Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

A student used steel ball bearings falling through a viscous liquid to investigate the relationship between the terminal velocity *v* of a ball bearing and its radius *r*.

The student used ball bearings with different radii.

Describe how the student can make measurements of the ball bearing to determine its radius.

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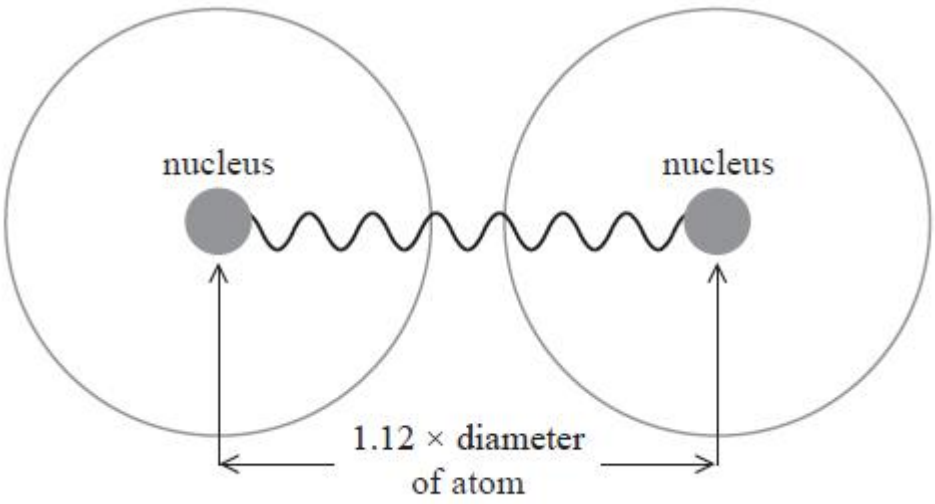
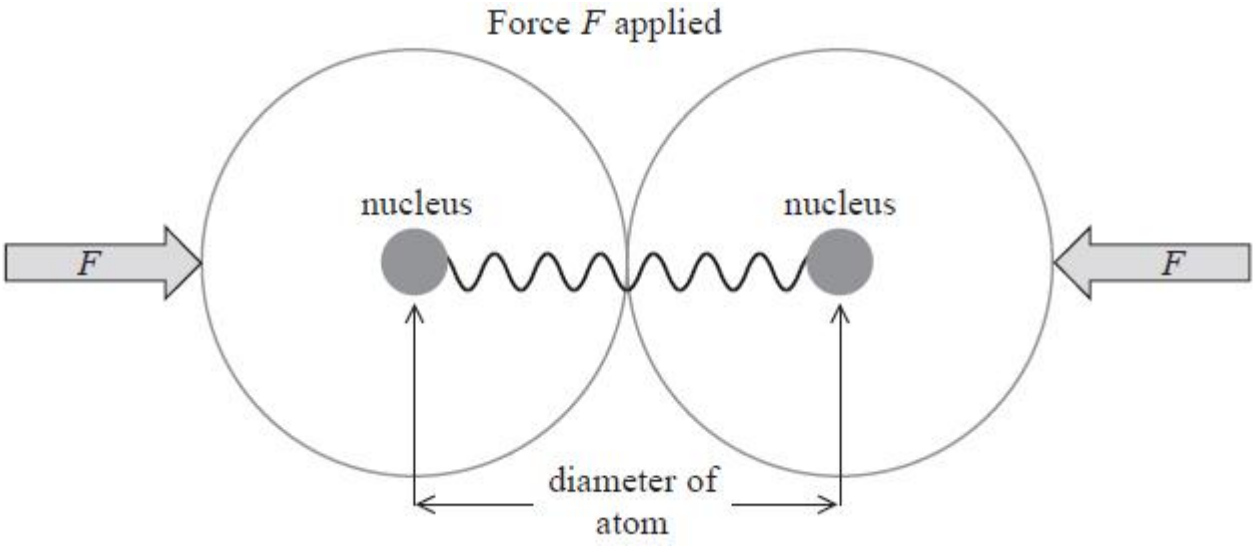
(Total for question = 3 marks)

Q2.

The forces between the two atoms in a molecule of hydrogen can be modelled using a spring. When in equilibrium the nuclei are separated by 1.12 × diameter of the atom.



(a) When the atoms are squashed together by a force *F*, the spring is under compression.



When the force F acts on the atoms, the separation between the nuclei becomes equal to the diameter of the atom.
Calculate the force F.
spring constant for hydrogen = 1130 N m^{-1}
diameter of an atom of hydrogen = 1.06 × 10^{-10} m

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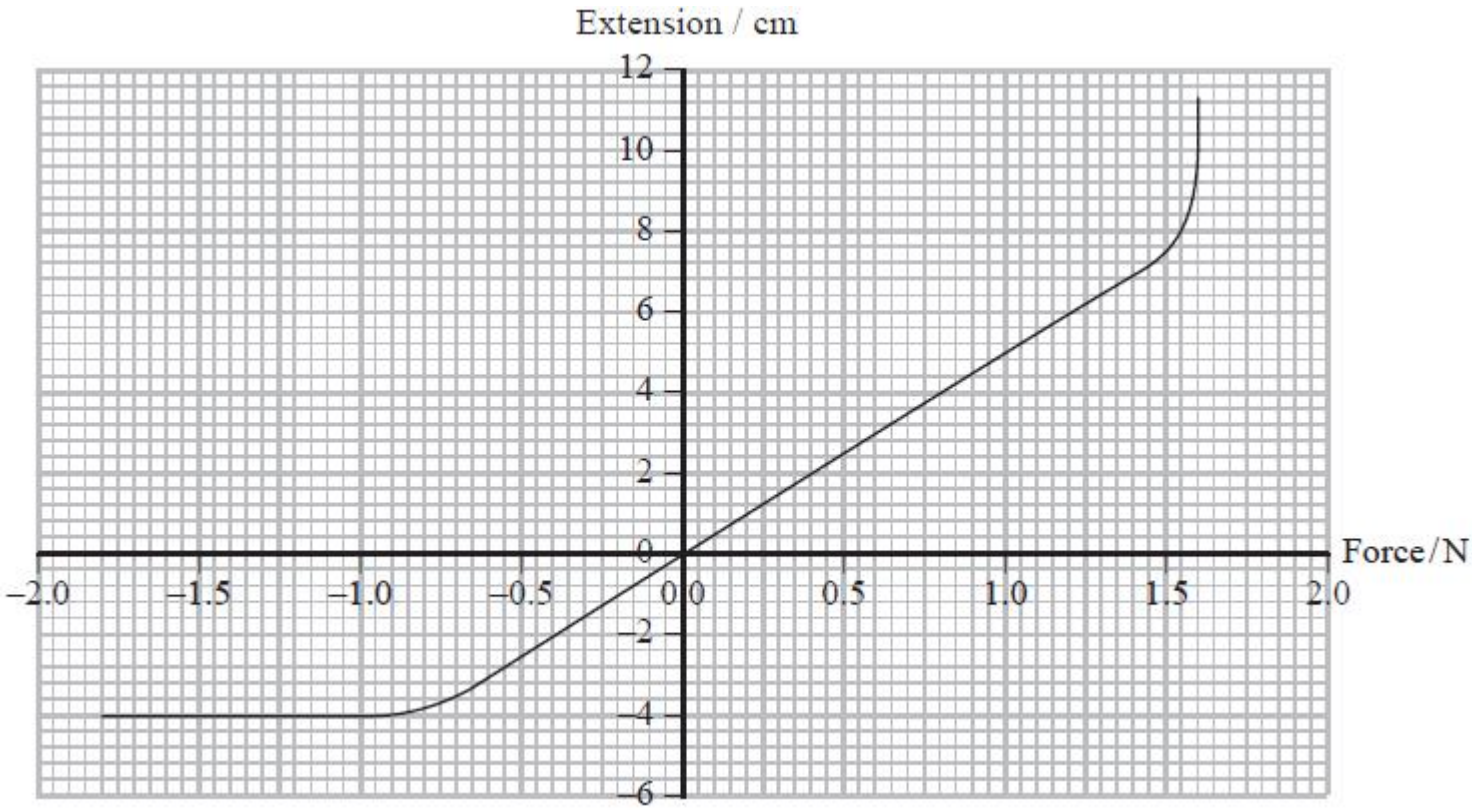
Force = ...

(b) A student carries out an experiment to model the forces between atoms.

A varying force is applied to the end of a spring. The student measures the length of the spring and calculates the extension for each force applied.
The student plots the following graph.



(i) Explain the shape of the graph.

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(ii) Use the graph to calculate the spring constant.

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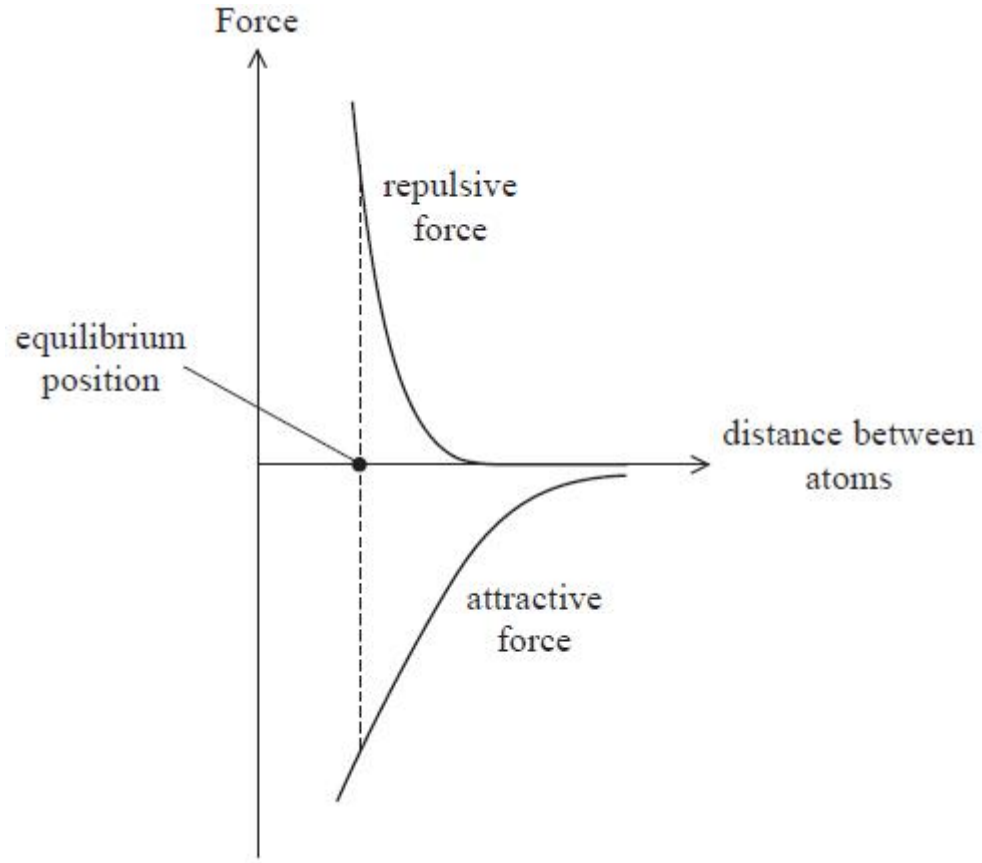
Spring constant = ...

*(c) The graph below shows how the forces acting between two atoms consist of a repulsive force and an attractive force. At the equilibrium position, the sum of these forces is zero.



Use the graph to explain why the forces between atoms are attractive when they are pulled apart and repulsive when pushed together.

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(Total for question = 11 marks)

Q3.

A force meter measures force by making use of Hooke's Law.

The extension of a spring inside the force meter allows the magnitude of the force applied to be read from a scale.

*A beaker of water is placed on a balance and a rock is hung from a force meter as shown in diagram 1.

The initial reading on the balance is *R*, and the initial reading on the force meter is *F*.
The rock is lowered gently into the beaker of water until it is completely submerged.

Diagram not to scale

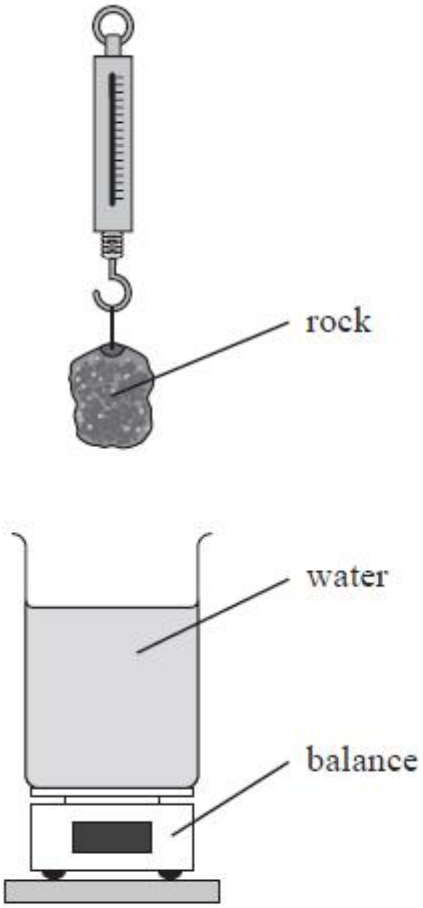

Diagram 1

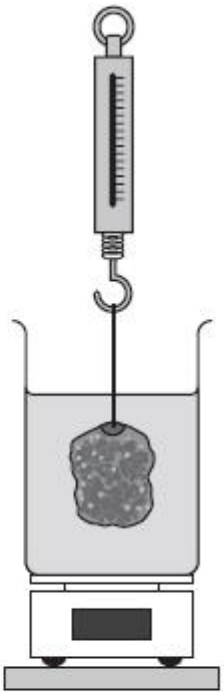

Diagram 2

(Source: adapted from https://passnownow.com/wp-content/uploads/2014/06/upthrust)

Explain any changes in the readings *R* and *F* as the rock is lowered into the water as shown in diagram 2.

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(Total for question = 6 marks)