Fluid Density, Viscosity & Drag

Question Paper 1

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Materials
Sub Topic	Fluid Density, Viscosity & Drag
Booklet	Question Paper 1

Time Allowed: **50 minutes**

Score: **/41**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A swimmer jumps from a diving platform into a swimming pool. The swimmer is slowed to a stop by friction with the water.

The total work done by the water on the swimmer does **not** depend on

☒ **A** the mass of the swimmer.

☒ **B** the speed of the swimmer on entering the water.

☒ **C** the depth of the swimming pool.

☒ **D** the height of the diving platform.

(Total for Question 1 = 1 mark)

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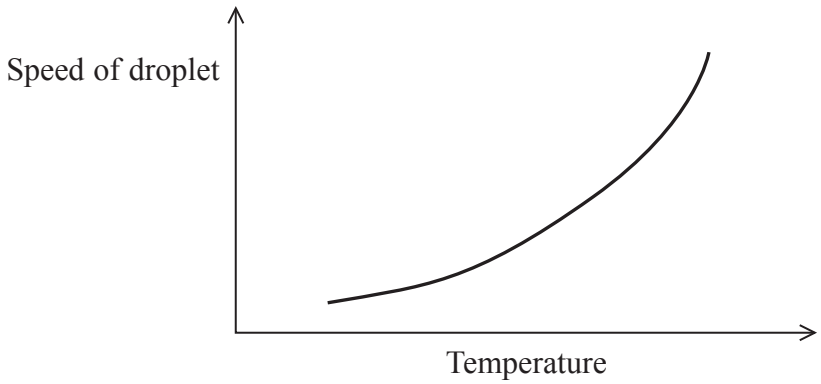
2 A glue dispenser produces small droplets of glue. The glue dispenser contains a small heater.

The graph shows how the speed of a droplet leaving the dispenser varies with the temperature of the glue.



A higher temperature of glue is preferred because

☒ **A** the viscosity will be greater and the glue will flow at a greater speed.

☒ **B** the viscosity will be greater and the glue will flow at a lower speed.

☒ **C** the viscosity will be lower and the glue will flow at a greater speed.

☒ **D** the viscosity will be lower and the glue will flow at a lower speed.

(Total for Question 2 = 1 mark)

3 An object of radius r and mass m falls through air of viscosity η. At terminal velocity v

$$mg = 6\pi\eta rv$$

For this equation to apply which of the following assumptions is **not** correct?

☒ **A** The air flow around the object is laminar.

☒ **B** The object is a small sphere.

☒ **C** The speed of the object is very high.

☒ **D** The upthrust is negligible.

(Total for Question 3 = 1 mark)

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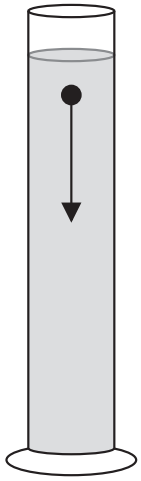
4 In an experiment a small metal ball is dropped into a cylinder of oil. The time taken for the ball to fall to the bottom of the cylinder is recorded.



The experiment is repeated. Which changes to the ball would result in the greatest decrease in the time it takes to reach the bottom of the cylinder?

☒ **A** smaller mass and smaller diameter

☒ **B** smaller mass and greater diameter

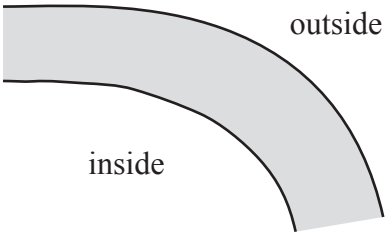
☒ **C** greater mass and smaller diameter

☒ **D** greater mass and greater diameter

(Total for Question 4 = 1 mark)

5 Along a river there are changes in the speed of the water due to natural obstacles such as bends and rocks.

(a) At a bend, the water on the inside of the bend is shallower than the water on the outside of the bend.



Suggest why the speed of the water is lower at the inside of the bend than at the outside of the bend.

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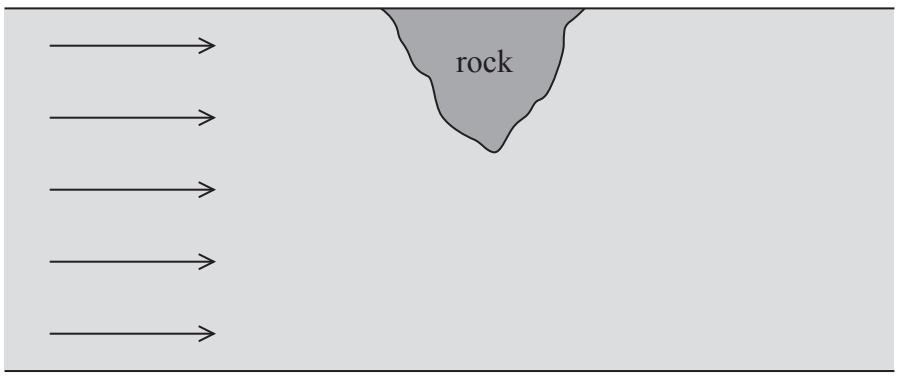
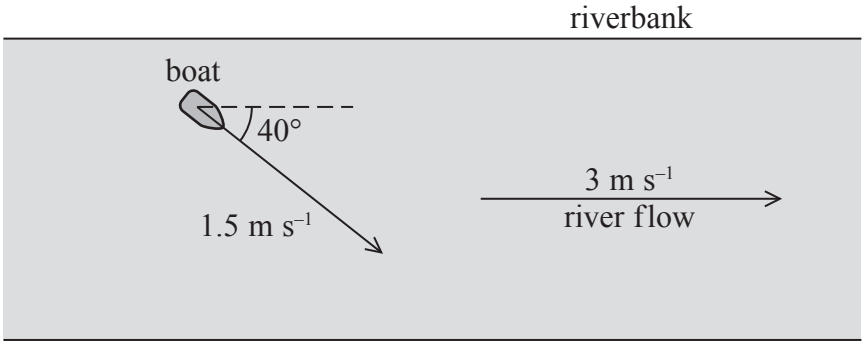
(b) On a straight section of the river, the water becomes very turbulent around a large rock. Complete and label the diagram below to show the flow of the water around the rock.

(2)



(c) The river is flowing at a speed of 3 m s^{-1}. A boat is pointed at an angle of 40° to the riverbank and paddled at a speed of 1.5 m s^{-1}, as shown in the diagram.



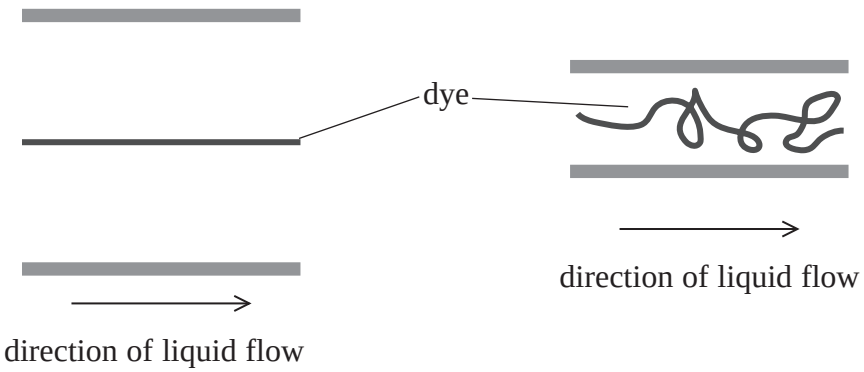
In the space below, draw a vector diagram to scale and use it to determine the magnitude of the actual velocity of the boat.

(3)

Magnitude of actual velocity = ...

(Total for Question 5 = 6 marks)

6 A small drop of dye was injected into the centre of the flow of a liquid moving freely through a pipe. This was repeated for a pipe with a smaller diameter. The dye was seen to take the following paths.



(a) Describe the differences between the flow of the liquid through the large diameter pipe and the smaller diameter pipe.

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(b) Suggest a possible reason, other than the diameter, for the difference in the flow between the two pipes.

(1)

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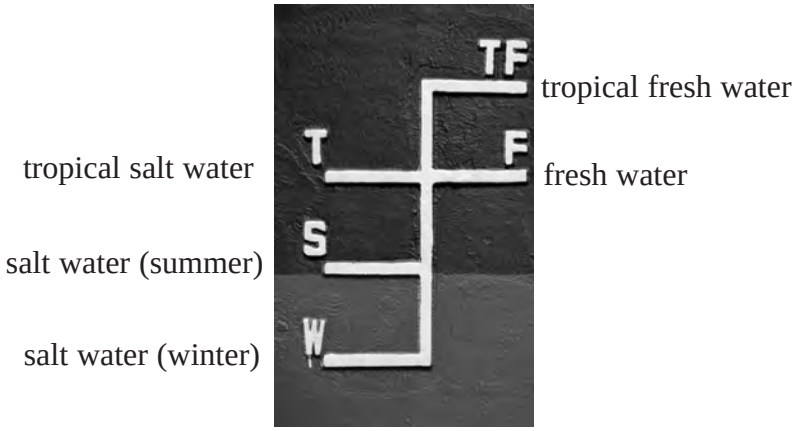
(Total for Question 6 = 4 marks)

7 As a ship is loaded, it moves lower in the water so that the water level rises up the side of the ship. The Plimsoll line, on the side of the ship, shows the maximum depth to which the ship can be immersed when loaded with cargo.

(a) The photograph shows the Plimsoll line markings on a ship.



The maximum loading depth depends upon:

- the ship's dimensions
- the time of year
- water density

(i) Use the idea of upthrust to explain why a ship would be lower in the water when loaded.

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*(ii) Explain why the marking for tropical fresh water is higher up the side of the ship than the marking for tropical salt water.

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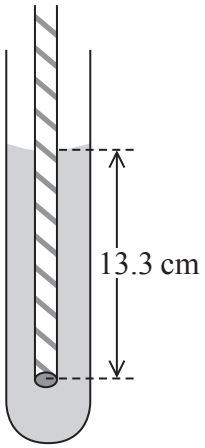
(b) A student devised a simple experiment to demonstrate the change in position of a ship when in water of different salt concentrations.

The student placed a straw, sealed and weighted at the bottom, into a test tube containing distilled water. The length of straw below the surface of the water was then measured.



The straw settled in a position so that the length below the surface of the water was 13.3 cm. The experiment was then repeated using water containing 20% salt.

Calculate the length of straw now below the surface of the water.

density of distilled water = 998 kg m^{-3}
density of distilled water containing 20% salt = 1150 kg m^{-3}

(5)

Length below surface = ...

(Total for Question 7 = 11 marks)

***8** The designer of a new lorry trailer claims it will save 10% on the amount of fuel used compared to a traditional trailer.

The photographs show the airflow around a traditional trailer and around the new trailer.

Traditional trailer

New trailer

Using information from the photographs, explain why the new trailer would use less fuel compared to the traditional trailer.

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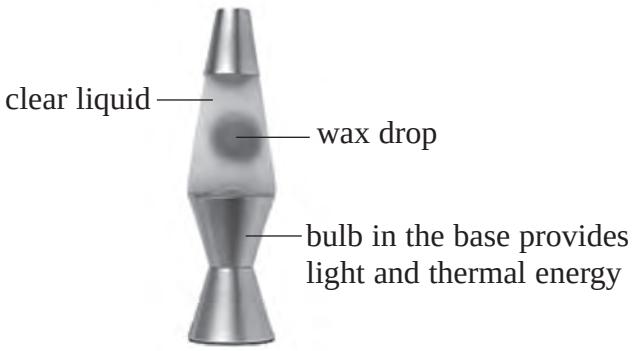
(Total for Question 8 = 4 marks)

9 The photograph shows a 'lava lamp'.



When the lamp is switched on, large drops of liquid wax are seen to rise and then fall within the clear liquid.

(a) As a wax drop is heated it expands, its density decreases and it rises through the clear liquid.

(i) Explain why the wax drop begins to move upwards as it is heated.

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(ii) The wax drop accelerates initially and then reaches a terminal velocity.

Write a word equation for the forces acting on the wax drop when it is moving upwards at its terminal velocity.

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(b) The wax drop is seen to slow down as it reaches the top of the lamp.

Explain this observation.

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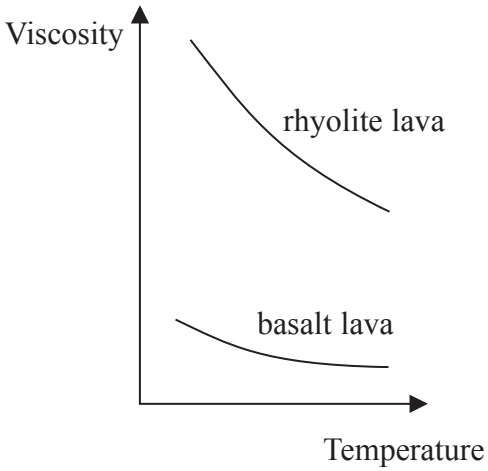
(Total for Question 9 = 8 marks)

***10** Lava is molten rock, which sometimes erupts from beneath the Earth's surface. As the lava cools volcanoes form. The shape of the volcano is determined by the flow rate of the lava. The graph below shows how the viscosities of two types of lava vary with temperature.



The diagrams below shows the shapes of two typical volcanoes.

Both types of lava are at the same temperature as they reach the Earth's surface. The shield volcano is formed from basalt lava and the cone volcano is formed from rhyolite lava. Use the information in the graph to explain the shape of each volcano.

(4)

(Total for Question 10 = 4 marks)