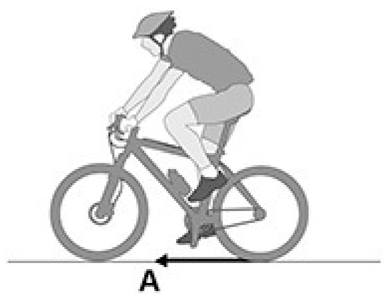
Questions are for both separate science and combined science students unless indicated in the question

1. **Figure 1** shows a cyclist riding a bicycle.

Force **A** causes the bicycle to accelerate forwards.

Figure 1



(a) What name is given to force **A**?

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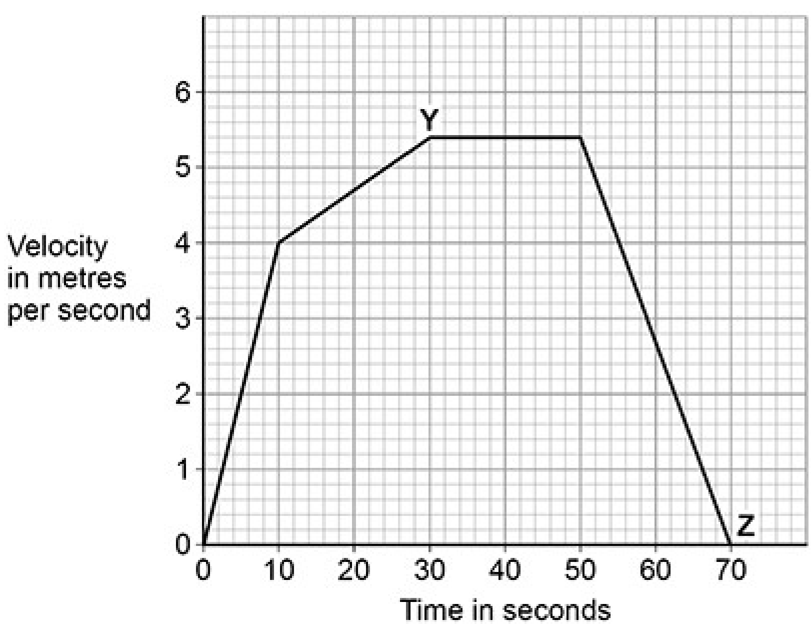
(1)

Figure 2 shows how the velocity of the cyclist changes during a short journey.

Figure 2



(b) Determine the distance travelled by the cyclist between **Y** and **Z**.

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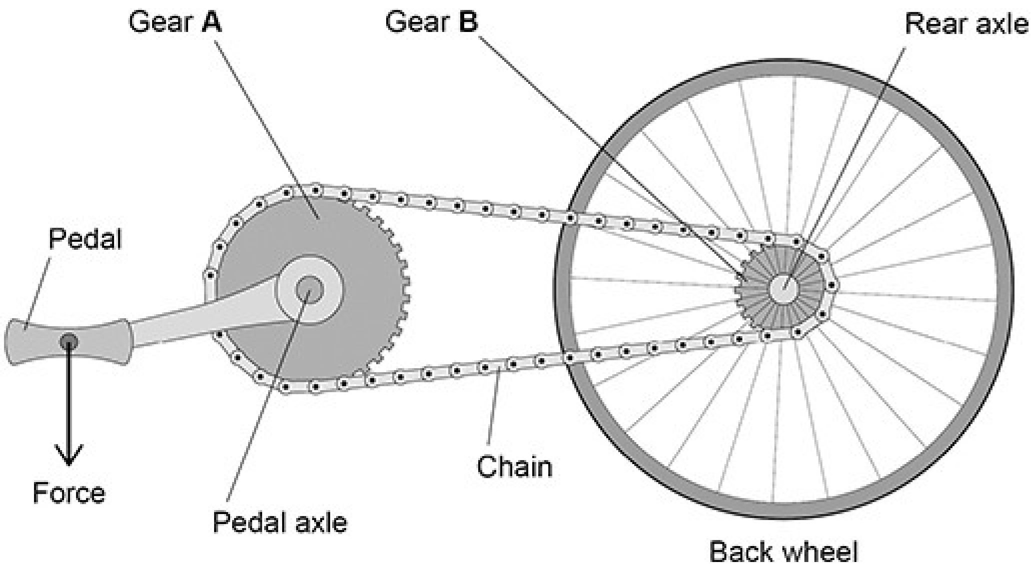
Distance travelled by the cyclist between **Y** and **Z** = ____________ m

(3)

(c) **Figure 3** shows the gears on the bicycle.

Figure 3



Describe how the force on the pedal causes a moment about the rear axle. (separate only)

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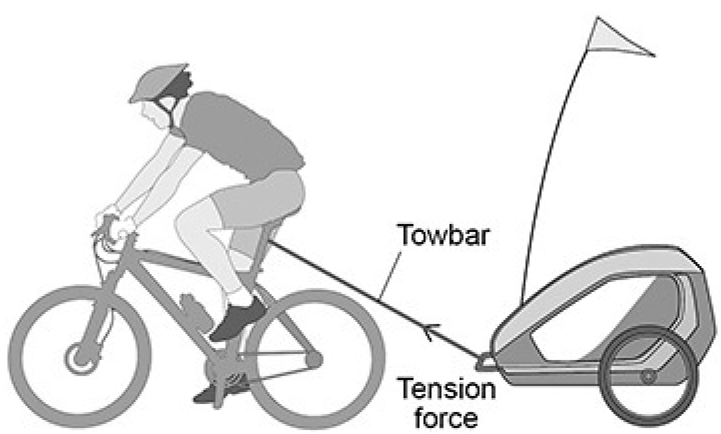
____ **(2)**

Figure 4 shows a different cyclist towing a trailer.

Figure 4



(d) The speed of the cyclist and trailer increased uniformly from 0 m/s to 2.4 m/s.

The cyclist travelled 0.018 km while accelerating. Calculate the initial acceleration of the cyclist.

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Acceleration = _______________ m/s2

(3)

(e) The resultant force of the towbar on the trailer has a horizontal component and a vertical component.

horizontal force = 200 N

vertical force = 75 N

Determine the magnitude and direction of the resultant force of the towbar on the trailer by drawing a vector diagram.

Magnitude of force = _______________ N

Direction of force = ________ degrees

(4)

(Total 13 marks)

2. The image below shows two ice hockey players moving towards each other.

They collide and then move off together.

Before the collision

Player A
Mass = 78 kg
Velocity = +7.5 m/s

Player B
Mass = 91 kg
Velocity = –5.5 m/s

During the collision, the total momentum of the players is conserved.

(a) What is meant by 'momentum is conserved'?

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(1)

(b) Immediately after the collision the two players move together to the right.

Calculate the velocity of the two players immediately after the collision. (separate only)

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Velocity = _______________ m/s

(4)

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(c) The ice hockey players wear protective pads filled with foam.

Explain how the protective pads help to reduce injury when the players collide. (separate only)

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(3)

(Total 8 marks)

3. (a) An adult of mass 80 kg has more inertia than a child of mass 40 kg

What is inertia?

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(1)

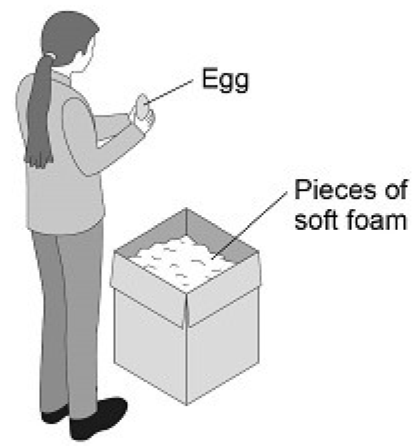
(b) A teacher demonstrated the idea of a safety surface.

She dropped a raw egg into a box filled with pieces of soft foam.

The egg did not break.

Figure 1 shows the demonstration.

Figure 1



Explain why the egg is less likely to break when dropped onto soft foam rather than onto a concrete floor. (separate only)

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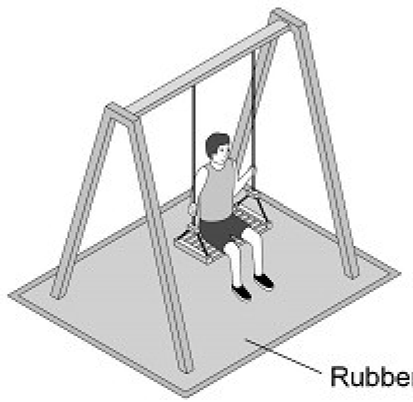
(3)

(c) **Figure 2** shows a child on a playground swing. The playground has a rubber safety surface.

Figure 2



A child of mass 32 kg jumped from the swing.

When the child reached the ground she took 180 milliseconds to slow down and stop.

During this time an average force of 800 N was exerted on her by the ground.

Calculate the velocity of the child when she first touched the ground.

Use the Physics Equations Sheet. (separate only)

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Velocity = ______________________________ m/s

(4)

(Total 8 marks)

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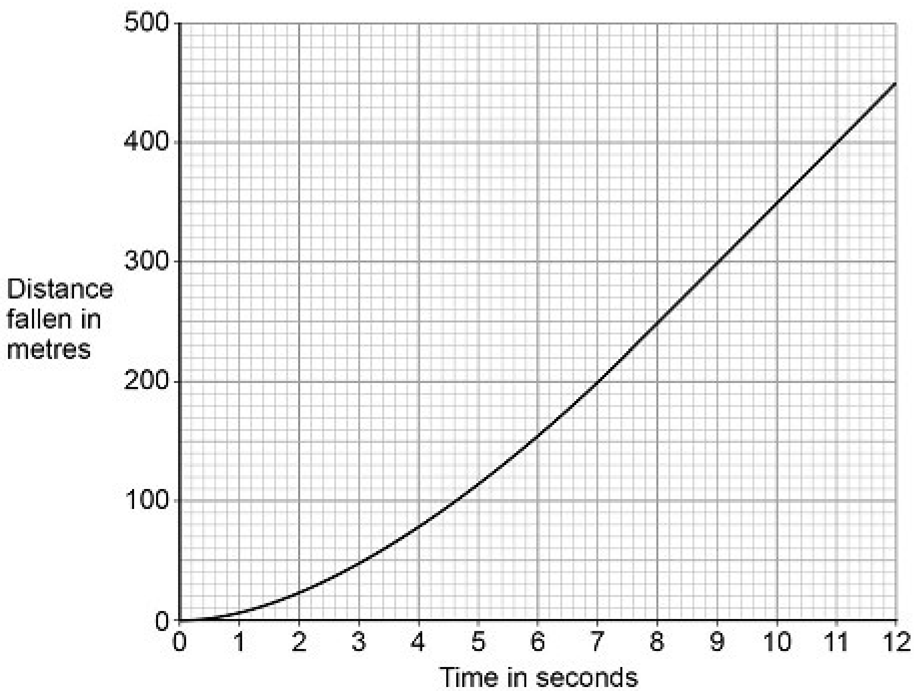
4. An aeroplane is 4000 m above the Earth's surface.

A skydiver jumps from the aeroplane and falls vertically.

Figure 1 shows the distance the skydiver falls during the first 12 seconds after jumping.

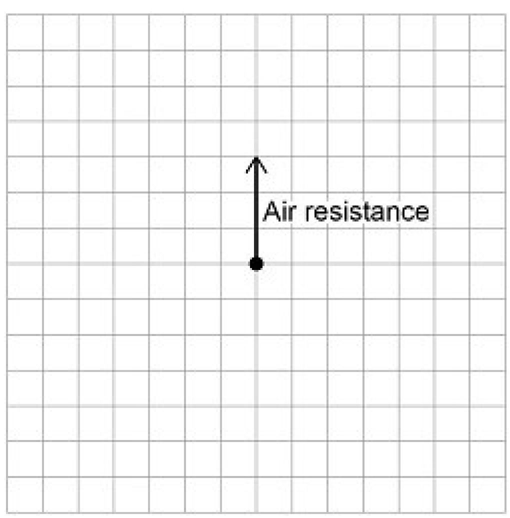
Figure 1



(a) **Figure 2** shows part of the free body diagram for the skydiver three seconds after jumping.

Complete the free body diagram for the skydiver.

Figure 2



(2)

(b) Explain the changing motion of the skydiver in terms of the forces acting on the skydiver.

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(4)

(c) Use **Figure 1** to determine the speed of the skydiver between 7 seconds and 12 seconds.

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Speed = ___________________________ m/s

(3)

(d) In 2012 a skydiver jumped from a helium balloon 39 000 metres above the Earth's surface.

The skydiver reached a maximum speed of 377 m/s Jumping from 39 000 metres allowed

the skydiver to reach a much higher speed than a skydiver jumping from 4000 metres.
Explain why.

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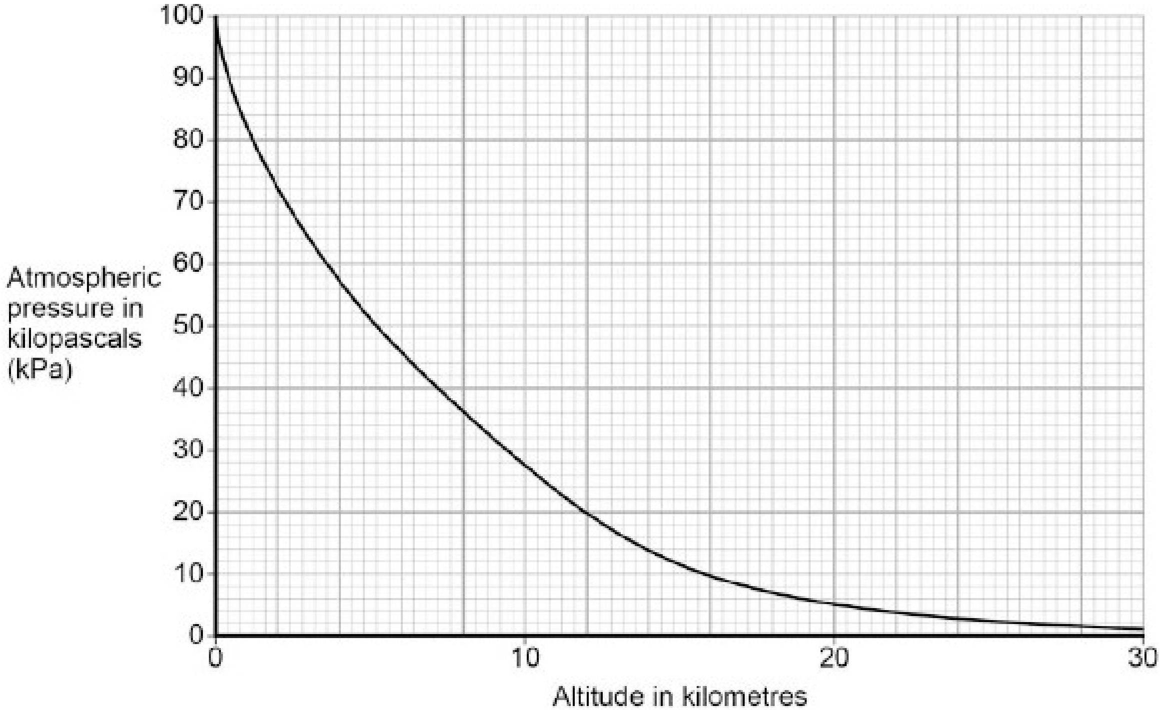
(3)
(Total 12 marks)

5. **Figure 1** shows how atmospheric pressure varies with altitude.

Figure 1



(a) Explain why atmospheric pressure decreases with increasing altitude. (separate only)

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(3)

(b) When flying, the pressure inside the cabin of an aircraft is kept at 70 kPa. The aircraft window has an area of 810 cm2.

Use data from **Figure 1** to calculate the resultant force acting on an aircraft window when the aircraft is flying at an altitude of 12 km.
Give your answer to two significant figures

(separate only)

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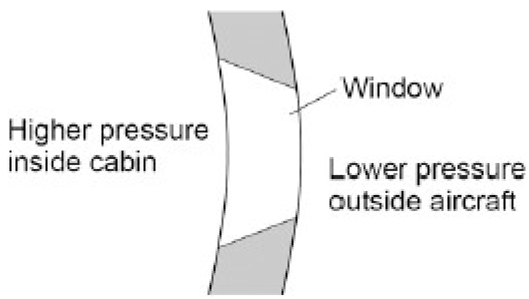
Resultant force = ___________________ N

(5)

(c) **Figure 2** shows the cross-section of one type of aircraft window.

Figure 2



Explain why the window has been designed to have this shape. (separate only)

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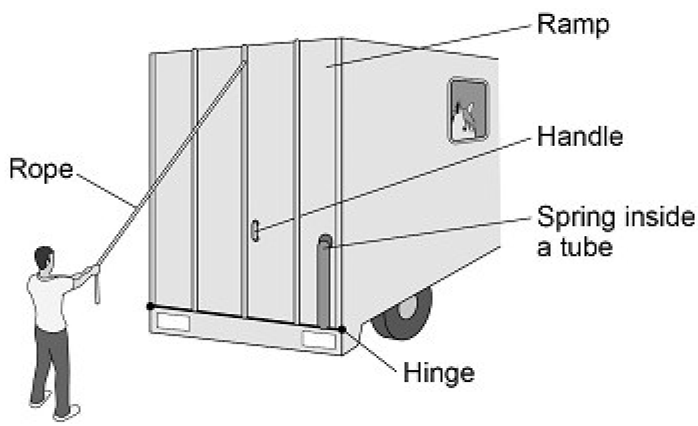
(2)
(Total 10 marks)

6. **Figure 1** shows the back of a lorry. The lorry is used to carry horses.

Figure 1



The ramp is lowered by pulling on the rope or by pulling on the handle.

The hinge acts as a pivot.

(a) Explain why it is easier to lower the ramp by pulling on the rope rather than pulling on the handle.(separate only)

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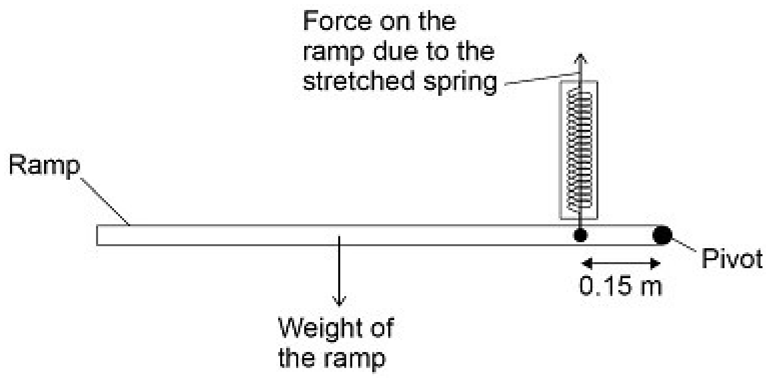
(2)

When the ramp is lowered, work is done to stretch a spring on the side of the ramp. Elastic potential energy is stored in the stretched spring.

Figure 2 shows the ramp part way down in a balanced horizontal position.

Figure 2



(b) With the ramp horizontal:

the moment caused by the weight of the ramp = 924 Nm

the spring is stretched by 0.250 m

Calculate the elastic potential energy stored in the stretched spring.

Use data from **Figure 2**. (separate only)

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Elastic potential energy = ___________________________ J

(6)
(Total 8 marks)

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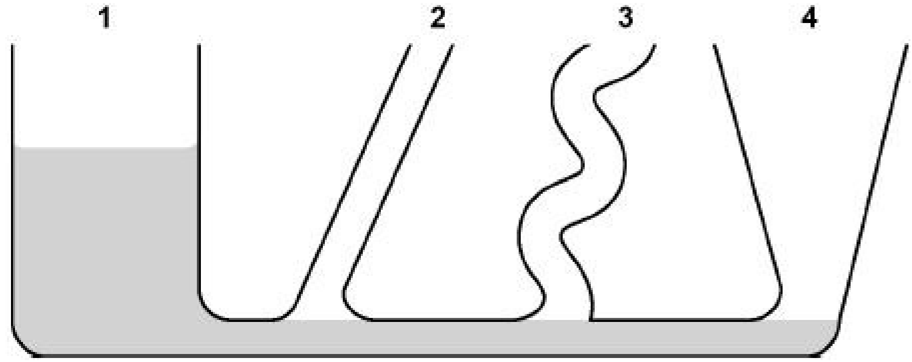
7. The diagram below shows an unusually shaped container.

The container has four vertical tubes of different shape and size.



Water is poured into the container up to the level shown in tube **1**.

(a) Complete the diagram above to show the height of the water in tubes **2**, **3** and **4**. (separate only)

(1)

(b) The further a swimmer dives below the surface of the sea, the greater the pressure on the swimmer.

Explain why.(separate only)

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(2)

(c) A person swims from a depth of 0.50 m to a depth of 1.70 m below the surface of the sea.

density of the sea water = 1030 kg/m3

gravitational field strength = 9.8 N/kg

Calculate the increase in pressure on the swimmer.

Give the unit.

Use an equation from the Physics Equation Sheet. (separate only)

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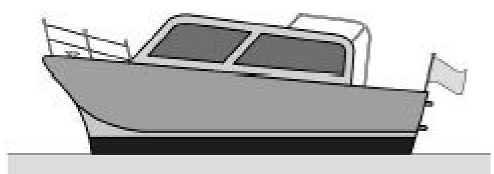
Increase in pressure = ____________________ Unit ___________

(4)

(Total 7 marks)

8. **Figure 1** shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2

(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**. gravitational field strength = 9.8 N/kg Give your answer to **two** significant figures.

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Mass = ______________________ kg

(4)

(c) When the boat propeller pushes water backwards, the boat moves forwards.

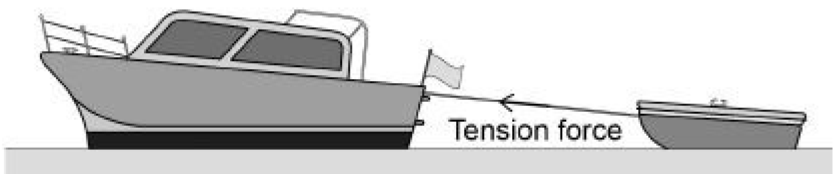
The force on the water causes an equal and opposite force to act on the boat.

Which law is this an example of?

____ **(1)**

(d) **Figure 3** shows the boat towing a small dinghy.

Figure 3



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

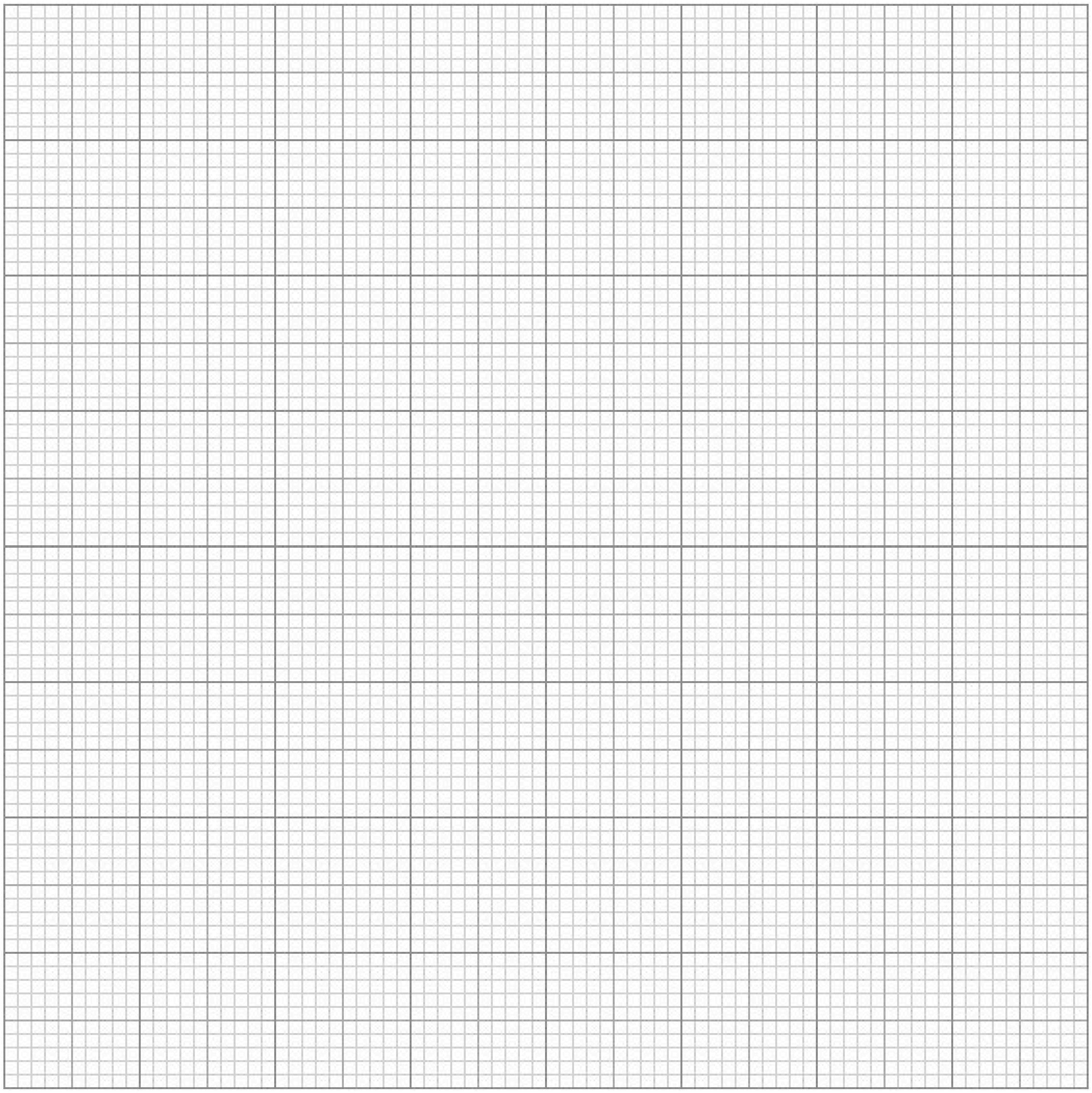
horizontal force forwards = 150 N

vertical force upwards = 50 N

Figure 4 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Figure 4



Magnitude of the tension force in the tow rope = ______________________ N

Direction of the force on the dinghy caused by the tension force in the tow rope = ________________________

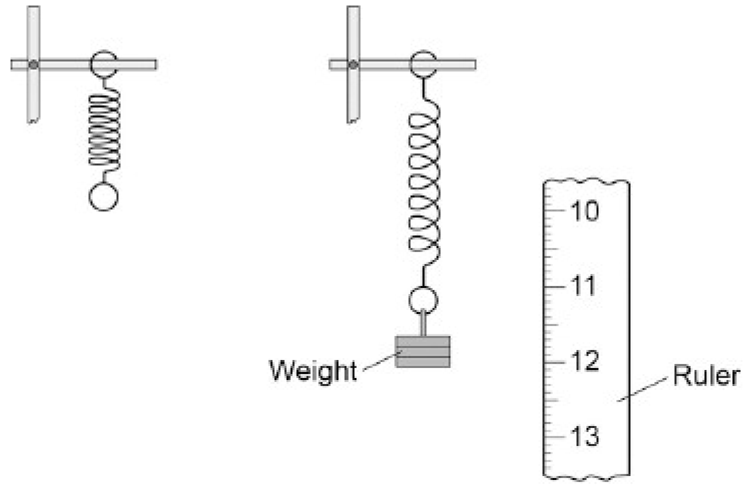
(4)

(Total 11 marks)

9. A student suspended a spring from a laboratory stand and then hung a weight from the spring.

Figure 1 shows the spring before and after the weight is added.

Figure 1



(a) Measure the extension of the spring shown in **Figure 1**.

Extension = ________________________ mm

(1)

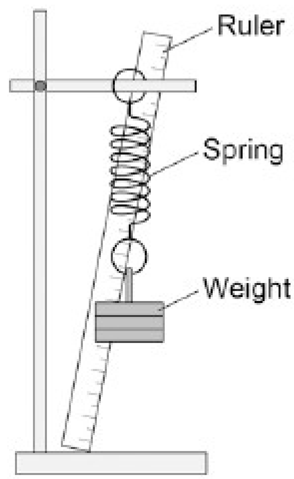
(b) The student used the spring, a set of weights and a ruler to investigate how the extension of the spring depended on the weight hanging from the spring.

Before starting the investigation the student wrote the following prediction:

The extension of the spring will be directly proportional to the weight hanging from the spring.

Figure 2 shows how the student arranged the apparatus.

Figure 2



Before taking any measurements, the student adjusted the ruler to make it vertical.

Explain why adjusting the ruler was important.

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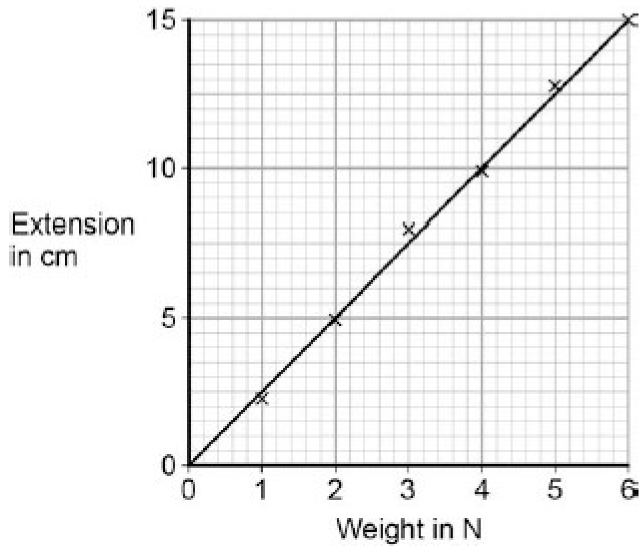
(2)

(c) The student measured the extension of the spring using a range of weights.

The student's data is shown plotted as a graph in **Figure 3**.

Figure 3



What range of weight did the student use?

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(1)

(d) Why does the data plotted in **Figure 3** support the student's prediction?

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(1)

(e) Describe **one** technique that you could have used to improve the accuracy of the measurements taken by the student.

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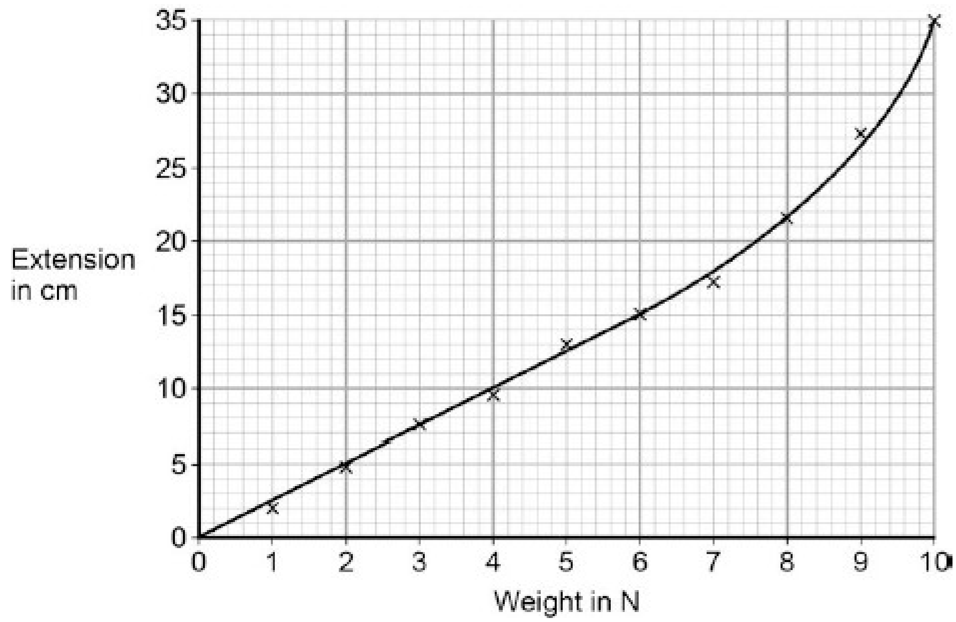
(2)

(f) The student continued the investigation by increasing the range of weights added to the spring.

All of the data is shown plotted as a graph in **Figure 4**.

Figure 4



At the end of the investigation, all of the weights were removed from the spring.

What can you conclude from **Figure 4** about the deformation of the spring?

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Give the reason for your conclusion.

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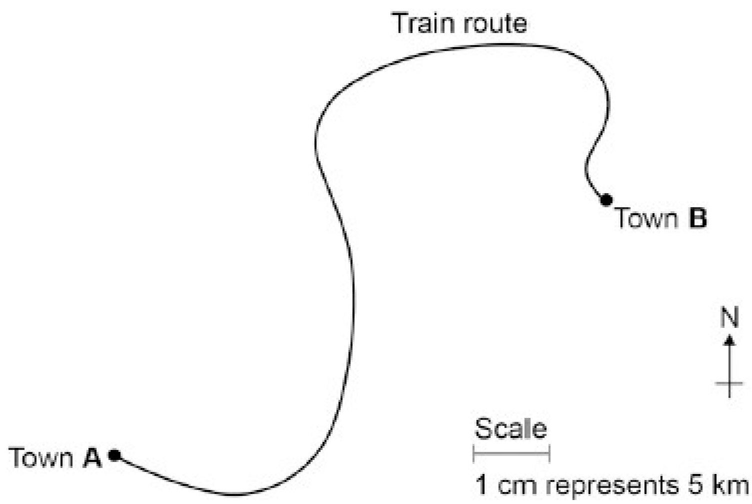
(2)
(Total 9 marks)

10. A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

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(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

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Displacement = ____________________ km

Direction = __________________________

(2)

(c) There are places on the journey where the train accelerates without changing speed.

Explain how this can happen.

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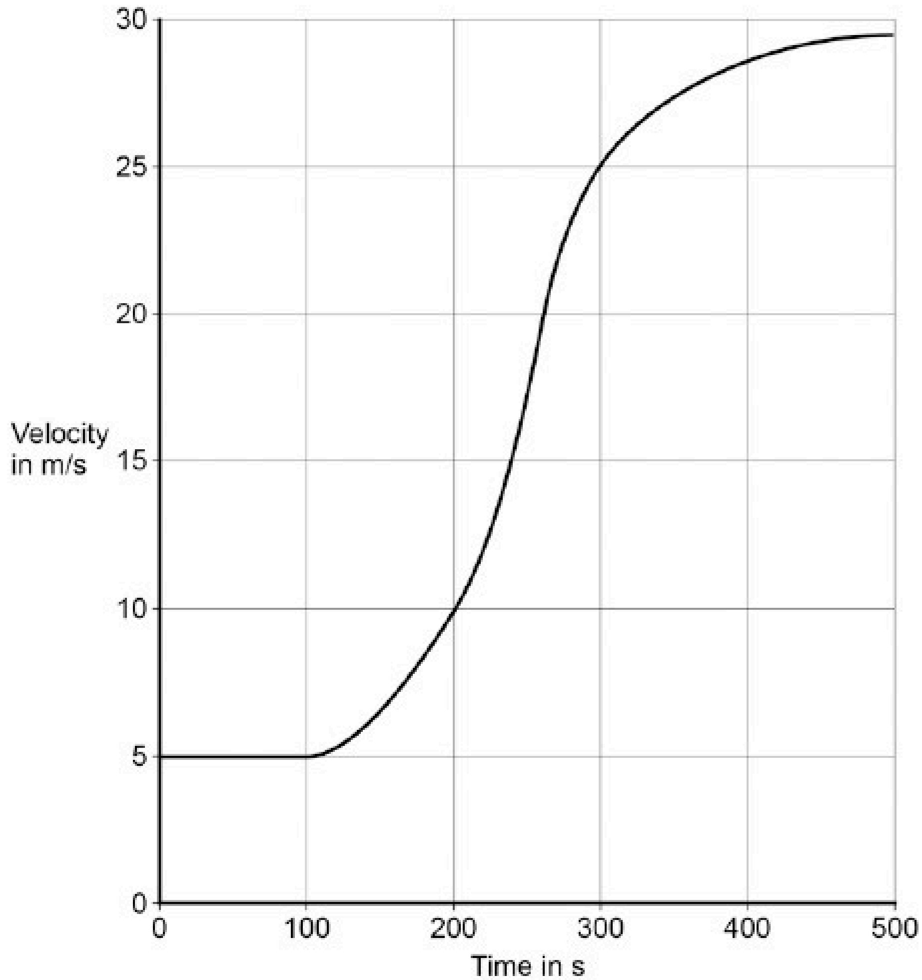
(2)

(d) **Figure 2** shows how the velocity of the train changes with time as the train travels along a straight section of the journey.

Figure 2



Estimate the distance travelled by the train along the section of the journey shown in **Figure 2**.

To gain full marks you must show how you worked out your answer.

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Distance = ___________________________ m

(3)

(Total 8 marks)

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11. The stopping distance of a car is the sum of the thinking distance and the braking distance.

The table below shows how the thinking distance and braking distance vary with speed.

Speed in m/s	**Thinking distance in m**	**Braking distance in m**
10	6	6.0
15	9	13.5
20	12	24.0
25	15	37.5
30	18	54.0

(a) What is meant by the braking distance of a vehicle?

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____ **(1)**

(b) The data in the table above refers to a car in good mechanical condition driven by an alert driver.

Explain why the stopping distance of the car increases if the driver is very tired.

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(2)

(c) A student looks at the data in the table above and writes the following:

thinking distance $\propto$ speed

braking distance $\propto$ speed

Explain whether the student is correct.

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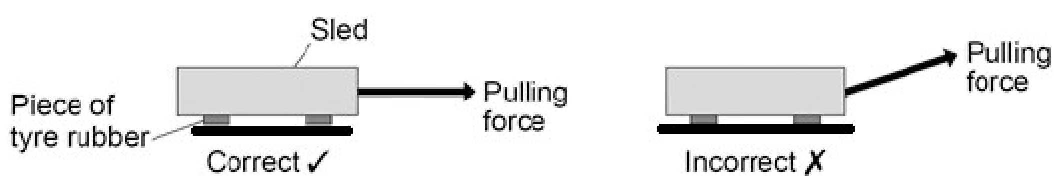
(2)

(d) Applying the brakes with too much force can cause a car to skid.

The distance a car skids before stopping depends on the friction between the road surface and the car tyres and also the speed of the car.
Friction can be investigated by pulling a device called a 'sled' across a surface at constant speed.
The figure below shows a sled being pulled correctly and incorrectly across a surface.

The constant of friction for the surface is calculated from the value of the force pulling the sled and the weight of the sled.



Why is it important that the sled is pulled at a constant speed?

Tick **one** box.

If the sled accelerates it will be difficult to control. ☐

If the sled accelerates the value for the constant of friction will be wrong. ☐

If the sled accelerates the normal contact force will change. ☐

(1)

(e) If the sled is pulled at an angle to the surface the value calculated for the constant of friction would not be appropriate.

Explain why.

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____ **(2)**

(f) By measuring the length of the skid marks, an accident investigator determines that the distance a car travelled between the brakes being applied and stopping was 22 m.

The investigator used a sled to determine the friction. The investigator then calculated that the car decelerated at 7.2 m/s2.

Calculate the speed of the car just before the brakes were applied.

Give your answer to two significant figures.

Use the correct equation from the Physics Equation Sheet.

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Speed = ___________________________ m/s

(3)

(Total 11 marks)