

Solutions

2.1 Convert: $e = 0.030$ m (C1).

$$k = F/e = 6.0/0.030 = \mathbf{200} \text{ N/m}$$

(C1, A1)

2.2 Convert: $e = 0.050$ m (C1).

$$E_e = \frac{1}{2} \times 200 \times 0.050^2 = \mathbf{0.25} \text{ J}$$

(C1, A1)

2.3 Elastic: the object returns to its original length/shape when the load is removed; inelastic: it does not – permanently deformed.

3.1 (a) Extensions: 0, 4.0, 8.0, 12.0, 18.5, 26.0 cm. (b) A straight line through the origin up to 4.0 N load, then curving upwards; limit of proportionality at 4.0 N / 12.0 cm extension. (c) Using linear data, e.g. 4.0 N over 8.0 cm:

$$k = \frac{4.0 \text{ N}}{0.080 \text{ m}} = \mathbf{50} \text{ N/m}$$

(C1 for m conversion, A1) (d) The limit of proportionality has been exceeded – the spring deforms beyond Hooke’s-law behaviour.

3.2 (a) Weight: $F = mg = 60 \times 9.8 = 588$ N (C1). Predicted force at 0.75 m: $F = ke = 800 \times 0.75 = 600$ N (C1); within rounding the weight equals ke ✓. (b)

$$E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 800 \times 0.75^2 = \mathbf{225} \text{ J}$$

(C1, A1) (c) From the person’s gravitational potential store (they descended stretching the cord); the cord’s elastic potential store filled as they fell.

3.3 (a) $e_X = F/k = 8.0/100 = \mathbf{0.080}$ m (C1, A1); $e_Y = 8.0/400 = \mathbf{0.020}$ m (C1, A1). (b)

$$E_X = \frac{1}{2} \times 100 \times 0.080^2 = 0.32 \text{ J} \quad E_Y = \frac{1}{2} \times 400 \times 0.020^2 = 0.080 \text{ J}$$

(each energy C1; ratio **4 : 1** A1) (c) Spring Y: stiffer means larger k , and the work for an extra stretch Δe is approximately $F\Delta e = k\Delta e$ – Y needs four times the force at any given extension.