Eduqas Physics GCSE
Topic 3.1: Forces and their interactions
Questions by topic

1 (HIGHER).

On 14 October 2012 Felix Baumgartner created a new world record when he jumped from a stationary balloon at a height of 39 km above the surface of the Earth. At 42 s of free fall he reached a terminal velocity of 373 m/s, which was greater than the speed of sound. The total mass of Felix and his suit was 118 kg.

(a) Explain in terms of weight and air resistance how terminal velocity is reached. [3]

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(b) (i) Use an equation from page 2 to calculate Felix's change in momentum in the first 42 s of his fall. [2]

change in momentum = ... kg m/s

(ii) Use an equation from page 2 to calculate the mean resultant force acting on him during the first 42 s. [2]

mean resultant force = ... N

(iii) Calculate the mean value of the air resistance force during the first 42 s. [3]

mean air resistance force = ... N *(c)* At 39 km the air particles are very far apart. Explain how jumping from this height allowed Felix to reach such a high terminal velocity. [2]

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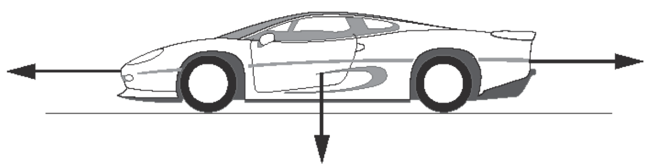
12

2 (HIGHER).

The diagram below shows some of the forces acting on a car of mass 800kg. On Earth, the weight of 1kg is 10N.



(a) (i) Describe the difference between the weight and the mass of the car. [2]

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....

....

(ii) Calculate the weight of the car. [1]

weight = ... N

(b) (i) The car is travelling at a **constant speed**. Write down the size of the driving force. [1]

driving force = ... N

(ii) The driving force is now increased to 4200 N.
Calculate the resultant horizontal force on the car. [1]

resultant force = ... N

(iii) Use the equation:

$$\text{acceleration} = \frac{\text{resultant force}}{\text{mass}}$$

to calculate the acceleration of the car. [2]

acceleration = ... m/s^2

(iv) Explain why the car will eventually reach a new higher constant speed when the driving force is increased to 4200 N. [2]

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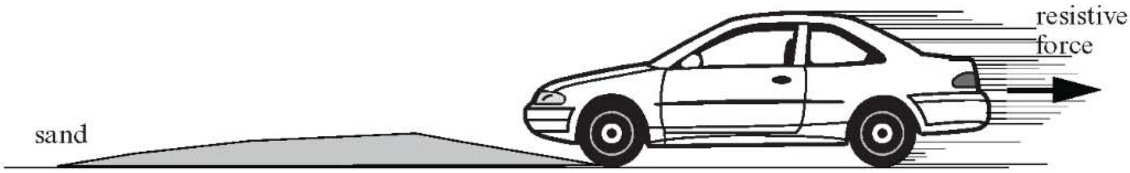
9

3.

A car of mass 1 500 kg, travelling at 15 m/s has its speed reduced to 5 m/s when it travels 7.5 m through a pile of sand in the road.



(a) Use an equation from page 2 to calculate the loss of kinetic energy of the car. [3]

Loss in kinetic energy = ...

(b) Use your answer to part *(a)* along with an equation from page 2 to find the (mean) resistive force produced by the sand during the collision. [3]

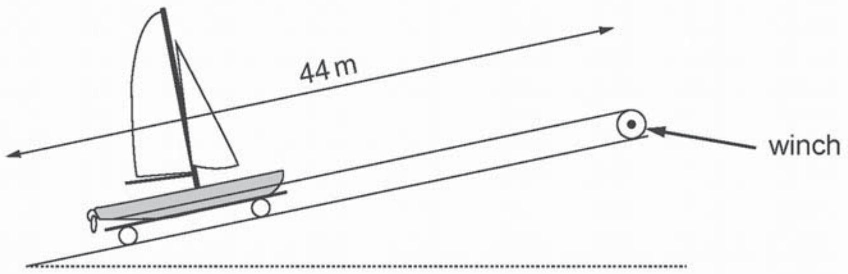
Resistive force = ... N

(c) Write down the value of the horizontal force that acts on the **sand** in this collision. [1]

Force on the sand = ... N

7

4. The diagram shows a winch that is used to pull a boat 44 m up a ramp.



(a) (i) There is a friction force of 50 N acting against the boat as it is being pulled up the ramp. Use the equation:

work = force × distance

to calculate the work done against friction. [2]

work done against friction = ... J

(ii) The boat has gained 3200 J of potential energy when it is at the top of the ramp. Calculate the total work done by the winch to move the boat up the ramp. [1]

total work done = ... J

(iii) Later, the boat is released from the top of the ramp and it rolls down to the sea. Some of its 3200 J of potential energy is used up as work against friction. Use your answer to *(a)*(i) to calculate the energy it has left when it reaches the sea. [1]

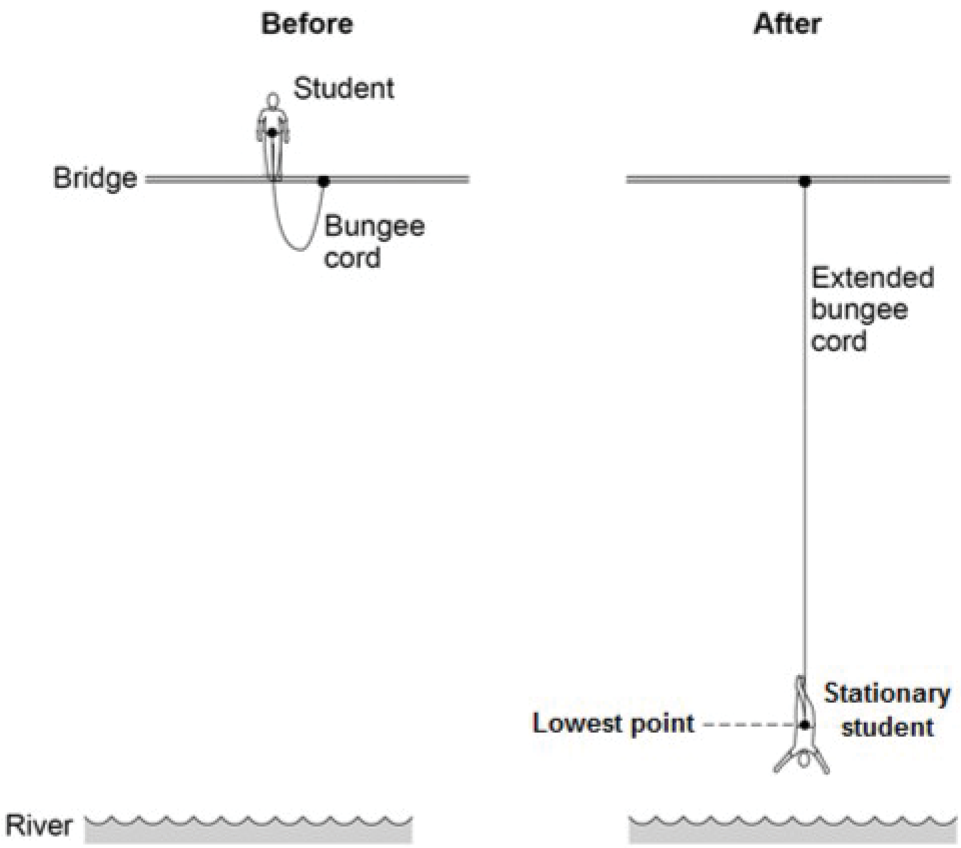
energy = ... J

5.

Figure 2 shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.

Figure 2



1 For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

[2 marks]

1

2

2 The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

[3 marks]

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

______________________ energy.

When he is falling, the student's store of ______________ energy increases.

When the bungee cord is stretched, the cord stores energy as

______________________ energy.

3 At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N/m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

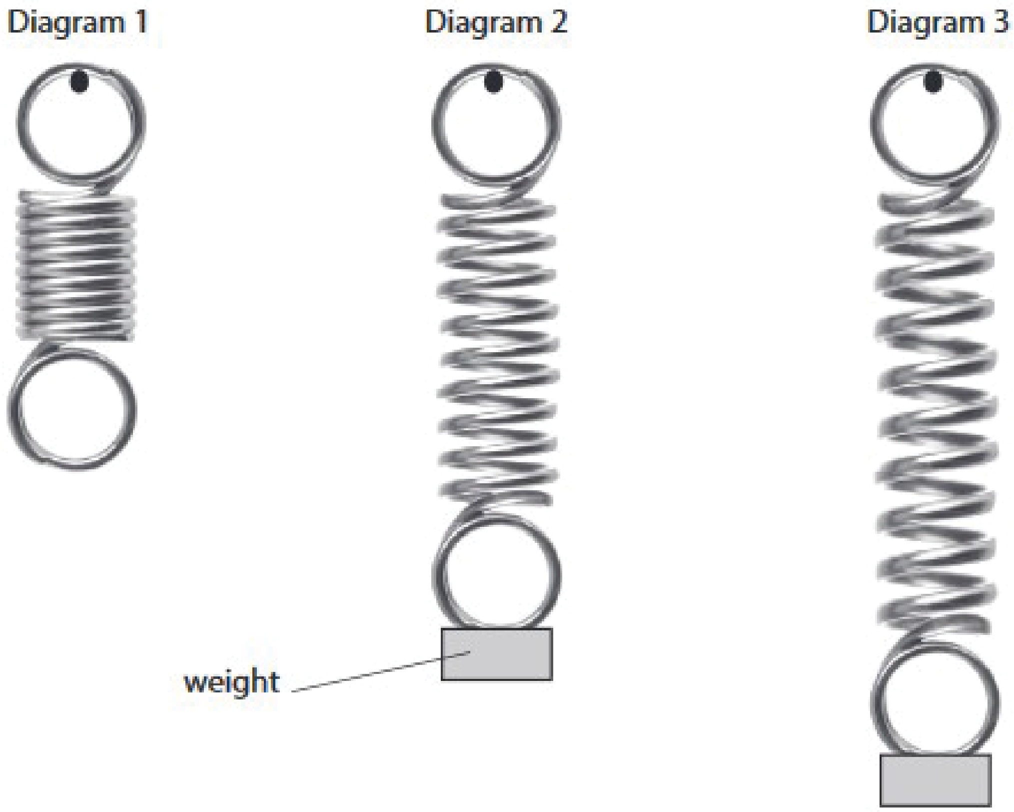
[2 marks]

Energy = ______________ J

6.

(a) The diagrams show a spring hanging from a nail.

- In Diagram 1 there is no weight on the spring.
- Diagram 2 shows the spring after a weight is added.
- Diagram 3 shows the spring after the weight has been pulled down slightly.



(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

When held stationary as in Diagram 3,

(1)

☐ **A** the spring has zero elastic potential energy

☐ **B** the weight has equal amounts of elastic potential and kinetic energy

☐ **C** the weight has more kinetic energy than gravitational potential energy

☐ **D** the spring has more elastic potential energy than the weight has kinetic energy

(ii) The spring is stretched from the position shown in Diagram 2 to the position shown in Diagram 3.
The spring is then released.
Describe the energy changes that take place until the spring stops vibrating.

(3)

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7.

An athlete of mass 64 kg is bouncing up and down on a trampoline.

At one moment, the athlete is stationary on the stretched surface of the trampoline. Fig. 3.1 shows the athlete at this moment.

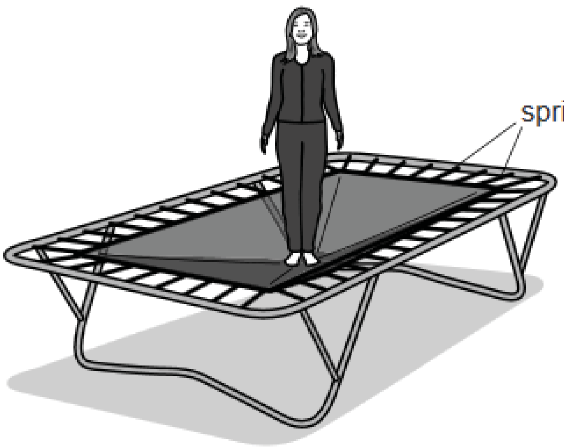

Fig. 3.1

(a) State the form of energy stored due to the stretching of the surface of the trampoline.

....[1]

(b) The stretched surface of the trampoline begins to contract. The athlete is pushed vertically upwards and she accelerates. At time *t*, when her upwards velocity is 6.0 m/s, she loses contact with the surface.

(i) Calculate her kinetic energy at time *t*.

kinetic energy = ...[2]

(ii) Calculate the maximum possible distance she can travel upwards after time *t*.

maximum distance = ...[3]

(iii) In practice, she travels upwards through a slightly smaller distance than the distance calculated in **(ii)**.

Suggest why this is so.

....

....[1]

(c) The trampoline springs are tested. An extension-load graph is plotted for one spring. Fig. 3.2 is the graph.

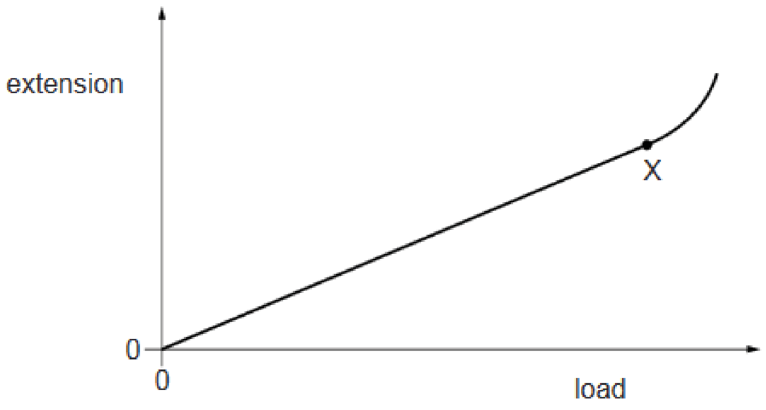

Fig. 3.2

(i) State the name of the point X.

....[1]

(ii) State the name of the law that the spring obeys between the origin of the graph and point X.

....[1]

[Total: 9]