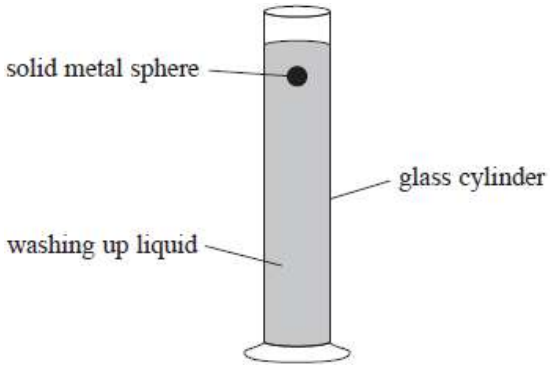
Q1.

A student carried out an experiment to determine the viscosity of washing up liquid using the apparatus shown.



(a) The student released the sphere at the top of the cylinder and made measurements, using a stopwatch and metre rule, so the terminal velocity of the sphere could be determined.

(i) Describe a method that the student could use to determine an accurate value for the terminal velocity of the sphere. You may add to the diagram above.

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(ii) Explain why the use of a larger sphere would increase the percentage uncertainty in the calculated value of the terminal velocity.

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(b) (i) Complete the free-body force diagram for the sphere when travelling at terminal velocity.

(3)

(ii) The student obtained a value of 0.16 m s^{-1} for the terminal velocity of the sphere.

Calculate the viscosity η of the washing up liquid in Pa s.

radius of sphere = 4.8×10^{-3} m
weight of sphere = 3.5×10^{-2} N
density of washing up liquid = 1.1×10^{3} kg m^{-3}

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η = ... Pa s

(Total for question = 16 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A sample of sea water is collected using a beaker. The sample contains some particles of sand which settle at the bottom of the beaker.

Which of the following would result in a decrease in the time taken for the sand to settle?

☐ **A** smaller particles of sand

☐ **B** lower temperature of the sea water

☐ **C** smaller terminal velocity of sand particles

☐ **D** lower viscosity of the sea water

(Total for question = 1 mark)

Q3.

Stokes' law can be used to determine the magnitude of the viscous drag for small, spherical objects moving through a fluid.

(a) State one other condition that must be met in order for Stokes' law to apply to the moving object.

(1)

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(b) A sphere falls through water at a constant speed of 0.50 m s^{-1}.

Assess whether Stokes' law can be applied to the falling sphere.

You should include calculations in your answer.

diameter of ball bearing = 6.0×10^{-3} m
mass of steel ball bearing = 9.1×10^{-4} kg
upthrust on ball bearing = 1.1×10^{-3} N
viscosity of water = 8.9×10^{-4} Pa s

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(Total for question = 6 marks)

Q4.

Stokes' law can be used to determine the frictional force on an object moving through a fluid.

To which of the following would Stokes' law best apply?

☐ **A** A large sphere moving quickly through a fluid.

☐ **B** A large sphere moving slowly through a fluid.

☐ **C** A small sphere moving quickly through a fluid.

☐ **D** A small sphere moving slowly through a fluid.

(Total for question = 1 mark)