FREE REVISION PACK

Elastic Strain Energy

AQA A-level Physics · 7407 / 7408 · Specification 3.4.2.1

Medium | Hard | Multiple choice · past-paper questions

6	6	≈ 10 min
QUESTIONS	TOTAL MARKS	SUGGESTED TIME*

Contents

Q	LEVEL	FOCUS	SOURCE	MARKS
1	Medium	Strain energy in terms of the Young modulus	AQA June 2022 · AS Paper 2 · Q29	1 mark
2	Medium	Which wire extends least before breaking?	AQA June 2018 · AS Paper 2 · Q23	1 mark
3	Medium	Average power from a released spring	AQA June 2024 · A-level Paper 1 · Q26	1 mark
4	Hard	Graphs of strain energy against extension and tension	AQA June 2024 · AS Paper 2 · Q10	1 mark
5	Hard	Adding mass to a hanging spring	AQA June 2022 · A-level Paper 1 · Q27	1 mark
6	Hard	Increase in strain energy when the load doubles	AQA June 2024 · A-level Paper 1 · Q25	1 mark

Key ideas to have ready

- The energy stored when a material is stretched is the **area under the force–extension graph**.
- Within Hooke's law: $E = \frac{1}{2}F\Delta L = \frac{1}{2}k\Delta L^2$. Using $F = k\Delta L$, also $E = F^2 / (2k)$. For one spring or wire, $E \propto \Delta L^2$ and $E \propto F^2$.
- For a wire, $F = (\text{Young modulus} \times A \times \Delta L) / L$, so the energy stored is $(\text{Young modulus} \times A \times \Delta L^2) / (2L)$.
- The energy added between two forces is the trapezium area $\frac{1}{2}(F_1 + F_2)(x_2 - x_1)$. Average power = energy ÷ time.

How to use this pack

1. The questions are grouped into levels (Medium and Hard). Work through them in order, and check your answers at the end of each level before moving on.
2. Every question is multiple choice with one correct answer. Write down your working anyway; that is how you find mistakes.
3. The separate mark scheme uses the same numbers and explains every answer.

Levels are based on how students did in AQA's examiner reports where that information exists, plus our own difficulty rating. *About 1.5 minutes per question.

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Medium

Two or three steps. Roughly a third to a half of students get these right.

Questions 1–3

Only **one** answer per question is allowed. For each question, completely fill in the circle alongside the appropriate answer.

AQA June 2022 · AS Paper 2 · Q29

1 A wire is made from a material of Young modulus E.
The wire obeys Hooke's law.
The wire has an unstretched length L and a cross-sectional area A.
When a force is applied to the wire, the extension of the wire is e.

What is the elastic strain energy stored in the wire?

[1 mark]

A $\frac{AEe^2}{2L}$ ⬭

B $\frac{L}{2Ae}$ ⬭

C $\frac{Ae^2}{2EL}$ ⬭

D $\frac{AEL}{2e}$ ⬭

AQA June 2018 · AS Paper 2 · Q23

2 The table contains information on four wires. It shows the stiffness of each wire and the maximum strain energy stored in the wire when extended to the breaking point.

Assume each wire has the same initial dimensions and obeys Hooke's law.

Which wire extends the least before reaching the breaking point?

[1 mark]

	Stiffness / N m^{-1}	Maximum strain energy / J	
A	4.0	1	⬭
B	9.0	1	⬭
C	16	3	⬭
D	25	3	⬭

AQA June 2024 · A-level Paper 1 · Q26

3 A spring is compressed by a force F. The spring has stiffness k and its length changes by ΔL during the compression. When the force is removed the spring returns to its original length in time t.

What is the average power developed by the spring as it returns to its original length?

[1 mark]

A $\frac{k\Delta L}{2t}$ ⬭

B $\frac{k\Delta L}{t}$ ⬭

C $\frac{k(\Delta L)^2}{2t}$ ⬭

D $\frac{k(\Delta L)^2}{t}$ ⬭

Hard Several steps, often with a trap built in. Fewer than 3 in 10 students get these right. **Questions 4–6**

AQA June 2024 · AS Paper 2 · Q10

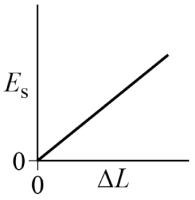
4 A wire obeys Hooke's law.

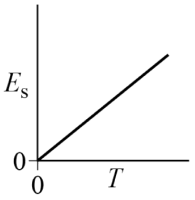
When the wire is extended by ΔL, the elastic strain energy is E_s and the tension in the wire is T.

Which pair of graphs shows the variation of E_s with ΔL and the variation of E_s with T?

[1 mark]

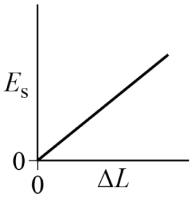
A

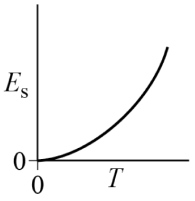




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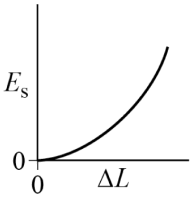
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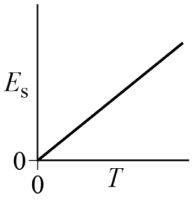




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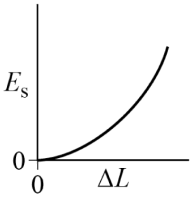
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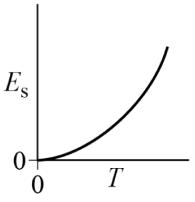




○

D





○

AQA June 2022 · A-level Paper 1 · Q27

5 A mass M is suspended from a spring. When the mass is at rest at the equilibrium position, the elastic potential energy stored is E.
An extra mass of $2M$ is added to the spring and the spring extends while still obeying Hooke's law.

What is the total elastic energy stored when the system is at rest at the new equilibrium position?

[1 mark]

A $2E$ ⬭

B $3E$ ⬭

C $4E$ ⬭

D $9E$ ⬭

AQA June 2024 · A-level Paper 1 · Q25

6 A uniform wire is stretched by a load F.
The elastic strain energy stored in the wire is E.

The load is increased from F to $2F$.
The wire obeys Hooke's law.

What is the increase in the elastic strain energy stored in the wire?

[1 mark]

A E ⬭

B $2E$ ⬭

C $3E$ ⬭

D $4E$ ⬭

End of questions. Check your answers with the matching mark scheme. More free packs and 1-to-1 tuition:
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