physics UK
Smarter practice. Stronger understanding
SOLUTIONS
ATTEMPT CHECK CORRECT IMPROVE

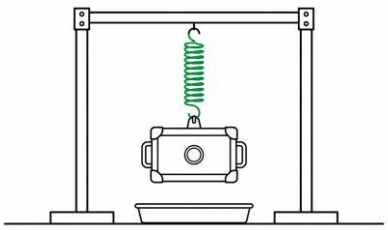
Six mark answers AS physics solutions

Matching answers and examiner-style commentary

AQA AS 7407 and OCR A AS H156 | First-year A-level foundation

Your task

An optics team is taking a precision alignment sensor to a mountain observatory. Before fitting the transport crate's suspension, engineers test one spring mount on a bench. Your job is to turn the test evidence into a recommendation and a method that a technician can follow.



A bench model of one suspension mount. Not to scale.

Physics reference

In the stated linear range, F = kx. F is the magnitude of the restoring force in N; x is extension from the unloaded length in m; k is the spring constant in N m^{-1}. The restoring force opposes the extension.

For the same x, a larger k gives a larger F. For the same applied force, x = F/k. The gradient of a graph of F vertically against x horizontally is k. All mounts here remain linear and elastic over the stated test range.

Use the physics reference throughout. Preparation tasks are unscored; score Questions 4 and 5 separately out of 6. Use a calculator. Clear reasoning matters more than a fixed number of sentences.

AQA 7407: 3.4.2.1 (spring behaviour and density); section 7.3 written practical skills.

OCR A H156: 3.4.1(a)–(d), 3.2.4(a); 1.1.1–1.1.4 practical skills.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

1 Connect the cause to the physics

1(a) At the same extension, a second mount has twice the spring constant of the first. State how the restoring-force magnitude changes and explain why. [Practice]

Answer

It doubles. Since F = kx and x is unchanged, F is directly proportional to k. The answer links the changed quantity, the relationship and the consequence.

Teaching note "The force is bigger" describes a change but does not explain it.

1(b) A trainee writes: "The spring constant increases as more load is added." Rewrite this accurately for a mount that remains in its linear range. [Practice]

Answer

The spring constant remains constant. As the applied force increases, the extension increases in direct proportion, so F/x remains constant. Do not claim that all elastic materials must have linear force–extension behaviour.

Teaching note The constant is a property in this model; the extension changes.

2 Select evidence before writing

Requirement 1 Under a 6.0 N test load, extension must be no greater than 30 mm.

Requirement 2 In a separate test, the force needed to hold the mount at an extension of 40 mm must be no greater than 15 N.

These are tests of a single mount, not a complete model of a crate in a road impact. Use F = kx within the stated linear range.

Mount	k / N m^{-1}	Extension at 6.0 N / mm	Force at 40 mm / N
A	180	33.3	7.2
B	240	25.0	
C	450	13.3	18.0

2(a) Calculate the missing force for mount B at an extension of 40 mm. Show the unit conversion. [Practice]

Answer

x = 40 mm = 0.040 m. F = kx = 240 × 0.040 = 9.6 N. This is the force magnitude; the restoring force acts opposite the extension.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

2 Explain what the evidence means

2(b) A student recommends C because it has the smallest extension under 6.0 N. Explain why this is an incomplete argument. [Practice]

Answer

C meets the extension limit, but both limits must be checked. Its force at 40 mm is 18.0 N, greater than 15 N, so it fails Requirement 2. A single favourable measurement cannot establish suitability.

2(c) Prepare two evidence notes for Question 4: one for each requirement. Include relevant values and what they mean for the choice. Use notes rather than a full answer. [Practice]

Answer

Requirement 1: A gives 33.3 mm > 30 mm and fails; B gives 25.0 mm and C 13.3 mm, so both pass.
Requirement 2: A gives 7.2 N and B 9.6 N, so both pass; C gives 18.0 N > 15 N and fails.

B is the only mount that meets both.

Teaching note This planner is unscored preparation; do not credit the same comparison twice.

Read the question in three passes

First identify the command: recommend, justify and reject. Next identify the two limits and the data that test them. Finally check that your planned argument covers both the chosen mount and its alternatives.

3 The sample question

The next task asks you to judge two answers to a different investigation. Use the physics below; the marks are deliberately not shown.

A spacer is a uniform solid cylinder, about 8 mm in diameter and 20 mm long. Density $\rho = m/V$ and cylinder volume $V = \pi d^2 L/4$. Here m is mass, d is diameter and L is length. Use kg and m to obtain ρ in kg m^{-3}.

A millimetre rule has 1 mm divisions. A suitable micrometer resolves 0.01 mm; suitable callipers resolve 0.1 mm. A smaller measurement uncertainty generally gives a smaller percentage uncertainty for the same dimension. Check for zero errors.

Question being answered

Describe how to determine the density of a solid cylindrical spacer from measurements of its mass and dimensions. Explain one choice or change that reduces the percentage uncertainty in the result.
[6 marks]

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

3 Marking guidance and sample answers

Use this guidance to compare the answers. Judge the whole response before choosing a mark within the level.

Level and marks	What this density answer needs to demonstrate
Level 3 5–6	A usable method for mass, length and diameter; correct processing to density; a specific measurement choice or change with a valid uncertainty reason. The steps and reasoning are clear and linked.
Level 2 3–4	Some suitable measurements and a valid route through cylinder volume to density, but method detail is incomplete or the improvement is missing or not justified. Some relevant reasoning is connected.
Level 1 1–2	A useful measurement or limited processing is identified, but the route to density is incomplete. Relevant ideas are mostly isolated or insufficiently developed.
0	No creditworthy response.

Read the whole response. Choose the level that best fits it, then use the upper mark for a secure match and the lower mark for a less complete match. Indicative ideas are examples, not a checklist of six automatic marks.

Response A

Measure the spacer's mass using a balance. Measure its length using a ruler. Repeat the measurements and average them to make the result accurate. Then put the measurements into the density equation.

Response B

Check the balance reads zero and measure the mass. Measure the cylinder's length with callipers and its diameter with a micrometer, correcting any zero error. Check the diameter at several positions and in perpendicular directions, then average consistent readings. Use kg and m to calculate $V = \pi d^2 L/4$ and then $\rho = m/V$.

A micrometer gives a smaller absolute uncertainty in the 8 mm diameter than a millimetre rule, so its percentage uncertainty is smaller. This matters because diameter is squared in the volume calculation.

This is original PhysicsUK teaching guidance informed by AQA and OCR A assessment, rather than an official board mark scheme.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

3 Judge the answers and improve one

Use the density marking guidance. Support your judgements with evidence from each response.

3(a) Use the marking guidance to give Response A and Response B a level and a mark out of 6. For each response, cite a phrase or omission and explain how it matches the descriptor. [Practice]

Suggested examiner-style decisions

Response A

Response A: Level 1, 2/6. “Mass using a balance” and “length using a ruler” are useful starts, but diameter and a method of finding volume are absent. “Put the measurements into the density equation” does not supply the missing route to volume. The generic repetition claim gives no specific uncertainty reason.

Response B

Response B: Level 3, 6/6. It specifies all needed measurements, processes them to V and ρ, and justifies a micrometer using the small diameter and its squared role in volume.

Why A receives the upper mark in Level 1

A makes a useful start, but it does not measure diameter or explain how to obtain the cylinder’s volume. Its general statement about repetition does not repair those gaps. This supports 2 marks, rather than a developed Level 2 response.

Why B securely reaches 6 marks

B meets all three demands: measurements, processing to density, and a justified improvement. Its reasoning is linked. It does not need every possible precaution or extra detail to secure the upper mark in Level 3.

3(b) Identify one place where Response B connects a method choice to a physical or measurement reason. Explain why that link is useful. [Practice]

Answer

The micrometer gives a smaller absolute uncertainty for the same 8 mm diameter, so the percentage uncertainty in d is smaller. Because V depends on d^2, this reduces the diameter contribution to the uncertainty in V and hence ρ.

It explains why the named instrument improves this result.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

3 Model a precise improvement

3(c) Replace Response A's sentence about repeating measurements with two sentences describing a specific improvement and why it helps. Name the part of the marking guidance that your revision addresses. [Practice]

Answer

Example: "Measure the diameter with a micrometer rather than a millimetre rule. Its smaller absolute uncertainty gives a smaller percentage uncertainty in this small diameter, reducing its contribution to the uncertainty in the calculated volume and density." This addresses a specific, justified improvement.

It does not by itself repair the missing volume-processing method, so it does not automatically make the whole answer Level 3.

3(d) Would adding more sentences about repeating measurements necessarily move Response A into Level 3? Explain using the marking guidance. [Practice]

Answer

No. The response still needs a workable route through all the required measurements and volume calculation to density, plus a justified improvement. Repetition of a general point does not meet those missing demands. Length is not the descriptor.

How to use the review

Allow 15–20 minutes. Revisit the exact question demands, compare pupils' marks for A and B with the guidance, and model a specific repair. Pupils then revise their own Question 4 or 5 answer.

Discuss the evidence for a level before choosing the mark within it. A correct calculation, a long answer or a general statement about repeating measurements does not by itself address all the demands.

OCR A identifies level-of-response questions with an asterisk. Both boards use question-specific demands. These original questions use the printed levels approach; not every six-mark question is marked identically. Diagrams and coherent bullets can support clear reasoning.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

4 Write a supported six mark comparison

Requirement 1 Under a 6.0 N test load, extension must be no greater than 30 mm.

Requirement 2 In a separate test, the force needed to hold the mount at an extension of 40 mm must be no greater than 15 N.

Mount	k / N m^{-1}	Extension at 6.0 N / mm	Force at 40 mm / N
A	180	33.3	7.2
B	240	25.0	9.6
C	450	13.3	18.0

4 Recommend a spring mount for the instrument crate. Use the physical behaviour of the mounts and numerical evidence for both requirements to justify your choice and explain why the other mounts should be rejected. **[6 marks]**

One full response

Choose B. Under 6.0 N it extends by 25.0 mm, below the 30 mm limit. At an extension of 40 mm, F = kx = 240 × 0.040 = 9.6 N, below 15 N.

A gives a lower force in the second test, but its extension under 6.0 N is 33.3 mm, so it fails the first limit.

C extends by only 13.3 mm under 6.0 N, but requires 18.0 N at 40 mm, so it fails the second limit. Increasing k reduces extension for a fixed load but increases restoring force for a fixed extension.

B is therefore the only option that meets both bench-test requirements.

Teaching note A correct letter without the linked evidence and physics is not a complete comparison.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

4 Assess the comparison

Level and marks	Marking guidance for Question 4
Level 3 5–6	A justified choice using both limits, with numerical evidence for accepting the chosen mount and rejecting the others. Correctly links stiffness to extension or restoring force. The argument is clear and coherent.
Level 2 3–4	Some correct numerical comparison and a supported choice, but coverage of the limits, rejected alternatives or physical trade-off is incomplete. There is a partly developed argument.
Level 1 1–2	Some relevant data or spring physics, with little explanation of how it supports a decision. A choice by itself is insufficient.
0	No creditworthy response.

Read the whole response. Choose the level that best fits it, then use the upper mark for a secure match and the lower mark for a less complete match. Indicative ideas are examples, not a checklist of six automatic marks.

Evidence to look for

Check B against both limits. Use A's failed extension limit and C's failed force limit. Connect the trade-off to F = kx and x = F/k while naming the quantity held constant.

Accept equivalent coherent comparisons. The exemplar is one valid answer, not a paragraph order pupils must memorise. A correct letter without linked evidence and physics is not a complete comparison.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

5 Plan an independent six mark method

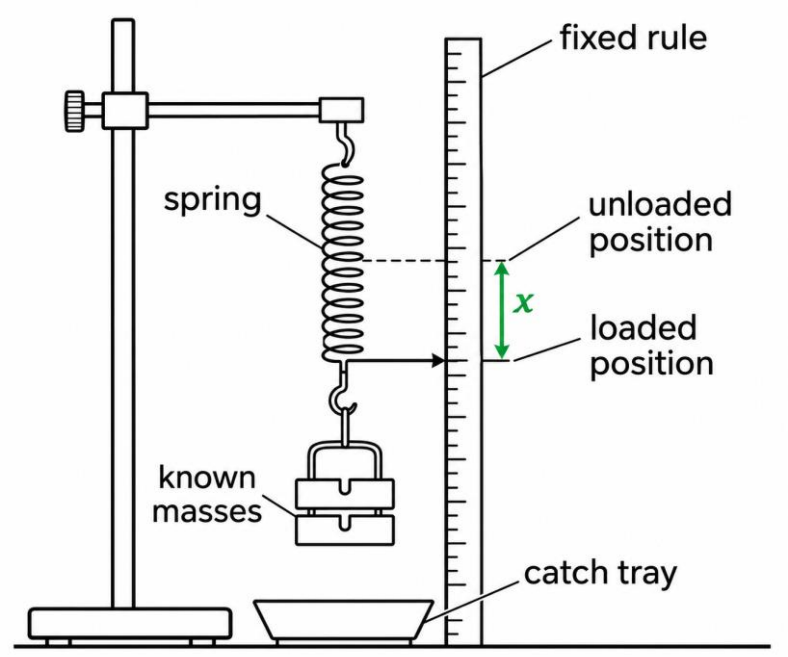
Requirement 1 Under a 6.0 N test load, extension must be no greater than 30 mm.

Requirement 2 In a separate test, the force needed to hold the mount at an extension of 40 mm must be no greater than 15 N.

Physics available $F = kx$; $F = mg$ for a hanging total mass m, with $g = 9.81\ \text{N kg}^{-1}$. Extension is the change from the unloaded length. A force–extension gradient gives k.

The spare is linear and elastic for total forces from 0 to 12 N. Do not exceed this test limit.

5 An unlabelled spare mount must be checked. Describe how to determine its spring constant experimentally and use your result to decide whether it meets both design requirements. Include a labelled sketch, the measurements you would make and how you would use a graph in the analysis. **[6 marks]**



One workable arrangement. x is the change in pointer position; the scale is schematic.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

5 A complete method and its marking

One full response with an illustrative result

Secure a stable stand to the bench and suspend the spare mount vertically, with a catch tray below the masses. Fix a rule beside a pointer at the lower end. Record its unloaded position r_0.

Add known masses in steps up to the stated 12 N limit, including the hanger in the total mass m. For each load calculate F = mg, let the mount settle and read the loaded position r at eye level.

Calculate $x = r - r_0$, using metres. Repeated readings or load cycles help estimate random variation; averaging does not remove a zero error. Plot F vertically against x horizontally and draw a straight line of best fit.

Use a large triangle on that line to find $k = \Delta F/\Delta x$ in N m^{-1}. With the measured k, predict x = 6.0/k and compare it with 0.030 m. Also calculate F = k × 0.040 and compare it with 15 N.

For example, if k = 250 N m^{-1}, x = 0.024 m and F = 10 N, so both limits are met within this model. The example value is illustrative, not a required result.

Level and marks	Marking guidance for Question 5
Level 3 5–6	A workable, clearly communicated method and labelled sketch; suitable force and extension measurements; a graph analysis that gives k; and a clear way to use k to check both requirements.
Level 2 3–4	A partly developed method with some correct measurements and analysis, but the sketch, extraction of k or checking of the requirements is incomplete. Some steps are linked.
Level 1 1–2	Limited relevant procedure, measurements or analysis. The answer does not yet lead clearly to a usable result.
0	No creditworthy response.

Read the whole response. Choose the level that best fits it, then use the upper mark for a secure match and the lower mark for a less complete match. Indicative ideas are examples, not a checklist of six automatic marks.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk

5 Check the reasoning in a practical answer

Measurements

The measurements must lead to extension and total applied force. Include the hanger when using mg, or use a correctly zeroed force gauge. A ruler reading alone is not automatically an extension.

Graph analysis

F against x gives k directly. A graph of x against F is valid if the reciprocal gradient is used. Accept an appropriate sensor or another workable measurement arrangement; this question requires graph analysis.

Measurement quality

Choose a useful range of loads and read after the mount settles. A fixed scale and pointer can reduce parallax. Repeats address random variation; correct a zero error separately.

Decision

Check both x at 6.0 N and F at 40 mm. Equivalently, $200 \leq k \leq 375$ N m^{-1} satisfies both limits in the ideal model. Deriving that interval is not required.

Uncertainty

A result close to a boundary needs uncertainty considered, or a better measurement, before a secure pass is claimed. This is useful evaluation, not an extra compulsory point in every full-mark answer.

Evidence used: AQA 7407/1 June 2016 Q03.4 and June 2025 Q06.1; OCR A H156/02 June 2018 Q2, with matching schemes and examiner reports. Scenarios, data, sample answers and guidance are original. This worksheet does not certify completion of a required practical.

Continue your physics journey
Videos, practice and support for your next step
www.physicsuk.co.uk