



STEM SMART Double Maths 37 - Energy & Elasticity

Gravitational and Kinetic Energy 6

Linking Concepts in Pre-Uni Physics 1.6

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** A Level P1

At what speed will a 4.2 kg lump of clay hit a potter's wheel if it is thrown downwards at 1.1 m s^{-1} from a height 40 cm above the wheel?



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The Lift

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** GCSE C2, A Level P1

Part A

Descending Lift: Tension

A lift, of mass m , is travelling downwards at a speed u . It is brought to rest by a constant acceleration over a distance h .

What is the tension, T , in the lift cable when the lift is stopping?

The following symbols may be useful: T , g , h , m , u

Part B

Descending Lift: Work Done

What is the work done by the tension whilst stopping the lift?

The following symbols may be useful: g , h , m , u

Part C**Ascending Lift: Tension**

A lift, of mass m , is travelling upwards at a speed u . It is brought to rest by a constant acceleration over a distance h .

What is the tension, T , in the lift cable when the lift is stopping?

The following symbols may be useful: T , g , h , m , u

Part D**Ascending Lift: Work Done**

What is the work done by the tension whilst stopping the lift?

The following symbols may be useful: g , h , m , u

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Work, Energy and Power 8

Essential Pre-Uni Physics B8.8

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** GCSE C3, A Level P1

Physical constants which may be necessary to answer this problem can be found within the hint tab.

A 55 kW motor is used to lift a 4800 kg mass vertically up a mine shaft. What is the maximum possible speed that the mass could move upwards? Give your answer to 2 significant figures.

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The Skiers

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** GCSE C2, A Level C1

Two skiers want to reach the top of an incline without pushing. The first skier, of mass m , reaches the start of the incline with a speed v . He just makes it to the top of the incline. The second skier, of mass $\frac{2}{3}m$, has a speed $\frac{2}{3}v$ at the bottom of the incline. The incline has a vertical height h .

Will she make it to the top without pushing? It can be assumed that frictional forces are negligible.

- ☐ No, she makes it to $\frac{8}{9}h$
- ☐ No, she makes it to $\frac{8}{27}h$
- ☐ No, she makes it to $\frac{4}{9}h$
- ☐ Yes, she makes it to the top with a non-zero velocity
- ☐ Yes, she just makes it to the top

Adapted with permission from UCLES, A Level Physics, June 1987, Paper 1, Question 5.

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Pedal Power

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** A Level C2

A 75 kg cyclist on a 15 kg bicycle pedals against a backwards resistive force that is proportional to the square of their speed. On a flat road, they can travel at a steady speed of 10.0 m s^{-1} . While cycling up an incline, they produce the same power, but their steady speed is only 5.0 m s^{-1} .

Part A

Coasting down

At what speed could the cyclist coast down the incline, if they do not pedal?

Part B

Head down

The cyclist knows that, regardless of their speed, they can reduce the resistive force by 20% by putting their head down. This allows them to travel at a higher steady speed.

By how much does their speed increase, if they put their head down:

(i) while coasting down the incline?

(ii) while pedalling on a flat road?

Part C

Angle of the incline

When the cyclist puts their head down while cycling on a flat road at a steady speed, their initial acceleration is 0.050 m s^{-2} .

What is the angle of the incline from earlier in the question?

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Springs 4

Essential Pre-Uni Physics B7.4

Subject & topics: Physics | Mechanics | Statics **Stage & difficulty:** GCSE C1, A Level P1

What mass should be suspended from a spring of length 20 cm and spring constant 6.0 kN m^{-1} in order for the spring to be stretched to a length of 22 cm?

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A Spring and a Thread

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** GCSE C2, A Level C1

A light spring has a mass, m , suspended from its lower end. A second mass, n is suspended from the first by a thread. The arrangement is allowed to come into static equilibrium and then the thread is burned through.

At this instant, what is the upward acceleration of the mass m ?

The following symbols may be useful: a , g , m , n

Used with permission from UCLES, A Level Physics, November 1987, Paper 1, Question 5.

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Spring Triangle

Subject & topics: Physics | Mechanics | Statics **Stage & difficulty:** A Level C2

A rod AB of length $d = 2.00 \text{ m}$ is fixed horizontally. Two light identical springs of spring constant $k = 14.0 \text{ N m}^{-1}$ are attached to the rod, one at each end. The loose ends of the springs are attached to each other at a point C and in this framework the springs are just taut. It is found that the angle made by one of the springs to the vertical $\alpha = 45.0^\circ$. A metal ball is then suspended from the springs at C and the angle made by one of the springs to the vertical is found to be $\beta = 30.0^\circ$.

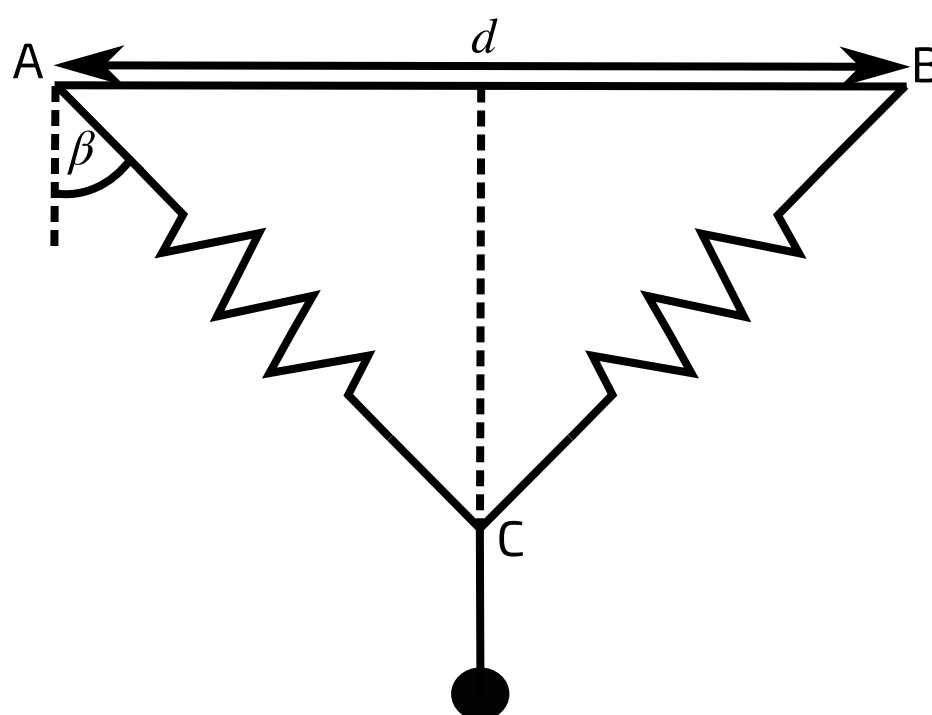


Figure 1: A metal ball suspended from two strings.

Taking the acceleration due to gravity as $g = 9.81 \text{ m s}^{-2}$, what is the mass m of the ball?

- ☐ 4.94 kg
- ☐ 1.67 kg
- ☐ 0.725 kg
- ☐ 1.45 kg
- ☐ 0.837 kg

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Energy, Springs and Materials 3

Essential Pre-Uni Physics B9.3

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** GCSE C1, A Level C1

Assume that extension is proportional to the tension.

A spring with natural length 75 cm requires a force of 300 N in order for it to stretch to 85 cm. How much EPE would be stored in the spring if it were stretched to 90 cm? Give your answer to 2 significant figures.

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Energy and Elastic Strings

Subject & topics: Physics | Mechanics | Dynamics **Stage & difficulty:** Further A P2

A light elastic string, of natural length 50.0 cm and modulus of elasticity 15.0 N, has one end attached to a fixed point A. A particle of mass 2.00 kg is attached to the other end of the string. The particle is projected vertically downwards from A with a velocity of 3.00 m s^{-1} .

Part A

Distance below A

Find the distance of the particle below A when it first comes to rest.

Part B

Modulus of elasticity

The first string is removed and replaced with a different light elastic string of natural length 85.0 cm and modulus of elasticity λ . One end is again attached to A and the other end is attached to a particle of mass 2.00 kg. When the particle is projected vertically downwards from A with a velocity of 3.00 m s^{-1} , it first comes to rest 3.35 m below A.

Find the modulus of elasticity of the new string.

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