Question 20 (Answer: **A**)

- The graph plots *length*: at $F = 0$ the spring is already 8 cm long.
- At $F = 6.0$ N it is 12 cm, so the extension is 4 cm = 0.040 m.
- $E = \frac{1}{2}Fx = \frac{1}{2}(6.0)(0.040) = 0.12$ J; using the whole 12 cm gives C.

Question 23 (Answer: **C**)

- Rubber shows hysteresis, so the unloading curve lies below the loading curve.
- Both curves still begin and end at the origin, so the band does return to its original length – it stays elastic.
- The curves are not straight, so Hooke's law is not obeyed, and the area between them is energy lost as heat.

A-Level Physics: w25 12

Question 23 (Answer: **C**)

- Read the force at an extension of 4.0 cm from the graph: 30 kN.
- The energy stored is the area under the line, $\frac{1}{2}Fx$.
- $\frac{1}{2}(30 \times 10^3)(0.040) = 600$ J; D omits the factor of one half.

A-Level Physics: w25 14

Question 21 (Answer: **B**)

- The area under the loading line is the work done stretching the rubber.
- The area under the unloading line is the work the rubber gives back.
- The area between them is the difference – energy dissipated as heat in the rubber.

A-Level Physics: s25 12

Question 22 (Answer: **B**)

- From the graphs $k_X = 20/0.10 = 200$ N m^{-1} and $k_Y = 80/0.05 = 1600$ N m^{-1}.
- So Y is eight times as stiff as X.
- At the same extension $E = \frac{1}{2}kx^2$, so Y stores eight times the energy.

Question 23 (Answer: **D**)

- Beyond the elastic limit the material no longer returns to its original shape.
- So the elastic limit is the smallest strain at which the deformation becomes plastic.
- A describes the limit of proportionality, where Hooke's law stops holding – a different point.

A-Level Physics: s25 13

Question 23 (Answer: **D**)

- The limit of proportionality is set by the *stress*, so the force at which it occurs is unchanged.
- A wire of twice the length stretches twice as far for the same force, since $x = FL/AE$.
- So the new point sits at the same height on the force axis but at double the extension.

A-Level Physics: s25 14

Question 18 (Answer: **D**)

- The first 2.0 N produces 0.05 m of extension, so $k = 2.0/0.05 = 40$ N m^{-1}.
- With the full 6.0 N the extension is $6.0/40 = 0.15$ m.
- The extra energy is $\frac{1}{2}(40)(0.15^2 - 0.05^2) = 0.45 - 0.05 = 0.40$ J.

Question 19 (Answer: **D**)

- Elastic deformation means the wire returns to its original length once the force is removed.
- Proportionality is Hooke's law – a stricter and separate condition.
- C describes plastic deformation, which is the opposite case.