



General Certificate of Education
Advanced Subsidiary Examination
June 2013

Biology

BIO3X/TN

Unit 3X AS Externally Marked Practical Assignment

Teachers' Notes

Confidential

A copy should be given immediately to the teacher responsible for GCE Biology

Open on receipt

Estimated entries must be submitted to AQA in order for centres to receive hard copies of the materials to be used for candidates.

Teachers' Notes**Confidential**

These notes must be read in conjunction with *Instructions for the Administration of the EMPA: GCE Biology* published on the AQA Website.

The effect of surface area to volume ratio on the uptake of a substance**Introduction**

Candidates are provided with a large block of agar which has been stained with cresol red dye.

Task 1

Candidates will cut the block of agar into two different sized pieces to obtain one larger piece and one smaller piece. They will then drop these pieces into 1.0 mol dm^{-3} hydrochloric acid and time how long it takes for each piece to change colour completely from red to orange.

Task 2

Candidates will make model cells by cutting cubes of agar of different sizes from a block of agar stained with cresol red. They will investigate the effect of surface area to volume ratio on the time taken for the cresol red to change colour completely from red to orange.

Materials**Task 1**

In addition to access to general laboratory equipment, each candidate needs the following:

- block of agar jelly stained with cresol red dye (one block from an ice cube tray or other type of tray – block needs to be large enough to cut two pieces $10 \text{ mm} \times 10 \text{ mm} \times 10 \text{ mm}$)
- scalpel
- 100 cm^3 beaker
- 50 cm^3 1.0 mol dm^{-3} hydrochloric acid
- white tile or light-coloured bench mat
- timer
- ruler with millimetre measurements
- forceps.

Task 2

In addition to access to general laboratory equipment, each candidate needs the following:

- block of agar jelly stained with cresol red dye (block from an ice cube tray or other type of tray) – needs to be large enough to cut cubes of the following dimensions
 - 13 mm × 13 mm × 13 mm
 - 10 mm × 10 mm × 10 mm
 - 7 mm × 7 mm × 7 mm
 - 5 mm × 5 mm × 5 mm
 - 3 mm × 3 mm × 3 mm
- scalpel
- 100 cm³ beaker
- 50 cm³ 1.0 mol dm⁻³ hydrochloric acid
- white tile or light-coloured bench mat
- timer
- ruler with millimetre measurements
- forceps.

Centres should have additional blocks of stained agar jelly available in case candidates make errors and require another block.

Technical Information**The tasks must be trialled before use.**

The investigation has been successfully trialled using the following method.

Bring 7 g of agar powder mixed with 250 cm³ water to the boil. Add 15 cm³ of cresol red dye to the mixture and allow it to cool slightly. Add 6 cm³ of 2 mol dm⁻³ ammonia and stir the mixture. Pour this mixture into ice cube trays and store in a fridge in a sealed bag.

This amount makes approximately 14 blocks in an ice cube tray (30 mm × 20 mm × 20 mm). The colour fades over time so it is best to make it fresh. Blocks can be stored for up to one week in a fridge but must be brought to room temperature before use.

Cresol red dye may be purchased as a solution or can be prepared by dissolving 0.5 g cresol red powder in 20 cm³ ethanol, then adding 30 cm³ distilled water.

Additional Information

AQA might publish Additional Information about an ISA/EMPA practical. This will be placed on e-AQA in Secure Key Materials. We will email Exam Officers who have downloaded the particular Teachers' Notes so they can print a copy for the Head of Biology. Additional Information will cover issues such as suitable suppliers or suggestions about getting a practical to work.

Turn over ►

Information to be given to candidates

Candidates must **not** be given information about the EMPA until one week before Task 1. One week before Task 1, teachers may give their candidates the following information.

You will investigate the effect of surface area to volume ratio on the uptake of a substance.

In addition, you will need to understand the following topics:

- diffusion
- the effects of emphysema on lung function
- cigarette smoking and the risk of coronary heart disease
- size and surface area
- gas exchange.

There must be **no** further discussion and candidates must **not** be provided with any further resources to prepare for the assessment.

In this investigation, teachers must not give candidates the following information:

- when the pieces of agar have changed colour completely.

Task 1

Introduction

You are provided with a large block of agar which has been stained with cresol red dye. Cresol red is an indicator which is red in alkaline conditions and orange in acidic conditions. You will cut this block of agar into two different sized pieces to obtain one larger piece and one smaller piece. You will then drop these pieces into dilute hydrochloric acid and time how long it takes for each piece to change colour completely from red to orange.

Materials

You are provided with:

- a block of agar jelly stained with cresol red dye
- scalpel
- 100 cm³ beaker
- dilute hydrochloric acid
- white tile
- timer
- ruler with millimetre measurements
- forceps.

You may ask your teacher for any other apparatus you require.

Method

Read these instructions carefully before you start your investigation.

1. Place the block of agar on the white tile. Making sure that the scalpel blade is vertical, cut the block to produce two cubes each measuring 10 mm × 10 mm × 10 mm. Keep one as your large piece of agar.
2. Cut the other cube in half to produce two smaller pieces, each measuring 10 mm × 10 mm × 5 mm. Keep one as your small piece of agar.
3. Stand the beaker on the white tile. Pour dilute hydrochloric acid into the beaker until it is half full.
4. Carefully place the large piece and one of the smaller pieces of agar into the beaker and start the timer. Make sure that the two pieces do **not** touch each other.
5. Observe the colour change as the acid penetrates the agar.
6. Time in seconds how long it takes each piece to change colour completely from red to orange and record your results in the table on page 3.

You must decide for yourself:

- when the pieces of agar have changed colour completely.

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Recording your results

Complete the table.

Size of piece of agar / mm	Time for agar to completely change colour from red to orange / seconds
10 × 10 × 10	
10 × 10 × 5	

Teacher use only

Questions on Task 1

Answer **all** questions in the spaces provided.

- 1** You were told to cut your pieces of agar from the same block (steps 1 and 2). Suggest why this was important.
- 2** You did not add a fixed volume of acid to the beaker (step 3). Why was it **not** necessary to use a fixed volume of acid?
- 3 (a)** You were told to make sure that the pieces of agar did **not** touch each other when they were in the acid (step 4).

Explain why this was important.
- 3 (b)** During this time in the acid, the pieces of agar may have had one face in contact with the beaker which could have affected your results.

Suggest how the method could be modified to reduce this problem.
- 4** When you placed your pieces of agar in the acid (step 4), the indicator gradually changed colour from red to orange.
Explain why.
- 5** You investigated the effect of size on the difference in time taken for the pieces of agar to change colour from red to orange.

Explain your results.

END OF TASK 1

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Task 2

Introduction

Cells absorb substances across their cell surface membranes. In Task 2, you will make model cells by cutting cubes of agar of different sizes out of a block of agar stained with cresol red. You will investigate the effect of different surface area to volume ratios on the time it takes cubes of different sizes to turn completely from red to orange.

Materials

You are provided with:

- a block of agar stained with cresol red dye
- scalpel
- 100 cm³ beaker
- dilute hydrochloric acid
- white tile
- timer
- ruler with millimetre measurements
- forceps.

You may ask your teacher for any other apparatus you require.

Method

Read these instructions carefully before you start your investigation.

1. Place the agar block on the white tile.
2. Making sure that the scalpel blade is vertical, cut any curved edges off the agar to form a rectangular block.
3. From this block, cut five cubes with the following dimensions:

Cube 1 - 13 mm × 13 mm × 13 mm

Cube 2 - 10 mm × 10 mm × 10 mm

Cube 3 - 7 mm × 7 mm × 7 mm

Cube 4 - 5 mm × 5 mm × 5 mm

Cube 5 - 3 mm × 3 mm × 3 mm

4. Stand the beaker on the white tile. Pour dilute hydrochloric acid into the beaker until it is half full.
5. Drop all the cubes into the beaker at the same time and start the timer. Make sure that the cubes do **not** touch each other.
6. Time in seconds how long it takes each cube to change colour completely from red to orange and record your results.

You must decide for yourself:

- when each cube has changed colour completely.

Presenting your data

- 6 Record the results of your investigation in an appropriate table in the space below. Hand in this sheet at the end of each practical session.
- 7 You will be awarded up to 2 marks for the quality of your practical work.
- 8 The table shows the surface area to volume ratio for each cube. To make it easier for you to plot your graph, the surface area to volume ratios have been shown as decimals. For example, the ratio 1 : 2.16 is expressed as 0.46.

Size / mm	Surface area to volume ratio
$13 \times 13 \times 13$	0.46
$10 \times 10 \times 10$	0.60
$7 \times 7 \times 7$	0.86
$5 \times 5 \times 5$	1.20
$3 \times 3 \times 3$	2.00

- 8 (a) Explain how the surface area to volume ratios were calculated.

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- 8 (b) Use the graph paper to plot an appropriate graph using the surface area to volume ratios in the table opposite and your own data.



END OF TASK 2

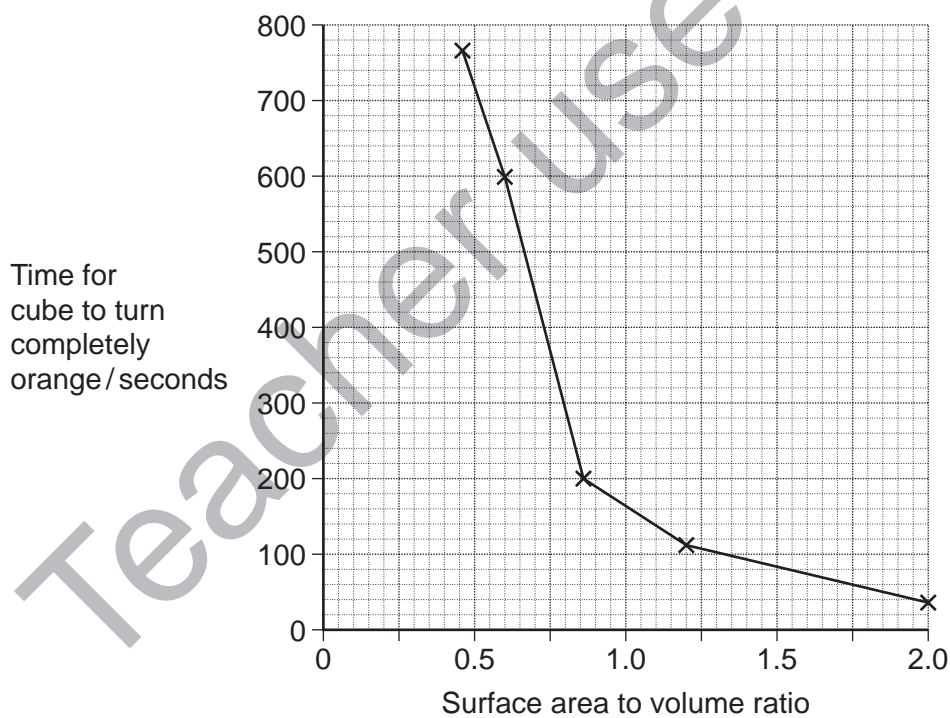
Section A

These questions are about your investigation into the effect of surface area to volume ratio on the uptake of a substance.

Use your copy of Task Sheet 2, your results and your graph to answer the questions.

Answer **all** questions in the spaces provided.

- 9** Other than surface area and volume, give **one** variable that could have affected diffusion in this investigation.
- Explain how this variable would affect diffusion of acid into the agar.
- 10** Suggest **two** limitations of the method you used that could have affected your results.
- 11** You used agar cubes as model cells to find the relationship between surface area to volume ratio and the rate of diffusion.
- Evaluate the use of agar cubes as model cells in this investigation.
- 12** A student carried out a similar investigation to yours. The graph shows her results.



- 12 (a)** Describe her results.

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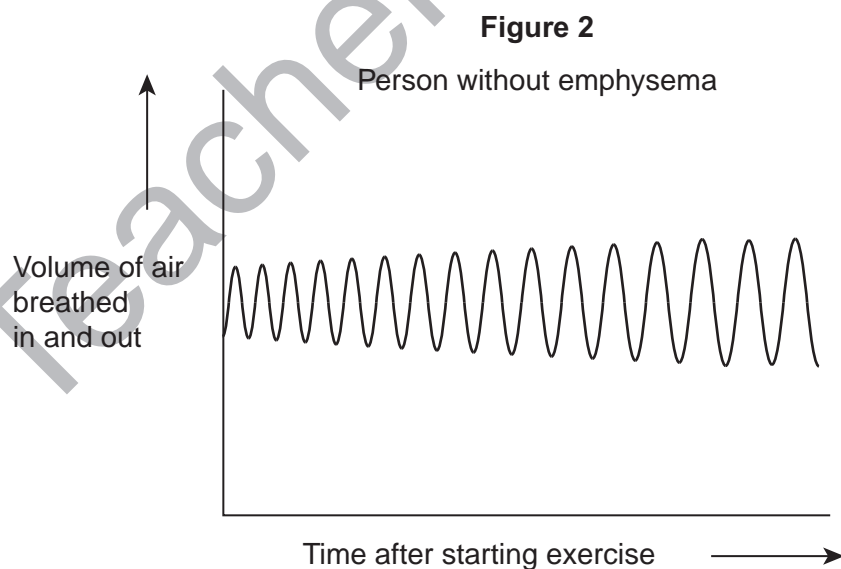
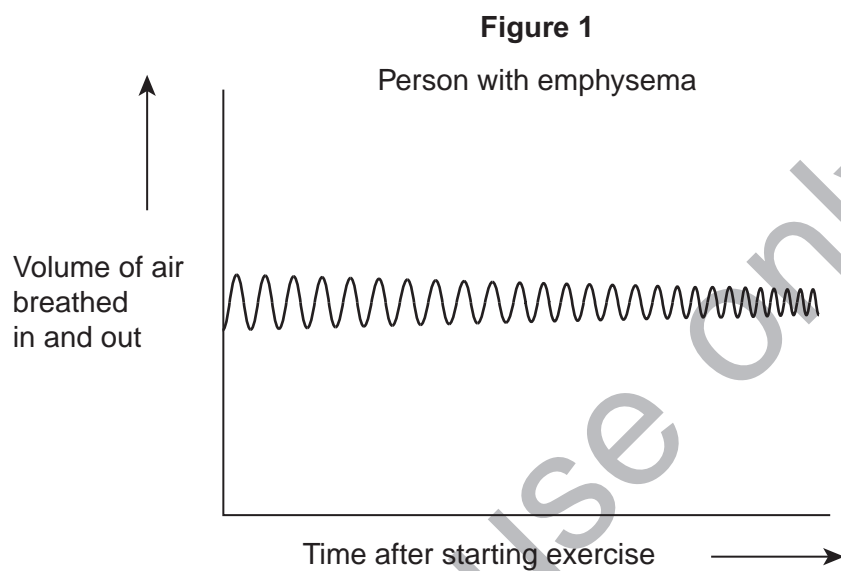
- 12 (b)** She used agar cubes as models to investigate the hypothesis that very small animals are able to carry out efficient gas exchange without gas exchange surfaces such as gills or lungs.
- Explain how her data support this hypothesis.
- 13** The student also used her results to explain the advantage of some adaptations of the leaves of xerophytes.
- Suggest and explain how **one** adaptation of the leaves of xerophytes affects surface area to volume ratio and water loss.
- 14** Another student carried out a similar investigation to yours but he used different concentrations of acid with agar cubes all measuring $10\text{ mm} \times 10\text{ mm} \times 10\text{ mm}$. As in your investigation, he obtained a range of times for the agar cubes to change colour.
- Explain why.

Teacher use only

Resource Sheet**Resource A**

Emphysema is a disease which affects lung function.

A doctor measured the rate and volume of breathing of a person with emphysema after he started exercise, **Figure 1**. The doctor made the same measurements for a person without emphysema, **Figure 2**.

**Turn over ►**

Resource B

Doctors investigated the effect of the smoking habits of men on their non-smoking wives.

The doctors recruited 540 non-smoking women aged 40 or older. They divided these women into groups according to the smoking habits of their husbands.

After 14 years, the doctors recorded how many of the wives had died and their cause of death. They used these data to determine the relative risk of a wife dying from a particular disease according to her husband's smoking habit.

In this comparison, they gave the relative risk to the wife of a non-smoker as 1.00. A value greater than 1.00 shows an increased risk compared to the wife of a non-smoker.

The results are shown in **Figure 3**.

Figure 3

Cause of death	Relative risk of wife dying		
	Husband non-smoker	Husband smokes 1 to 19 cigarettes / day	Husband smokes more than 19 cigarettes / day
Lung cancer	1.00	1.61	2.08
Emphysema	1.00	1.29	1.49
Cervical cancer	1.00	1.15	1.14
Stomach cancer	1.00	1.02	0.99
Heart disease	1.00	0.97	1.03

Section B

Use the information in the **Resource Sheet** and your own knowledge to answer the questions.

Answer **all** questions in the spaces provided.

Use **Resource A** to answer **Questions 15 to 18**.

15 Describe **two** differences between the breathing of a person with emphysema and a person without emphysema.

16 The person with emphysema found it difficult to carry out the exercise.

Explain why.

17 People suffering from emphysema have less elastic tissue in their lungs.

Explain how this affects the efficiency of gas exchange in the alveoli.

18 (a) Micrographs of lung tissue taken from people with emphysema show large air spaces compared with lung tissue from healthy people.

Explain why.

18 (b) Explain why the presence of these large air spaces reduces gas exchange.

Use **Resource B** to answer **Questions 19 to 20**.

19 A journalist concluded from these data that if a husband smoked, it greatly increased the risk of his wife dying of certain diseases. Evaluate this statement.

20 The doctors told the men who smoked that continuing to smoke cigarettes would increase their risk of suffering heart disease in later life.

Explain how smoking cigarettes increases the risk of developing heart disease.

END OF QUESTIONS