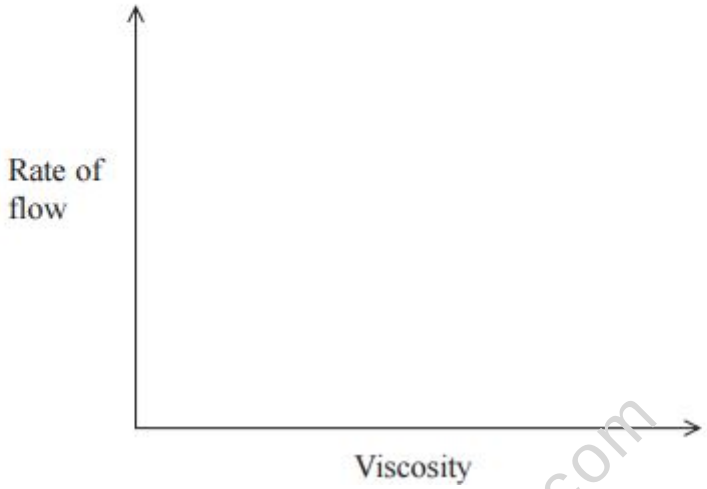
1 The rate of flow of blood through arteries in the human body depends on the viscosity of the blood.

(a) Sketch, on the axes below, a possible graph to show how the rate of flow of blood varies with viscosity.

(1)



(b) When the temperature of the body is reduced, the heart has to do more work in order to pump blood through the arteries.

In terms of viscosity, explain why.

(3)

2 (a) A student investigated the motion of a small sphere falling through oil.

The sphere was released at the top of a cylinder containing oil and measurements were taken to enable the terminal velocity of the sphere to be determined.

Describe the apparatus the student should use and the measurements to be taken. The student does **not** have access to a motion sensor or a data logger. You may include a labelled diagram in your answer.

(5)

3 Magma consists of molten rock and gas and is found beneath the surface of the Earth. During a volcanic eruption the magma rises to the surface and pours through an opening in the Earth's crust. As the magma rises, the pressure decreases and bubbles of gas expand and rise through the magma.

(a) Explain why the bubbles rise faster through the magma as they start to expand.

(3)

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(b) The table shows three types of magma: basaltic, andesitic and rhyolitic.

Magma type	Viscosity
basaltic	low
andesitic	medium
rhyolitic	high

Explain through which magma type the bubbles will rise with the greatest velocity.

(2)

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(c) The magma cools as it reaches the surface of the Earth.

State how cooling affects the magma.

(1)

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4 A table tennis ball is held under water. When the ball is released it rises to the surface of the water.

Explain why.

(3)

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5 The viscosity of paint determines how smoothly and easily the paint can be applied. If the viscosity is too high, the finish will appear bumpy and if the viscosity is too low, the paint will run.

Paint viscosity too high

Paint viscosity too low

(a) State what is meant by viscosity.

(1)

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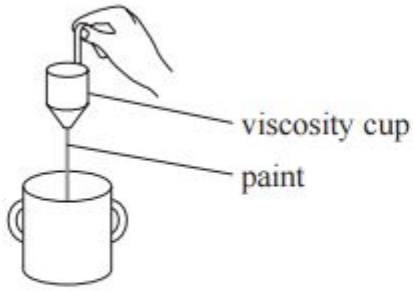
(b) Before paint is applied, its viscosity can be checked using a viscosity cup. A viscosity cup has a small hole at the bottom for the paint to drain through.



The cup is filled with the paint to a fixed level and the time for the paint to drain from the bottom of the cup is measured. The time to drain the cup can then be converted to a viscosity using a table supplied by the paint manufacturer.

(i) Explain why this method can be used to determine the viscosity of the paint.

(2)

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(ii) The time taken for the paint to drain from the cup was 17 s. The following day the same paint took 24 s to drain from the cup.

Suggest why the times were different.

(1)

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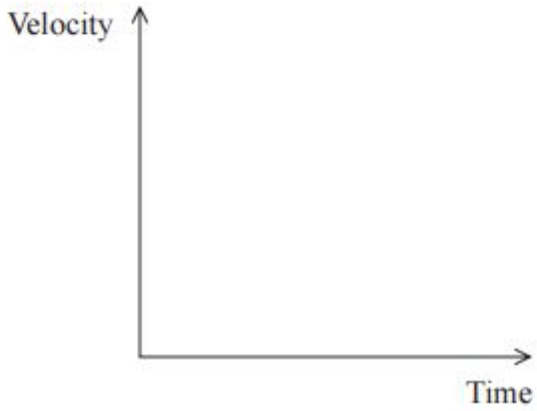
6 Raindrops reach terminal velocity within a few metres of starting to fall.

(a) (i) On the axes below, sketch a velocity-time graph for the motion of a raindrop.

(2)



(ii) Explain why terminal velocity is reached.

(3)

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(iii) Suggest why the upthrust acting on a raindrop is often considered to be negligible.

(1)

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(b) After reaching terminal velocity, a raindrop took 2.6 minutes to fall 1100 m to the ground.

(i) Calculate the terminal velocity of the raindrop.

(2)

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Terminal velocity = ...

(ii) Calculate the radius of the raindrop. You may assume that Stokes' law applies to the raindrop.

viscosity of air = 1.8×10^{-5} Pa s
density of water = 1.0×10^{3} kg m^{-3}

(3)

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Radius of raindrop = ...

(c) The shape of the raindrop depends on its velocity.

Once at terminal velocity the raindrop is flat at the bottom due to laminar air flow around it and remains curved at the top due to turbulent air flow.

Add to the diagram below to show the air flow around the falling raindrop.

(2)

Direction of motion of raindrop