Required Practicals 3 and 11, Dilution Series and Calibration Curves: AQ

13 questions · 34 marks · about 44 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2017 · Q08.2 · 1 mark

A student investigated the effect of different concentrations of sucrose solution on "chips" cut from a potato. Each chip had the same dimensions.

The student:
- weighed each chip at the start
- placed each chip in a separate test tube, each containing 10 cm^3 of sucrose solution at a different concentration
- left the chips in the sucrose solution for 24 hours
- dried the surface of the chips and then weighed them again.

Table 4 shows the student's results.

Table 4

Concentration of sucrose solution / mol dm^{-3}	Initial mass of chip / g	Final mass of chip / g	Ratio of final mass to initial mass of chips
0.0	2.79	3.82	
0.2	2.75	2.97	
0.4	2.78	2.67	
0.6	2.69	2.31	
0.8	2.72	2.20	
1.0	2.77	1.99	

0 8 . 2 The student produced the sucrose solutions with different concentrations from a concentrated sucrose solution.

Name the method she would have used to produce these sucrose solutions.

[1 mark]

Name of method _____

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0 8 . 1 A student investigated a method for estimating the concentration of protein in solution by using a measure of the density of the solutions.

Copper sulfate solutions of different concentration have known densities, so they can be used to measure the density of other solutions.

The student prepared a dilution series of a copper sulfate solution.

Complete **Table 3** by giving all headings, units and volumes required to make 30 cm^3 of the concentration of the copper sulfate solution shown.

[2 marks]

Table 3

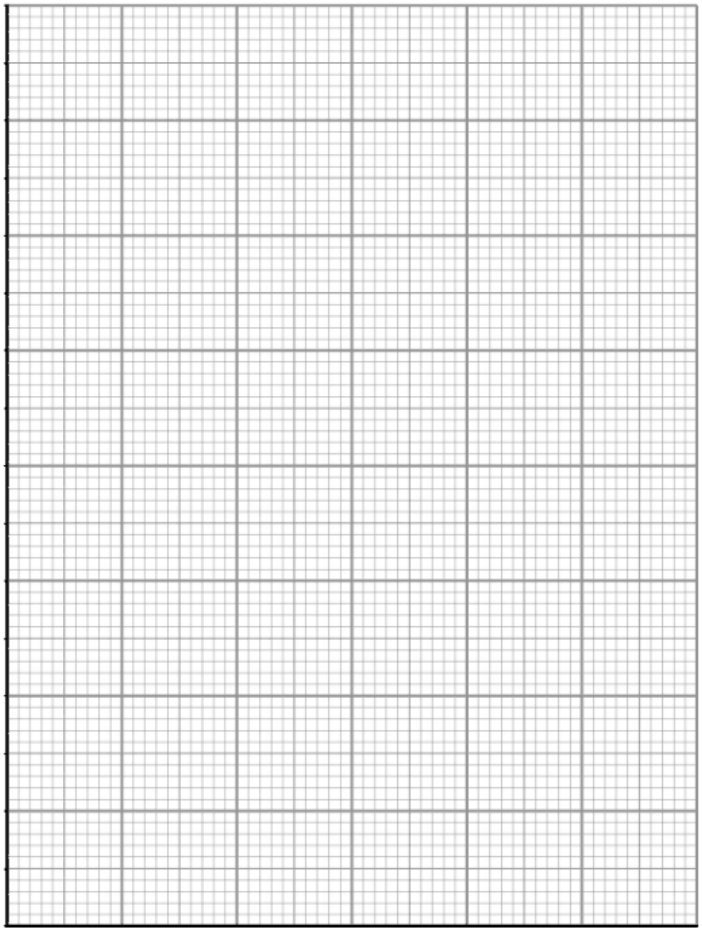
Concentration of copper sulfate solution / g kg^{-1}	**Volume of 100 g kg^{-1} copper sulfate solution /** _____	**Volume of water /** _____
75	_____	_____

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Question 3 · AS Paper 1 · June 2017 · Q08.3 · 3 marks

0 8 . 3 Calculate the ratio of final mass to initial mass of potato chips and plot a suitable graph of your processed data. Express the ratios in **Table 4** as a single number (for example 5.26:1 would be expressed as 5.26).

[3 marks]



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Question 4 · information from earlier in the question

0 8 An unfertilised chicken egg is a single cell surrounded by a shell.

A student investigated osmosis in chicken eggs. She dissolved the shells of two eggs without damaging the cell contained inside the shells. She then:

- measured the mass of each egg without its shell
- covered one egg with vinegar and covered the other egg with a sugar solution
- kept both eggs covered at 30 °C for 24 hours.

After 24 hours, she measured the mass of each egg.

The student designed **Table 2** and added her results to this table.

Table 2

Initial mass of egg / g	Final mass of egg / g	Name of solution covering egg	Ratio of final mass to initial mass
66	85	Vinegar	1.29:1
60	43	Sugar	0.7:1

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Question 4 · AS Paper 1 · November 2021 · Q08.4 · 4 marks

0 8 . 4 The student wanted to determine the water potential of chicken eggs. She:

- produced a dilution series of sugar solution
- followed the procedure described on **page 20**.

She calculated the final mass to initial mass ratio of the egg covered in each sugar solution.

How would you advise the student to use her calculated ratios to determine the water potential of the eggs?

In your answer state the independent variable in the student's investigation.

[4 marks]

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Question 5 · A level Paper 1 · June 2022 · Q06.3 · 4 marks

0 6 . 3 The higher rate of transpiration at high tide shows that the mangrove tree is absorbing water from the sea water surrounding its roots.

Describe an experiment that you could do to investigate whether the mangrove root cells have a lower water potential than sea water.

You are given:

- a piece of fresh mangrove root
- sea water
- access to laboratory equipment.

[4 marks]

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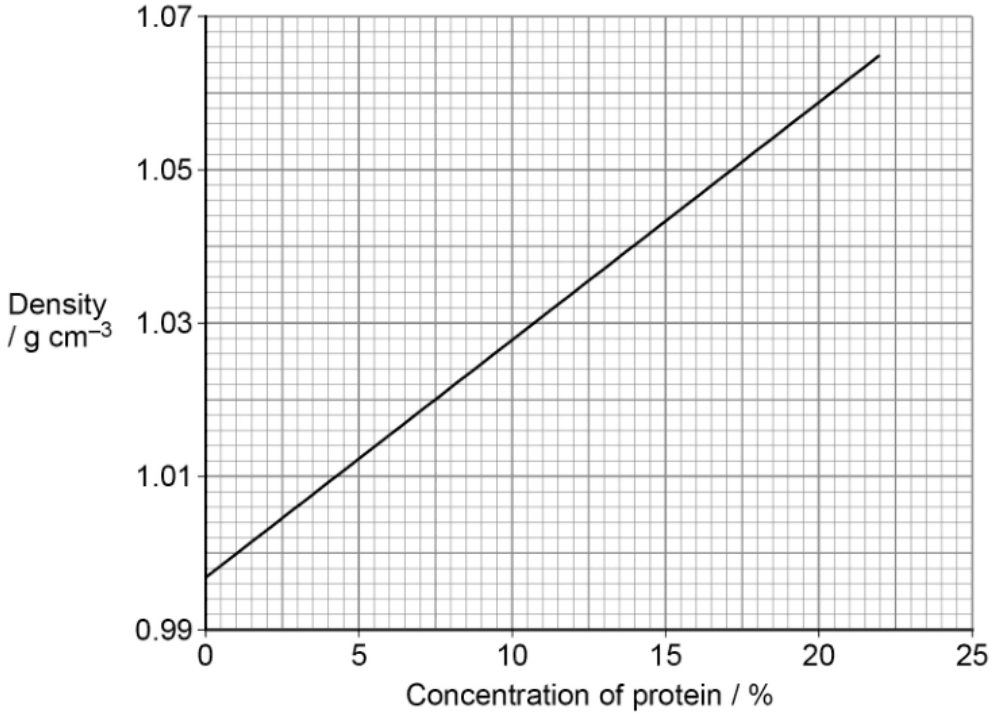
0 8 . 2 **Table 4** shows the densities of the dilution series of the copper sulfate solution.

Table 4

Concentration of copper sulfate solution / g kg^{-1}	Density of solution / g cm^{-3}
0	0.997
25	1.014
50	1.030
75	1.048
100	1.065

Figure 5 shows the densities of protein solutions of different concentration.

Figure 5



The student put one drop of 10% protein solution into each of the copper sulfate solutions shown in **Table 4**.

Using **Figure 5**, he predicted that the drop would sink in the 0 and 25 g kg^{-1} copper sulfate solutions and float in the 50, 75 and 100 g kg^{-1} copper sulfate solutions.

Give the density of the 10% protein solution **and** explain why the student predicted that the drop would sink in the 25 g kg^{-1} copper sulfate solution.

[2 marks]

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Question 7 · AS Paper 2 · June 2023 · Q08.3 · 1 mark

0 8 . 3 State the range of possible concentrations of a protein solution that sinks in 75 g kg^{-1} copper sulfate solution and floats in 100 g kg^{-1} copper sulfate solution.

[1 mark]

Minimum concentration _____ %

Maximum concentration _____ %

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Creatinine is produced in muscle tissues. Creatinine diffuses into the blood. The kidneys then excrete creatinine.

A calibration curve can be used to determine the concentration of creatinine in urine. One method of producing a calibration curve needs:

- creatinine solution of known concentration
- distilled water
- creatinine-detecting solution
- a colorimeter.

Creatinine-detecting solution reacts with creatinine to produce an orange colour.

0 4 . 2 Use the information provided to describe how you could produce a calibration curve for creatinine.

Do **not** include details on the use of glassware in your answer.

[4 marks]

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Question 9 · A level Paper 2 · November 2020 · Q04.3 · 2 marks

0 4 . 3 Describe how you would determine the concentration of creatinine in a urine sample using your calibration curve.

[2 marks]

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Question 10 · AS Paper 2 · June 2017 · Q04.4 · 3 marks

0 4 . 4 The scientists measured the absorption of each sample of blood plasma using a colorimeter. They used a calibration curve to find the concentration of protein in samples of blood plasma.

Describe how the scientists could obtain data to produce a calibration curve and how they would use the calibration curve to find the concentration of protein in a sample of blood plasma.

[3 marks]

[Extra space]

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Question 11 · AS Paper 1 · June 2022 · Q04.3 · 2 marks

0 4 . 3 The intensity of the red colour in blood is affected by the pO_2 of the blood.
The intensity of the colour in a solution is measured using a colorimeter.

The scientist used a colorimeter to measure the intensity of red colour in samples of lugworm blood with different pO_2 values. She prepared a calibration curve with this information.

Describe how the scientist will use information from the colorimeter and her calibration curve to determine the pO_2 in a sample of lugworm blood.

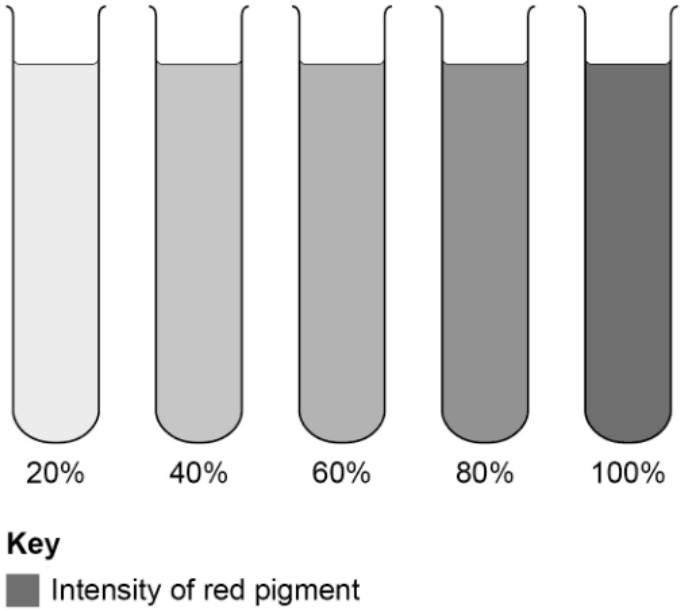
[2 marks]

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Another student carried out the same investigation, ensuring that **all** variables were controlled.

Figure 11 shows a dilution series the student prepared from 100% red beetroot pigment solution.

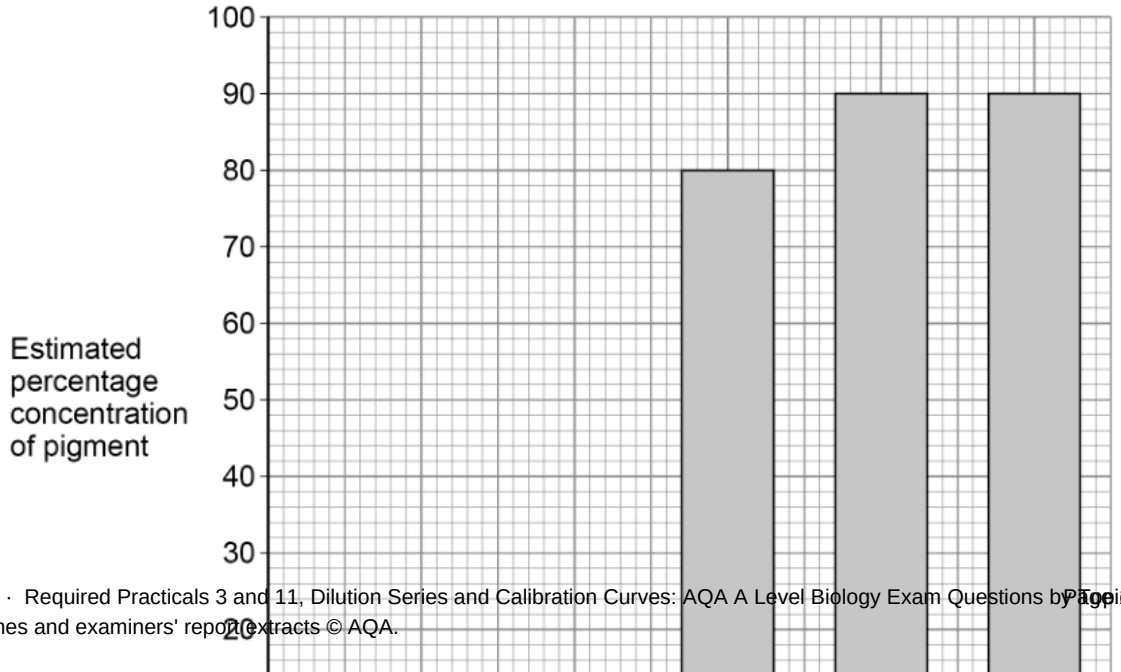
Figure 11



This student used the colours of the dilution series to estimate the percentage concentration of pigment in the boiling tubes at each temperature.

Figure 12 shows the student's results.

Figure 12



Question 12 · AS Paper 1 · June 2025 · Q08.4 · 3 marks

0 8 . 4 Describe how the student could use the dilution series (**Figure 11**, on page 22) and a colorimeter to determine an accurate measurement of the pigment concentration in the tubes at different temperatures.

[3 marks]

Question 13 · information from earlier in the question

0 4 Anthocyanins are coloured pigments found in the cell vacuole of some plant cells. Anthocyanins cannot move across undamaged cell membranes.

A student investigated how to extract anthocyanins from blueberries.

She mixed 10 g of crushed, fresh blueberries with 100 cm^3 of extraction solvent for 1 hour.

She investigated three different extraction solvents:

- **E** – Ethanol, water and acid
- **F** – Ethanol and water
- **G** – Water

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0 4 . 4 A different student did this investigation. He did **not** have a colorimeter.

Describe a method this student could use to prepare colour standards and use them to give data for the total anthocyanin extracted.

[3 marks]

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Mark schemes

Question 1 · AS Paper 1 · June 2017 · Q08.2 · 1 mark

08.2	Dilution series;	1	Accept serial dilution

Question 2 · AS Paper 2 · June 2023 · Q08.1 · 2 marks

08.1

One mark for each row.

If values do not match the given unit, **max 1**.

Concentration of copper sulfate solution / g kg^{-1}	Volume of 100 g kg^{-1} copper sulfate solution / cm^3	Volume of water / cm^3
75	22.5	7.5

2 (2 x AO3)

Accept dm^3 / mm^3 for volume unit.

Accept 0.0225/2.25 × 10^{-2}/22 500 and 0.0075/7.5 × 10^{-3}/7500

Ignore units in 2nd row.

Do not accept mm^{-3}/cm^{-3}/dm^{-3}/ml

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Question 3 · AS Paper 1 · June 2017 · Q08.3 · 3 marks

08.3	1. Axes correct way round with linear scales; 2. Axes labelled with mol dm^{-3} and ratio without units; 3. Correct values correctly plotted and suitable curve drawn;	3	3. Accept point to point or smooth curve but no extrapolation **NFP** – 3. Graph starts just below 1.4 and finishes just above 0.7 and looks right.

Question 4 · AS Paper 1 · November 2021 · Q08.4 · 4 marks

08.4	Independent variable 1. Concentration of (sugar) solution; Determining water potential 2. Plot calibration curve **OR** Graph of ratio against concentration (of sugar); 3. Interpolate from ratio of 1; 4. Change concentration into water potential;	4	1. Accept water potential/dilution for "concentration" 2. Ignore unqualified "plot graph" 3. Accept description of interpolation 4. Accept for example, descriptions using a table/graph to find water potential
TOTAL		**11**	

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06.3	**Mark in groups, either 1 to 4 OR 5 to 8** 1. Record mass/length before **and** after; 2. Place in sea water for (specified/equal) time; 3. Method to remove surface water; 4. Increase in mass/length shows water has been absorbed by osmosis **OR** Increase in mass/length shows cells have lower water potential; **OR** 5. Put tissue/cells on (microscope/glass) slide; 6. Add seawater (and leave) 7. Observe under (optical) microscope; 8. If cells become flaccid they do not have a lower water potential than seawater **OR** (If cells become) turgid cells show water is absorbed by osmosis **OR** (If cells become) turgid cells show cells have a lower water potential **OR** (If cells are) not flaccid/plasmolysis cells show water is not lost by osmosis **OR** (Determine) percentage plasmolysis;	4 (4 x AO3)

Accept 'weight' for 'mass'.

Accept 'diameter' for 'length'.

2. Ignore period of time

2. Accept seawater in

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Question 6 · AS Paper 2 · June 2023 · Q08.2 · 2 marks

08.2	1. Density of 10% protein solution = 1.028; 2. More dense (than 25 g kg^{-1} copper sulfate solution);	2 (2 x AO2)

Question 7 · AS Paper 2 · June 2023 · Q08.3 · 1 mark

08.3	16.5 **and** 22;	1 (AO3)	Must be in correct order

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Question 8 · A level Paper 2 · November 2020 · Q04.2 · 4 marks

04.2	1. Use (distilled) water and creatinine solution to produce dilutions (series); 2. Addition of (creatinine-)detecting solution (to each solution); 3. Using a known/specified/constant volume of a solution (e.g. diluted creatinine solution); 4. Record absorbance/transmission of solution/s using a <u>colorimeter</u>; 5. Plot dilution/concentration of (creatinine) solution against absorbance/transmission;	4 max

1. Accept description of dilutions (series).

2 and 3. The addition of a known/specific volume of (creatinine-)detecting solution = 2 marks.

4 and 5. Accept absorption for 'absorbance'.

4 and 5. Accept description of absorbance or transmission.

4. Reject calorimeter.

Ignore details provided on 'blank'.

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Question 9 · A level Paper 2 · November 2020 · Q04.3 · 2 marks

04.3	1. Use same volumes of solutions as used in producing (calibration curve) **OR** Add (creatinine-)detecting solution (to urine); 2. Read off (creatinine) concentration against absorbance/transmission (value) obtained;	2	1. Ignore 'add indicator' on its own. 1. Ignore calorimeter in this part of the question. 2. Ignore 'line of best fit'. 2. Accept 'compare' for 'read off'.

Question 10 · AS Paper 2 · June 2017 · Q04.4 · 3 marks

04.4	1. Produce known concentrations of <u>protein</u>; 2. Measure absorbance of each concentration OR Measure each concentration with colorimeter; 3. Plot a graph of absorbance on y-axis against concentration (on x-axis) <u>and</u> draw curve; 4. Use absorbance of sample to find protein concentration from curve;	3 max	1. Idea of known concentrations required. Accept % transmission / absorption for absorbance

Question 11 · AS Paper 1 · June 2022 · Q04.3 · 2 marks

04.3	1. (Measure light) absorption/transmission; 2. Interpolate/draw line to curve/line then to pO_2 **OR** Read off (pO_2 figure) against absorbance/transmission value obtained;	2 (2 x AO3)	1. Accept 'absorbance' for absorption

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Question 12 · AS Paper 1 · June 2025 · Q08.4 · 3 marks

08.4	1. (Use colorimeter to) measure absorbance/transmission of diluted solutions/series/standards; 2. Produce a calibration curve; 3. Measure absorbance/transmission of sample **and** find concentration (on calibration curve);	3 (3 x AO3)

1. Accept description of absorbance or transmission 2. Accept descriptions of calibration curve

Question 13 · A level Paper 1 · November 2020 · Q04.4 · 3 marks

04.4	1. Use known concentration of blueberry juice/extract OR Use known concentration of anthocyanin/pigment (solution) OR Use known concentration of (extraction) solvent to be added to blueberries; 2. Prepare dilution series; 3. Compare (results) with colour standards to give score/value/concentration;	3	2. Accept descriptions and 'serial dilutions' 2. Accept dilution series in terms of pigment or solvent. 3. For 'colour standards' accept 'dilutions'.

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