1 A science class is investigating the density of solids. One student has pieces of aluminium and lead of the same size and shape. One of the pieces is shown in Fig. 6.1.

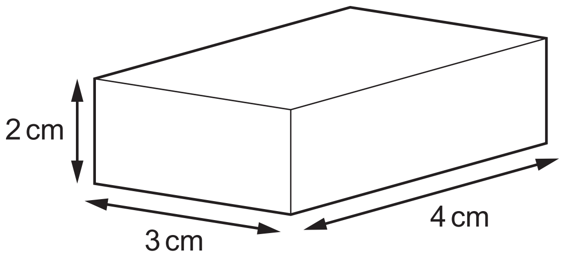


Fig. 6.1

(a) (i) Calculate the volume of this piece of metal.

volume = ... cm^3 [1]

(ii) The student weighs the pieces of metal. Fig. 6.2 shows the balance windows.

Read the scales to the nearest 1 g and record the masses below.

mass of aluminium

mass of lead

Fig. 6.2

mass of aluminium = ... g

mass of lead = ... g [2]

(iii) Find the density of each metal. Use the formula given.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

density of aluminium = ... g/cm^3

density of lead = ... g/cm^3 [2]

(iv) Table 6.1 shows some data about aluminium and lead. The two metals have the same crystal structure.

Table 6.1

metal	atomic size / nm	relative atomic mass
aluminium	0.29	27
lead	0.35	207

Use the data in Table 6.1 to suggest why lead is much denser than aluminium.

....

.... [1]

(b) The student has cut pieces of two types of wood; balsa and pine. The pieces are the same size and shape as shown in Fig. 6.3.

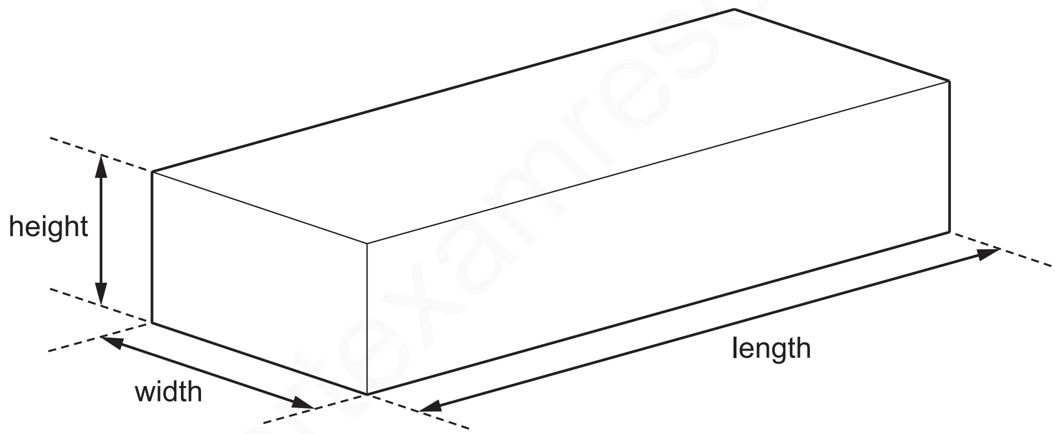


Fig. 6.3

(i) Use a ruler to measure, to the nearest 1 mm, the length, width and height of this piece of wood.

length .... cm

width .... cm

height .... cm [1]

(ii) Table 6.2 shows data collected by the student about the pine wood and balsa wood.

Use your answer to part **(i)** to calculate the volume of the pieces of wood. Record them in Table 6.2.

[1}

Table 6.2

wood	balsa	pine
volume / cm^3		
mass / g	0.77	40.8
density g / cm^3	0.16	0.85

(c) **(i)** The student immerses the pieces of aluminium, lead, balsa wood and pine wood in water and leaves them there for one week.

After one week, he weighs them again.

Both pieces of wood have gained mass. Both metals have the same mass as before.

Suggest a reason for the gain in mass of the pieces of wood.

....

.... [1]

(ii) Wood consists of carbohydrates.

Suggest **one** reason why the density of balsa wood is much less than the density of pine wood.

....

.... [1]

MARKING SCHEME

(a) **(i)** 24 ; [1]

(ii) 65 ;
273 ; [2]

(iii) density of A*l* is: 2.7(083333) (ecf) ;
density of lead is: 11.4 / 11.375 / 11.38 (ecf) ; [2]

(iv) lead atoms are heavier than A*l* atoms ; [1]

(b) **(i)** length = 8.0 cm
width = 3.0 cm
height = 2.0 cm ; [1]

(ii) 48 cm^3 correctly recorded in the table twice ; [1]

(c) **(i)** the wood has absorbed water ; [1]

(ii) there are more air spaces in the balsa wood / balsa wood grows faster so is less dense ; [1]

[Total: 10]

2 A student has been given a plastic cup, shown in Fig. 3.1. He finds the volume of the cup in cm^3 using two different methods, **method 1** and **method 2.**

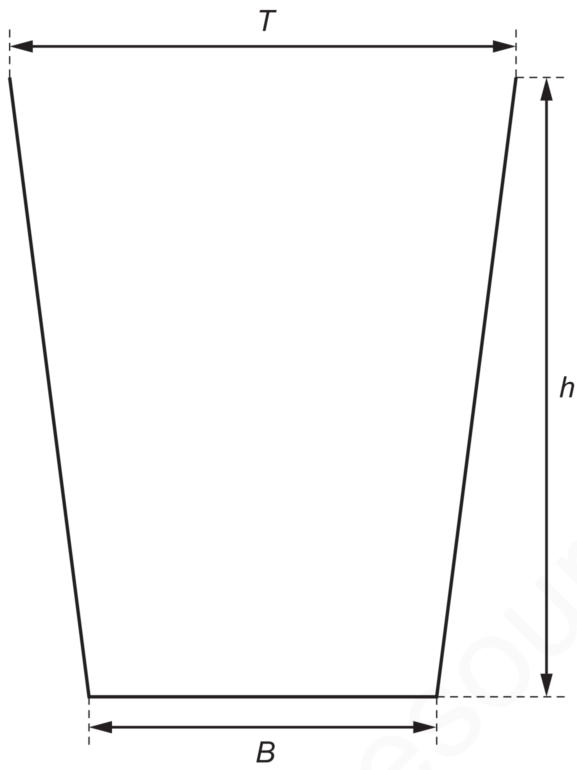


Fig. 3.1

method 1

Fig. 3.1 shows the actual size of the cup. Use a ruler to answer **(a)(i)**, **(ii)** and **(iii)**.

(a) **(i)** Measure *h*, the vertical height of the cup, to the nearest 0.1 cm.

h = ... cm [1]

(ii) Measure *B*, the diameter of the bottom of the cup, to the nearest 0.1 cm.

B = ... cm [1]

(iii) Measure *T*, the diameter of the top of the cup, to the nearest 0.1 cm.

T = ... cm [1]

(iv) Calculate *d*, the average diameter of the cup, using your answers to **(a)(ii)** and **(iii)**.

d = ... cm [1]

(v) Calculate V_1, the volume of the cup, to the nearest cm^3, using the equation

$$V_1 = \pi d^2 \frac{h}{4}$$

V_1 = ... cm^3 [1]

method 2

The student places 250 cm^3 of water into a measuring cylinder. He fills the plastic cup from the measuring cylinder.

Fig. 3.2 shows the amount of water left in the measuring cylinder.

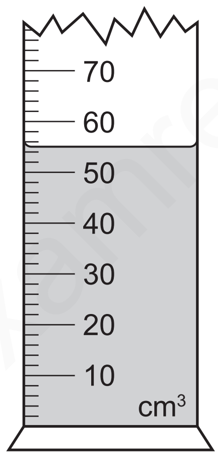


Fig. 3.2

(b) (i) Read the scale to the nearest 1 cm^3 to find the volume of water left in the measuring cylinder.

volume of water = ... cm^3 [1]

(ii) Find V_2, the volume of water that was placed in the plastic cup.

V_2 = ... cm^3 [1]

(c) The student thinks that **method 2** is less accurate than **method 1**.

Suggest **two** sources of inaccuracy in **method 2.**

1 ....

....

2 ....

....

[2]

(d) Another student finds the mass in grams of the empty plastic cup. Then he finds its mass when it is full of water.

Explain how he can use these two masses to find the volume of water in the cup.

....

....

.... [1]

MARKING SCHEME

(a) **(i)** $h = 8.2$ (cm) ; **(ii)** [1]

$B = 4.6$ (cm) ; [1]

(iii) $T = 6.7$ (cm) ; [1]

(iv) $d = 4.6 + 6.7 = 11.3$, $\frac{11.3}{2} = 5.7$ (cm) ; *(allow: 5.65 or ecf)* [1]

(v) $V_1 = \pi d^2 \frac{h}{4} = 3.14 \times 5.7^2 \times \frac{8.2}{4} = 209$ or 209.2 (cm^3) ; [1]

(b) **(i)** 55 (cm^3) ; [1]

(ii) $V_2 = 250 - 55 = 195$ (cm^3) ; [1]

(c) the student cannot tell when the cup is 'full' of water / owtte ;
measuring cylinder / scale is not accurate / to 1 cm^3 ;
air bubbles in the water ;
warmer / colder affecting density ; [max 2]

(d) subtract the masses **AND** gives volume ; [1]
(allow: subtract masses and divide by the density)

[Total: 10]

3

A student has samples of three different liquids, **A**, **B** and **C**.

He carries out an experiment to compare the densities of these liquids. The apparatus he uses is shown in Fig. 6.1.

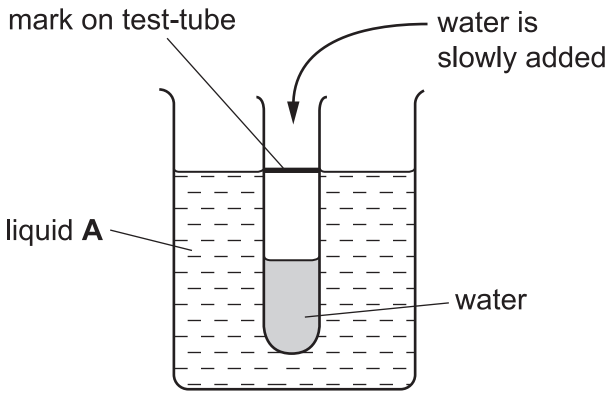


Fig. 6.1

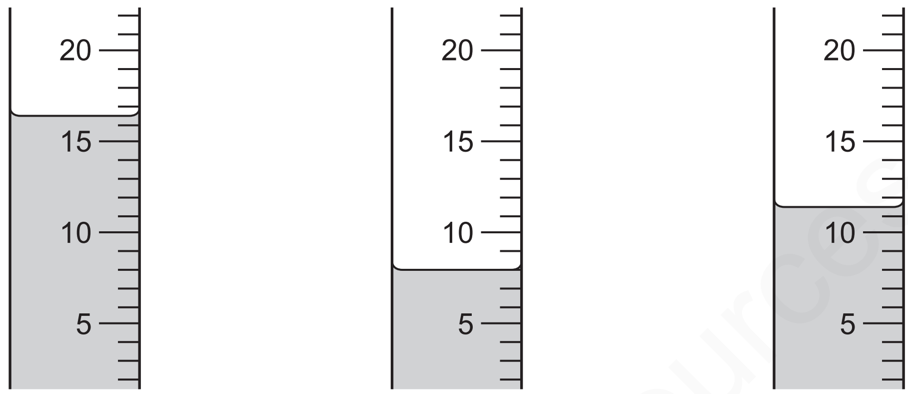
Method

- He makes a mark on a test-tube.
- He holds the test-tube upright in the beaker and slowly adds water to it, drop by drop, until it floats in the beaker of liquid **A** and the mark on the test-tube is level with the surface of liquid **A**.
- He pours the water from the test-tube into a measuring cylinder and records the volume in Table 6.1.
- He repeats the experiment using liquids **B** and **C**.

(a) Name the piece of apparatus that the student could use to add water, drop by drop, to the test-tube in Fig. 6.1.

.... [1]

(b) The liquid which requires the greatest volume of water in the test-tube is the most dense. Fig. 6.2 shows the volume of water contained in each test-tube when it floats in liquids **A**, **B** and **C**.



liquid **A** liquid **B** liquid **C**

Fig. 6.2

(i) Record, in Table 6.1, each volume of water to the nearest 0.5 cm^3.

Table 6.1

	liquid **A**	liquid **B**	liquid **C**
volume of water / cm^3			

[3]

(ii) Use the results from Table 6.1 to place the liquids **A**, **B**, and **C** in order of density.

most dense ....

....

least dense .... [1]

(c) The teacher tells the student that one of the three liquids is water.

Suggest **one** chemical test and **one** physical test that the student can use to identify the water.

chemical test

....

physical test

....

[2]

(d) Another student uses two pieces of apparatus to measure two properties of the sample of liquid **A** which he can use to calculate the density of liquid **A**.

(i) Suggest the names of two pieces of apparatus that he uses and the property measured by each by completing the sentences.

The student uses a .... to measure the ....

of the sample of liquid **A**.

The student uses a .... to measure the ....

of the sample of liquid **A**. [2]

(ii) State how the student uses the two measurements to calculate the density of liquid **A**.

....

.... [1]

MARKING SCHEME

(a) (teat) pipette / dropper ; [1]

(b) (i) **A**: 16.5 ;
B: 8.<u>0</u> ;
C: 11.5 ; [3]

(ii) **A**
C
B ; [1]

(c) (anhydrous) copper sulfate / cobalt chloride ;
boiling / freezing point / melting point ; [2]

(d) (i) measuring cylinder *(to measure)* volume ;
balance / scale(s) *(to measure)* mass ; [2]

(ii) the mass is divided by the volume / $\frac{\text{mass}}{\text{volume}}$; [1]

[Total: 10]

4 A student investigates how the period of a simple pendulum depends on its length.

The period of a pendulum is the time for one complete swing (oscillation) of the pendulum. This is shown in Fig. 3.1, where the period is the time taken for the bob to swing from **P** to **Q** and back to **P** again.

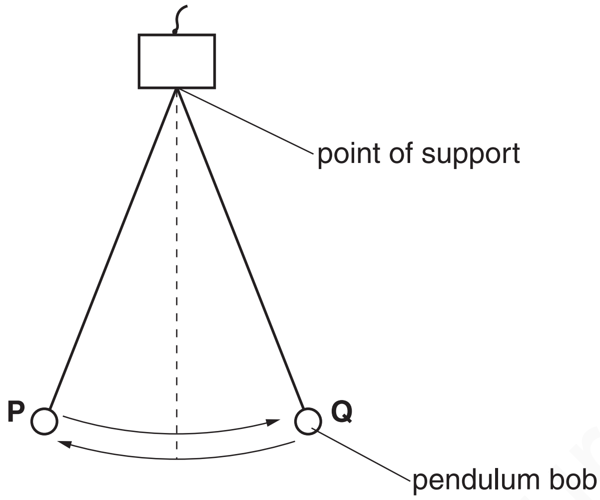


Fig. 3.1

She sets up the pendulum as shown in Fig. 3.2.

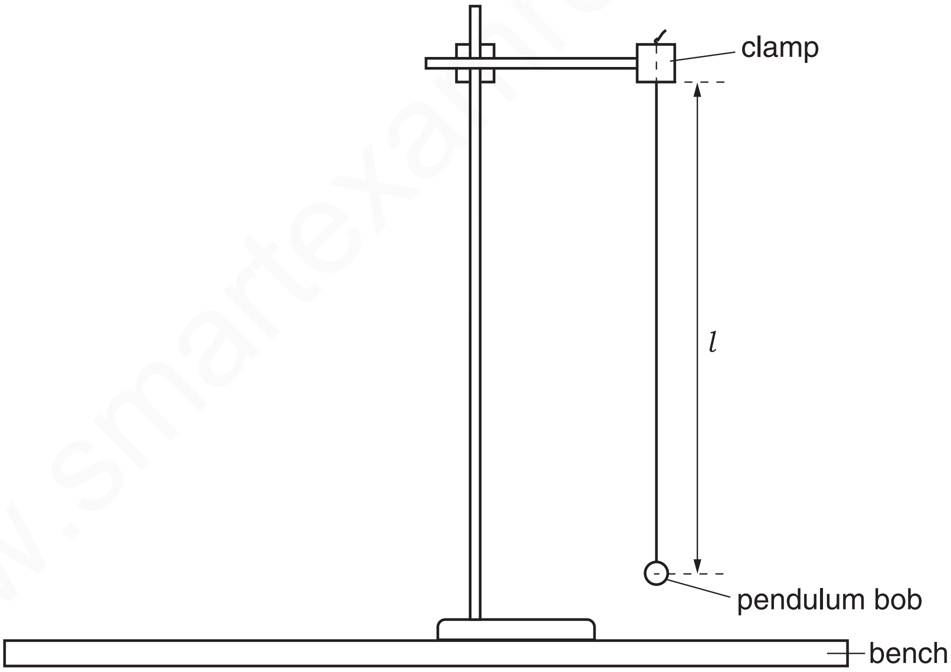


Fig. 3.2

Fig. 3.2 is drawn to a scale of **one-tenth full size**.

(a) **(i)** Measure the length l of the pendulum in Fig. 3.2 to the nearest 0.1 cm.

length l = ... cm [1]

(ii) Calculate the actual length l_A of the pendulum she uses. Record your answer below and in Table 3.1 in **(b)**.

actual length l_A = ... cm [1]

(iii) The actual length l_A of the pendulum is the distance from the point of support to the centre of the pendulum bob.

Describe a precaution that the student should take to measure l_A as accurately as possible. You may draw a diagram if you wish.

....

....[1]

(b) The student then moves the pendulum bob to position **P** and releases it so that it oscillates. She records the time taken for 20 oscillations. Fig. 3.3 shows the reading on the stopwatch.

00 : 30 . 98

Fig. 3.3

Record in Table 3.1 the reading on the stopwatch to three significant figures. [1]

Table 3.1

l_A / cm	time for 20 oscillations / s	period T / s	T^2 / s^2
50.0	28.4	1.42	2.0
40.0	25.4	1.27	1.6
30.0	22.0	1.10	1.2
20.0	18.0	0.90	0.8

She repeats the procedure described in **(b)** for lengths l_A of 50.0 cm, 40.0 cm, 30.0 cm and 20.0 cm.

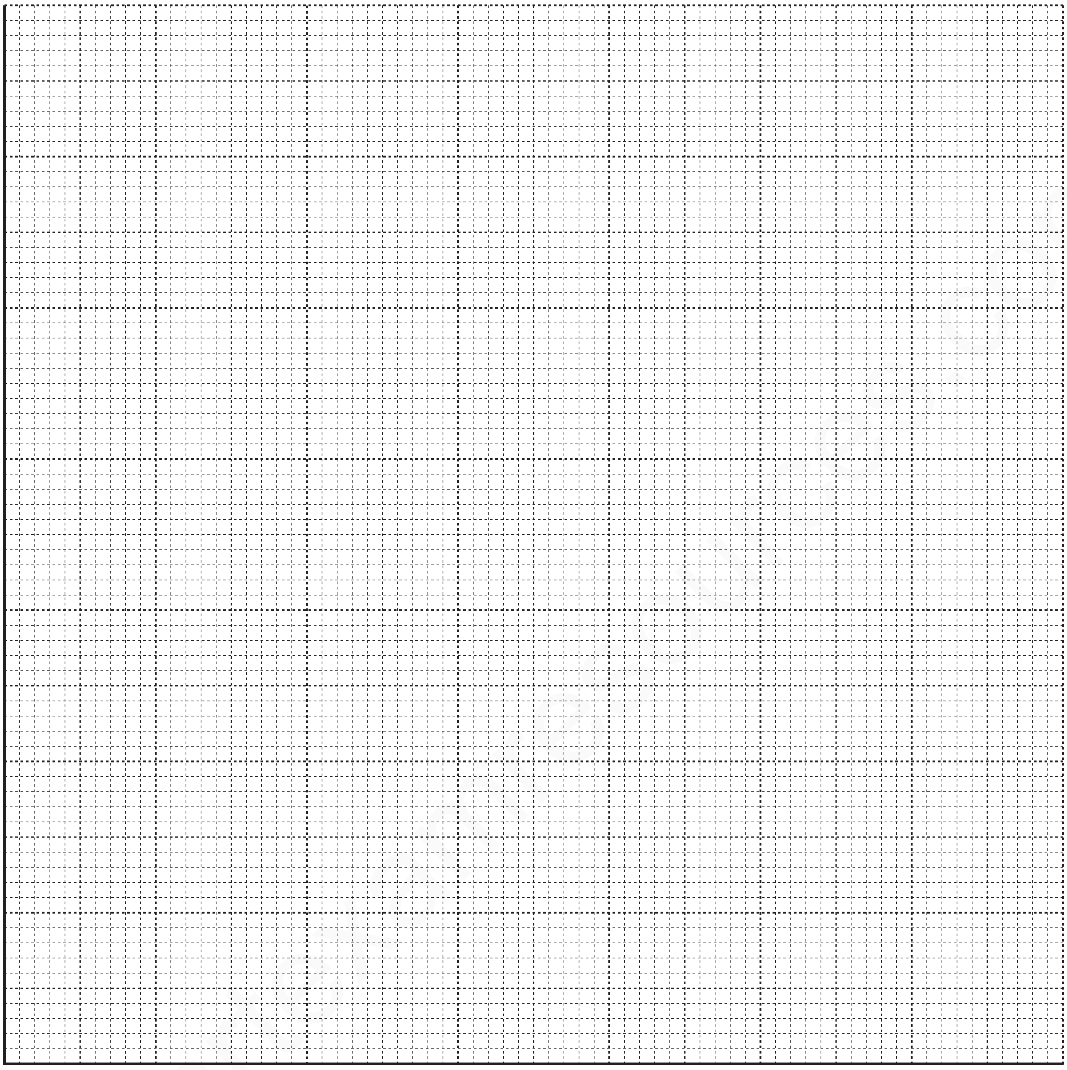
Her values are shown in Table 3.1.

(c) Complete Table 3.1 by calculating the period T of the pendulum and T^2 for the first set of results. Remember that the period is the time for **one** oscillation.

[2]

(d) On the grid provided, use the information in Table 3.1 to plot a graph of T^2 against l_A.

Start both axes of your graph from the origin (0, 0). Draw the best-fit straight line.



T^2 / s^2

l_A / cm

[3]

(e) Another student suggests that T^2 is directly proportional to l_A.

State whether your graph supports this suggestion. Give a reason for your answer.

....

....

....[1]

MARKING SCHEME

(a)(i)	6.5 ;	**1**
(a)(ii)	65 ;	**1**
(a)(iii)	appropriate precaution (either written or shown on diagram) ; take reading at eye level / use of set square to ensure rule vertical / use of fiducial aid ;	**max 1**
(b)	31.<u>0</u> ;	**1**
(c)	T = 1.55 ; T^2 = 2.4 ;	**2**
(d)	suitable choice of scales (more than half the grid used) ; at least 4 plots correct to ½ small square ; good best-fit straight line with a ruler, omission of anomalous point ;	**3**
(e)	yes agree (no mark) (straight) line through the origin no disagree (no mark) all points / anomaly not on the (straight) line ;	**max 1**
	Total:	**10**

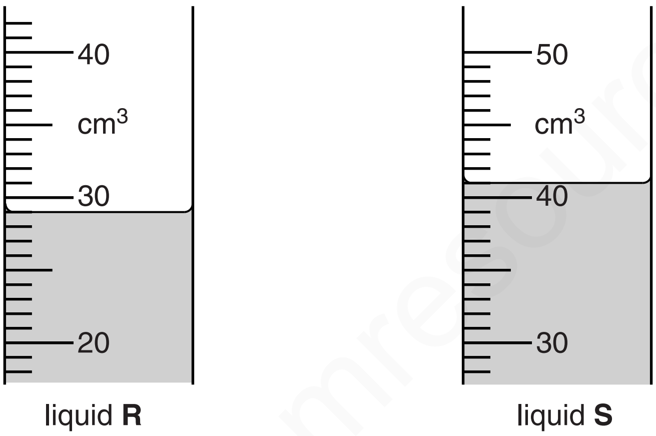
5 A student is given three liquids labelled **R**, **S** and **T**.

The student has a mass balance, a 50 cm^3 measuring cylinder and samples of the three liquids.

- She places the measuring cylinder on the balance and weighs it. She records the mass in Table 6.1.
- She adds liquid **R** to the measuring cylinder until the total mass is approximately 60 g. She records the actual mass in Table 6.1.
- She measures the volume of liquid **R**.
- She repeats the procedure using samples of the other two liquids with the same measuring cylinder.

(a) **(i)** Fig. 6.1 shows the measuring cylinders for liquids **R** and **S**.

Read the volumes to the nearest 0.5 cm^3 and record the values in Table 6.1.



[2]

Fig. 6.1

Table 6.1

	liquid		
	R	**S**	**T**
mass of measuring cylinder + liquid / g	60.1	59.9	60.0
mass of measuring cylinder / g	25.5	25.5	25.5
mass of liquid / g	34.6	34.4	34.5
volume of liquid in measuring cylinder / cm^3			34.5
density of liquid / g per cm^3			1.0

(ii) Explain how the student makes sure that her readings from the measuring cylinder are as accurate as possible. You may draw a diagram to help your explanation.

....

....[1]

(b) Use the data in Table 6.1 and the formula below to calculate the densities of liquids **R** and **S**.

Record the densities in Table 6.1 to **one decimal place**.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[2]

(c) (i) Name a piece of apparatus that the student could use to add the last few drops of liquid to the measuring cylinder so that the total mass is close to 60 g.

....[1]

(ii) Suggest a reason why the student does not need to make the total mass exactly 60.0 g to calculate density.

....

....[1]

(iii) The student knows that her results for the densities of the liquids will be slightly inaccurate.

She repeats the experiment two more times, giving three results for the volumes and masses of each liquid.

Suggest how she can use the results of the three experiments to find more reliable values for the densities of the liquids.

....

....[1]

(d) **(i)** Liquid **T** is water. Hydrocarbon oils float on water.

State which of the liquids, **R** or **S**, is a hydrocarbon oil and give a reason for your answer.

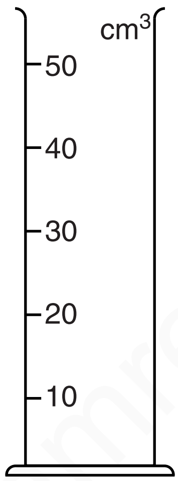
liquid .... because ....

....[1]

(ii) The third liquid is an aqueous solution of a salt.

The student pours 10 cm^3 of each of the liquids **R**, **S** and **T** into one new measuring cylinder. She stirs the mixture and allows it to settle.

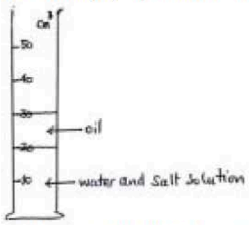
Complete Fig. 6.2 to show what she would observe when the mixture has settled. Label your diagram.



[1]

Fig. 6.2

MARKING SCHEME

(a)(i)	29.0 ; 41.0 ;	2
(a)(ii)	eye level / bottom of meniscus ;	1
(b)	1.2 (1.193103448275862) ; 0.8 (0.8390243902439024463) ;	2
(c)(i)	(teat / dropping) pipette ;	1
(c)(ii)	formula takes it into account ;	1
(c)(iii)	find the average / mean (of the three results for each liquid) ;	1
(d)(i)	**S and** because it is less dense than water / liquid T ;	1
(d)(ii)	oil / S on top (ecf) with **one** line at 20 ;  (water and salt solution or water and solution **R**)	1
	Total:	**10**