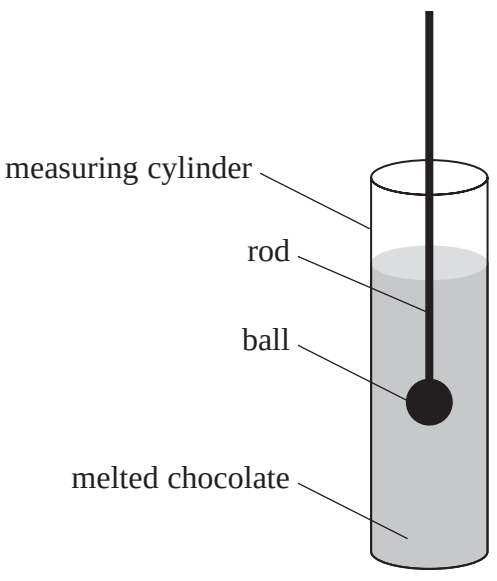
12 Chocolate is a solid at room temperature, but melts just below body temperature.

(a) 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.

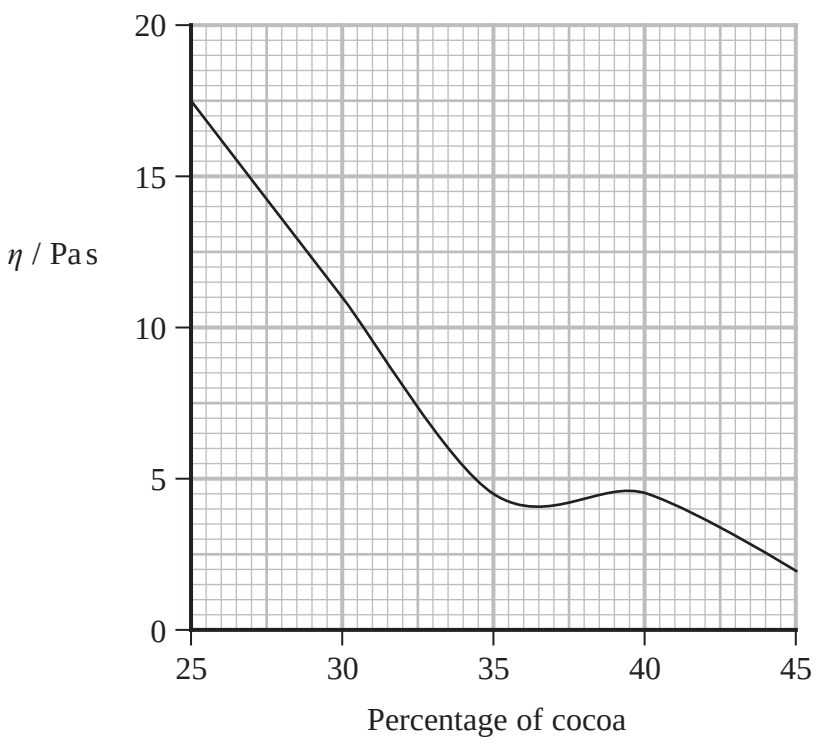
t_1 / s	t_2 / s	t_3 / s
9.6	9.9	9.6

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
$\rho_B = 7750\,\text{kg m}^{-3}$
$\rho_C = 1330\,\text{kg m}^{-3}$

(5)

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

(2)

(b) One type of chocolate melts at a temperature of 32°C.

The energy released when 65 g of this chocolate is digested is 345 kcal.

It is suggested that the energy used to melt a piece of this chocolate is at least 15% of the energy released when the chocolate is digested.

Assess the accuracy of this suggestion.

initial temperature of chocolate = 15°C
specific heat capacity of chocolate = 3.9×10^3 J kg^{-1} K^{-1}
specific latent heat of chocolate = 1.50×10^5 J kg^{-1}
1 kcal = 4200 J

(6)

(Total for Question 12 = 13 marks)