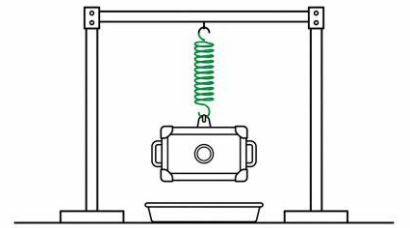
Six mark answers AS physics

35–40 minutes independent work + 15–20 minutes review

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.

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]

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]

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]

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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]

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]

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]

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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.

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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]

Response A Level: ..... Mark: ..... / 6

Evidence and reason

Response B Level: ..... Mark: ..... / 6

Evidence and reason

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]

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]

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

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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]**

Plan briefly: choice → evidence for each limit → why the alternatives fail → physical explanation. These prompts are not separate marks.

Write your full response

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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]**

Use this page for your labelled sketch and rough plan. Write the complete method on the next page.

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5 Write your full method

Use your sketch and plan to answer Question 5. Explain how your measurements lead to k, and how k is used to check both requirements.

Final check

Have I answered every demand? Have I linked physics to evidence? Does my method reach a result? During the review, replace one vague sentence with a precise one.

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