Kinetic, gravitational and elastic energy

Name _____ Class _____ Date _____

Three equations let you calculate how much energy is in the kinetic, gravitational potential and elastic potential stores.

KEY EQUATIONS

$E_k = \frac{1}{2} m v^2$
kinetic energy (J), mass (kg), speed (m/s)

$E_p = m g h$
gravitational potential energy (J), mass (kg), g (N/kg), height (m)

$E_e = \frac{1}{2} k e^2$
elastic PE (J), spring constant (N/m), extension (m)

On Earth, g = 9.8 N/kg.
Only use $E_e = \frac{1}{2}ke^2$ up to the limit of proportionality.

Section A · Recall and calculate

Grade 4–5

1 Calculate the kinetic energy of a 2 kg ball moving at 3 m/s. [2]

$E_k = \frac{1}{2} \times 2 \times 3^2$

$E_k = 9$ J

2 Calculate the gravitational potential energy gained by a 50 kg student who climbs 4 m. (g = 9.8 N/kg) [2]

$E_p = 50 \times 9.8 \times 4$

$E_p = 1960$ J

3 A spring with k = 40 N/m is stretched by 0.2 m. Calculate the elastic potential energy stored. [2]

$E_e = \frac{1}{2} \times 40 \times 0.2^2$

$E_e = 0.8$ J

Section B · Rearrange and apply

Grade 5–6

4 Complete the table. [4]

Mass (kg)	Speed (m/s)	Kinetic energy (J)
4	5	**50**
0.5	**10**	25
1200	20	240 000
70	6	**1260**

5 A 0.6 kg book falls 1.5 m from a shelf to the floor. (g = 9.8 N/kg)

a Calculate the gravitational potential energy lost by the book. [2]

$E_p = 0.6 \times 9.8 \times 1.5$

$E_p = 8.82$ J

b Ignoring air resistance, state the kinetic energy of the book just before it hits the floor. [1]

8.82 J (all of the energy in the gravitational potential store is transferred to the kinetic store)

6 A 1200 kg car speeds up from 10 m/s to 20 m/s. Calculate the increase in its kinetic energy. [3]

At 10 m/s: Ek = ½ × 1200 × 10² = 60 000 J

At 20 m/s: Ek = ½ × 1200 × 20² = 240 000 J

Increase = 180 000 J

Section C · Stretch

Grade 7+

7 Explain why doubling the speed of a car makes its kinetic energy four times bigger. [2]

Ek = ½mv², so kinetic energy depends on speed squared.

2² = 4, so doubling v multiplies Ek by 4.

8 A 0.05 kg stone is fired straight up from a catapult with 4.9 J of energy. Calculate the maximum height it reaches. Ignore air resistance. [3]

At the top, all the energy is in the gravitational potential store: Ep = 4.9 J

h = Ep ÷ (mg) = 4.9 ÷ (0.05 × 9.8)

h = 10 m

Exam-style question

AQA style

9 A child of mass 30 kg slides from rest down a slide. The top of the slide is 2.5 m above the ground. (g = 9.8 N/kg)

a Calculate the gravitational potential energy lost by the child. [2]

Ep = 30 × 9.8 × 2.5

Ep = 735 J

b Assuming no energy is wasted, calculate the child's speed at the bottom. [3]

Ek = 735 J, so ½ × 30 × v² = 735

v² = 735 ÷ 15 = 49

v = 7 m/s

c The child's real speed at the bottom is less than this. Explain why. [2]

Friction between the child and the slide (and air resistance) does work,

so some energy is dissipated to the thermal store of the surroundings.

Total: _____ / 28

How confident am I?	Not yet	Nearly	Got it
I can use Ek = ½mv² and Ep = mgh	☐	☐	☐
I can use Ee = ½ke²	☐	☐	☐
I can link gravitational potential energy lost to kinetic energy gained	☐	☐	☐