.0 m cable length or labels the result J.

Likely issue: The physical height or resulting unit has been confused.

Say: The height is how far the load changes vertically. Dividing joules by newtons gives metres; a cable's full length does not tell you the rise.

Ask: In question 11, which quantity is unknown, and which unit should h have?

Expect: Vertical rise is unknown, in metres. The given energy implies 3.0 m, not cable length.

Next: Use page 2's height rearrangement, then complete Try again C on page 5 instead of 13-14; complete 12 and 15-17.

Pupil page 2, vertical-change and units rows.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 4: Exit

Question 19

Look for: Q19: 0.600 kg , $v^2=36$, $v=6.0 \text{ m/s}$; $h=4.0 \text{ m}$; new $E_k=43.2 \text{ J}$ with $\times 4$ reason.

If secure: Record which equation, unit and comparison skills are independently secure.

If: Speed is 36 m/s, uses 600 kg or has the wrong unit.

Likely issue: Conversion or the final square root still needs follow-up.

Say: Convert the mass first. Rearranging kinetic energy gives speed squared, so the final operation is a positive square root; the result is a speed, not an energy.

Ask: For question 19(a), what are 600/1000 and the positive square root of 36?

Expect: 0.600 kg and 6.0 m/s .

Next: Next lesson revisit the relevant page 2 model, then complete Try again D independently on page 8.

Pupil page 2, speed-unknown model and conversion row.

If: Height wrong or says doubled speed doubles energy.

Likely issue: The GPE rearrangement or square relationship needs follow-up.

Say: Use a separate equation for each physical change. Divide the lift energy by mg ; for a changed speed at fixed mass compare the squares.

Ask: For question 19, what is $200/(5 \times 10)$, and what factor is $(2v)^2/v^2$?

Expect: Height 4.0 m ; factor 4, so new E_k is 43.2 J .

Next: Next lesson revisit the relevant page 2 model, then complete Try again D independently on page 8.

Pupil page 2, height and squared-speed rows.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Specification and review

AQA 8463: 4.1.1.2 | AQA 8464: 6.1.1.2. Both courses and tiers: kinetic/GPE calculations, comparisons, supplied g , units and rearrangements. Excludes spring, work-done and power calculations.

PhysicsUK original cover lesson. Reviewed 2026-11-01. Timings estimated.