1(a). Temperature and concentration are two factors that affect the rate of diffusion.

State **one other** factor that affects the rate of diffusion.

_____ **[1]**

(b). Students used a model cell to investigate the effect of temperature on the rate of diffusion across membranes.

They were provided with:

- a calibrated colorimeter
- a calibration curve
- Benedict's solution and all the apparatus required to carry out a Benedict's test
- glucose solution
- dialysis tubing.

i. Name **two** more pieces of apparatus they would need to make sure this is a controlled investigation.

1 _____

2 _____ **[2]**

ii. Outline the method that the students would use to carry out an investigation into the effect of **temperature** on the diffusion rate in their model cells.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[4]**

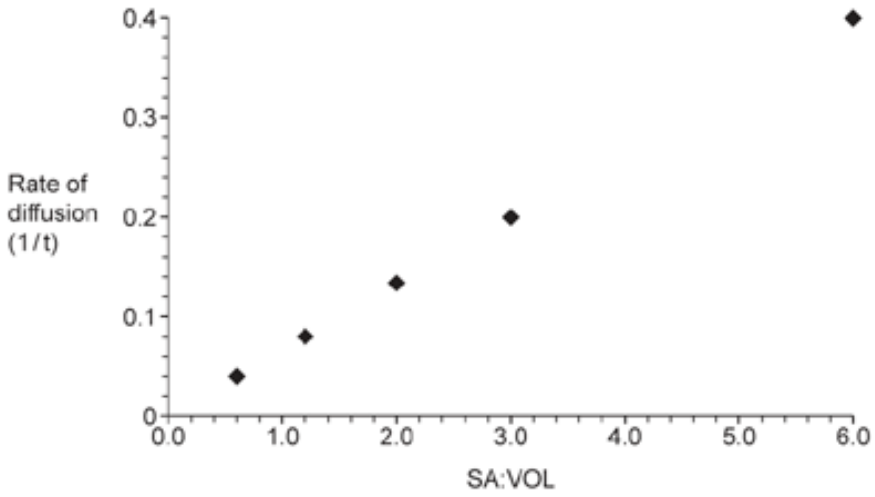
(c). The table shows some results from a model cell investigation.

Temperature (°C)	Concentration of glucose found outside the dialysis tubing after two minutes (mol dm^{-3})
10	1.5
20	3.6
30	4.7
40	5.8

Explain these results in terms of the effect of temperature on the rate of diffusion.

[3]

2. The graph shows the results of an investigation into diffusion rates in cubes of agar jelly with different surface area to volume ratios (SA:VOL).



Which option best describes the results of the investigation?

A SA:VOL is directly proportional to rate of diffusion.
B SA:VOL is inversely proportional to rate of diffusion.
C There is a negative correlation between SA:VOL and rate of diffusion.
D There is an inverse correlation between SA:VOL and rate of diffusion.

Your answer ☐ **[1]**

3. Calculate the SA:VOL of a cube with edges 4 cm long.

A 0.25
B 0.67
C 0.96
D 1.5

Your answer ☐ **[1]**

4. Male infertility is associated with low motility (ability to move) of sperm cells.

i. Superoxide dismutase (SOD) is an enzyme that is often located together with catalase in cells.

Superoxide ions are produced in mitochondria and are highly reactive. Superoxide ions cause damage to many biological molecules, including DNA and lipids.

SOD converts superoxide ions into hydrogen peroxide and oxygen.

Explain why sperm cells might have high concentrations of hydrogen peroxide.

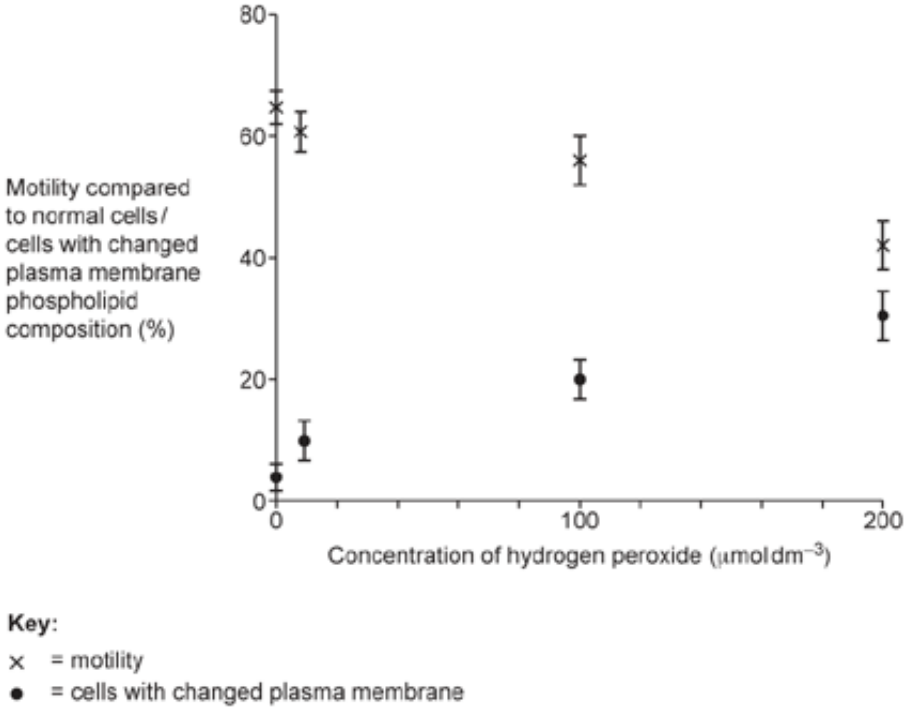
---**[2]**

ii. Scientists investigate the effect of hydrogen peroxide on sperm cells. This is the method that they use:

- incubate sperm cells with different concentrations of hydrogen peroxide for two hours
- measure the motility of the cells compared with normal sperm cells
- measure the percentage of cells that have changes in the composition of phospholipids in the plasma membrane.

They use sperm samples from 10 different men attending a fertility clinic and calculate mean values.

Their results are shown in the figure below



The scientists conclude that hydrogen peroxide causes changes in the plasma membrane of sperm cells that reduces their motility.

Evaluate this conclusion.

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

iii. Suggest how hydrogen peroxide could affect the plasma membrane.

_____

_____

_____

_____

_____ **[2]**

5(a). A student investigates the effect of ethanol on the membranes of beetroot cells at 25 °C.

They place equal masses of beetroot in tubes containing different concentrations of ethanol.

They then use a colorimeter to measure the concentration of purple pigment that leaked out of the cells.

The student replicates the experiment five times at each ethanol concentration and plots a graph of absorption in arbitrary units (A.U.) against concentration of ethanol.

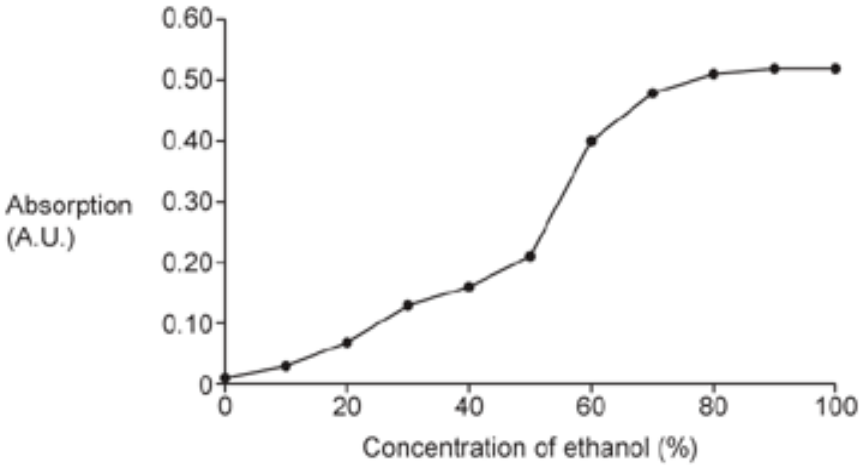
The student controls the mass of beetroot in this investigation.

Identify **two** other variables that the student should control in this investigation.

1 _____

2 _____ **[2]**

(b). The student's graph is shown below.



i. Explain the shape of the graph.

---**[2]**

ii. The student repeats the experiment at a temperature of 30 °C.

Sketch the graph you expect the student to obtain.

Answer on the graph.

[2]

6. Which statement describes a feature of plasma membranes?

A Channel proteins are a type of intrinsic protein.
B Glycolipids are intrinsic proteins that have lipid molecules attached.
C Phospholipids form a rigid bilayer that membrane proteins are attached to.
D The plasma membrane forms an impermeable barrier.

Your answer ☐ **[1]**

7. The diagram shows part of a plasma membrane.

How can molecule **X** be described?

A It has a hydrophilic head and a hydrophobic tail.
B It is formed when the glycerol in a triglyceride is replaced by a phosphate.
C It is non-polar.
D The tails are joined to the head by peptide bonds.

Your answer ☐ **[1]**

8(a). A group of students are investigating osmosis in plant cells.

This is the method they use:

- Use a cork borer to cut cylinders of sweet potato to 30 mm in length.
- Dry each cylinder using a paper towel and record its mass.
- Prepare 5 cm^3 of sucrose concentrations of 0.0, 0.1, 0.2, 0.4 and 0.8 mol dm^{-3} in test tubes.
- Place one cylinder into each test tube.
- Leave test tubes at room temperature for 48 hours.
- Remove each cylinder, dry using a paper towel and record its mass.
- Repeat the experiment three times at each sucrose concentration.
- Calculate the percentage change in mass for each cylinder.

The table shows the processed results obtained by the students.

Sucrose concentration / (mol dm^{-3})	Percentage change in mass				Mean percentage change in mass
	Replicate 1	Replicate 2	Replicate 3	Replicate 4	
0.0	+30.3	+25.5	+28.8	+29.2	+28.5
0.1	+23.3	+25.5	+10.3	+22.2	+20.3
0.2	+12.7	+14.4	+14.8	+12.3	+13.6
0.4	+2.7	+4.3	+4.4	+2.9	+3.6
0.8	−13.9	−10.9	−12.5	−12.8	−12.5

Explain the difference between the mean results obtained at the 0.0 mol dm^{-3} and 0.8 mol dm^{-3} sucrose concentrations.

[2]

(b). The students suggested that there was an anomaly in their results in the table.

Identify the anomalous result **and** explain how the anomalous result affects the **precision** of the data obtained.

[3]

(c). The students prepared the sucrose concentrations using a serial dilution technique. The students were provided with 10 cm^3 of a 0.8 mol dm^{-3} sucrose concentration.

Describe how the students produced 0.4, 0.2 and 0.1 mol dm^{-3} sucrose concentrations each with a volume of 10 cm^3.

[2]

(d). The students carried out a similar experiment with carrot tissue.

Explain how the students could use their data to estimate whether sweet potato tissue or carrot tissue had a higher sucrose concentration in its cells.

[2]

9(a). Cell surface membranes are composed of many different components, including cholesterol.

Describe **two** roles of a cell surface membrane.

1 _____

_____

2 _____

[2]

(b). The presence of cholesterol is one of several factors that affect membrane fluidity.

A student examined two different cell surface membranes. One membrane had a higher concentration of cholesterol than the other membrane.

The student concluded that 'the membrane with the higher concentration of cholesterol would have less fluidity than the other membrane'.

Discuss whether the student's conclusion can be supported.

[3]

10. Infection by pathogens such as bacteria and viruses often causes release of pyrogens into the blood.

Pyrogens stimulate the enzyme COX-2 to produce the compound PGE_2.

PGE_2 binds to receptors in the hypothalamus and this results in an increase in the thermogenic set point.

i. Suggest the consequences of an increase in the thermogenic set point.

[2]

ii. PGE_2 receptors are located on the cell surface membrane.

State **two** functions of the cell surface membrane that are illustrated by the action of PGE_2.

1 _____

_____

2 _____

[2]

11. Plants are often watered with a solution containing minerals to help them grow.

While preparing a class practical a technician accidentally watered some sunflower plants with a mineral concentration that was 1000 times higher than normal.

i. Explain why the plants wilted, even though they were given a lot of water.

_____

_____

_____

_____

_____

[3]

ii. The teacher suggested that the same effect would be seen if the plants had been watered with a solution containing cyanide ions that inhibit ATP synthesis.

Explain whether the teacher was correct.

_____

_____

_____

_____

[2]

iii. Explain why plants growing in high light intensity require more water than plants growing in shade, even when the temperatures are the same.

_____

_____

_____

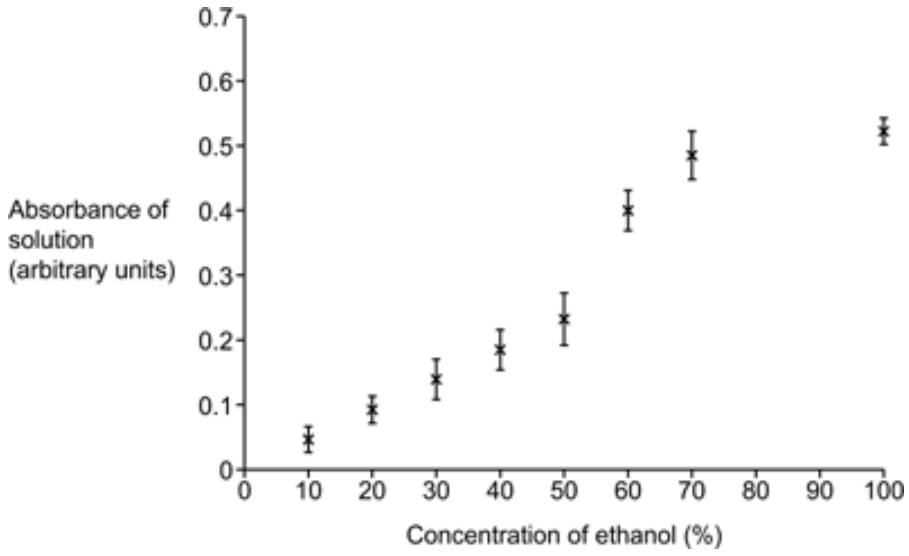
_____

[2]

12. Beetroot cell vacuoles contain a red pigment.
Some students are investigating the effect of ethanol on the permeability of plant cell membranes.
This is the method that they use:

- Soak identical pieces of beetroot for 30 minutes in different concentrations of ethanol.
- After 30 minutes, measure the redness of the ethanol solution using a colorimeter.

The graph shows the students' results. Each data point shows the mean ± 2 standard deviations.



One student made the following observations:

1 Ethanol disrupts the cell membranes leading to increased permeability.

2 The permeability of the cell membranes is proportional to concentration of ethanol between 0% and 50% ethanol.

3 The cell membranes are completely disrupted in 60% ethanol.

Which observation(s) is / are correct?

A 1, 2 and 3 are correct

B Only 1 and 2 are correct

C Only 2 and 3 are correct

D Only 1 is correct

Your answer ☐ **[1]**

13(a). The cells in beetroot contain a red pigment called betalain. The plasma membrane of the beetroot cell is impermeable to betalain.

A group of students set out to investigate how temperature affects the structure and permeability of the plasma membrane of beetroot cells. The method they used is shown below.

- Cut some pieces of beetroot.
- Place them in a flask containing 100 cm^3 of distilled water.
- Stand this flask in a water bath and increase the temperature at 10 °C intervals.
- Take a sample of water from the flask 5 minutes after each new temperature is reached.
- Measure the absorbance of the water samples taken using a blue filter in the colorimeter.

A second group of students made improvements to this method. One of the improvements they made was to carry out two further trials at each temperature.

Suggest **two** further improvements they could have made **and** give a reason for the improvements you have suggested.

Improvement and reason 1

Improvement and reason 2

[4]

(b). Name the independent variable in this investigation.

[1]

(c). In a second experiment, students followed the same method but used pieces of beetroot that had been frozen for several days and then defrosted. They were surprised when their results differed from the students that had been given fresh beetroot.

Suggest how their results would **differ** from those given in the table **and** provide an explanation.

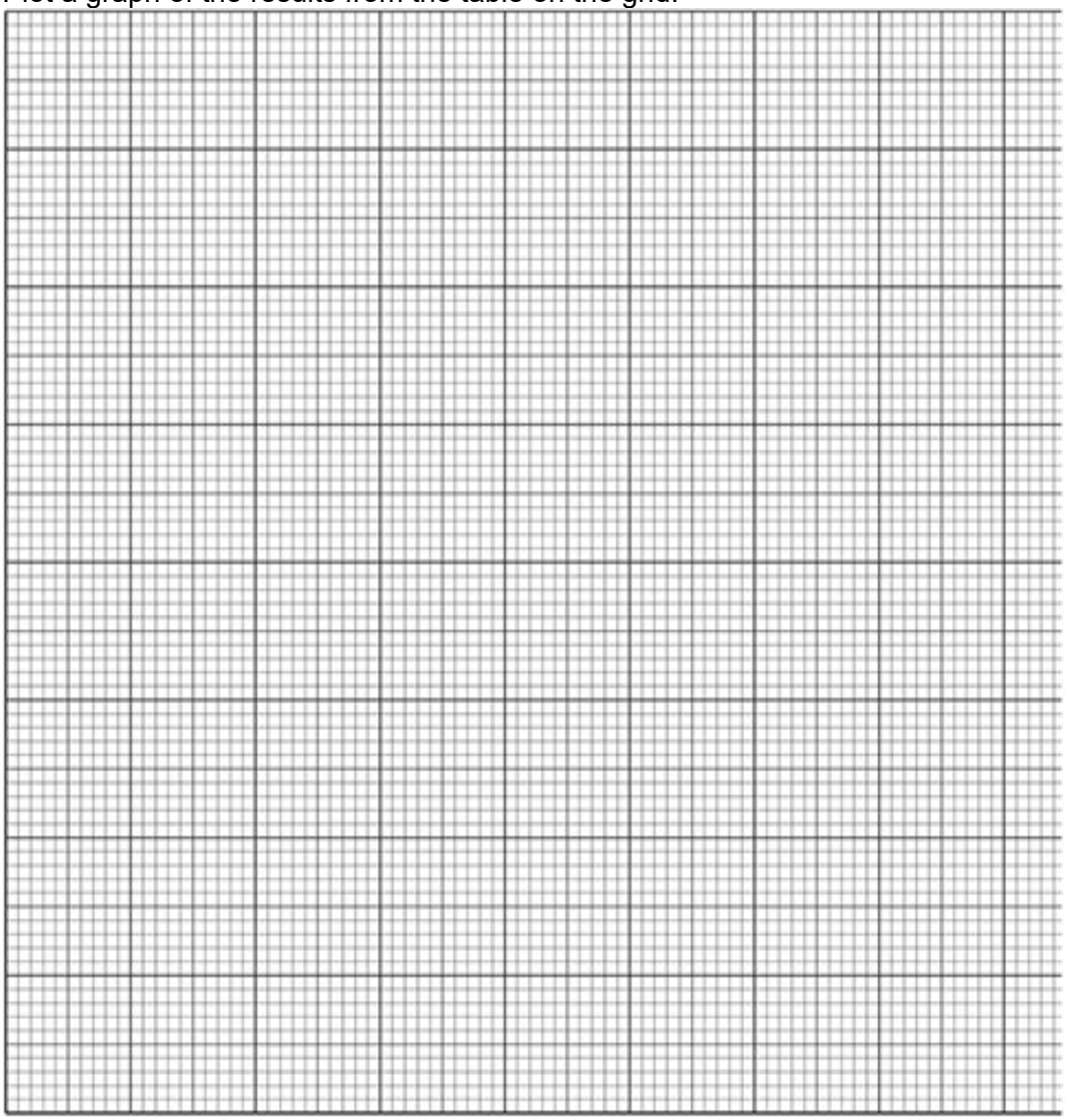
[2]

(d).

i. The table shows the results obtained by the second group of students.

Temperature (°C)	Absorbance (%)			
	Trial 1	Trial 2	Trial 3	Mean
10	0	0	0	0.0
20	0	0	0	0.0
30	2	3	2	2.3
40	6	5	7	6.0
50	9	7	7	7.7
60	46	45	47	46.0
70	78	78	80	78.7

Plot a graph of the results from the table on the grid.



[3]

ii. *Explain the results between 20 °C and 70 °C using your knowledge of the structure and properties of phospholipid molecules in the plasma membrane.

[6]

Additional answer space if required.

14. A group of students were investigating mitosis. They examined cells from onion root tip squashes that had been prepared using acetic orcein stain. Chromosomes appear a purple red colour when this stain is used.

Fig. 2.4 shows a light micrograph of one of these cells. A student stated that this cell was at metaphase.

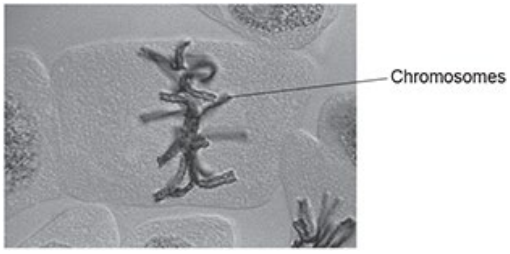


Fig. 2.4

i. Describe how **Fig. 2.4** shows the importance of differential staining for observing cells undergoing mitosis.

[1]

ii. Identify one piece of evidence that would have led the students to conclude that the cell in **Fig. 2.4** is at metaphase.

[1]

iii. Three students were studying onion root tip squashes under the microscope. They recorded the number of cells at each stage of mitosis. A record of their observations is shown below.

Student 1:	Metaphase 1 cell
	Anaphase 3 cells
	Prophase 3 cells
Student 2:	Anaphase 4 cells
	Prophase 5 cells
	Telophase 1 cell
Student 3:	Telophase 3 cells
	Metaphase 5 cells
	Prophase 2 cells

In the space below draw an appropriate table to present the students' observations.

Include the headings for the columns. You are **not** required to enter any of the results into your table.

[2]

15. Cellulose is the main component of plant cell walls.

Which option is **not** a property of cellulose?

A High tensile strength
B Inflexible
C Insoluble in water
D Resistant to digestion by enzymes

Your answer ☐ **[1]**

16. Hormones can be classed as either steroid or non-steroid. Steroids are lipid soluble.

Suggest the location of the receptors for steroid hormones and state a reason for your suggestion.

[2]

17. Erythrocytes are formed from bone marrow stem cells. During this process they lose most of their organelles.

Which statement about respiration in erythrocytes is correct?

A Oxygen bound to haemoglobin is used by erythrocytes in aerobic respiration.
B They do not respire because their cell surface membrane is impermeable to glucose.
C They respire aerobically because they always have adequate supplies of oxygen.
D They respire anaerobically because they do not have mitochondria.

Your answer ☐ **[1]**

18(a). A student investigated osmosis in plant cells.

They used cylinders of potato cut with a cork borer and measured the change in length of the cylinders after they were placed in sucrose solutions and left overnight.

The student was given 100 cm^3 of a solution of 1 mol dm^{-3} sucrose and asked to prepare 30 cm^3 of each dilution.

i. Complete **Table 18.1** to show how the student should prepare the solutions.

Final concentration of solution (mol dm^{-3})	**Volume of 1 mol dm^{-3} sucrose solution (cm^3)**	**Volume of distilled water (cm^3)**	**Final volume (cm^3)**
1.0			30.0
0.8			30.0
0.6			30.0
0.4			30.0
0.2			30.0
0.0			30.0

Table 18.1

[3]

ii. The solution given to the student was prepared using 34.23 g of sucrose in 100 cm^3 water.

The sucrose was measured on an electronic balance using the following procedure:

- mass of weighing boat empty = 10.55 g
- mass of weighing boat plus sucrose = 44.78 g.

The balance recorded masses to two decimal places with an uncertainty of ± 0.01 g.

Calculate the percentage uncertainty in the mass of sucrose.

Uncertainty = ... % **[2]**

(b). The student's results are shown in **Table 18.2**.

Concentration of sucrose (mol dm^{-3})	Length of potato cylinder (mm)			Percentage change in length (%)	Mean Percentage change in length (%)
	initial	final	change		
1.0	49.5	48.0	−1.50	−3.0%	−3.4%
	50.5	49.0	−1.50	−3.0%	
	49.0	47.0	−2.00	−4.1%	
0.8	49.0	48.0	−1.00	−2.0%	−2.6%
	50.5	49.5	−1.00	−2.0%	
	51.0	49.0	−2.00	−3.9%	
0.6	50.0	50.5	0.50	1.0%	0.3%
	51.0	51.0	0.00	0.0%	
	50.5	50.5	0.00	0.0%	
0.4	50.5	51.5	1.00	2.0%	0.7%
	49.5	51.0	1.50	3.0%	
	51.0	49.5	−1.50	−2.9%	
0.2	50.0	52.0	2.00	4.0%	4.3%
	50.5	52.5	2.00	4.0%	
	49.5	52.0	2.50	5.1%	
0.0	49.5	52.0	2.50	5.1%	4.4%
	49.0	51.0	2.00	4.1%	
	50.0	52.0	2.00	4.0%	

Table 18.2

The student was told that one of their results was anomalous.

i. Identify the anomalous result.

---------- **[1]**

ii. State **one** variable that should be controlled in this experiment and give a reason for your choice.

Control variable _____

Reason _____

_____

_____

[2]

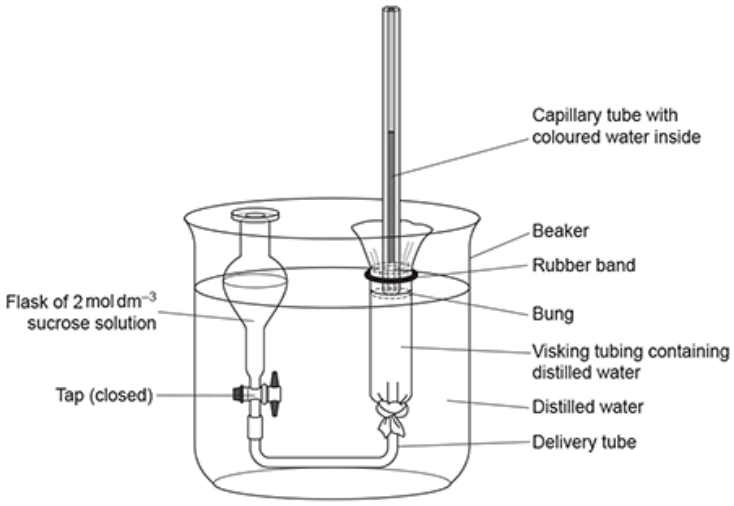
19. Describe how oncotic pressure is established.

[3]

20(a). A student is investigating how sucrose is loaded into phloem sieve tubes by companion cells, using a model of phloem tissue.

To create the model, the student added distilled water to a bag made from Visking tubing (an artificial partially permeable membrane). They inserted a capillary tube into one end of the Visking tubing and connected the other end to a flask containing 2 mol dm^{-3} sucrose solution.

They placed the Visking tubing and connected flask into a beaker of distilled water, as shown in the diagram.



The capillary tube, the flask and the beaker of distilled water represent plant tissues involved in the active loading of sucrose. The Visking tubing represents the cell surface membrane of the phloem sieve tube.

The student opens the tap on the flask and the level of the coloured water in the capillary remains the same. After a few minutes, the water level in the capillary tube starts to rise. The tap is then closed after 5 minutes.

i. Describe what happens inside the model, immediately after the tap on the flask is opened.

[1]

ii. Explain why the water level in the capillary tube starts to rise after a few minutes.

[2]

iii. With reference to the diagram, name the plant cells or tissues that are represented by:

The capillary tube

The beaker of distilled water

The flask

[3]

(b). The student measured the increase in the level of the coloured liquid in the capillary tube after 2 minutes. It had risen by 8 mm. The capillary tube has a diameter of 1 mm.

Calculate the rate of osmosis as the volume of water moved per second.

Use the formula: Volume of cylinder = $\pi r^2 l$

Rate of osmosis = ... $mm^3 s^{-1}$ **[2]**

21. Fick's Law describes the relationship between the rate of diffusion and factors that affect this rate.

This can be simplified as the equation:

$$\text{Rate of diffusion } \alpha \frac{\text{surface area} \times \text{concentration gradient}}{\text{thickness of surface}}$$

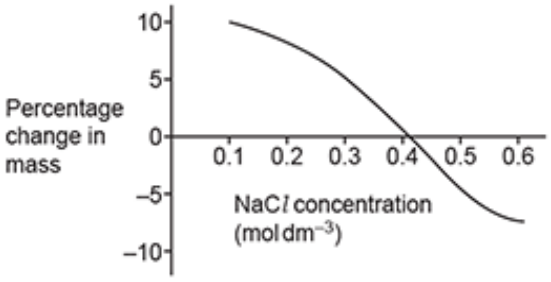
Inhalation of asbestos dust can cause a thickening of the alveolus wall.

Which option shows the change in the rate of diffusion if the alveolus wall increases from a thickness of 2.0 μm to 2.5 μm?

A Decreases by 20%
B Decreases by 50%
C Increases by 20%
D Increases by 50%

Your answer ☐ **[1]**

22. The graph below shows the results of an osmosis experiment investigating the effect of changing the concentration of sodium chloride (NaC*l*) on mass of potatoes.



Which concentration of NaC*l* causes equal movement of water into and out of the potato?

A 0.36 mol dm^{-3}
B 0.40 mol dm^{-3}
C 0.42 mol dm^{-3}
D 0.62 mol dm^{-3}

Your answer ☐ **[1]**

END OF QUESTION PAPER