AQA – Work, energy and power – A2 Further Mathematics Mechanics

1. June/2020/Paper_3/No.2

The tension, T newtons, in a spring is given by $T = 20e$, where e metres is the extension of the spring.

Calculate the work done when the extension is increased from 0.2 metres to 0.4 metres.

Circle your answer.

[1 mark]

0.4 J 0.9 J 1.2 J 1.6 J

2. June/2020/Paper_3/No.4

A car has mass 1000 kg and travels on a straight horizontal road.

The maximum speed of the car on this road is $48\,\text{m}\,\text{s}^{-1}$

In a simple model, it is assumed that the car experiences a resistance force that is proportional to its speed.

When the car travels at $20\,\text{m}\,\text{s}^{-1}$, the magnitude of the resistance force is 600 newtons.

(a) Show that the maximum power of the car is 69 120 W

[2 marks]

(b) Find the maximum acceleration of the car when it is travelling at $25\,m\,s^{-1}$

[3 marks]

(c) Find the maximum acceleration of the car when it is travelling at $3\,m\,s^{-1}$

[1 mark]

(d) Comment on the validity of the model in the context of your answers to parts **(b)** and **(c)**.

[2 marks]

3. June/2020/Paper_3/No.7

In this question use $g = 9.8\,\text{m s}^{-2}$

A box, of mass 8 kg, is on a rough horizontal surface.

A string attached to the box is used to pull it along the surface.

The string is inclined at an angle of 40° above the horizontal.

The tension in the string is 50 newtons.

As the box moves a distance of x metres, its speed increases from $2\,\text{m s}^{-1}$ to $5\,\text{m s}^{-1}$

The coefficient of friction between the box and the surface is 0.4

(a) By using an energy method, find x.

[6 marks]

(b) Describe how the model could be refined to obtain a more realistic value of x and use an energy argument to explain whether this would increase or decrease the value of x.

[2 marks]

4. June/2019/Paper_3/No.1

A spring has natural length 0.4 metres and modulus of elasticity 55 N

Calculate the elastic potential energy stored in the spring when the extension of the spring is 0.08 metres.

Circle your answer.

[1 mark]

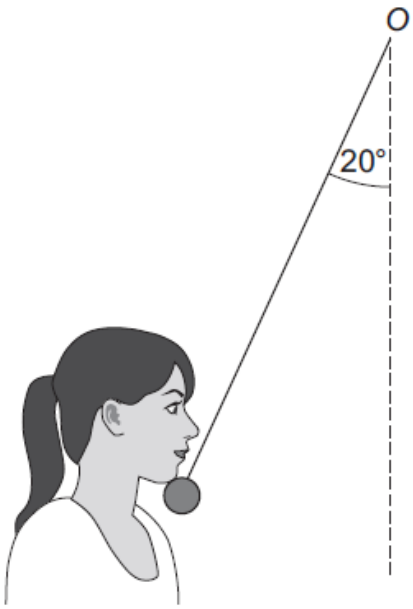
0.176 J 0.44 J 0.88 J 1.76 J

5. June/2019/Paper_3/No.4

In this question use $g = 10\,\text{m s}^{-2}$

An inelastic string has length 1.2 metres.
One end of the string is attached to a fixed point *O*.
A sphere, of mass 500 grams, is attached to the other end of the string.

The sphere is held, with the string taut and at an angle of 20° to the vertical, touching the chin of a student, as shown in the diagram below.



The sphere is released from rest.

Assume that the student stays perfectly still once the sphere has been released.

(a) Calculate the maximum speed of the sphere.

[3 marks]

(b) Find the maximum tension in the string.

[3 marks]

(c) State, with a reason, whether or not the sphere touches the student's chin again after it has been released.

[2 marks]

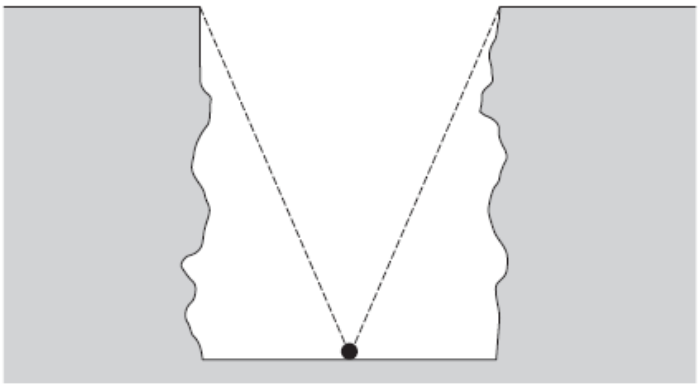
6. June/2019/Paper_3/No.8

In this question use $g = 9.8\,\text{m s}^{-2}$

A 'reverse' bungee jump consists of two identical elastic ropes. One end of each elastic rope is attached to either side of the top of a gorge.

The other ends are both attached to Hannah, who has mass 84 kg

Hannah is modelled as a particle, as shown in the diagram below.



The depth of the gorge is 50 metres and the width of the gorge is 40 metres.

Each elastic rope has natural length 30 metres and modulus of elasticity 3150 N

Hannah is released from rest at the centre of the bottom of the gorge.

(a) Show that the speed of Hannah when the ropes become slack is $30\,\text{m s}^{-1}$ correct to two significant figures.

[6 marks]

(b) Determine whether Hannah is moving up or down when the ropes become taut again.
[5 marks]