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

1. June/2020/Paper_2/No.1

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

A particle of mass 2 kg is attached to one end of a light elastic string of natural length 0.5 metres and modulus of elasticity 100 N. The other end of the string is attached to the point *O*.

Find the extension of the elastic string when the particle hangs in equilibrium vertically below *O*.

Circle your answer.

[1 mark]

0.01 m 0.1 m 0.2 m 0.4 m

2. June/2020/Paper_2/No.2

An object moves under the action of a single force F newtons.

It is given that $F = 6x^2$, where x represents the displacement in metres from the initial position of the object.

Find the work done by F in moving the object from $x = 1$ to $x = 2$

Circle your answer.

[1 mark]

12 J 14 J 18 J 42 J

3. June/2020/Paper_2/No.5

A train consisting of an engine and eight carriages moves on a straight horizontal track.

A constant resistive force of 2400 N acts on the engine.

A constant resistive force of 300 N acts on **each** of the eight carriages.

The maximum speed of the train on the track is 120 km h^{-1}

Find the maximum power output of the engine.

Fully justify your answer.

[5 marks]

4. June/2020/Paper_2/No.7

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

As part of a competition, Jo-Jo makes a small pop-up rocket.

It is operated by pressing the rocket vertically downwards to compress a light spring, which is positioned underneath the rocket.

The rocket is released from rest and moves vertically upwards.

The mass of the rocket is 18 grams and the stiffness constant of the spring is $60\,\text{N m}^{-1}$

Initially the spring is compressed by 3 cm

(a) Find the speed of the rocket when the spring first reaches its natural length.

[4 marks]

(b) By considering energy find the distance that the rocket rises.

[2 marks]

(c) In order to win a prize in the competition, the rocket must reach a point which is 15 cm vertically above its starting position.

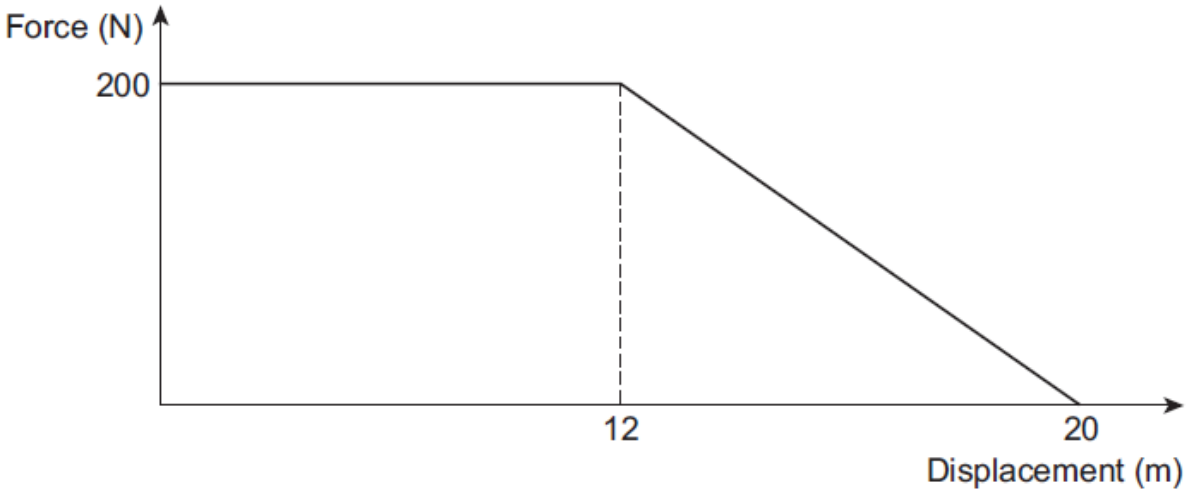
With reference to the assumptions you have made, determine if Jo-Jo wins a prize or not.

Fully justify your answer.

[3 marks]

5. June/2019/Paper_2/No.2

The graph shows the resistance force experienced by a cyclist over the first 20 metres of a bicycle ride.



Find the work done by the resistance force over the 20 metres of the bicycle ride.

Circle your answer.

[1 mark]

1600 J 3000 J 3200 J 4000 J

6. June/2019/Paper_2/No.5

A car of mass 1000 kg has a maximum speed of 40 m s^{-1} when travelling on a straight horizontal race track.

The maximum power output of the car's engine is 48 kW

The total resistance force experienced by the car can be modelled as being proportional to the car's speed.

Find the maximum possible acceleration of the car when it is travelling at 25 m s^{-1} on the straight horizontal race track.

Fully justify your answer.

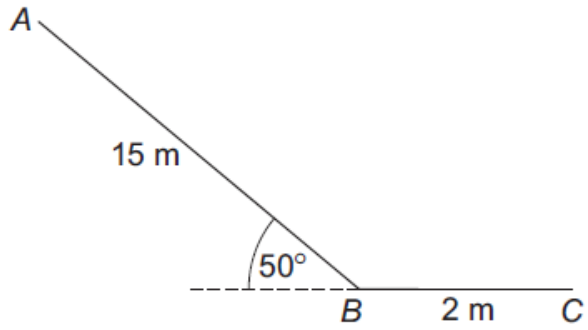
[7 marks]

7. June/2019/Paper_2/No.6

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

Martin, who is of mass 40 kg, is using a slide.

The slide is made of two straight sections *AB* and *BC*.
The section *AB* has length 15 metres and is at an angle of 50° to the horizontal.
The section *BC* has length 2 metres and is horizontal.



Martin pushes himself from *A* down the slide with initial speed $1\,\text{m s}^{-1}$
He reaches *B* with speed $5\,\text{m s}^{-1}$

Model Martin as a particle.

(a) Find the energy lost as Martin slides from *A* to *B*.

[4 marks]

(b) Assume that a resistance force of constant magnitude acts on Martin while he is moving on the slide.

(b) (i) Show that the magnitude of this resistance force is approximately 270 N

[2 marks]

(b) (ii) Determine if Martin reaches the point *C*.

[3 marks]