GET BETTER AT PHYSICS · MARK SCHEME

# Stress, Strain & the Young Modulus: tiered multiple choice

AQA A-level Physics · 7407 / 7408 · Specification 3.4.2.2 · 8 questions · 8 marks

1 mark per correct letter | Worked reasoning for every question | **How students did** = from AQA examiner reports, where available

## Answer key

| Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
|---|---|---|---|---|---|---|---|
| C | C | D | B | C | D | D | B |

## Easy

Questions 1–3

**1** **C**

Units of the Young modulus · AQA June 2017 · AS Paper 2 · Q26

The Young modulus has the units of stress: Pa = N $m^{-2}$. In base units N = kg m $s^{-2}$, so N $m^{-2}$ = kg $m^{-1}$ $s^{-2}$. A, B and D are all valid; C (kg $m^{-2}$ $s^{-2}$) is not.

**Watch out:** This asks which unit **cannot** be used. Convert each one to base units and find the odd one out.

**How students did:** In June 2017 about 30% of students chose D, which is a valid unit.

**2** **C**

Order of magnitude of a stress · AQA June 2019 · A-level Paper 1 · Q19

$\sigma = F / A = 50 \div (1 \times 10^{-6}\ m^2) = 5 \times 10^7$ Pa, which lies between $10^6$ and $10^9$ Pa.

**Watch out:** 1 $mm^2 = 10^{-6}\ m^2$, not $10^{-3}\ m^2$. Using $10^{-3}$ gives $5 \times 10^4$ Pa, answer B.

**How students did:** Most students got this right in June 2019; about a quarter chose B.

**3** **D**

Young modulus from a stress–strain graph · AQA June 2023 · AS Paper 2 · Q27

Use the straight section. At a strain of 0.020 the stress is 3.0 GPa, so $E = 3.0 \times 10^9 \div 0.020 = 1.5 \times 10^{11}$ Pa.

**Watch out:** Use the straight-line part only. The end point (0.030, 3.6 GPa) is past the limit of proportionality and gives $1.2 \times 10^{11}$ Pa, answer C. Remember 1 GPa = $10^9$ Pa.

**How students did:** At least 65% of students got this right in June 2023.

## Medium

Questions 4–6

**4** **B**

Does the Young modulus depend on the sample? · AQA June 2017 · A-level Paper 1 · Q24

The Young modulus is a property of the material. The second sample is made from an identical material, so its Young modulus is still E.

**Watch out:** Changing the length and diameter changes how far the wire stretches for a given force, but not the Young modulus.

**5** **C**

Comparing stress, strain and extension in two wires · AQA June 2022 · A-level Paper 1 · Q28

Same area, double force: Q's stress is double P's (A is wrong). Same material, so stress ÷ strain is the same for both (D is wrong); with double the stress, Q's strain is double P's, so C is correct. Q's extension = strain × length = 2 × 2 = 4 times x, not 2x (B is wrong).

**Watch out:** Strain is extension ÷ **original length**. Q is twice as long, so double the strain means four times the extension.

**6** **D**

Stress along a heavy hanging cable · AQA June 2023 · A-level Paper 1 · Q26

At any point the cable holds up the load plus the part of the cable below that point. At K it holds only the load, so the stress is not zero there. Moving up towards J, the weight below increases steadily (constant area and density), so the stress rises in a straight line to a maximum at J. That is graph D.

> **Watch out:** A ignores the load (it gives zero stress at K). C ignores the cable's own weight.

**How students did:** Fewer than 40% of students got this right in June 2023.

## Hard

Questions 7–8

**7** **D**

Extension of a longer, thinner wire · AQA June 2019 · AS Paper 2 · Q28

$\Delta L = FL / (AE)$ with $A = \pi d^2/4$, so $\Delta L \propto L / d^2$. Doubling L doubles ΔL. Halving d makes the area a quarter, which multiplies ΔL by 4. New extension = $2 \times 4 \times \Delta L = 8\Delta L$.

> **Watch out:** Area depends on diameter **squared**. Halving the area instead of quartering it gives 4ΔL, answer C.

**How students did:** Only about a quarter of students got this right in June 2019.

**8** **B**

Stress ÷ strain for two joined wires · AQA June 2025 · AS Paper 2 · Q21

Stress ÷ strain is the Young modulus. P and Q are made from the same material, so $X_Q = X_P$, even though their stresses and strains are different.

> **Watch out:** There is no need to work out the stress and strain in each wire. Recognise stress ÷ strain as a property of the material.

**How students did:** In June 2025 this was one of the less successful questions, and a wrong answer was the most popular choice.

**End of mark scheme.** Answers from AQA's published keys; explanations written for this pack. AQA material is © AQA. More free packs and 1-to-1 tuition: **www.getbetteratphysics.co.uk**

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