# International GCSE Human Biology

## Core Practicals

CP1: Investigate the qualitative and quantitative content of vitamin C in food

CP2: Investigate the energy content of food

CP3: Investigate the effect of temperature and pH on enzyme activity

CP4: Investigate the action of immobilised enzymes including the preparation of alginate beads

CP5: Investigate the number and position of sensory receptors, such as touch and temperature receptors in the skin

CP6: Investigate the range of frequency audible to the human ear

CP7: Investigate the difference between inspired and expired air for carbon dioxide concentration

CP8: Investigate the effect of exercise on the rate of breathing and measure lung capacity

CP9: Investigate the effect of exercise on the pulse rate

CP10: Investigate diffusion using a partially-permeable membrane such as Visking tubing

## CORE PRACTICAL 1

# 2.4 Investigate the qualitative and quantitative content of vitamin C in food

### Links to the specification content

| | |
|---|---|
| 2.4 | Practical: investigate the qualitative and quantitative content of vitamin C in food |
| 6.1 | explain the importance of a balanced diet including the recommended dietary intake of carbohydrates, fats, proteins, vitamins A and C, calcium, iron and fibre |
| 6.2 | understand variations in diet related to age, pregnancy, climate and occupation |
| 6.3 | know the sources and functions of carbohydrates, proteins, lipids (fats and oils), vitamins A, C and D, and the mineral ions, calcium and iron |
| 6.4 | describe the causes and symptoms of deficiency diseases limited to scurvy (lack of vitamin C), anaemia (lack of iron), blindness (lack of vitamin A) and Kwashiorkor (lack of protein) |
| 6.10 | know the types, structure and functions of teeth, the factors that affect their growth and how to care for teeth and gums |
| 9.2 | understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy |

### Introducing the practical

There are a couple of ways you can estimate vitamin C content of food – for example the quantity of vitamin C can be estimated using a simple colour test: vitamin C turns DCPIP from blue to colourless. Students could investigate different fruit juices measuring, for example, the volume of juice required to turn a set volume of DCPIP (eg 1 $cm^3$ of 0.1% solution) from blue to colourless. Depending on the apparatus available, this practical could be readily extended using burettes and titrating the fruit juices.

Note that blackcurrant juice is dark so can be difficult to assess in this practical.

Alternatively, a simple investigation using iodine and starch could be carried out. If iodine solution is added to a starch solution, it turns blue-black. If iodine solution is added to a solution containing vitamin C and starch, it reacts with both the starch and vitamin C - a permanent blue-black colour only develops after iodine has reacted with all of the vitamin C in the solution. Students could measure the volume of iodine solution they need to add to turn the solution permanently blue-black and use this as a measure of the amount of vitamin C. They could for example extract the juice (using a blender and muslin cloth) from raw and boiled potatoes and use this method to compare the vitamin C content in the uncooked and cooked potatoes.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- How can you measure the volumes of fruit juices precisely?
- Are the end points / colour changes clear?
    - If not what are you going to do?
    - How can you decide the end point?
- What foods are the richest sources of vitamin C?
- How does the vitamin C content of drinks marketed as 'healthy' compare to other drinks?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts or graphs
- Understand the terms mode and median
- Plot two variables (discrete and continuous) from experimental or other data

## CORE PRACTICAL 2

# 2.5 Investigate the energy content in a food sample

### Links to the specification content

| | |
|---|---|
| 2.5 | Practical: investigate the energy content of food |
| 2.1 | know the chemical elements present in carbohydrates, proteins and lipids (fats and oils) |
| 2.2 | understand the structure of carbohydrates, proteins and lipids as large molecules made up from smaller basic units:<br>• starch and glycogen from simple sugars<br>• protein from amino acids<br>• lipids from fatty acids and glycerol. |
| 4.5 | understand the dietary factors controlling the healthy development of muscle and bone |
| 6.1 | explain the importance of a balanced diet including the recommended dietary intake of carbohydrates, fats, proteins, vitamins A and C, calcium, iron and fibre |
| 6.2 | understand variations in diet related to age, pregnancy, climate and occupation |
| 6.3 | know the sources and functions of carbohydrates, proteins, lipids (fats and oils), vitamins A, C and D, and the mineral ions, calcium and iron |
| 6.11 | understand BMI, including the calculation of BMI, and the role of obesity as a risk factor in early onset of diabetes and the significance of high cholesterol levels in atherosclerosis |
| 7.1 | know that the process of respiration releases energy in living organisms |
| 9.2 | understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy |

### Introducing the practical

To investigate the energy content of food, students can burn a known mass of the food stuff and use the heat energy released to heat a known volume of water.

Suitable foods are potato crisps or puffed wheat snacks. These can be obtained as low fat or reduced fat versions and a comparison can be made to the normal versions. The food stuff is lit in a Bunsen then transferred under a boiling tube of water and the temperature change of the water is recorded. If the food goes out it needs to be relit until it will no longer burn.

It is also informative to calculate the energy released from the food and compare this to the values given on the packets.

Nuts should not be used as some students may have allergies.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- Why is the energy value we calculate much less than the value on the packet?
- Why do individual student results show variation?
- How can we improve our method to obtain the most accurate and valid measurement we can using this apparatus?
- How could we improve our apparatus to deliver an energy value nearer to the published value?
- How does the energy value relate to the nutritional information on the food packet?

**Skills that are covered in the practical**

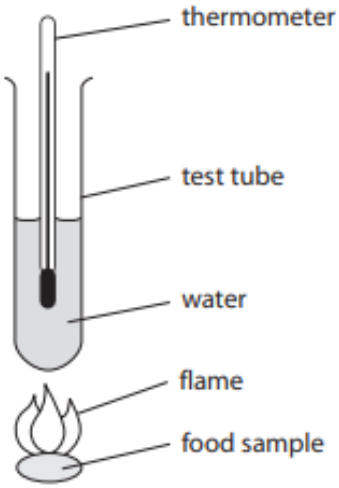
- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Recognise and use numbers in standard form
- Use ratios, fractions, percentages, powers and roots
- Make estimates of the results of simple calculations, without using a calculator
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Understand the principles of sampling as applied to scientific data
- Understand the terms mode and median
- Substitute numerical values into algebraic equations using appropriate units for physical quantities
- Plot two variables (discrete and continuous) from experimental or other data

**PAST PAPER QUESTION**

**6** This apparatus is used to investigate the amount of energy available in food.




(a) (i) Describe how the apparatus can be used to investigate the energy available in different foods.

(4)

(ii) A student uses this apparatus to compare the amount of energy available in two different foods.

What variable should she control to obtain valid results?

(1)

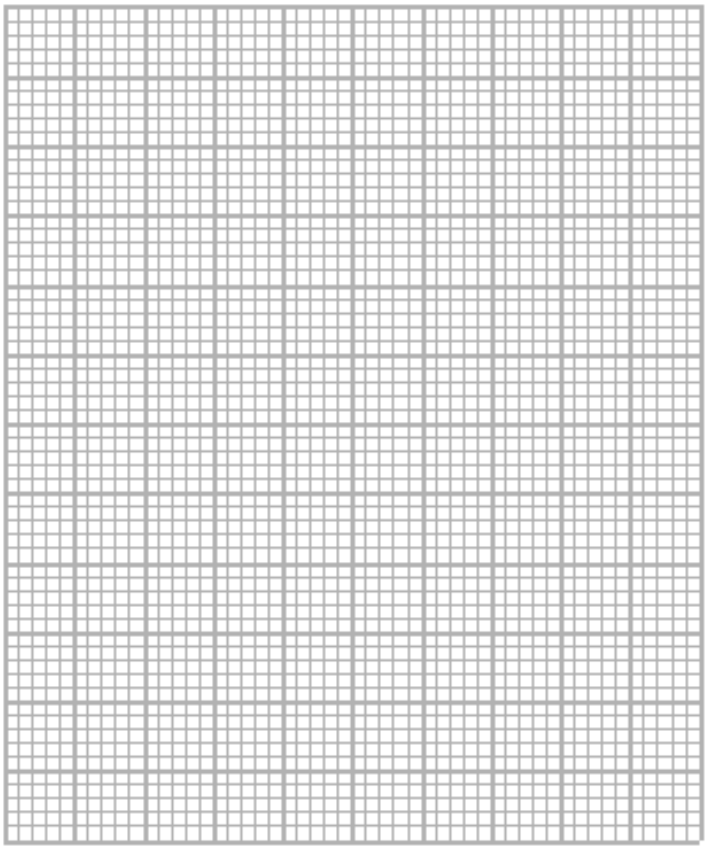
(b) The amount of energy available is measured in kilojoules (kJ).

The table shows the amount of energy available per 10 g of different foods.

| Food type | Energy available per 10 grams of food (kJ) |
|---|---|
| broccoli | 10 |
| orange | 25 |
| bread | 50 |
| chicken | 120 |
| butter | 300 |

(i) Draw a bar graph to display the data from the table.

(5)



(ii) Suggest three reasons for the variation in the amount of energy available in the different foods.

**(3)**

(c) Explain why the average daily energy requirement for teenage males is different from the requirement for males over 60 years of age.

**(2)**

**(Total for Question 6 = 15 marks)**

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **6(a)(i)** | A description that includes four from:<br><br>• measure out a known volume of water;<br>• take the starting temperature of the water;<br>• burn food;<br>• use the heat released to heat the water/temperature of water rises;<br>• measure the temperature once the food has stopped burning/after a set amount of time;<br>• calculate temperature change/increase;<br>• greater temperature change/increase indicates more energy in food; | | (4) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **6(a)(ii)** | Any one from:<br><br>• volume of water;<br>• mass of food;<br>• distance of food from water;<br>• length of time food is burning for; | | (1) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **6(b)(i)** | axes labelled correctly(food type vs energy available);<br>units for axes labels (kJ);<br>correct scale;<br>bars drawn correctly;<br>bars label correctly; | Max 3 marks if line graph drawn | (5) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **6(b)(ii)** | An suggestion that includes three from:<br>• more energy available in butter;<br>• butter contains the most fat;<br>• fat has a high energy content;<br>• bread is a good source of carbohydrate;<br>• carbohydrates contain energy;<br>• broccoli/vegetables/oranges/fruit are a poor sources of energy/ correct statement about other food shown;<br>• as they contain little/no fat/carbohydrates/contain cellulose; | Ignore chicken<br>Allow more kiloJoules | (3) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **6(c)** | An explanation including two of the following:<br>• teenage males need more energy;<br>• as they are more active;<br>• higher metabolism;<br>• still growing;<br>• greater muscle:fat ratio; | Accept reverse argument | (2) |

## CORE PRACTICAL 3

# 2.8 Investigate the effect of temperature and pH on enzyme activity

### Links to the specification content

| | |
|---|---|
| 2.6 | explain the role of enzymes as biological catalysts in metabolic reactions |
| 2.7 | explain the action of enzymes and how their activity is affected by:<br>• temperature<br>• pH<br>• substrate concentration<br>• competitive and non-competitive inhibitors. |
| 2.8 | Practical: investigate the effect of temperature and pH on enzyme activity |
| 6.7 | understand the role of digestive enzymes including:<br>• their site of production and action<br>• the digestion of starch to glucose by amylase and maltase<br>• the digestion of proteins to amino acids by proteases (pepsin, trypsin)<br>• the digestion of lipids to fatty acids and glycerol by lipases. |

### Introducing the practical

#### (a) Investigating temperature

The enzyme system used depends upon student familiarity with different enzymes.

The digestion of starch by amylase can be used with students using potassium iodide to detect the presence of starch. If the concentrations and volumes are appropriate then the digestion of the starch will be not too fast or too slow. Students are looking for the time at which the digestion mixture no longer contains any starch. This experiment can then be repeated at different temperatures.

If the practical is done at room temperature first say 25 $^{o}$C then it can be repeated by different groups within a class at a range of temperatures and data pooled.

Students will need to understand the relationship between the time taken for digestion to be completed and rate of reaction.

It is of course possible to use other enzymes, such as catalase from potato, with hydrogen peroxide as the substrate. In this case you can measure the rate of reaction directly by measuring the volume of oxygen evolved at each temperature.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- What is the relationship between time taken for starch to be digested and rate of reaction?
- What are the independent, dependent and control variables in the investigation?
- How can we ensure that all the reagents are at the correct temperature during the experiment?
- What happens to the starch during the course of the reaction?
- How could we use our knowledge of other food tests to check what has happened to the starch?
- Explain why temperature affects enzyme action.

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret graphs
- Understand the terms mode and median
- Translate information between graphical and numerical form
- Plot two variables (discrete and continuous) from experimental or other data

**PAST PAPER QUESTION**

**2** (a) Milk contains fat which can be broken down by the enzyme lipase.

A student uses this method to investigate the effect of temperature on the action of lipase.

- add a solution containing lipase to equal volumes of milk in four different test tubes
- incubate each test tube at different temperatures for 20 minutes
- record the pH of each milk solution every two minutes

The table shows the change in the pH of the milk and lipase solution, at each temperature, over the 20-minute period.

| Temperature in °C | Time in minutes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| 30 | pH9 | pH9 | pH9 | pH9 | pH9 | pH8 | pH8 | pH7 | pH6 | pH6 |
| 40 | pH9 | pH8 | pH7 | pH7 | pH6 | pH6 | pH6 | pH6 | pH6 | pH6 |
| 50 | pH9 | pH9 | pH9 | pH9 | pH8 | pH8 | pH7 | pH7 | pH7 | pH6 |
| 60 | pH9 | pH9 | pH9 | pH9 | pH9 | pH9 | pH9 | pH9 | pH9 | pH9 |

(i) Explain the results of the investigation at 40 °C.

**(2)**

(ii) Explain why the results at 30 °C are different from the results at 40 °C.

**(2)**

(iii) Explain why the results at 60 °C are different from the results at 40 °C.

**(2)**

(iv) State one way that measurements of pH might have been taken during the investigation.

**(1)**

(v) Explain why the results of the investigation would differ if bile was added to the lipase and milk solution at the beginning of the investigation.

**(3)**

(b) Describe how the structure of the small intestine helps absorption of the products of fat digestion.

**(3)**

**(Total for Question 2 = 13 marks)**

| Question Number | Answer | Notes | Marks |
|---|---|---|---|
| **2(a)(i)** | An explanation including two from:<br><br>• lipase/enzyme breaks down fat;<br>• produces fatty acids;<br>• pH (of solution) decreases/changes from alkali to acid;<br>• 40 °C optimum temperature/fastest rate of reaction at 40 °C;<br><br>• All fat broken down by 10 minutes; | Accept enzyme works best at 40 °C<br>Ignore references to body temperature/37 °C | (2) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **2(a)(ii)** | An explanation including two from:<br><br>• less (kinetic) energy at 30 °C;<br>• less chance of enzyme and substrate colliding;<br>• slower rate of reaction / enzyme works more slowly (at 30 °C); | Allow reverse argument for 40 °C | (2) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **2(a)(iii)** | An explanation including two from:<br><br>• enzyme denatured/inactive;<br>• active site changed shape;<br>• shape no longer complementary to substrate;<br>• no enzyme:substrate complexes formed;<br>• no fatty acids produced to lower pH; | | (2) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **2(a)(iv)** | using a pH probe/pH meter/ indicator paper/solution; | Do not allow litmus paper / phenolphthalein / methyl orange | (1) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **2(a)(v)** | An explanation including three from:<br>• bile emulsifies fats/breaks down large droplets to smaller droplets;<br>• increases surface area;<br>• faster reaction/breakdown of fats;<br>• pH drop more rapid; | Ignore bile breaks down fat / molecule X | (3) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| **2(b)** | An explanation including three from:<br>• villi/microvilli/long length;<br>• increase surface area (of small intestine);<br>• wall one cell thick;<br>• faster absorption / diffusion/shorter diffusion distance;<br>• into lacteal;<br>• into lymphatic system; | Allow thin wall | (3) |

## Introducing the practical

### (b) pH

The enzyme system used depends upon student familiarity with different enzymes.

The digestion of starch by amylase can be used with students using potassium iodide to detect the presence of starch. If the concentrations and volumes are appropriate then the digestion of the starch will be not too fast or too slow. Students are looking for the time at which the digestion mixture no longer contains any starch. This experiment can then be repeated at different pH. The pH can be altered by adding 1 $cm^3$ sodium carbonate solution, 0.5 $cm^3$ sodium carbonate solution, 2 $cm^3$ ethanoic (acetic) acid or 4 $cm^3$ ethanoic (acetic) acid. The pH of each solution can be determined by using universal indicator paper.

If the practical is done at pH 7, nothing added, then it can be repeated by different groups within a class at a range of pHs and data pooled.

Students will need to understand the relationship between time taken for digestion to be completed and rate of reaction.

It is of course possible to use other enzymes such as catalase from potato with hydrogen peroxide as the substrate. In this case you can measure the rate of reaction directly by measuring the volume of oxygen evolved at each pH.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- What is the relationship between time taken for starch to be digested and rate of reaction?
- What are the independent, dependent and control variables in the investigation?
- Explain why pH affects enzyme action.
- Why would this practical be difficult using protease enzymes?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret graphs
- Understand the terms mode and median
- Translate information between graphical and numerical form
- Plot two variables (discrete and continuous) from experimental or other data

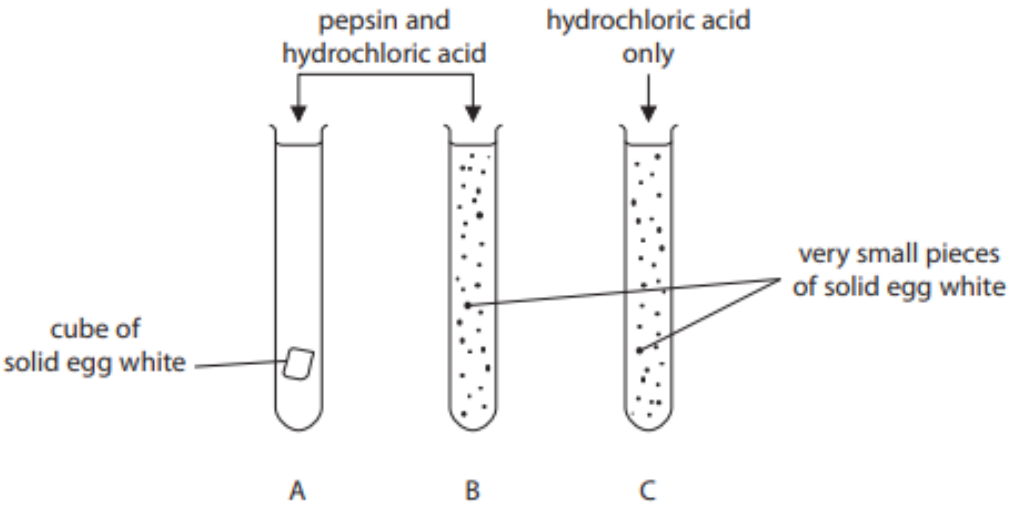
**PAST PAPER QUESTION**

**4** A student investigates the effect of the enzyme pepsin on solid egg white (protein).

This is the student's method.

- place a 1g cube of solid egg white in tube A
- place 1g of very small pieces of solid egg white in each of tubes B and C
- add pepsin to tubes A and B
- add hydrochloric acid to all three tubes
- leave the tubes at 37°C for 30 minutes

The diagram shows the student's investigation.




During the 30 minute period, the cube of egg white in tube A becomes smaller and the very small pieces of egg white in tube B disappear.

(a) (i) State where this reaction takes place in the human body.

**(1)**

(ii) State why hydrochloric acid is added to tubes A and B.

**(1)**

(iii) Explain the results observed in tubes A and B.

**(4)**

(iv) After 30 minutes the student does a biuret test to see if protein is still present in tube B.

Explain why this test is positive for protein.

**(2)**

(b) (i) Explain what results would be expected for tube C after 30 minutes.

**(2)**

(ii) Explain the purpose of tube C in the investigation.

**(2)**

**(Total for Question 4 = 12 marks)**

| | | | |
|---|---|---|---|
| 4 (a) (i) | stomach; | | 1 |
| (ii) | provide optimum pH/to simulate conditions in stomach; | Allow pepsin works best in acidic conditions/pH2 | 1 |
| (iii) | • pepsin digests/breaks down protein/egg white/substrate;<br>• into amino acids;<br>• smaller surface area of protein in A/larger in B;<br>• so process more rapid in tube B/slower in A;<br>• for enzyme to act on; | | 4 |
| (iv) | 2 from:<br>• pepsin/enzyme still present;<br>• pepsin is a protein/enzymes are proteins;<br>• not enough time for complete digestion (of protein/egg white) | Allow incomplete digestion | 2 |
| (b) (i) | • no (visible) change/protein/egg white still present/egg white not broken down;<br>• no pepsin/enzyme present; | | 2 |
| (ii) | • control;<br>• to prove that pepsin is responsible for the action/that HCl is not responsible/has an effect; | | 2 |
| | | | Total 12 |

# CORE PRACTICAL 4

## 2.10 Investigate the action of immobilised enzymes including the preparation of alginate beads

### Links to the specification content

| | |
|---|---|
| 2.6 | explain the role of enzymes as biological catalysts in metabolic reactions |
| 2.7 | explain the action of enzymes and how their activity is affected by:<br>• temperature<br>• pH<br>• substrate concentration<br>• competitive and non-competitive inhibitors. |
| 2.8 | Practical: investigate the effect of temperature and pH on enzyme activity |
| 2.9 | describe the advantages of using immobilised enzymes in:<br>• the production of lactose-free milk<br>• the conversion of sucrose into glucose and fructose<br>• glucose testing strips for diabetics. |
| 6.7 | understand the role of digestive enzymes including:<br>• their site of production and action<br>• the digestion of starch to glucose by amylase and maltase<br>• the digestion of proteins to amino acids by proteases (pepsin, trypsin)<br>• the digestion of lipids to fatty acids and glycerol by lipases. |

### Introducing the practical

A very nice experiment can be done here using immobilised lactase to breakdown lactose in milk. If enough time pupils can prepare the beads themselves which is very satisfying indeed! Lactase is mixed with sodium alginate solution, then draw up into small syringe. The alginate-enzyme is released one drop at a time into calcium chloride solution and the beads immediately form.

The beads can then be put into a larger syringe and milk poured over the beads and left to drain out of the bottom. The milk can be tested before treatment and after one or more runs over the beads using the glucose test strips to estimate glucose concentration. Before treatment should show no glucose present, but progressively more runs of the milk over the beads show increasing concentrations of glucose present.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- Why do the test strips only test for glucose (enzyme lock and key idea)?
- Why does more glucose appear if you run the milk over the beads more times?
- How could you scale up this process to produce commercial quantities of lactose free milk?
- Why immobilise the enzyme for this process? What are the benefits?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills:**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Make estimates of the results of simple calculations, without using a calculator
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts or line graphs
- Understand the terms mode and median
- Translate information between graphical and numerical form
- Plot two variables (discrete and continuous) from experimental or other data

# CORE PRACTICAL 5

## 5.7 Investigate the number and position of sensory receptors, such as touch and temperature receptors in the skin

### Links to the specification content

| | |
|---|---|
| 5.1 | know the structure of neurones: sensory, motor and relay |
| 5.4 | know the structure and functions of the spinal cord and the structure of a reflex arc |
| 5.5 | understand that the body contains receptors that can detect the stimuli for light, temperature, pressure/pain and taste |
| 5.6 | describe the pathway taken by a nerve impulse to cause a response to a stimulus |
| 5.7 | Practical: investigate the number and position of sensory receptors, such as touch and temperature receptors in the skin |
| 5.8 | understand how nerve impulses are initiated, the direction of movement of an impulse along a neurone and transmission across a synapse |

### Introducing the practical

A simple investigation can highlight the different number/density of touch or pressure receptors in the skin. This experiment assumes that one 'touch' is detected or felt when one receptor is stimulated, and two 'touches' are felt when two different receptors are stimulated. Pupils can work in pairs and data pooled to get repeats to analyse. This experiment is really effective on the arm working away from the wrist. However, different areas of the skin can be compared – for example the back of the hand, cheeks, forehead and the back of the neck.

Use hairgrips, callipers or unfolded paper clips with two points a known distance apart (for example repeat the experiment with the points 1cm, 2cm and 3cm apart). The experiment is best done in pairs and the pupils take it in turns to be blindfolded and tested. Their skin is touched gently with either one or both points and the pupil has to state if they are being touched with one or two points. Different parts of the body and the points at different distances apart reveal surprising and interesting results which can be analysed in a variety of ways depending on how you carried out the experiment.

One interesting variation on this is to keep the distance apart the same, but test whether the test pupil can detect one or two points working up the arm away from the wrist. The further away from the wrist the harder it gets!

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- Which parts of the body have the most receptors?
- Why should this be? What is the evolutionary advantage of some bits being more sensitive to touch than others?
- Why are the parts of the body you have identified more sensitive?
- How could you devise an experiment to test the density of other types of receptor for example temperature receptors in the hand and arms?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

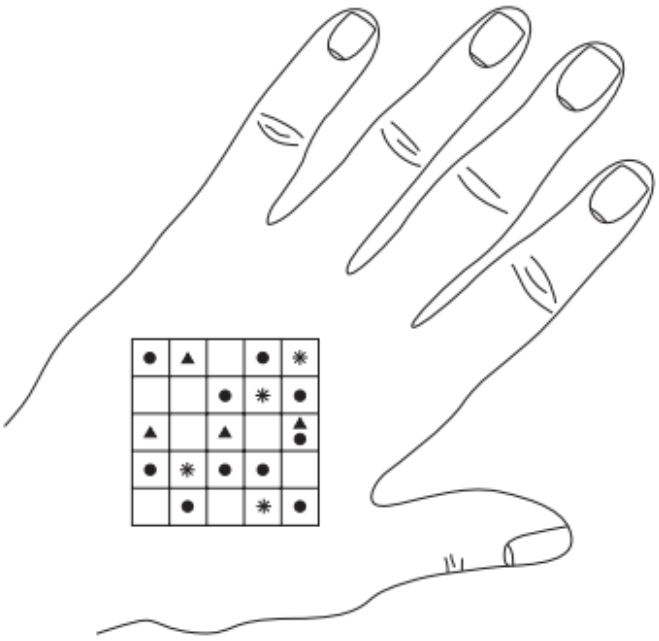
- Recognise and use numbers in decimal form
- Recognise and use numbers in standard form
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Understand simple probability
- Understand the terms mode and median
- Translate information between graphical and numerical form

**PAST PAPER QUESTION**

**10** (a) In an investigation into skin receptors, a grid was drawn on the back of a student's hand.

Experiments were carried out to find the location of touch, heat and cold receptors.

The diagram shows the positions of these receptors found during the investigation.



**key**

- ● touch receptor
- ▲ heat receptor
- ✳ cold receptor

(i) How many receptors of each type are shown on the grid?

**(3)**

Touch .....

Heat .....

Cold .....

(ii) Describe how the experiment to find the positions of **touch receptors** should be carried out.

**(3)**

(b) Suggest how the results would be different if the investigation were repeated on the fingertips instead of the back of the hand.

**(2)**

**(Total for Question 10 = 8 marks)**

| Question number | Answer | Notes | Marks |
|---|---|---|---|
| 10 (a) (i) | pin/mounted needle used;<br>subject/pupil blindfolded/looks away;<br>so can't see when skin is touched;<br>pupil reports when they can feel pin;<br>repeat/use more than one person;<br>appropriate example of fair testing e.g. same age/sex/use of same pin; | | 3 max |
| (ii) | 10;<br>4;<br>4; | | 3 |
| (b) | more receptors;<br>receptors closer together; | | 2 |

# CORE PRACTICAL 6

## 5.15 Investigate the range of frequency audible to the human ear

### Links to the specification content

| | |
|---|---|
| 5.3 | know the main areas of the brain and their functions including the cerebral hemispheres, cerebellum, mid brain, pituitary gland and hypothalamus |
| 5.5 | understand that the body contains receptors that can detect the stimuli for light, temperature, pressure/pain and taste |
| 5.13 | explain the structure and function of the ear in balance and hearing |
| 5.14 | understand how prolonged exposure to high noise levels affects the functioning of the ear and hearing |
| 5.15 | Practical: investigate the range of frequency audible to the human ear |

### Introducing the practical

This could be an ideal opportunity for students to design, plan, review and carry out an investigation perhaps using the CORMS prompt to help them. The beauty of this is pupils really can carry out their own investigation as little apparatus is required – just a computer or iPad/tablet with headphones or speaker.

You can find many pitch generators online – for example go to http://www.szynalski.com/tone-generator/

Pupils could work in pairs with one changing the pitch and the other with their back to them listening (so they cannot see when they are about to play the sound). Pupils could predict their hearing range. Perhaps only certain frequencies are tested and pupils recording if they could hear it and class data pooled.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- What was the range of frequencies detected by the class?
- How does this compare to adult hearing (from research on line?)
- Which frequencies are lost as you get older?
- How do other animals compare?
- For which animals is hearing a more important sense? Why?
- Which sense do you think is more important in humans – hearing or sight?
- How can people be helped who have lost part of all of their hearing?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Recognise and use numbers in standard form
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Construct and interpret frequency tables, diagrams and histograms
- Understand the principles of sampling as applied to scientific data

**CORE PRACTICAL 7**

## 7.2 Investigate the difference between inspired and expired air for carbon dioxide concentration

### Links to the specification content

| | |
|---|---|
| 2.1 | know the chemical elements present in carbohydrates, proteins and lipids (fats and oils) |
| 3.1 | know simple definitions of diffusion, osmosis and active transport |
| 6.1 | explain the importance of a balanced diet including the recommended dietary intake of carbohydrates, fats, proteins, vitamins A and C, calcium, iron and fibre |
| 7.2 | Practical: investigate the difference between inspired and expired air for carbon dioxide concentration |
| 7.3 | know the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms |
| 8.2 | explain the role of the intercostal muscles and the diaphragm in ventilation |
| 8.3 | explain how the lungs are adapted for gas exchange by diffusion |
| 8.4 | understand the terms lung capacity, vital capacity, tidal volume and interpret spirometer traces showing breathing movement |
| 8.6 | describe the regulation of carbon dioxide content in the blood including the role of chemoreceptors in the aorta and carotid arteries |

### Introducing the practical

This investigation uses limewater or hydrogen-carbonate indicator to compare the content of inhaled and exhaled air. This can be done using a T-tube arrangement going from a mouthpiece into two conical flasks. The inhaled and exhaled air bubbles through the indicator as the student breathes in and out.
The changes in the indicators before and after breathing can be used to illustrate the difference between inhaled and exhaled air.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- How can we tell which flask receives inhaled and which flask receives exhaled air?
- What other differences are there between inhaled and exhaled air?
- How could we show these in a practical?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

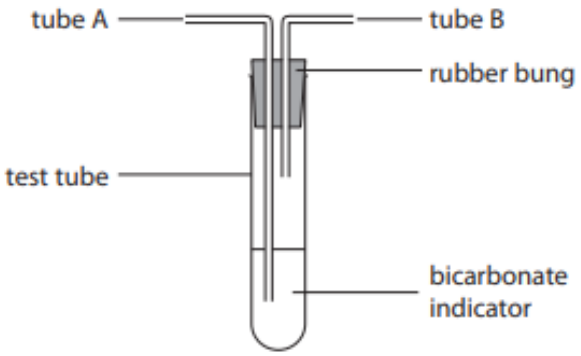
**Maths skills**

This experiment would have to be adapted if you want to use it to develop maths skills – for example changing the breathing rate or depth of breaking and measuring the time for limewater to turn milky and repeats taken or class data pooled. If this was done some basic maths skills could be developed.

- Recognise and use numbers in decimal form
- Make estimates of the results of simple calculations, without using a calculator
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Understand the terms mode and median
- Plot two variables (discrete and continuous) from experimental or other data

**2** A student carries out an investigation to compare the carbon dioxide content of inhaled and exhaled air.

The diagram shows the apparatus used. Bicarbonate indicator is used to show the presence of carbon dioxide. The gas changes the colour of the bicarbonate indicator from red to yellow.

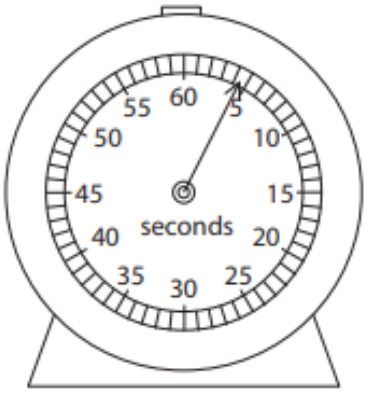



The following two experiments are carried out.

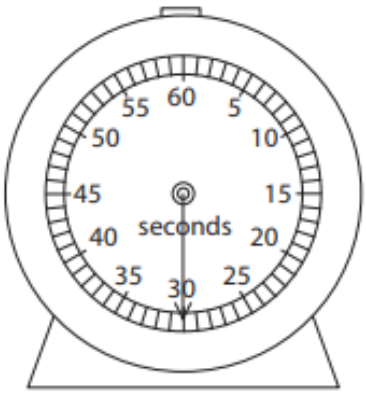
1) The student breathes out into tube A until the bicarbonate indicator turns yellow.

2) The bicarbonate indicator is replaced and the student breathes in through tube B until the indicator turns yellow.

The time taken for the bicarbonate indicator to change from red to yellow is shown in the diagrams.




experiment 1




experiment 2

(a) (i) What is the time taken for the bicarbonate indicator to change from red to yellow in each experiment?

**(2)**

time taken in experiment 1 = ..... s

time taken in experiment 2 = ..... s

(ii) How much longer does it take for the bicarbonate indicator to change colour in experiment 2, compared with experiment 1?

**(1)**

difference in time = ..... s

(iii) Explain why there is a difference between the two times.

**(2)**

.....

.....

.....

.....

(iv) Suggest a safety precaution that the student should observe during the experiments.

**(1)**

.....

.....

.....

(v) Explain why it is better to use bicarbonate indicator in these experiments rather than limewater.

**(2)**

.....

.....

.....

.....

(b) The student exercises for five minutes and then repeats the investigation.

(i) Complete the table by placing a tick (✓) in the correct box for each experiment to show how the times after exercise compare with the times before exercise.

**(2)**

| | **Longer time** | **Shorter time** | **Same time** |
|---|---|---|---|
| experiment 1 | | | |
| experiment 2 | | | |

(ii) Explain why you think that the student will obtain these results.

**(3)**

.....

.....

.....

.....

.....

.....

**(Total for Question 2 = 13 marks)**

| Question number | Answer | Accept | Marks |
|---|---|---|---|
| 2 (a) (i) | experiment 1 = 4.5s;<br>experiment 2 = 30s; | | 1<br>1 |
| (ii) | 25.5s; | ecf | 1 |
| (iii) | Any two from<br>• exhaled air contains more carbon dioxide;<br>• produced during respiration;<br>• removed by lungs; | inhaled air contains less carbon dioxide for 1 mark | 2 |
| (iv) | One from<br>• care not to suck up liquid;<br>• care not to break glass;<br>• sterilise/clean tube A/B/mouthpiece; | | 1 |
| (v) | • bicarbonate indicator more sensitive to carbon dioxide;<br>• change in colour clearer/more easily seen;<br>• more accurate/easier to time colour change; | | 2 |

| Question number | Answer | Accept | Marks |
|---|---|---|---|
| 2 (b) (i) | <table><tr><th></th><th>longer time</th><th>shorter time</th><th>the same time</th></tr><tr><td>experiment 1</td><td></td><td>✓</td><td></td></tr><tr><td>experiment 2</td><td></td><td>✓</td><td></td></tr></table> | do not accept more than one tick on each row | 1<br>1 |
| (ii) | Any three from<br>• more exercise requires more respiration/energy;<br>• more carbon dioxide released/carbon dioxide exhaled/inhaled faster;<br>• bicarbonate indicator changes colour quicker; | | 3 |

**CORE PRACTICAL 8**

## 8.5 Investigate the effect of exercise on the rate of breathing and measure lung capacity

### Links to the specification content

| | |
|---|---|
| 7.2 | Practical: investigate the difference between inspired and expired air for carbon dioxide concentration |
| 7.3 | know the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms |
| 8.2 | explain the role of the intercostal muscles and the diaphragm in ventilation |
| 8.3 | explain how the lungs are adapted for gas exchange by diffusion |
| 8.4 | understand the terms lung capacity, vital capacity, tidal volume and interpret spirometer traces showing breathing movement |
| 8.6 | describe the regulation of carbon dioxide content in the blood including the role of chemoreceptors in the aorta and carotid arteries |
| 8.7 | understand the term aerobic exercise |
| 8.8 | understand the long-term benefits of exercise on the cardiovascular system |
| 8.12 | understand how an oxygen debt arises and how it is repaid after exercise |

### Introducing the practical

This practical could be done in conjunction with Core Practical 7. This part of the investigation is to compare breathing rates before and after exercise. This would be an ideal opportunity for students to design, plan, review and carry out an investigation perhaps using the CORMS prompt to help them.

The beauty of this is pupils really can carry out their own investigation as little apparatus is required – just a stopwatch and somewhere to do exercise of their choice.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- How else does breathing change following exercise?
- How could we show these changes in a practical?
- What the benefits to the body for these changes in rate during exercise?
- What happens when exercise stops? Does breathing rate fall immediately (perhaps this could be investigated as an extension exercise?)
- Why does breathing rate not fall immediately after exercise?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

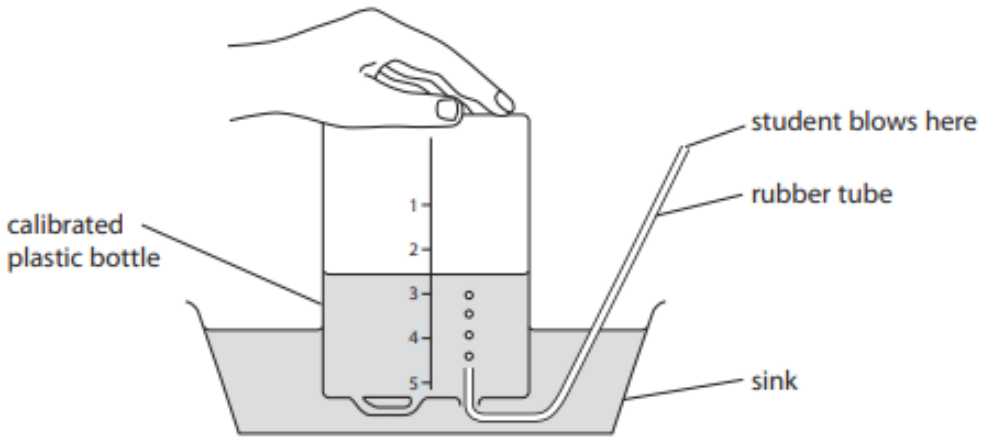
**Maths skills**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Make estimates of the results of simple calculations, without using a calculator
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Construct and interpret frequency tables, diagrams and histograms
- Understand the principles of sampling as applied to scientific data
- Understand the terms mode and median
- Translate information between graphical and numerical form
- Plot two variables (discrete and continuous) from experimental or other data

**PAST PAPER QUESTION**

**8** Five female physical education students wanted to find out about their aerobic fitness. They carried out an experiment to measure the vital capacity of their lungs.

They made the simple spirometer shown in the diagram.




(a) (i) What is meant by the **vital capacity** of the lungs?

(1)

(ii) Explain why a large vital capacity is important to a physical education student.

(2)

(b) Describe how the equipment shown in the diagram could be used to measure vital capacity.

(2)

(c) Each student measured her vital capacity three times and then calculated her average vital capacity in $dm^3$. The results are shown in the table.

| | vital capacity in $dm^3$ | | | |
|---|---|---|---|---|
| **student** | **result 1** | **result 2** | **result 3** | **average** |
| **A** | 3.7 | 3.4 | 3.4 | |
| **B** | 4.6 | 3.1 | 4.3 | **4.0** |
| **C** | 4.5 | | 4.5 | **4.4** |
| **D** | 2.6 | 2.5 | 2.1 | **2.4** |
| **E** | 3.1 | 2.6 | 2.7 | **2.8** |

(i) Calculate the missing average for student **A**.

**(1)**

..... $dm^3$

(ii) Calculate the missing result for student **C**.

**(1)**

..... $dm^3$

(iii) Circle the anomalous result in the table.

**(1)**

(d) Explain why student **C** might be considered to be the fittest.

**(2)**

.....

.....

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.....

**(Total for Question 8 = 10 marks)**

| Question number | Answer | Marks |
|---|---|---|
| 8 (a) (i) | The maximum volume of air that the lungs can hold/breath in / breathe out; | **1** |
| (ii) | Two from:<br>Able to exercise for longer / more exercise;<br>Because can take in more oxygen;<br>Needed for respiration / energy; | **2** |
| (b) | Breathe out into the rubber tube (after taking a deep breath in);<br>The decrease in water level indicates the vital capacity; | **2** |
| (c) (i)<br>(ii)<br>(iii) | 3.5;<br>4.2;<br>3.1 / result 2 for student B; | **1**<br>**1**<br>**1** |
| (d) | Student C has the largest vital capacity;<br>The larger the vital capacity the more oxygen can be taken in / the stronger the muscles associated with the lungs; | **2** |
| | **Total** | **10** |

**CORE PRACTICAL 9**

## 8.11 Investigate the effect of exercise on the pulse rate

### Links to the specification content

| | |
|---|---|
| 7.3 | know the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms |
| 8.7 | understand the term aerobic exercise |
| 8.8 | understand the long-term benefits of exercise on the cardiovascular system |
| 8.9 | understand the pulse rate as a measure of heart rate and explain why resting pulse can be used as a measure of physical fitness |
| 8.10 | explain why the heart rate changes during exercise and the influence of adrenaline |
| 8.11 | Practical: investigate the effect of exercise on the pulse rate |
| 8.12 | understand how an oxygen debt arises and how it is repaid after exercise |
| 8.13 | understand the damage to the respiratory and cardiovascular system caused by smoking |
| 9.2 | understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy |
| 9.4 | explain how red blood cells are adapted for oxygen transport |

### Introducing the practical

This would be an ideal opportunity for students to design, plan, review and carry out an investigation perhaps using the CORMS prompt to help them. The beauty of this is pupils really can carry out their own investigation as little apparatus is required – just a stopwatch and somewhere to do exercise of their choice. They will need to be shown how to take their own pulse or someone else's depending how the experiment is designed. Alternatively all pupils can do the same exercise and pulse rates before and after exercise pooled. The practical could be extended further by investigating duration or intensity of exercise and heart rate to produce a line graph rather a 'before or after' bar graph. It also works well to investigate heart rate after a set exercise (eg sit ups) and how soon it returns to resting heart rate – again producing a nice line graph.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- Did your pulse rate level off?
- If you increased the duration or intensity of exercise further would pulse rate continue to rise indefinitely?
- Why does pulse rate increase?
- What is more important – increased uptake of oxygen or removal of carbon dioxide?
- What is detected in the blood to cause this increase in pulse rate?
- Why does your pulse rate increase before exercise – for example just before an big race? What causes this increase?
- When else does your pulse rate increase? What is the benefit/evolutionary reason for this?
- What happens to your pulse rate when exercise has stopped? (Perhaps this can be predicted then investigated as an extension exercise?)

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

**Maths skills**

- Recognise and use numbers in decimal form
- Recognise and use numbers in standard form
- Use ratios, fractions, percentages, powers and roots
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Construct and interpret frequency tables, diagrams and histograms
- Understand the principles of sampling as applied to scientific data
- Understand the terms mode and median
- Translate information between graphical and numerical form
- Plot two variables (discrete and continuous) from experimental or other data

**PAST PAPER QUESTION**

**7** (a) A scientist uses this method to investigate the effect of exercise on the pulse rate of four people.

This is the scientist's method.

- measure the pulse rate of each person before they exercise
- the people then exercise for five minutes
- measure the pulse rate at one-minute intervals during exercise
- record the pulse rate in beats per minute (bpm)

(i) Draw a table that could be used to record the scientist's results.

(4)

(ii) Suggest one factor that the scientist should consider to make sure the test is carried out safely.

(1)

.....

.....

(iii) One of the people taking part in the investigation is a cigarette smoker.

Suggest why this person's pulse rate is likely to be higher than the pulse rates of the non-smokers in the group.

**(3)**

.....

.....

.....

.....

.....

.....

(b) (i) Name the substance in cigarette smoke that can cause lung cancer.

**(1)**

.....

(ii) Name the substance in cigarette smoke that causes addiction.

**(1)**

.....

**(Total for Question 7 = 10 marks)**

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 7(a) (i) | • space in table for four people;<br>• space to record pulse at rest and each minute of exercise;<br>• pulse rate in bpm;<br>• table structured in logical manner; | | (4) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 7(a)(ii) | A suggestion including one from the following:<br>• make sure people are healthy/example/wear correct sports clothing/correct trainers/make sure that there are no slippery surfaces | Accept other suitable suggestion | (1) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 7(a)(iii) | A suggestion including three of the following:<br>• lungs damaged/small lung capacity/less surface area for gas exchange/more CO in blood;<br>• less oxygen into blood;<br>• narrowed arteries due to fatty deposits;<br>• heart beats faster/has to work harder;<br>• to pump blood faster/more blood;<br>• to provide enough oxygen to muscles | | (3) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 7(b)(i) | tar; | | (1) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 7(b)(ii) | nicotine; | | (1) |

## CORE PRACTICAL

### 10.10 Investigate diffusion using a partially-permeable membrane such as Visking tubing

### Links to the specification content

| | |
|---|---|
| 3.1 | know simple definitions of diffusion, osmosis and active transport |
| 3.2 | understand that movement of substances into and out of cells can be by diffusion, osmosis (understanding of water potential is required) and active transport |
| 3.3 | understand the factors that affect the rate of movement of substances into and out of cells to include the effects of surface area to volume ratio, temperature and concentration gradient |
| 6.9 | understand how the structure of the villus helps absorption of the products of digestion in the small intestine |
| 8.3 | explain how the lungs are adapted for gas exchange by diffusion |
| 10.9 | describe the advantages and disadvantages of:<br>• kidney transplants<br>• kidney dialysis. |

### Introducing the practical:

Visking tubing can also be used in many way to investigate diffusion. Visking tubing could contain glucose solution and be put into a test tube of water. Afterwards the water can be tested using benedict's solution to show that it has diffused out of the tube. Alternatively starch solution could be put into the visking tubing – afterwards iodine tests would show the starch was too large to leave the tube and enter the water. This could be extended further by putting starch and amylase into the visking tubing – afterward the water could be tested using Benedicts solution to show that the products of breakdown were small enough to leave the tubing. Even simpler, a solution of potassium permanganate in the tubing can be seen to diffusion out of the tubing into the surrounding water.

Osmosis can also be demonstrated by filling the tubing with sucrose solution and putting it into a beaker of water. The mass before and mass afterwards will show a dramatic change in mass showing osmosis has occurred and water has entered the visking tubing. To develop maths skills mass before and mass after can be taken. Repeats or class data can be pool to allow calculations of means and percentage changes.

**Questions you could ask to enhance learning and focus your students on important aspects of the practical**

- Why does the visking tubing allow diffusion of some molecules and not others?
- How has this simple idea been used in medicine – for example in dialysis?
- What factors determine the rate of diffusion into or out of the visking tubing in the experiment you did?
- How could you increase the rate of diffusion in your experiment?
- What are the independent, dependent and control variables in the investigation?
- How does diffusion differ from osmosis?
- How does diffusion differ from active transport?
- How can visking tubing be used as a model for digestion and absorption in your intestines?

**Skills that are covered in the practical**

- Solve problems set in a practical context
- Apply scientific knowledge and understanding in questions with a practical context
- Devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- Demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- Make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- Identify independent, dependent and control variables
- Use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- Assess the reliability of an experimental activity
- Evaluate data and methods taking into account factors that affect accuracy and validity.

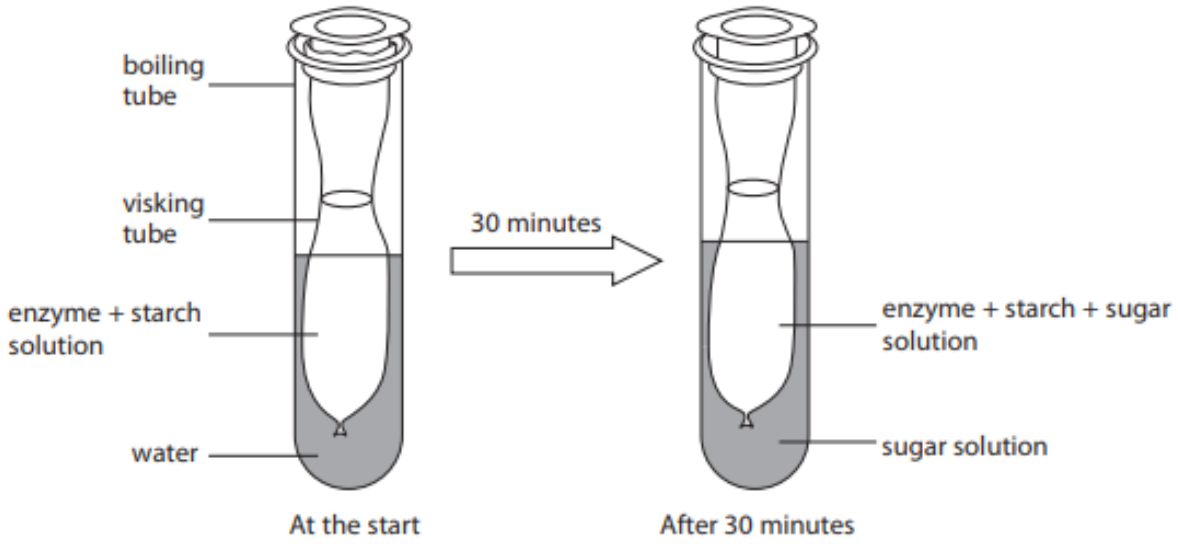
**Maths skills**

- Recognise and use numbers in decimal form
- Use ratios, fractions, percentages, powers and roots
- Use an appropriate number of significant figures
- Understand and find the arithmetic mean (average)
- Construct and interpret bar charts
- Plot two variables (discrete and continuous) from experimental or other data

## PAST PAPER QUESTIONS

**5** Visking tubing can be used to represent the small intestine.

The diagram shows apparatus used to investigate the digestion of starch in the small intestine. The apparatus is set up and left at a temperature of 40 °C for 30 minutes.




(a) Explain the changes that occur in the apparatus during the investigation.

**(4)**

(b) Explain why repeating the experiment at 70 °C will give different results.

**(3)**

(c) Explain what effect changing the concentration of the starch solution and the size of the visking tubing would have on the experiment.

**(4)**

(d) Name a location in the digestive system where the enzyme used in this investigation is produced.

**(1)**

**(Total for Question 5 = 12 marks)**

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 5(a) | An explanation including four of the following:<br><br>• enzyme is amylase;<br>• (enzyme) breaks down starch<br>• to maltose/glucose/sugar;<br>• glucose/sugar diffuses/passes into water;<br>• through partially permeable membrane/visking tubing;<br>• from a high concentration to a low concentration; | | (4) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 5(b) | An explanation including three of the following:<br><br>• reference to optimum temperature of enzyme;<br>• enzymes denature (if temperature is too high);<br>• change in shape/active site;<br>• no longer binds to substrate/shapes no longer complementary; | Allow enzyme inactive/ slower / no reaction takes place | (3) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 5(c) | An explanation linking two from:<br><br>For concentration of starch solution<br><br>• (higher concentration of starch) more collisions/enzyme-substrate complexes formed;<br>• faster reaction;<br>• more sugar produced/ greater concentration of sugar solution;<br>• *more sugar diffuses/diffusion of sugar quicker;<br><br>For size of the visking tubing<br><br>• larger surface area;<br>• *more sugar diffuses/diffusion of sugar quicker; | 2 marks for each explanation<br><br>Accept reverse argument for lower concentration of starch<br><br>Accept reverse argument for decrease in surface area<br><br>*Award only once | (4) |

| Question Number | Answer | Notes | Mark |
|---|---|---|---|
| 5(d) | • pancreas/salivary gland | | (1) |

Total for Question 5 = 12 marks