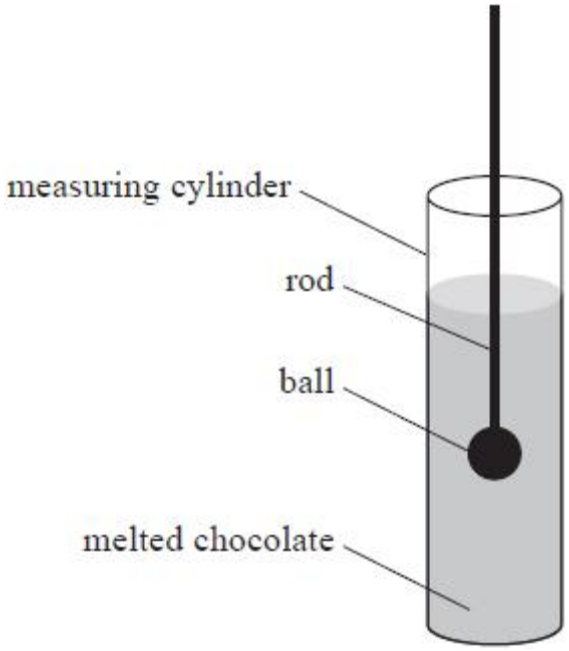
Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

Chocolate is a solid at room temperature, but melts just below body temperature.

A student investigated the viscosity of some melted chocolate using a falling-ball method. Since chocolate is opaque, a thin rod was attached to the ball so that the movement of the ball could be monitored. The apparatus is shown in the diagram.



The chocolate was maintained at a constant temperature during the investigation.

(i) The student used a stopwatch to measure the time *t* for the ball to fall 22.5 cm whilst travelling at its terminal velocity *v*.

Her results are shown in the table.

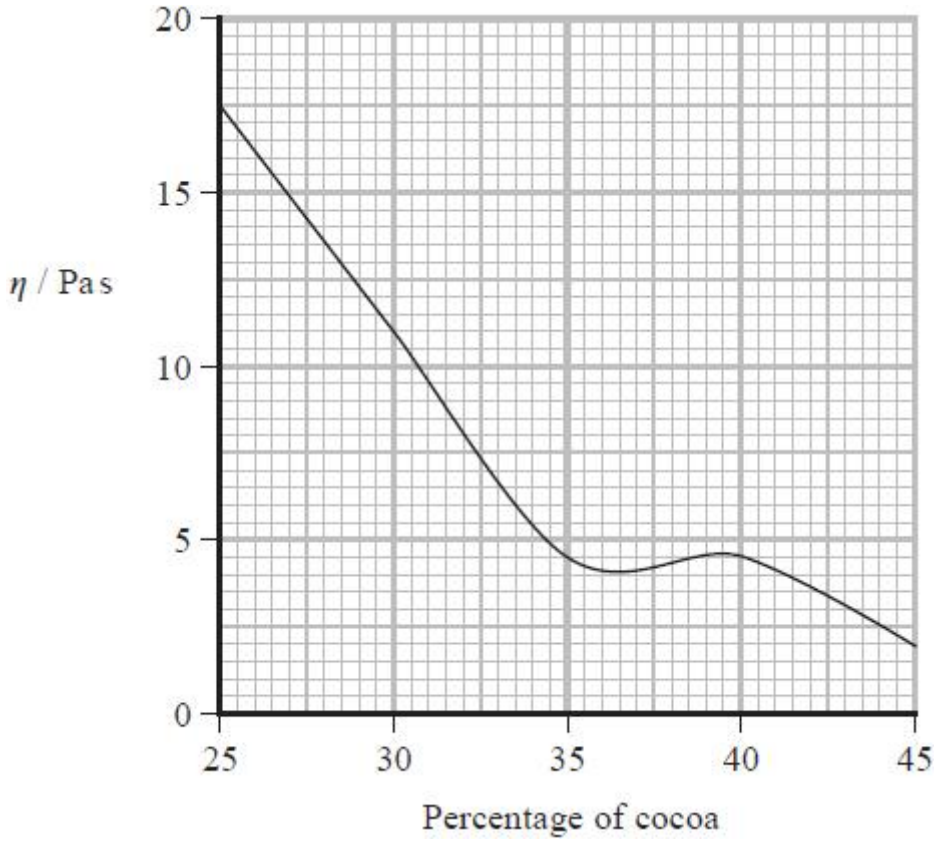
t_1 / s	t_2 / s	t_3 / s
9.6	9.9	9.6

v is given by the formula

$$v = \frac{2r^2 g(\rho_B - \rho_C)}{9\eta}$$

where
r is the radius of the ball
ρ_B is the density of the ball
ρ_C is the density of the chocolate

η is the viscosity of the chocolate.
The graph is taken from a commercial website. It shows how, at the temperature of the experiment, η depends on the percentage of cocoa in the chocolate.



The chocolate wrapper indicated that the chocolate had a 35% cocoa content.
Assess whether the student's timing data supports this percentage cocoa content.
$r = 4.25 \times 10^{-3}$ m
$\rho_B = 7750$ kg m^{-3}
$\rho_C = 1330$ kg m^{-3}

(5)

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(ii) Explain one reason why the student's data may have led to an inaccurate conclusion about the cocoa content.

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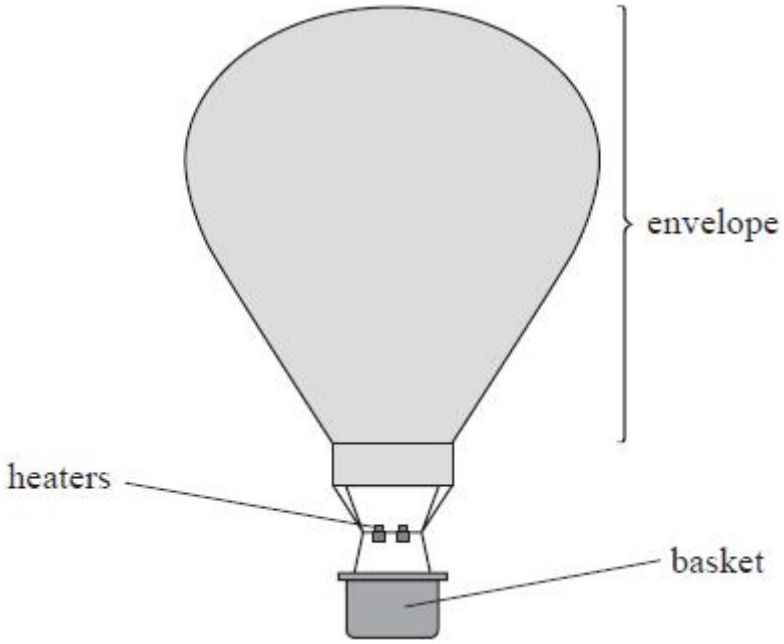
(Total for question = 7 marks)

Q2.

A hot air balloon consists of a fabric envelope, heaters and a basket, as shown.



When the balloon is set up, the envelope is partly filled with air at 20°C. The air is then heated to 120°C and expands to fill the envelope and becomes less dense.

The air pressure inside the envelope is always equal to the air pressure outside the envelope because the envelope is open at the bottom.

The balloon takes off when the upthrust is more than the total weight of the balloon, the air in the envelope and the passengers.

Deduce whether the balloon can take off.

volume of air at 120°C in inflated envelope = 2800 m^3
density of air at 20°C = 1.2 kg m^{-3}
mass of balloon = 380 kg
mass of passengers = 340 kg
upthrust when the envelope is full = 33 000 N

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(Total for question = 6 marks)

Q3.

The student then found a value of μ for a brass wire, using a different method.

(i) He measured the diameter d of the wire using a micrometer.

Explain one technique the student should use when measuring d.

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(ii) The student obtained the following data.

d / mm			
0.55	0.59	0.57	0.58

The stated value of μ for the brass wire used by the student was 2.14×10^{-3} kg m^{-1}.

Deduce whether the student's data supports this value for μ.

density of brass = 8700 kg m^{-3} ± 200 kg m^{-3}

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(Total for question = 8 marks)