

Combined science - Physics - Key stage 4 - Energy

# The elastic potential energy store

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# Exam style questions

Q1. The spring constant of a spring is  $40 \text{ N/m}$ .

Calculate the energy transferred to the spring when it is extended by  $0.45 \text{ m}$ .

Give your answer to two significant figures.

**3**



## Q2

This question is about a catapult holding a stone of mass 200 g.

- a) The catapult has a spring constant of 500 N/m. Calculate the energy transferred to the catapult when it is extended by 0.15 m **2**
- b) When released 90% of this energy is transferred to the kinetic store. What is the value of the kinetic store? **1**
- c) Calculate the maximum velocity of the stone when it leaves the catapult. Use the equation:

$$\text{Kinetic energy} = \frac{1}{2} mv^2 \quad \mathbf{2}$$



# Answers



# Q1.

$$\text{EPE} = \frac{1}{2} ke^2$$

$$\text{EPE} = \frac{1}{2} \times 40 \times 0.45^2 \quad \mathbf{1}$$

$$\text{EPE} = 4.05 \text{ J} \quad \mathbf{1}$$

$$\text{EPE} = 4.1 \text{ J to 2 significant figures} \quad \mathbf{1}$$



## Q2

a)  $EPE = \frac{1}{2} ke^2$

$$EPE = \frac{1}{2} \times 500 \times 0.15^2$$

$$EPE = 5.625 \text{ J}$$

b)  $KE = 5.0625 \text{ J}$

c)  $KE = \frac{1}{2} mv^2$

$$5.0625 = \frac{1}{2} \times 0.200 \times v^2$$

$$v = \sqrt{\frac{2 \times 5.0625}{0.200}}$$

$$v = 7.12 \text{ m/s}$$

*No mark for this as on equation sheet.*

**1**

**1**

**1**

**1**

**1**



# In lesson questions



# Independent practice

1. Define elastic potential energy store.
  - a. The energy stored by .....
2. When we stretch a spring, which two factors affect how much elastic potential energy is stored in it?
3. Do you need to know the total length of the spring to calculate the elastic potential energy store? Explain your answer.
4. Which will store more energy: a stiffer spring, or a less stiff spring stretched to the same extension?
5. Which will store more energy? A 10 cm long spring stretched to 15 cm, or a 20 cm long spring stretched to 25 cm?



# Independent practice

1. What is the extension of a spring?
2. What is the spring constant of a spring?
3. For a bungee jumper, would a rope with a high spring constant, or low spring constant be more useful?
4. Explain your answer
5. What is the equation linking elastic potential energy, spring constant and extension?



# Independent practice

1. Calculate the Elastic Potential Energy (in J) for each of the following:
  - a. Spring constant  $k = 5 \text{ N/m}$ , spring extension  $e = 0.1 \text{ m}$ .
  - b. Spring constant  $k = 20 \text{ N/m}$ , spring extension  $e = 0.15 \text{ m}$ .
2. A spring with  $k = 500 \text{ N/m}$  is compressed by 20 cm. How much energy is stored?
3. The coil springs on a car's suspension have a value of  $k = 64 \text{ kN/m}$ . When the car strikes a bump the springs briefly compress by 4.0 cm. How much energy is stored in each spring during this compression?
4. How much work is done to stretch a spring by 25 cm if its spring constant is 65 N/m?



# Independent practice

1. Calculate the spring constant (in N/m) for each of the following:
  - a. Elastic potential energy 0.1 J, spring extension  $e = 0.05$  m.
  - b. Elastic potential energy 5 J, spring extension  $e = 0.2$  m.
2. Find the spring constant of a spring which stores 1224 J of elastic potential energy when extended by 4.4 m.
3. A spring, when compressed 20 cm from its natural length, stores 30 J. What is the value of the spring constant?
4. **Challenge:** What is the spring constant for a spring that requires 2.5 kJ to compress by 25 mm?



# Independent practice

1. Calculate the extension (in m) for each of the following:
  - a. Elastic potential energy 7 J, spring constant  $k = 15 \text{ N/m}$ .
  - b. Elastic potential energy 2.5 J, spring constant  $k = 20 \text{ N/m}$ .
2. A spring in a car's suspension has elastic potential energy store 36 J. If the spring constant is 8 N/m, find the extension.
3. Find the extension of a spring of spring constant 160 N/m if the elastic potential energy stored is 40 J.
4. **Challenge:** Find the extension of a spring when the energy stored is 42 MJ and the spring constant 2.5 kN/m



# Answers



# Review

1. Define elastic potential energy store **The energy stored by stretching or compressing a spring.**
2. When we stretch a spring, which two factors affect how much elastic potential energy is stored in it? **Spring constant (stiffness), extension**
3. Do you need to know the total length of the spring to calculate the elastic potential energy store? Explain your answer **No. It is the extension that matters not the total length of the spring.**
4. Which will store more energy: a stiffer spring, or a less stiff spring stretched to the same extension? **A stiffer spring, because it requires more work to stretch it.**
5. Which will store more energy? A 10 cm long spring stretched to 15 cm, or a 20 cm long spring stretched to 25 cm? **Neither, they both have the same extension.**



# Review

1. What is the extension of a spring? **The change in length from its original length**
2. What is the spring constant of a spring? **A measure of how stiff the spring is. It is measured in N/m**
3. For a bungee jumper, would a rope with a high spring constant, or low spring constant be more useful? **Low**
4. Explain your answer **High spring constant would mean it would not extend very much and they would have to stop suddenly and this could cause a lot of pain.**
5. What is the equation linking elastic potential energy, spring constant and extension?  **$EPE = \frac{1}{2} ke^2$**



# Review

1. Calculate the Elastic Potential Energy (in J) for each of the following:
  - a. Spring constant  $k = 5 \text{ N/m}$ , spring extension  $e = 0.1 \text{ m}$ . **0.025 J**
  - b. Spring constant  $k = 20 \text{ N/m}$ , spring extension  $e = 0.15 \text{ m}$ . **0.225 J**
2. A spring with  $k = 500 \text{ N/m}$  is compressed by 20 cm. How much energy is stored?
  - a. **10 J**
3. The coil springs on a car's suspension have a value of  $k = 64 \text{ kN/m}$ . When the car strikes a bump the springs briefly compress by 4.0 cm. How much energy is momentarily stored in each spring? **51.2 J**
4. How much work is done to stretch a spring of 65 N/m spring constant by 25 cm? **2.0 J**



# Review

1. Calculate the spring constant (in N/m) for each of the following:
  - a. Elastic potential energy 0.1 J, spring extension  $e = 0.05$  m. **80 N/m**
  - b. Elastic potential energy 5 J, spring extension  $e = 0.2$  m. **250 N/m**
2. Find the spring constant of a spring which stores 1224 J of elastic potential energy when extended by 4.4 m. **126 N/m**
3. A spring, when compressed 20 cm from its original length, stores 30 J. What is the value of the spring constant? **1500 N/m**
4. **Challenge:** What is the spring constant for a spring that requires 2.5 kJ to compress by 25 mm? **8 000 000 N/m**



# Review

1. Calculate the extension (in m) for each of the following:
  - a. Elastic potential energy 7 J, spring constant  $k = 15 \text{ N/m}$ . **0.97 m**
  - b. Elastic potential energy 2.5 J, spring constant  $k = 20 \text{ N/m}$ . **0.5 m**
2. A spring in a car's suspension has elastic potential energy store 36 J. If the spring constant is 8 N/m, find the extension. **3 m**
3. Find the extension of a spring of spring constant 160 N/m if the elastic potential energy stored is 40 J. **0.7 m**
4. **Challenge:** Find the extension of a spring when the energy stored is 42 MJ and the spring constant 2.5 kN/m **183 m**

