AQA qualification training

A-level Biology Practical endorsement

Pre-event reading

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AQA

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Biology: A-level Practical assessment

Practical work is at the heart of biology, so we have placed it at the heart of this specification.

Practical assessments have been divided into those that can be assessed in written exams and those that can only be directly assessed whilst students are carrying out experiments.

A-level grades will be based only on marks from written exams.

A separate endorsement of practical skills will be taken alongside the A-level. This will be assessed by teachers and will be based on direct observation of students' competency in a range of skills that are not assessable in written exams.

Use of apparatus and techniques

All students taking an A-level Biology qualification are expected to have had opportunities to use the following apparatus and develop and demonstrate these techniques. These apparatus and techniques are common to all A-level Biology specifications.

Carrying out the 12 required practicals in section 8.2 means that students will have experienced use of each of these apparatus and techniques. However, teachers are encouraged to develop students' abilities by inclusion of other opportunities for skills development, as exemplified in the right-hand column of the content section of this specification.

	Apparatus and techniques
AT a	use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH)
AT b	use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer
AT c	use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions
AT d	use of light microscope at high power and low power, including use of a graticule
AT e	produce scientific drawing from observation with annotations
AT f	use qualitative reagents to identify biological molecules
AT g	separate biological compounds using thin layer/paper chromatography or electrophoresis
AT h	safely and ethically use organisms to measure: • plant or animal responses
	• physiological functions
AT i	use microbiological aseptic techniques, including the use of agar plates and broth
AT j	safely use instruments for dissection of an animal organ, or plant organ
AT k	use sampling techniques in fieldwork
AT l	use ICT such as computer modelling, or data logger to collect data, or use software to process data

Biology: A-level required practical activities

The following practicals must be carried out by all students taking this course. Written papers will assess knowledge and understanding of these, and the skills exemplified within each practical.

Required activity	Apparatus and technique reference
1. Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction	a, b, c, f, l
2. Preparation of stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index	d, e, f
3. Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue	c, h, j, l
4. Investigation into the effect of a named variable on the permeability of cell-surface membranes	a, b, c, j, l
5. Dissection of animal or plant gas exchange or mass transport system or of organ within such a system	e, h, j
6. Use of aseptic techniques to investigate the effect of antimicrobial substances on microbial growth	c, i
7. Use of chromatography to investigate the pigments isolated from leaves of different plants, eg leaves from shade-tolerant and shade-intolerant plants or leaves of different colours	b, c, g
8. Investigation into the effect of a named factor on the rate of dehydrogenase activity in extracts of chloroplasts	a, b, c
9. Investigation into the effect of a named variable on the rate of respiration of cultures of single-celled organisms	a, b, c, i
10. Investigation into the effect of an environmental variable on the movement of an animal using either a choice chamber or a maze	h
11. Production of a dilution series of a glucose solution and use of colorimetric techniques to produce a calibration curve with which to identify the concentration of glucose in an unknown 'urine' sample	b, c, f
12. Investigation into the effect of a named environmental factor on the distribution of a given species	a, b, h, k, l

Teachers are encouraged to vary their approach to these practical activities. Some are more suitable for highly structured approaches that develop key techniques. Others allow opportunities for students to develop investigative approaches.

This list is not designed to limit the practical activities carried out by students. A rich practical experience for students will include more than the 12 required practical activities. The explicit teaching of practical skills will build students' competence. Many teachers will also use practical approaches to the introduction of content knowledge in the course of their normal teaching. Students' work in these activities can also contribute towards the endorsement of practical skills.

CPAC Pen portraits

A series of pen portraits have been written to clarify what is meant by 'not achieved', 'achieved' and ‘achieved at a level of competence exceeding the CPAC standard’.

These exemplars have been developed in collaboration between the four Awarding Bodies: AQA, Eduqas, OCR and Pearson.
They are intended for guidance and training purposes, and to give an indication of the standard necessary for each CPAC statement.

Note that, although these pen portraits show (in the most part) CPAC skills in isolation, many practical exercises are likely to involve CPAC strands being assessed in combination.

CPAC 1: Follows written instructions

Not achieved	Achieved	Exceeds standard
Context Chemistry (Year 12): Make up a volumetric solution and carry out a simple acid-base titration **Observed** The practical lesson started with a full teacher demonstration and safety reminder in addition to all learners being provided with a detailed set of written method steps. Working in pairs, glassware and other equipment was collected and set up. One learner was responsible for the titration, the other for the preparation of the volumetric solution. There were several requests for reassurance from the teacher, particularly in the initial stages (the steps for the correct weighing procedure were very confused) leading to lots of teacher intervention and a spot demonstration of the drop-wise addition of burette solution towards endpoint. Although the method steps were being followed in the correct order, neither of the learners were working independently of the teacher and it was difficult to ascertain the degree of input from each individual learner throughout the practical as a whole. Students requested apparatus that was not needed to carry out the written method steps, indicating a lack of forward planning following reading the method.	**Context** Chemistry (Year 12): Make up a volumetric solution and carry out a simple acid-base titration **Observed** The learner was provided with a full of written method steps for the practical. This was supported by a brief class discussion at the start to highlight the safety requirements. **Independently**, the learner methodically and confidently followed the method steps in the correct order; firstly to make the volumetric solution, then to carry out the titration work. They generated a set of expected titre volumes of sodium hydrogensulfate solution. Prior to the rough titration, the learner asked the teacher for clarification about the number of drops of indicator to add (“2-3 drops” advised on the sheet) and decided to go with 3 drops to enable the end point to be seen more clearly. The learner proceeded to carry out a further three titration runs, sufficient to ensure that two results were concordant.	**Context** Chemistry (Year 12): Make up a volumetric solution and carry out a simple acid-base titration **Observed** The class was provided with a simple outline of the practical method steps as all the learners had carried out a number of titration practicals in previous lessons and did not need the heavy ‘scaffold’. Safety information was discussed verbally. Prior to starting, learners could be seen reading the outline in full before selecting apparatus independently from a range of glassware provided on a trolley. Both elements of the practical work – making up the standard solution and titration work – were carried out efficiently, methodically and **independently** with little reference to the written practical outline. The students demonstrated a developing degree of fluency with the techniques and apparatus being used. Learners designed and completed a table, the learner checking for obvious anomalous titres after each attempt and ensuring that a sufficient amount of results had been collected to achieve concordant titres. All method steps were carried out in the correct order, readings were ‘double checked’ (this was not asked for) and expected outcomes were generated. It was clear that learners had developed clear routines e.g. use of balance, addition of washings, re-filling of burette, end point addition etc that were fully embedded in their titration practical work.

Context Chemistry (Year 12): Preparation of a soluble salt using a titration **Observed** The teacher demonstrated how to use titration apparatus. A learner attempts to follow detailed written instructions but the teacher intervenes on a number of occasions to correct the learner. Learner is not working independently to follow instructions correctly as demonstrated by teacher intervention	**Context** Biology (Year 12): Extraction of DNA from living material **Observed** The class opened with a discussion about the principles of extraction of DNA. The specific detail of the method to be followed by learners was not discussed other than a reminder about safety issues. Learners worked individually to complete the task. A learner followed the written procedure carefully, confidently and without intervention by teacher.	**Context** Chemistry (Year 13): Estimation of copper(II) salts **Observed** The learner read the instructions through prior to starting the practical. He weighed accurately using 'weighing-by-difference' the mass of copper(II) sulfate and was able to use good technique to accurately make up the standard solution. At all points he worked efficiently and was able to complete the practical with minimal viewing of the instruction sheet. The learner was able to interpret instructions and use good techniques to meet their demand. The learner shows advanced skills in being able to interpret simple instructions by 'adding flesh to the bones'. He was able to correctly interpret where mass readings needed to be accurate (weighing copper sulfate) and approx. (weighing potassium iodide) and needed no prompting to use appropriate weighing techniques.
Context Biology (Year 12): Qualitative testing for biological molecules – glucose **Observed** The teacher reminds the class about the main points of the procedure, including safety matters. However, the learner does not manage to follow the instructions in the correct order and does not add Benedict’s solution prior to heating in the water bath for the first test. This has to be pointed out by the teacher.	**Context** Biology (Year 12): Qualitative testing for biological molecules – glucose **Observed** The teacher reminds the class about the main points of the procedure, including safety matters. The learner then works independently to collect the expected set of results. All procedural points are carried out in the correct order and the learner is methodical and confident in their approach to the task. The teacher does not have to have any involvement.	**Context** Biology (Year 12): Qualitative testing for biological molecules – glucose **Observed** The teacher reminds the class about the main points of the procedure, including safety matters. Following this, the learner works without intervention from the teacher and collects the expected set of results, having followed all of the method points in the correct order. The learner engages in a discussion with the teacher about the temperature the water bath needs to be maintained at to see a result with Benedict’s test and it is agreed that the instructions could be modified slightly.

Context Physics (Year 12): Determine the electrical resistivity of a material **Observed** A student is working a part of a pair. The student asks the teacher for reassurance that the apparatus provided is correct for the experiment. He takes no part in the setting-up of the circuit, leaving this task to his partner. The worksheet tells students to collect a reading every 10cm along a 1-metre length of wire. The student collects three readings only, and asks his teacher if this is enough data.	**Context** Physics (Year 12): Determine the electrical resistivity of a material **Observed** A student is working a part of a pair. The student reads the instructions provided for the practical. She is able to use the circuit diagram from the apparatus provided. With her partner, she asks her teacher to check the circuit, which is correct. At the end of the practical session, she has collected sufficient data, together with her partner, as outlined in the method on the worksheet.	**Context** Physics (Year 12): Determine the electrical resistivity of a material **Observed** The student is provided with an outline of the experiment, where some steps are given in outline only. He reads through the instructions provided and is able to formulate a correct method for the task. He finds all the apparatus independently (CPAC 2d). He sets up the circuit, and checks that it is correct before turning on the power pack. He works methodically to collect the data required, ensuring that is tabulated and checked as he goes along (CPAC 4b).

CPAC 2: Applies investigative approaches and methods when using instruments and equipment

Not achieved	Achieved	Exceeds standard
Context Biology (Year 12): Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction **Observed** In groups of three, learners were invited to plan and carry out an investigation to find out the effect of temperature on the rate of trypsin enzyme. One of the learners immediately took the lead and started to write things down. One of the others quickly joined in but the third, who was less familiar with enzyme work through recent absence from school, took a backseat. After a while it was clear to the teacher that little progress was being made as the group were unsure both how to measure trypsin action (dependent variable) or what variables to control so they gave the group a prescriptive set of method steps to follow. The students then chose appropriate equipment. They set up water baths using beakers and the started the procedure but, due to a lack of concentration and urgency demonstrated within the group, the data generated did not reflect the trend expected and so the teacher needed to intervene to help them to get back on track. For example, the teacher pointed out that the water baths were cooling. In this group, despite one of the learners being able to discuss the reasons for the method steps being carried out, the group as a whole were not convincingly able to express an understanding of what they were doing and how their work related either to the hypothesis or the expected conclusion.	**Context** Biology (Year 12): Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction **Observed** An individual learner was invited to investigate the effect of temperature on the rate of trypsin action. Using previous lesson theory and practical notes, they devised a potential set of simple method steps that would enable sufficient data to be generated. The learner asked the teacher to consider what they had done before modifying their method for control of temperature, recognising with little prompting that electrostatically controlled water baths would be a better choice than beakers. From that point, the learner chose all the necessary apparatus and prepared all the enzyme and substrate test tubes independently, allowing all tubes to equilibrate in the water baths for 10 minutes prior to mixing. The learner investigated 5 different temperatures with 10 degree intervals and repeated each temperature three times. It was clear that this learner had also recognised that the thickness of the pen used to draw the cross on to the test-tube glass was a control variable as they were seen using a fine marker prior to their use of a black board marker. This was as a result of the first set of enzyme – substrate tubes being mixed. When questioned by his teacher about why they had changed marker pens, the learner explained that they had found it difficult to fully judge the disappearance of the cross and so a modification of method steps was necessary and the first set of tubes was fully repeated. The learner produced a set of data that	**Context** Biology (Year 12): Investigation into the effect of a named variable on the rate of an enzyme-controlled reaction **Observed** The teacher gave all the learners in the class an open choice of which independent variable they might like to investigate when considering how trypsin enzyme reacts. She provided a list of apparatus and chemicals that would be available to them, plus an indication of the lesson time that would be dedicated to the task. The learners had been asked to carry out some research for homework to enable them to independently write a set of method steps to investigate their written hypothesis. Learners were then given the opportunity to carry out some preliminary practical work to enable them to tighten their written method. One learner, who decided to investigate the effect of temperature, carried out a trial experiment to decide the % concentration of trypsin enzyme to use (to ensure the experimental runs carried out at higher temperatures were measurable and not too fast). The learner was also keen to ensure that the overall volume of enzyme-substrate mixture was not too great to ensure that the contents of each tube were fully submerged in the water bath at the desired working temperature. Through questioning, the teacher could clearly evidence that the learner had a full understanding of what they were doing, could justify all their actions and link them to the expected outcome. Repeats had been considered to allow the mean data to generate the expected trend. The data table designed provided evidence of an understanding of accurately

	was showed the expected trend.	recording the independent variable, temperature. For example, despite the water bath dial being set at 20 °C, the temperature recorded was 21 °C, taken from a thermometer in the water bath.
Context Biology (Year 13): Investigation into the abundance and distribution of plants in a habitat. **Observed** The learners were asked to work in groups of three to plan and carry out the investigation. One of the learners appeared to have more input into the groups plan while the other two appeared to be more easily distracted and allowed the first candidate to lead. They were clearly distracted and consequently worked less methodically than they could have. Appropriate equipment was used by the members of the group although they demonstrated a somewhat cavalier approach to collecting the information. There was also some confusion over recording information. One learner in the group was able to give a rationale for the way in which they completed the investigation but the other two seemed less clear. It was difficult to be certain who contributed what to the investigation. One learner clearly took the lead but the group work was poorly managed which lead to some failures in the 'doing' of the activity. While group work may be allowable under certain circumstances, it is important that the contribution of each learner is clearly identifiable and that the learners can evidence the key aspects of the CPAC2 skills. In this case, the best that can be said is that one learner was working towards aspects of the assessment criteria while the other two showed little evidence.	**Context** Chemistry (Year 13): Planning a sequence of tests to identify organic compounds **Observed** A learner devised a suitable testing sequence that would allow for the identification of the compounds in relatively few steps. He was able to follow the steps, choosing appropriate reagents for each of the identified tests with minimal assistance. He recognised that one of the steps in his sequence was not necessary when testing compound 'V' – (benzenecarbaldehyde) and he modified his testing sequence accordingly. He was able to give reasons for his testing sequence and understood what he was doing.	**Context** Physics (Year 13): Measurement of *g* with a pendulum **Observed** The learners were given a box of equipment and asked to device a method to measure *g* using only equipment from the box. A learner illustrated the method that she would follow by drawing a simple diagram and by outlining the steps she proposed to follow. The learner first chose to make two trial runs to measure the time of a period for both the longest and shortest length in order to check the range of values and also to determine whether the shortest length could be measured without significant error. She decided to increase the length of the pendulum of her shortest run in the light of her experience. The learner understood what she was doing and could give clear reasoning for the method she proposed. The learner recognised the need to take multiple readings for each period of the pendulum and could give reasons for variations in the period for each length.

Context Physics (Year 13): Potential divider investigation **Observed** Students working in pair are unable to get their circuit to operate. The teacher leaves them for fifteen to twenty minutes to try and overcome their difficulties before stepping in to guide them to assembling a correctly functioning circuit.	**Context** Physics (Year 13): Potential divider investigation **Observed** Students working in pair are unable to get their circuit to operate. The students work though their circuit and after fifteen to twenty minutes overcome their difficulties and are able to collect data as required. (Achieves the use of instruments and equipment although not investigative 2a, b)	**Context** Physics (Year 13): Potential divider investigation **Observed** Students working in pair set up their apparatus with no issues, each participating and communicating with each other. They collect data as required and have completed the task set within twenty minutes. The teacher then asks them to determine the best value for the fixed resistor in their circuit to optimise the range of potential difference output. (Achieves the use of equipment and investigative nature 2a, b, c)
Context Biology (Year 12): Investigate a factor affecting the initial rate of an enzyme controlled reaction. **Observed** Although the student is following a clear outline of the experiment, it is evident that he does not know which variables should be controlled, so ends up varying the temperature, but failing to have a constant amount of enzyme in each experiment. The experimental steps are not carried out in a logical order, and the data collected is to a variety of significant figures.	**Context** Biology (Year 12): Investigate a factor affecting the initial rate of an enzyme controlled reaction. **Observed** The method followed by the student tells them to vary the concentration of the substrate. The student knows that temperature must be controlled, and sets up a beaker to use as a water bath, to control the temperature (CPAC 2c). The student correctly sets up a series of different substrate concentrations and, before adding the enzyme, places her test-tubes in the water bath, the water level rises; so the student then changes this to a larger beaker (CPAC 2b).	**Context** Biology (Year 12): Investigate a factor affecting the initial rate of an enzyme controlled reaction. **Observed** The worksheet used by the student contains an outline of the experiment. The student decides to investigate temperature as the factor, and plans to ensure that other factors (concentration of substrate, amount of enzyme used) are kept the same (CPAC 2c). Without prompting, he is able to find, in a text book, a suitable method to follow and selects and sets up appropriate apparatus for the experiment (CPAC 2d). When the teacher comes around to check, the student is already collecting data, and his blank results table shows that he is controlling concentration and planning to collect results at 5 different temperatures, using a water bath (CPAC 2c). Although he has planned to collect results every 10 °C, the teacher can see that the current experiment is using a water bath at 29 °C, and the student has already corrected the results table (CPAC 2b).

CPAC 3: Safely uses a range of practical equipment and materials

Not achieved	Achieved	Exceeding CPAC standard
Context Chemistry (Year 12): Carry out simple test-tube reactions to identify cations and anions in aqueous solution **Observed** The learner set up three test-tube racks of test-tubes, one for each of the parts of the experiment. In haste a couple of the test-tubes fell in their attempt to carry them over to the work space and broken glass was evident on the floor. Keen to get on with the practical steps, the learner did not deal with the incident and was seen gently kicking the glass under the desk. Other students expressed their concern as they were walking on it and carrying around the laboratory floor and so the teacher intervened and brushed up the broken glass. Later on during the practical lesson the same learner carried a stock dropper bottle of concentrated H_2SO_4 from the fume cupboard to use at their workspace. Others around them started to cough, drawing the teacher's attention to the action, again requiring immediate intervention. On both occasions the learner had failed to consider and therefore minimise risk or harm to themselves or other learners around them. There was a lack of consideration of health and safety procedure and too many prompts were required by the teacher to ensure safe working practice.	**Context** Chemistry (Year 12): Carry out simple test-tube reactions to identify cations and anions in aqueous solution **Observed** The learner had carefully set up an organised workspace and collected all the glassware, other equipment and reagents to limit the need for a lot of walking around the laboratory once the procedures started. Two of the reagents were located in the fume cupboard and the learner was fully aware both of that and had identified any hazards and risks associated with the practical as a whole. The learner handled the equipment confidently and sensibly, disposing of each of the reacted tubes as directed by their teacher. During Part 1 they accidentally spilled a small amount of limewater on the desk but without fuss, wiped it up with a paper towel. One of the learners on the same desk had left a stopper off one of the reagent bottles and they needed little prompting to replace it when they realised. When pupils worked in pairs it was clear that they had an understanding of any medical issues that might need consideration eg asthma. On one occasion the learner asked for clarification about how much solid a 'small spatula measure of solid potassium chloride' was, realising that this had a safety implication.	**Context** Chemistry (Year 12): Carry out simple test-tube reactions to identify cations and anions in aqueous solution **Observed** The learner was keen to write a full, detailed risk assessment to cover all aspects of the practical work. The number of reagents involved gave the learner an opportunity to gain more understanding about the hazards associated with a range of different chemicals. This exceeded the requirement as learners simply need to *be able to identify hazards and risks in their work and be able to address those accordingly.* The learner carried out the practical 3-part procedure confidently in a well organised work place with no need for teacher intervention. Mid-way through the lesson they noticed that another learner had brought a fume cupboard reagent across to their desk and left the dropper bottle stopper of it. They calmly went over and pointed it out to the student, replaced the stopper and offered to take it back to the fume cupboard before alerting the teacher after they saw another learner do exactly the same thing minutes later. It was clear that they had a full understanding of how to deal with an incident should it occur. The same student, when completing a part of the investigation using solid halides was seen halving the amount of solid that they had originally poured into the reaction tube, amending the procedure slightly to make it safer.

Context Chemistry (Year 12): Indirect determination of an enthalpy change of reaction **Observed** A learner breaks a mercury thermometer in the course of an experiment and is seen putting the broken thermometer in a draw. No attempt is made to deal with any spilt mercury. The learner continues with his work and does not report the incident to class teacher. The incident is mentioned to the teacher who intervenes. The learner has failed to minimise risk of harm to himself or others in the class.	**Context** Physics (Year 13): Measurement of the specific heat capacity for a solid by the method of heat transfer **Observed** A learner identifies hazards and risks associated with their procedure. His work space is well organised. He works safely and handles equipment confidently and competently. The practical period is completed without incident.	**Context** Chemistry (Year 13): Planning a sequence of tests to identify organic compounds **Observed** A learner prepares a detailed (suitable and sufficient) risk assessment covering all aspects of the practical work. The learner completes the investigation safely in accordance with laboratory requirements and risk assessment. At all times she works confidently and without need of intervention. Her work space is well organised. She spills a small amount of ethanamide in the fume cupboard but warns those working near her and then reports this to the teacher (laboratory rules specify that spills are to be reported to teacher who deals with situation). Learners are expected to identify hazards and risks in work. A detailed risk assessment exceeds this requirement.
Context Biology (Year 12): Investigation into the effect of exercise on pulse rate **Observed** The learner starts the investigation without consideration of the impact of the exercise on those participating. One participant has an asthma attack and has to stop and take medication and it is determined, in hindsight, that this individual should not have been asked to exercise.	**Context** Biology (Year 12): Investigation into the effect of exercise on pulse rate **Observed** The learner asks the individuals participating in the exercise if they have any relevant health concerns. He then proceeds with the investigation without incident once it has been established that no one suffers from a heart or lung condition.	**Context** Biology (Year 12): Investigation into the effect of exercise on pulse rate **Observed** The learner considers detailed risks and hazards with the investigation including whether any participant has a relevant health concern and the safety of the exercise to be carried out. One participant is asked not to take part as she has a heart condition. When the participants start the exercise (running up and down a flight of stairs), the learner decides that this is actually quite risky as there is more foot traffic in the school than originally anticipated. Therefore, he changes the exercise to a longer period of star jumps on the spot. A detailed risk assessment is provided as part of the investigation.

Context Chemistry (Year 12): Finding the concentration of a solution of hydrochloric acid by titration **Observed** The student reads the worksheet provided, which gives some information on safety for this experiment. The student collects safety glasses, but they spend the majority of the time pushed up on her head – she only pushes them down over her eyes when prompted by her teacher. She turns around to talk to someone else in the laboratory during the practical, and knocks over a conical flask as she turns. She does not notice the spillage.	**Context** Chemistry (Year 12): Finding the concentration of a solution of hydrochloric acid by titration **Observed** The student looks at the method given, and follows the instructions about correct use of lab coat and safety glasses. He tells his teacher how he attached the pipette filler to the pipette – this method is safe, and the teacher confirms this. Once he has used the pipette, he detaches the filler and puts the pipette somewhere where it will not roll off the lab bench. When he is washing up after the experiment, he accidentally pours some acid on his skin. He washes it off with plenty of water, and then tells his teacher what has happened: no further action is necessary.	**Context** Chemistry (Year 12): Finding the concentration of a solution of hydrochloric acid by titration **Observed** On being told that the experiment is a titration, the student knows that the safety equipment required will be a lab coat, eye protection and a pipette safety filler. The student is working in a pair, and she reminds her lab partner of the safe method of attaching the pipette filler to the pipette. She remembers all the key points for safely filling a burette, including bringing the burette down to a safe working level before filling. When her teacher asks what she would do in the event of a spillage, she is able to describe a safe method of clearing it away.

CPAC 4: Makes and records observations

Not achieved	Achieved	Exceeding CPAC standard
Context Biology (Year 12): Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue **Observed** A learner prepared all the dilutions of sucrose solution from 1.0M stock solution as directed and correctly completed a given table to show volumes of both stock sucrose and water they added to make up the required 20 cm^3 of all concentrations in the desired range. They then proceeded to use the cork borer to remove equally sized, peel free chips and blot them to remove excess moisture. Feeling tired and slightly pushed for time the learner quickly scribbled down a results table. Each of the variable headings was present but without units, in fact some values had units on the same line as the value, others did not. Unfortunately the learner did not consistently use the appropriate number of decimal places with some data recorded to only one decimal place and others to two, which was more appropriate. When this became obvious to the teacher towards the end of the practical lesson it was too late to repeat the tests.	**Context** Biology (Year 12): Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue **Observed** A learner designed a results table for their raw data that was complete with variable headings and units to the format expected outlined in their practical handbook. After blotting dry the chips the learner weighed each one, recording the initial masses to 2 decimal places as it was being collected. This number of significant figures appropriate for the weighing balance was used.	**Context** Biology (Year 12): Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue **Observed** The learner on this occasion was keen to reduce the uncertainty in their data and so wanted to carry out a number of repeats for each sucrose concentration. They had planned to use a number of sets of sucrose tubes and chips and demonstrated the ability to both make and record multiple readings throughout the procedure. Their data table had variable headings and units to the expected format and, in addition to their raw data, the table had columns housing processed data. This included both gain in mass and % gain in mass, enabling them to then draw their graph as directed.

Context Biology (Year 12): Preparation and scientific drawing of onion cells including calibration of actual size and magnification of drawing. **Observed** Three cells are drawn but these appeared out of proportion with cells viewed by candidate. Very little observation of the image was made by the learner who appeared to draw what she thought should be present. The learner was clearly distracted from the task by chatting to her neighbour. No indication of length in eye piece units was given. The candidate forgot to record the magnification of the drawing.	**Context** Chemistry (Year 12): Back titration - determination of calcium carbonate in limestone. **Observed** A learner accurately records data from the titration. He determines the mass weighed by difference. He records all readings at the time of taking them. His readings are recorded into suitable tables to an appropriate number of decimal places taking into account the resolution of the apparatus (e.g. burette readings were to 2dp with second figure as '0' or '5'). On one titre reading he omitted to write down '0'. This appeared to be an oversight by the candidate who recognised his error when his attention was brought to it.	**Context** Physics (Year 13): Measurement of g with a pendulum **Observed** She made two trial runs to measure the time of a period for the longest and shortest length she proposed to use in order to check the range of values and also determine whether the shortest length could be made measured without significant error. She increased the length of the pendulum of her shortest run in the light of her experience. The candidate then made multiple readings of the period of the pendulum at a total of six lengths approximately evenly spaced over the range she determined. She took period readings for six different lengths. She recorded all information immediately into suitable table to an appropriate precision with units correctly recorded. Her tables also facilitated the recording of processed data. This is a capable candidate who displays the full range of making and recording skills in one procedure. It is possible that different aspects of these skills could have been demonstrated in more than one experiment. It is not necessary to record processed data – only raw data- in an appropriate table so this candidate has exceeded the standard.

Context Biology (Year 12): An investigation into the water potential of potato **Observed** As part of the investigation, the learner is expected to draw an accurate results table. In this case, the learner confuses the dependent and independent variables and draws a table where the units are repeated in each line of data. This is pointed out by the teacher in discussion with the learner and the learner is then able to draw a more suitable table and know the format for the next time this skill is required.	**Context** Biology (Year 12): An investigation into the water potential of potato **Observed** The learner uses a balance to 2dp to weigh and record the mass of her potato chips. The table used has the variables and headings correctly labelled. The learner is reminded of the importance of recording all readings at the time of taking them and so does this for all readings after the first one.	**Context** Biology (Year 12): An investigation into the water potential of potato **Observed** The learner records the mass of potato chips accurately using a balance to 2dp and writes them down in a suitable table as they are weighed. The table has all headings and variables correctly labelled but the table is rough and sketched in the learner's lab book. The learner then goes on to draw a further table for processed data to include the percentage gain or loss of water of each chip and the mean. This is all recorded correctly.
Context Physics (Year 12): Determine the Young modulus of a material **Observed** The student takes a measurement of the diameter of the wire, but is not familiar enough with using a micrometer, and only takes a single reading. Only two different loads are used in the experiment, so the student simply records two forces and two extensions. It is not clear from the student's results what the units are for either measurement.	**Context** Physics (Year 12): Determine the Young modulus of a material **Observed** The student is competent in the use of the micrometer and reads the scale correctly to record the diameter of the wire. The student keeps a rough table of the mass used in each experiment (in grams) and the extension of the wire (in mm). In the time available, the student collects five* data points. His graph does have an outlier, but he draws a line of best fit and calculates a value for the test wire. The value does not match the data book, but the teacher is confident that the data has been collected as accurately as the apparatus allows and that the correct gradient has been calculated from the graph. *the exact number of data points to meet CPAC 4 may vary from experiment to experiment	**Context** Physics (Year 12): Determine the Young modulus of a material **Observed** The student takes two or three measurements of the diameter of the wire, using the micrometer with accuracy, and calculates a mean value. The student records extension and load, with units, in a suitable table and makes a rough plot of force versus extension as data is collected. The student continues to take readings up to the elastic limit of the test wire. The value that the student calculates does not match the data book value, but the student carries out an error analysis to help explain why the value may not match that in the literature.

CPAC 5: Researches, references and reports

Not achieved	Achieved	Exceeding CPAC standard
Context Physics (Year 12): Determination of *g* by free-fall method **Observed** The learner completed their experiment and was asked by his teacher to report his findings. It was evident after a while that they were having difficulty processing their raw data using the calculator and there was some lack of understanding and so the teacher needed to intervene. Despite a lot of support, the report produced was very brief and still contained some of the processed errors that the teacher had supported the learner managing. This, coupled with the fact that there is no evidence of any research conducted by the learner to support them with either the practical work or calculation work, led to an unsatisfactory write up on this occasion.	**Context** Physics (Year 12): Determination of *g* by free-fall method **Observed** Independent processing of raw data collected through the practical lesson was followed by a short, concise report being produced by the learner in their own words. They commented on the value of *g* obtained through calculation, the report commenting on the significance of uncertainty. Several, relevant research resources were included in the report, detailed to include the full url address and the time and date accessed so they could be accessed again if necessary. It was evident that the learner had accessed more information than the teacher had shared through this research.	**Context** Physics (Year 12): Determination of *g* by free-fall method **Observed** A full, detailed report had been completed in the learners own words, heavily supported by the extensive, relevant research resources that they had used to support them in practical work. The learner used the Harvard system to reference. The learner had been keen to minimise uncertainty in the data collection and so had considered several ways of adapting the procedure e.g. the use of a *g* ball with an integrated timer, the use of a millisecond timer electromagnetic circuit. Full, scientific terminology had been used correctly and a calculator used without error to process raw data to calculate *g*.
Context Chemistry (Year 12): Determination of an enthalpy change of combustion **Observed** The learners were asked to report their findings. The learner observed had some difficulties calculating the enthalpy change and needed assistance from the teacher. The final report was brief and contained some processing errors. There was no evidence of research (e.g. checking literature values for enthalpy changes).	**Context** Biology (Year 12): Investigation into the effect of temperature on enzyme activity **Observed** The learners were asked to write a report on their findings. The learner observed was able to process results to obtain an appropriate graph of rate (1/t) against temperature. His report commented on the significance of the findings and contained two relevant websites whose URLs and date accessed were recorded. The report was written in his own words and was not simply 'cut and pasted' from websites.	**Context** Physics (Year 12): Determination of *h* using LEDs **Observed** The learner completed a formal and detailed report of his findings using their own words. The learner correctly used a calculator to find relevant values. The report contained suitable graphs plotted using Excel to correctly determine *h*. The report also contained references to critically chosen websites and a textbook. The references were recorded using Harvard system. There is no requirement to use the Harvard System or to formally write-up an experiments findings and therefore the learner's work exceeds requirements.

Context Any subject or Year: Materials Report **Observed** Student presents information, which may be correct, but without any references or evidence of additional knowledge found from researching.	**Context** Any subject or Year: Materials Report **Observed** Student has identified a minimum amount of new information relevant to the material being studied and linked it to understanding from teaching. The references do not follow a standard format, but would allow the reader to locate the information.	**Context** Any subject or Year: Materials Report **Observed** Student has taken the project seriously and researched a wide range of additional data to support how the internal structure of a material lends that material to a particular use. The references follow an accepted pattern and are complete.
Context Biology (Year 12): Investigation of plant mineral deficiencies **Observed** As part of the preparatory work in advance of the practical, students are asked to undertake some research concerning the factors that could be investigated in this investigation. The student's research is poor: his only source of information is the textbook and, although he has read up on some of the theory, he has not considered how this would affect the practical work to be undertaken. No written record is made by the student to say which sources were used in his research.	**Context** Biology (Year 12): Investigation of plant mineral deficiencies **Observed** As part of the preparatory work in advance of the practical, students are asked to undertake some research concerning the factors that could be investigated in this investigation. The student uses Wikipedia as a source, along with her textbook, and she writes some notes in her lab book that show some factors that could be investigated. Her written report includes the URL for Wikipedia, along with the data and time accessed; and the title of the textbook used, the author, and the pages from which she obtained the information. When questioned, she acknowledges that Wikipedia is not always a reliable source, but says that the information on the website agreed with her textbook.	**Context** Biology (Year 12): Investigation of plant mineral deficiencies **Observed** As part of the preparatory work in advance of the practical, students are asked to undertake some research concerning the factors that could be investigated in this investigation. The student writes some notes in his lab book, based on the use of two different websites, and back up by two different textbooks. All sources used are accurately referenced. He uses these sources to state the main factors, and then goes on to outline a possible plan for the experiment, including some excellent experimental detail on apparatus and quantities.

CPAC assessment support document

What I am looking for when I am assessing each competency is …….

This aide memoire should **not** be used as a tick list. It is designed to help teachers in thinking about what they will look for in their students' practical work. Blanks have been left in each section for teachers to add their own criteria.

This document should be used **after** completing the endorsement training, available on the AQA website.

Common Practical Assessment Criteria (CPAC)	**I am looking for my students to be able to …**
1. Follows written instructions	• follow a set of written instructions that are appropriate to the level of familiarity to equipment or techniques • carry out steps in the correct order • generate a set of data that is expected. This might be close to my own value or that expected from a data trend seen in a secondary source • work independently, in pairs or small groups but they must carry out practical steps • feel confident to seek clarification when carrying out method steps, when either using an unfamiliar set of apparatus or carrying out a new technique • --- • --- • --- • --- • ---

2. Applies investigative approaches and methods when using instruments and equipment	• be able to select the most appropriate apparatus (including chemicals etc) to do this (this can be from a list, and could be done in written form) • use of ICT/dataloggers and be able to explain what they are doing • be able to identify areas that might be improved to allow the collection of more accurate data and note these in their lab records (these practical issues might be discussed with me before suitable adjustments being made) • work methodically • demonstrate the developing ability to 'multi-task' (carrying out one test while preparing for the repeat test is a good example of this) • understand the terminology 'independent, dependent and control variable' and write and/or follow method steps to allow a hypothesis to be tested • to consider which apparatus will support the collection of accurate data to allow them to read data using an appropriate scale • -- • -- • -- • -- • -- • -- • -- • -- • --

3. Safely uses a range of practical equipment and materials	• be able to identify the hazards and the risks associated with those hazards before carrying out the method steps • treat equipment and materials with respect and demonstrate confidence in handling them • be both very aware of their own personal work space and that of others around them • deal with an incidents calmly and effectively • amend the method steps to enable them to collect data more safely when appropriately. For example using smaller quantities or moving equipment to a safer position • wear safety goggles/clothing as standard when appropriate and without prompting. • -- • -- • -- • -- • -- • -- • -- • -- • -- • -- • -- • --

4. Makes and records observations	• design a data table to record their data as they collect it • record raw data in their data table • if using rough tables, these should be retained • put data table columns in order ie independent, control, dependent. • choose appropriate ranges for data to be collected • collect data at specific points across the full range in sequence to enable a pattern to be identified. • write headings clearly and units are written in the format as directed by the Practical handbook. • present data to the correct number of significant figures • take an appropriate number of repeats, based on the equipment used. • -- • -- • -- • -- • -- • -- • -- • -- • --

5. Researches, references and report	• write a short, concise report, inclusive of data tables, calculations (when appropriate), graphs, conclusion and evaluation • give enough detail that someone else could repeat the work • do not plagiarise • process data using software/tools and present calculations logically • research ideas linked to the scientific knowledge that is being studied at A-level or above if appropriate • use an appropriate referencing style (either in the body of the report or at the end), including full details • -- • -- • -- • -- • -- • -- • -- • -- • -- • --

AQA

Effect of alcohol concentration on beetroot cells

Required Practical 4:

Investigation into the effect of alcohol concentration on the leakage of pigment from beetroot cells.

There are three stages for each practical:

1. Pre-practical Questions: please complete these at home. You may need to use your notes, the textbook or to do some research. Competencies 2 and 5 require you to undertake self-directed research.

2. Practical

3. Post-practical questions: please complete these at home. You may need to use your notes, the textbook or to do some research. Competencies 2 and 5 require you to undertake self-directed research.

If you use any websites please include the URL and date otherwise this cannot be used as evidence.

Competencies achieved:

Competency 1	
Competency 2	
Competency 3	
Competency 4	
Competency 5	

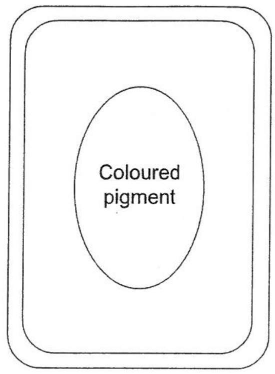
Name:

Date:

Pre-practical Questions

Beetroot contains high concentrations of betalin. This is a purple pigment found inside the vacuoles of the cells. The pigment cannot pass across undamaged plasma membranes. In this practical you will be investigate the effect of alcohol concentration on the amount of pigment leaking through beetroot plasma membranes.

1. The diagram shows one cell from a beetroot. Label all parts through which the pigment must pass to leave this cell. [2 marks]



2. You will be given discs taken from a fresh beetroot in your investigation. Boiling does **not** change the colour pigment.

   Explain why the results may be different if you had used cooked beetroot. [3 marks]

In **Part 1** you will produce a set of colour standards. You will then use these standards to compare the colour of the solutions obtained when beetroot discs have been soaked in different concentrations of alcohol.

3. What is the problem with comparing the colours by eye? [1 mark]

4. Can you describe a different technique that you could use in the classroom which would be preferable? Explain how this technique / apparatus would work and why it would be preferable. [2 marks]

5. Complete the table in **Part 1: Making the colour standards**, to show the concentration of extract and how you would generate each from a mixture of water a d beetroot extract. [3 marks]

6. Choose from the following list which apparatus you would select to measure your volumes. Give a reason for your choice(s): [1 mark]

   0.5ml, 1.0ml. 5ml, 10ml, 10ml measuring cylinder,
   25ml measuring cylinder, 50ml measuring cylinder,
   250 ml beaker.

In **Part 2** of this investigation you will use five concentrations of alcohol.

7. Describe a suitable control for your investigation. [1 mark]

8. Explain why this control would be necessary. [1 mark]

9. List the variables that you need to consider and describe how each of these could be controlled. [2 marks}

10. Are there any variables that you are not able to control in this investigation? [1 mark]

11. Read through the practical worksheet carefully. Draw a table to consider any hazards, the risk they pose and how any risks can be minimised. [2 marks]

If you use any sources of information from the internet in order to answer any of these questions, it is essential that you include the URL, the number of the page and the date on which you did this.

AQA

A level Biology required practical No. 4: Investigation into the effect of alcohol concentration on the leakage of pigment from beetroot cells

Introduction

Beetroot contains high concentrations of betalin. This is a purple pigment found inside the vacuoles of the cells. The pigment cannot move across undamaged plasma membranes. You will investigate the effect of alcohol concentration on the amount of pigment leaking through beetroot plasma membranes.

In **Part 1** of the investigation you will produce a set of standards. In **Part 2** you will use these standards to compare the colour of the solutions obtained when beetroot discs have been soaked in different concentrations of alcohol.

Method

You are provided with

- stock solution of beetroot extract
- five concentrations of alcohol labelled 100 %, 80 %, 60 %, 40 %, 20%
- discs cut from a beetroot and rinsed thoroughly in water
- graduated pipettes or syringes
- test tubes
- bungs to fit some of the test tubes
- thermometer
- large beaker to use as a water bath
- stop watch
- test tube rack
- small beakers
- permanent marker pen
- water

You should read these instructions carefully before you start work.

Part 1 Making the colour standards

1. Use the extract and water to prepare a series of six test tubes containing 5 cm^3 of different concentrations of extract. The concentrations should be equally spaced and cover a range from pure water (0 %) to pure extract (100 %). These will be your colour standards.
2. Label these standards 0, 2, 4, 6, 8, 10.
3. Complete **Table 1** to show the concentration of extract in each tube.
4. Complete **Table 1** to show how you made the colour standards in **Part 1** of the investigation.

AQA

Table 1

Volume of beetroot extract/cm3						
Volume of water /cm3						
Concentration of extract/%	0					100
Absorbance reading from colorimeter						

Part 2 The Investigation

5. Set up a water bath at 30°C.
6. With a second set of test tubes add 2 cm^3 of 100 % alcohol to a test tube and put a bung in the tube.
7. Label the tube with the alcohol concentration.
8. Repeat steps 5 and 6 with alcohol concentrations of 80 %, 60 %, 40 % and 20 %.
9. Put the tubes of alcohol in the water bath until temperature of the alcohol reaches 30°C.
10. Blot 10 discs of beetroot with a paper towel to remove excess water.
11. Gently put two discs of beetroot in each of the five tubes. Replace the bungs as soon as possible after doing so.
12. Leave the tubes in the water bath for five minutes. Shake the tubes gently once every minute. Then remove the tubes from the water bath.
13. Immediately pour each solution into a clean test tube, being careful to label the tubes appropriately. Throw the beetroot discs away.
14. Compare each of your solutions with the colour standards you made in **Part 1**. Note which standard has the same colour as each of your solutions. If the colour of the solution falls between two of the values you can use the intermediate number. E.g. if the colour value is between 2 and 4 record the colour value 3.
15. Record your results in a suitable table.

AQA

Required Practical 4: Investigation into the effect of alcohol concentration on the leakage of pigment from beetroot cells.

Post-practical Questions

1 You were provided with beetroot discs that were washed thoroughly before the start of the investigation. Explain why it was important to wash the beetroot discs. [1 mark]

2. *No question*

3 (a) Explain why you were instructed to shake the test tubes every minute .

[1 mark]

3 (b) Explain why you were instructed to pour the alcohol *immediately* from the experimental test tube into a clean test tube.

[1 mark]

AQA

Do not write outside the box

4 You were given discs taken from fresh beetroot in your investigation.
Explain why your results would have been different if you had used cooked beetroot.

....

....

....

....

(2 marks)

5 You used a water bath in this investigation. Explain why a decrease in temperature of 5 °C would affect the results.

....

....

....

....

(2 marks)

6 Two students carried out the same investigation as you did. They worked in the same practical session and followed the same procedure. They worked accurately but found their results were different. Suggest **one** reason for this.

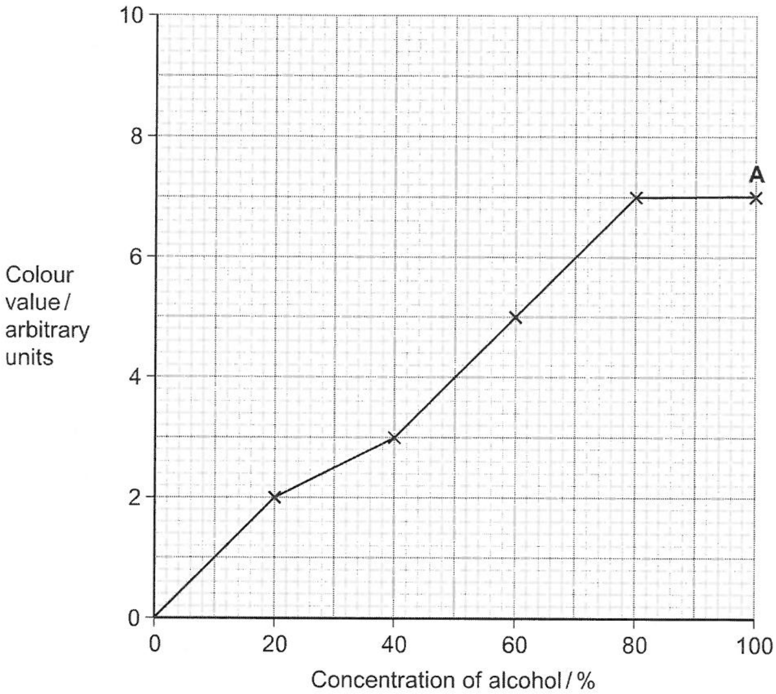
....

....

(1 mark)

AQA

7 A student carried out the same investigation as you did using the same concentrations of alcohol. He used his data to plot the following graph.



7 (a) The student started drawing his curve from the origin, was he correct to do this? Explain why.

....

....

....

(1 mark)

AQA

Do not write outside the box

7 (b) Phospholipids dissolve in alcohol.
Explain the shape of the curve between alcohol concentrations of 40 % and 80 %.

....

....

....

....

....

....

(3 marks)

Extra space ....

....

....

8 (a) The student suggested that point **A** on the graph was an anomaly. What should he do to check this?

....

....

....

....

(2 marks)

8 (b) After further investigation the student found the point was not an anomaly.
Suggest why the curve levels out.

....

....

(1 mark)

17

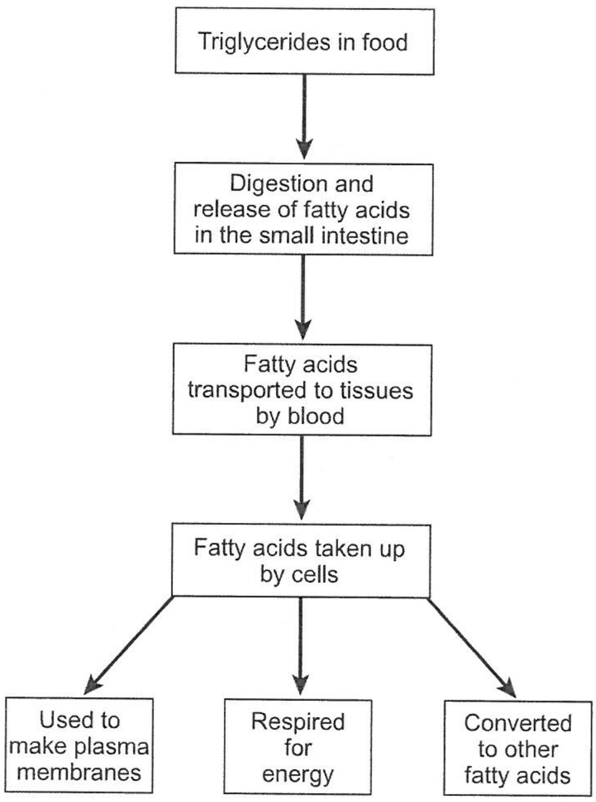
RESOURCE SHEET

Resource A

Triglycerides are taken into the body as part of a balanced diet. These triglycerides contain fatty acids including omega-3 fatty acids. It has been discovered that omega-3 fatty acids are associated with health benefits. The benefits include faster development of nerve cells and clearer vision. Omega-3 fatty acids are also associated with protection from heart disease, arthritis and cancer.

Figure 1 shows how omega-3 and other fatty acids are taken in and used by the bodies of animals including humans.

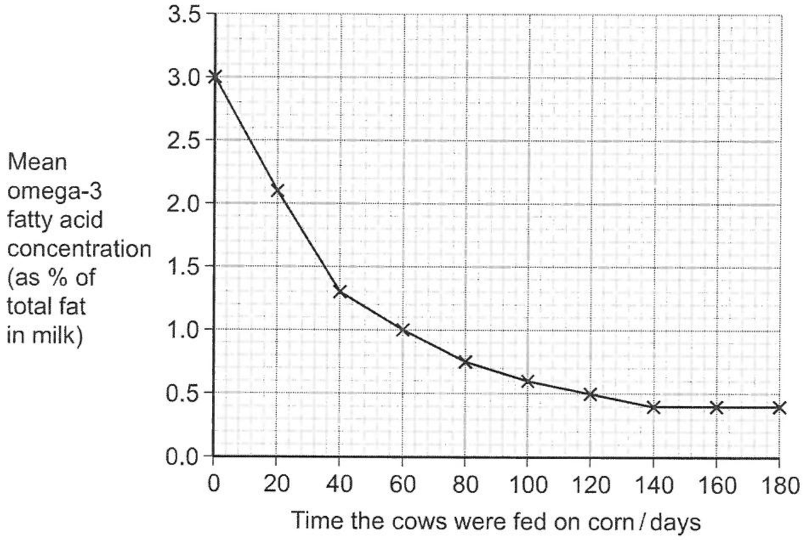
Figure 1



Resource B

Omega-3 fatty acids are found in cows' milk. Scientists investigated changes in the concentration of omega-3 fatty acids in milk when cows were moved from eating grass in fields to eating corn in cattle sheds. **Figure 2** shows the results of one investigation.

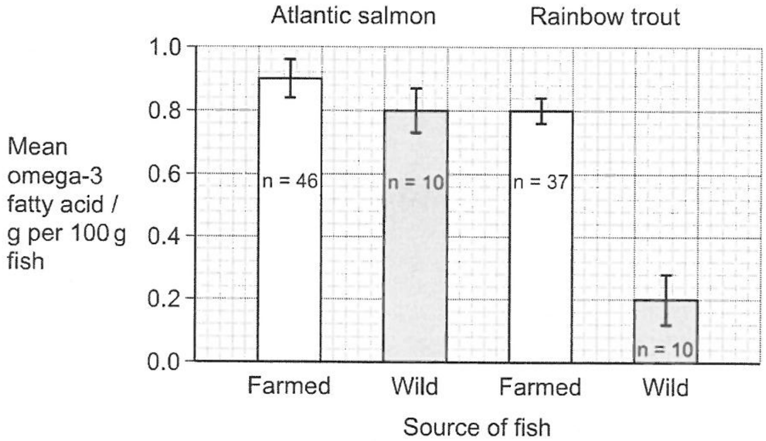
Figure 2



Resource C

Omega-3 fatty acids are also found in fish. Scientists investigated the concentration of omega-3 fatty acids from wild-caught and farmed fish. Their results are shown in **Figure 3**.

Figure 3



The bars show standard deviation; n is the sample size.

Do not write outside the box

Section B

Use the information in the **Resource Sheet** on triglycerides and omega-3 fatty acids to answer the questions.

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

Use information from **Resource A** and your own knowledge to answer Question **9**.

9 Use the information in **Figure 1** to explain **two** ways in which fatty acids are important in the formation of new cells.

1. ....

....

....

....

2. ....

....

....

....

(4 marks)

Use **Resource B** to answer Questions **10** and **11**.

10 The concentration of omega-3 fatty acids in milk changed when cows were fed on corn instead of grass. Describe how.

....

....

....

....

(2 marks)

Do not write outside the box

11 (a) Calculate the rate of decrease in the mean omega-3 fatty acid concentration between 0 and 40 days.
Show your working.

Answer...% per day
(2 marks)

11 (b) The omega-3 fatty acid concentration is expressed as a percentage of total fat. Explain the advantage of this.

....

....

....

....
(2 marks)

11 (c) One farmer concluded from the graph that feeding cows on corn reduces the omega-3 fatty acid content in milk. Evaluate this conclusion.

....

....

....

....

....

....

....

....
(4 marks)

Extra space ....

....

....

....

Do not write outside the box

Use **Resource C** to answer this question.

12 It is **not** possible to conclude from the data that the concentration of omega-3 fatty acids in the farmed salmon is higher than that of the wild salmon. Use the data to explain why.

....

....

....

....

(2 marks)

Use **Resource A** and **Resource C** to answer this question.

13 There is a difference between the concentration of omega-3 fatty acids in the wild trout and trout farmed in cages. Suggest **two** causes of this difference.

1. ....

....

2. ....

....

(2 marks)

18

END OF QUESTIONS

AQA

Factors which affect enzyme activity

CPAC 5

Learning objectives

- How to calculate rate
- Learn how to describe a graph clearly (and always get the marks)
- Explain the effect that temperature has on enzyme activity

Control variable	How was it controlled?	What could the impact of it changing be?

2. How do you know that it is the enzyme that is causing the milk to change colour and not anything else…? What experiment could you do to confirm it is the enzyme

Control variable	How was it controlled?	What could the impact of it changing be?
Volume & Conc. Of trypsin and milk	Vol cont. using pipette	
Temperature of enzyme + substrate before mixing	Put the solutions into waterbath for 5min (to equilibrate the temp) Checked the temp with thermometer	
pH	Using a buffer	

2. How do you know that it is the enzyme that is causing the milk to change colour and not anything else…? What experiment could you do to confirm it is the enzyme?

We put together all the classes' results from yesterday

Temp /°C	Time taken for milk to turn clear (sec)																			
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11	Trial 12	Trial 13	Trial 14	Trial 15	Trial 16	Trial 17	Trial 18	Trial 19	Trial 20
20	239	320	306	280	360	231	360	440	353	448	300	65	557	656	372	300	312	314	434	215
30	250	151	158	390	240	392	174	692												
40	55	79	110	180	120	50	120	336	300	330	272	247	140	165	190	191	336	300	330	272
50	105	80	240	1.55	60	104	180	130	130	149	62	154	105	312	150	270	230	230	200	232
65	91	90	246	390	no change	no change	no change	no change	322	540	295	560	692							

Temp /°C	Trial 21	Trial 22	Trial 23	Trial 24	Trial 25	Trial 26	Trial 27	Trial 28	Trial 29	Trial 30	Trial 31	Trial 32	Trial 33	Trial 34	Trial 35	Trial 36	Trial 37	Trial 38	Trial 39
20	600	678	436	360	300	312	314	434	215	600	678	436	360	350	722	438			
30																			
40	247	140	165	190	191	183	152	130											
50	152	215	434	145	270	230	230	200	232	152	215	434	145	70	204	200	257	191	330
65																			

If we were to plot it on a graph, what would the labels on the axes be?

Use your whiteboards to draw the axes

Time taken for milk to turn clear (sec)

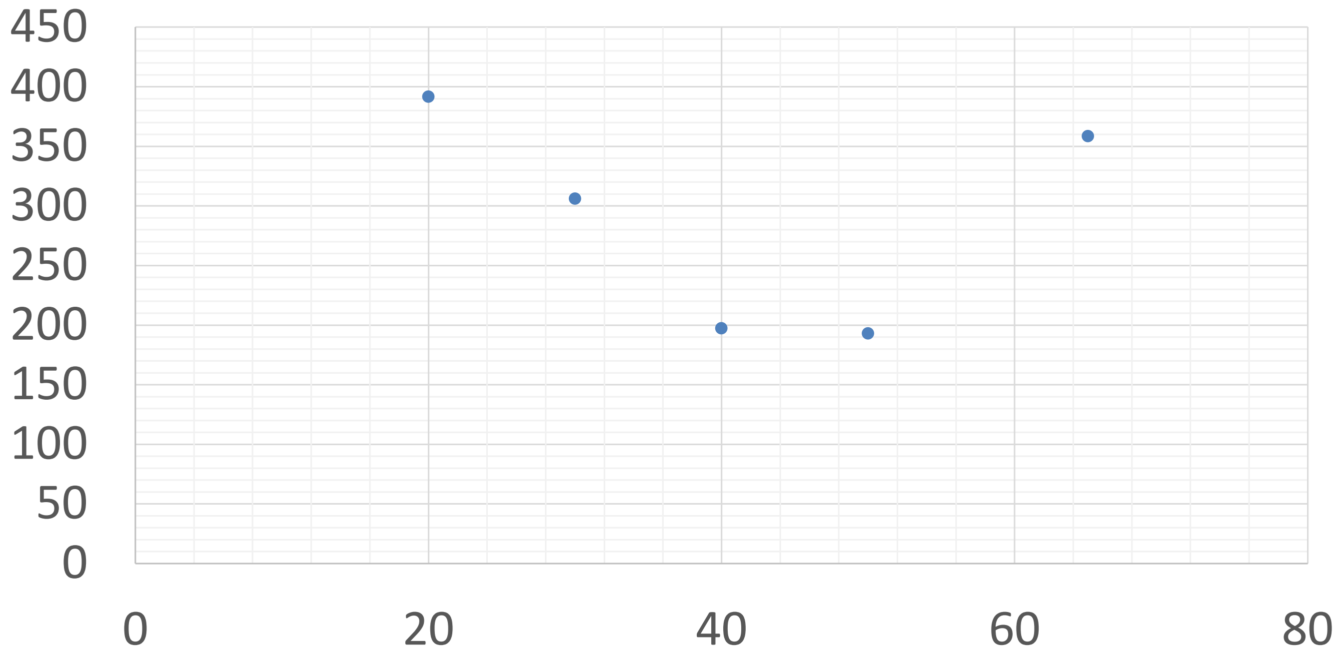
Temp /°C	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11	Trial 12	Trial 13	Trial 14	Trial 15	Trial 16	Trial 17	Trial 18	Trial 19	Trial 20
20	239	320	306	280	360	231	360	440	353	448	300	65	557	656	372	300	312	314	434	215
30	250	151	158	390	240	392	174	692												
40	55	79	110	180	120	50	120	336	300	330	272	247	140	165	190	191	336	300	330	272
50	105	80	240	1.55	60	104	180	130	130	149	62	154	105	312	150	270	230	230	200	232
65	91	90	246	390	no change	no change	no change	no change	322	540	295	560	692							

Temp /°C	Trial 21	Trial 22	Trial 23	Trial 24	Trial 25	Trial 26	Trial 27	Trial 28	Trial 29	Trial 30	Trial 31	Trial 32	Trial 33	Trial 34	Trial 35	Trial 36	Trial 37	Trial 38	Trial 39	Trial 40	
20	600	678	436	360	300	312	314	434	215	600	678	436	360	350	722	438					392
30																					306
40	247	140	165	190	191	183	152	130													197
50	152	215	434	145	270	230	230	200	232	152	215	434	145	70	204	200	257	191	330	287	193
65																					358

Factors which affect enzyme activity: TEMPERATURE

This is a graph of the results we got last lesson: -

- what should the labels on the axes be?
- whiteboards



BUT we wanted to find out the effect of temperature on the RATE of reaction…

At which temperature was the RATE highest?

How can you convert time to rate?

Temperature	Time taken for milk to turn clear (s)	Rate of reaction
20	392	
30	306	
40	197	
50	193	
65	359	

Calculate rate using the equation:

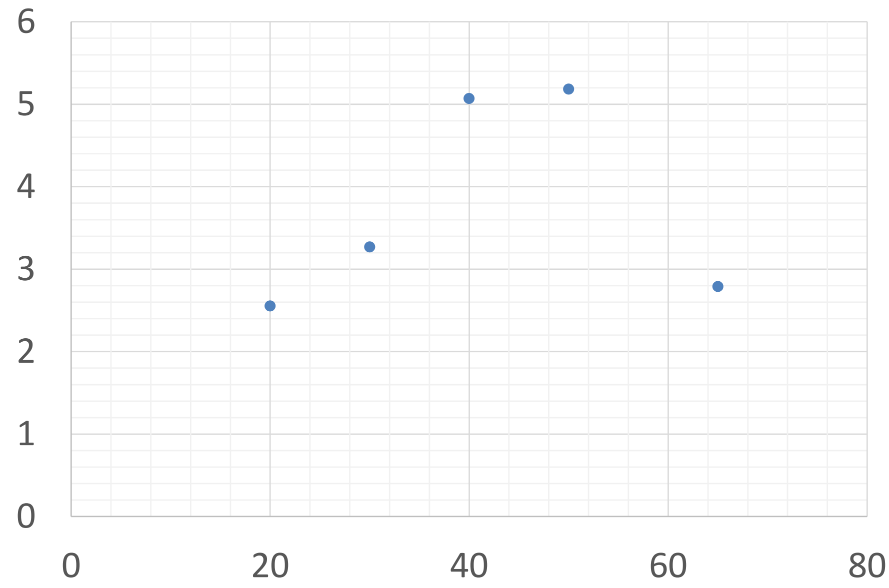
Rate = 1 / time OR Rate = 1000/time

Temperature	Time taken for milk to turn clear (s)	Rate of reaction
20	392	2.6
30	306	3.3
40	197	5.1
50	193	5.2
65	359	2.8

Calculate rate using the equation:

Rate = 1/time or 1000/time

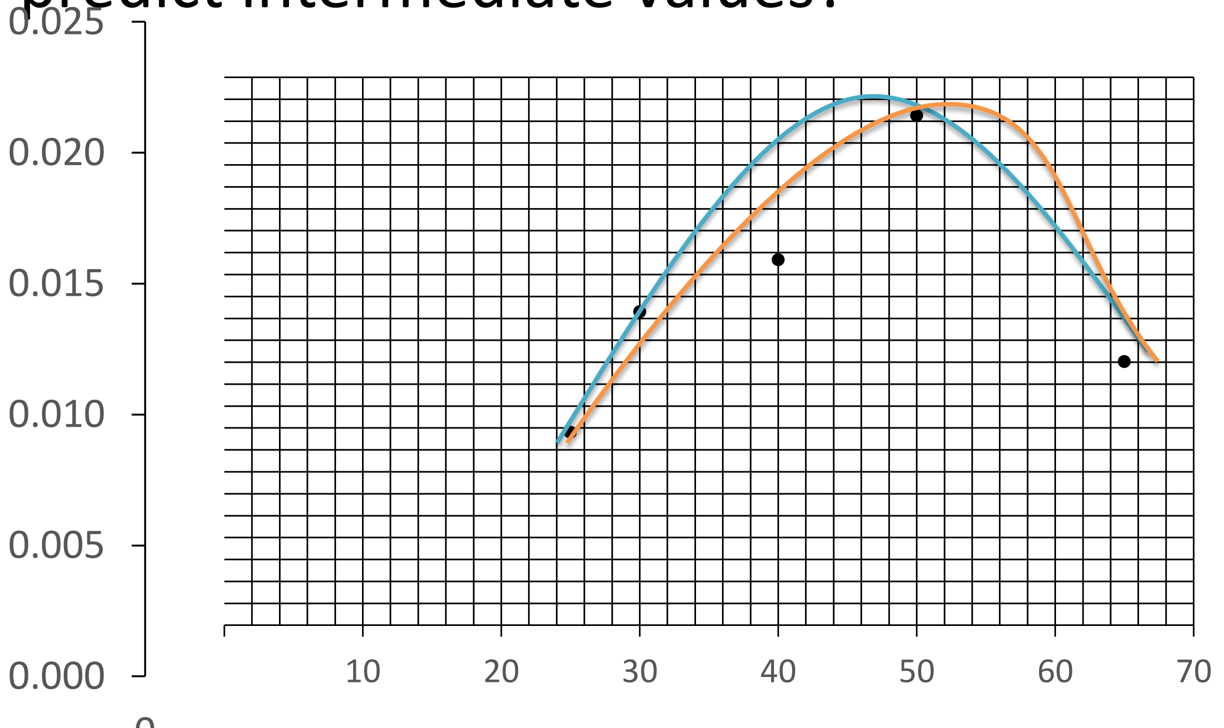
This is a graph of the effect of temperature on rate



The graphs need a line… what should the lines look like?

Draw a line from point to point **because we cannot predict intermediate values**

What do we mean by saying that we cannot predict intermediate values?



It's difficult to know which is correct just from this data so we join the points together

Describing Graphs

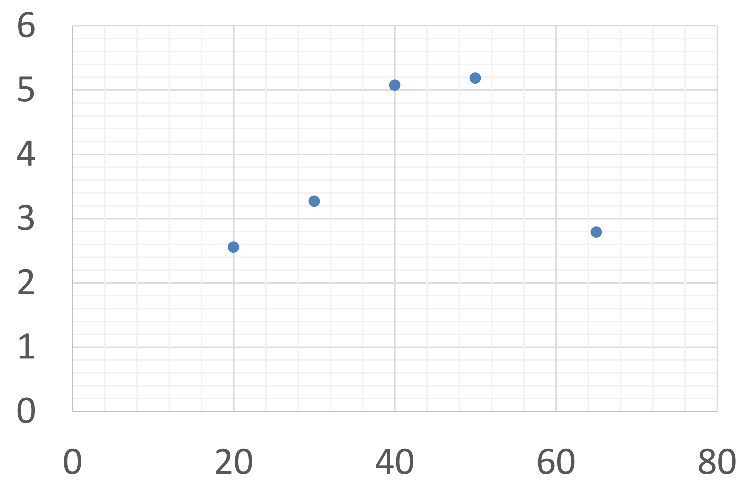
Split the graph into stages

Then you use this structure to describe the graph one stage at a time:

As 'x' increases from ... to ...

- ***'y' increases ………. from ... to ...***
- ***'y' decreases ……… from …. to ...***
- ***'y' stays the same at ….***

………….. = a descriptive word such as rapidly, slowly, exponentially



Discuss with your pair why you think changing the temperature has this effect on enzymes?

We need to explain why the rate of enzyme reaction increases and why after a certain temperature it decreases

What key words are you using?

AS A FLOW CHART!!
KEY WORDS:

Kinetic energy
Denature
Hydrogen bond
Collision
Enzyme – substrate complex
Active site
Complementary
Tertiary structure

CHALLENGE:

1. Thermophillic bacteria live in environments with very high temperatures (up to 120°C!). Think about how their enzymes might cope with these extreme temperatures? http://www.hindawi.com/journals/archaea/2013/373275/
2. How might studying these bacteria be useful to us? Can you think of any practical applications?

Risk assessment - 1

- 100%, 80%, 60%, 40%, 20% hydrogen peroxide
- Pasteur pipette
- boiling tubes
- bungs for boiling tubes
- burette
- delivery tube
- stop watch or timer
- large container to hold water
- pipettes
- marker pen

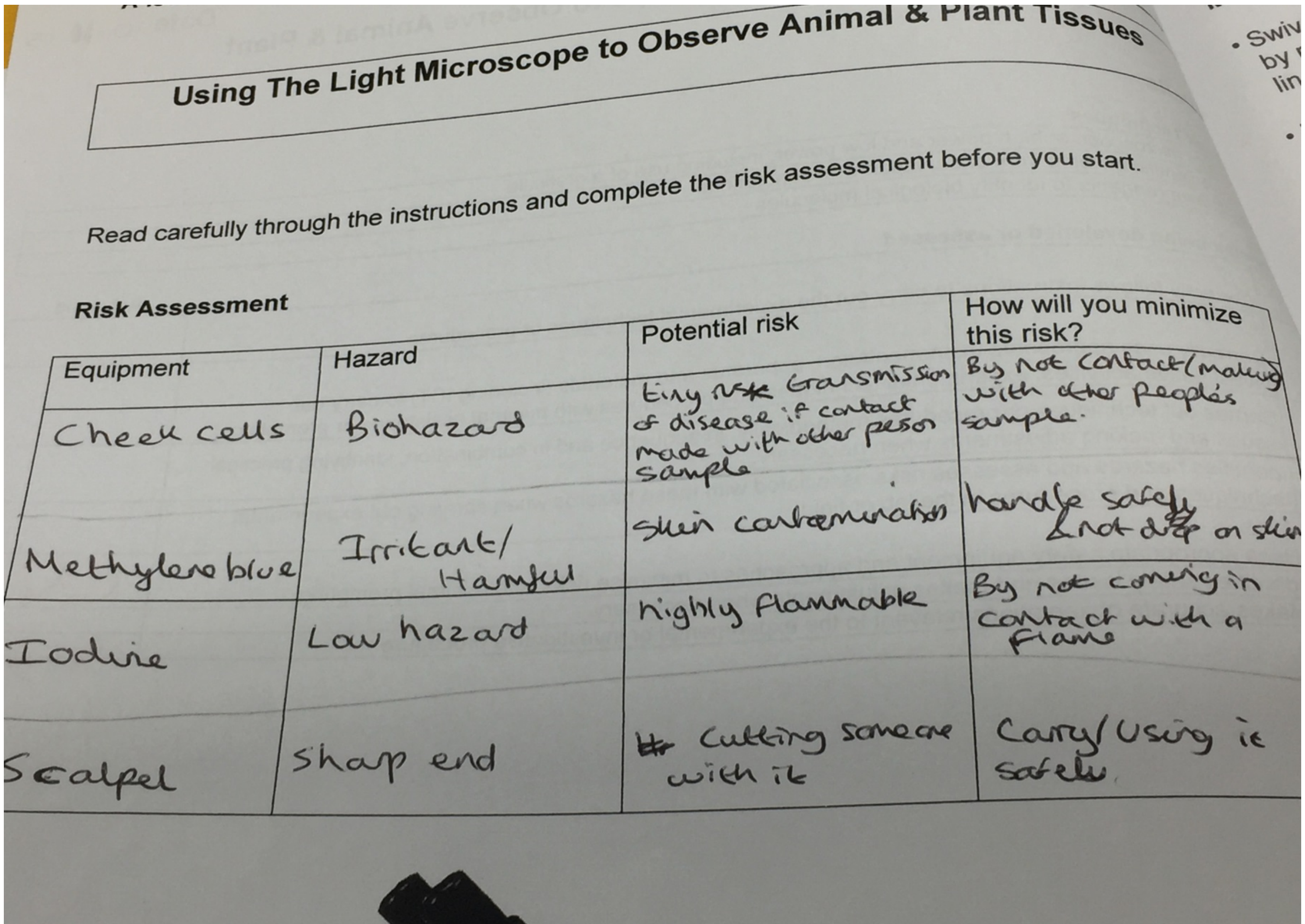
Read these instructions carefully and complete the risk assessment before you start your investigation.

Risk Assessment

Hazard	Relevant hazard warning symbol(s)	Potential risk(s)	How will you minimize this risk?
Hydrogen peroxide	Irritant	irritates eyes and skin	wear goggles wash skin if comes into contact ✓
Pasteur pipettes	Low hazard Glassware - smashes	Drop and smash, snap - glassware	Hold & close to end when putting in F?? clear glass up sa...
Catalase solution	Low hazards (dilute solution)	Unlikely to give any significant risk	clear up if spilt ✓ skin? eyes?
Burette	Low hazard Harm surrounding people	can smash - glassware Poke people in eye	clear glass up safely wear goggles a... watch surround... ✓

nearly achieved

Risk assessment - 2



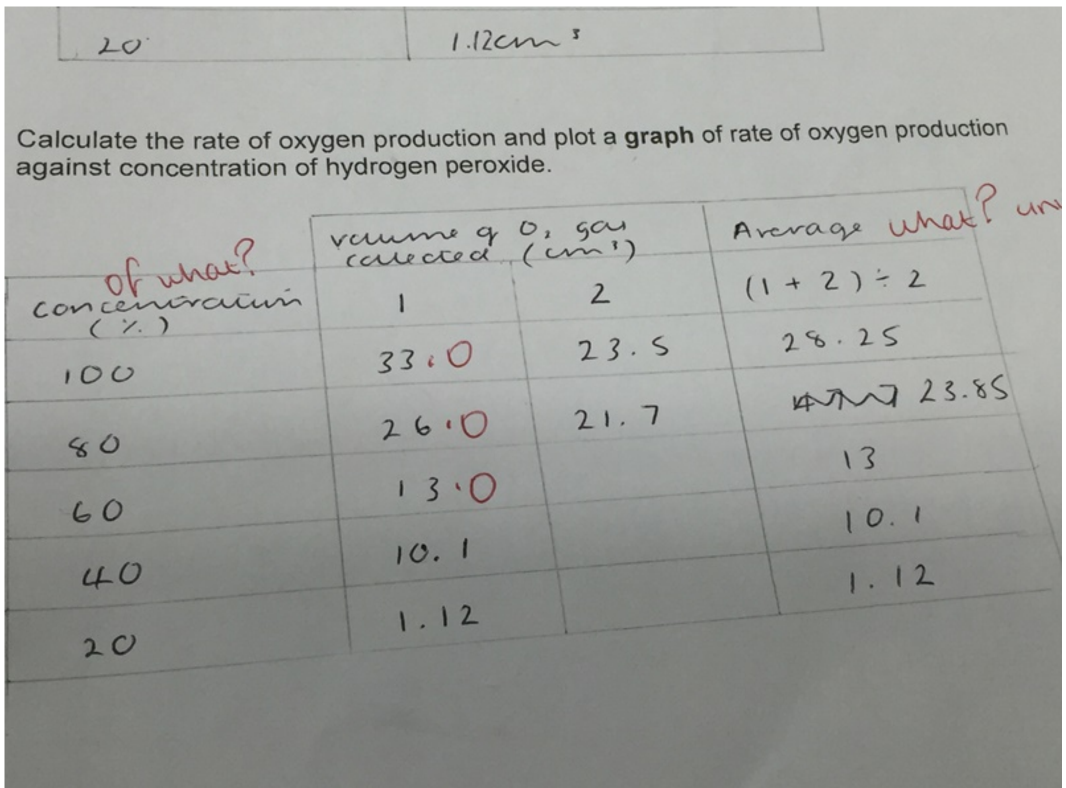
Using The Light Microscope to Observe Animal & Plant Tissues

Read carefully through the instructions and complete the risk assessment before you start.

Risk Assessment

Equipment	Hazard	Potential risk	How will you minimize this risk?
Cheek cells	Biohazard	tiny risk transmission of disease if contact made with other person sample	By not contact (making) with other people's sample.
Methylene blue	Irritant/ Harmful	skin contamination	handle safely & not drip on skin
Iodine	Low hazard	highly flammable	By not coming in contact with a flame
Scalpel	Sharp end	cutting someone with it	Carry/Using it safely

Graph of oxygen production against the concentration of hydrogen peroxide: significant figures



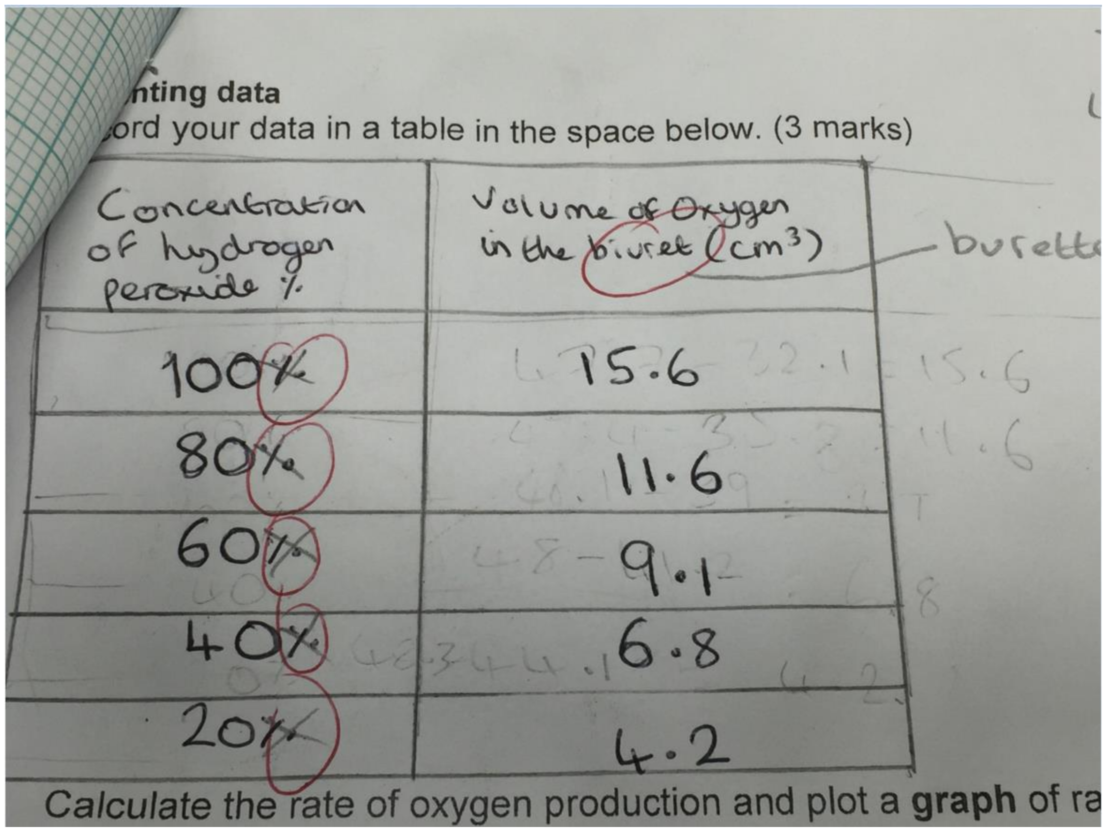
20	1.12cm³

Calculate the rate of oxygen production and plot a **graph** of rate of oxygen production against concentration of hydrogen peroxide.

concentration (%) [of what?]	volume of O_2 gas collected (cm^3)		Average [what? un]
	1	2	(1 + 2) ÷ 2
100	33.0	23.5	28.25
80	26.0	21.7	23.85
60	13.0		13
40	10.1		10.1
20	1.12		1.12

AQA

Graph of oxygen production against the concentration of hydrogen peroxide: not carrying units down



…nting data

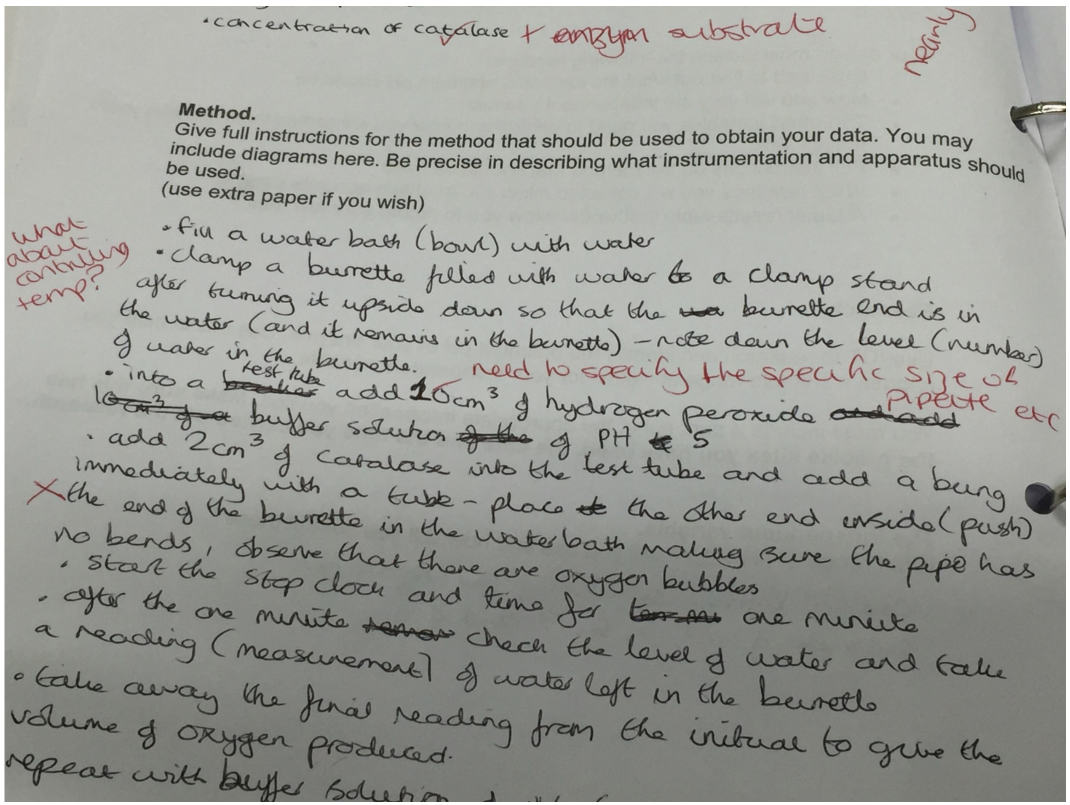
…ord your data in a table in the space below. (3 marks)

Concentration of hydrogen peroxide %	Volume of Oxygen in the biuret (cm^3)
100%	15.6
80%	11.6
60%	9.1
40%	6.8
20%	4.2

burette

Calculate the rate of oxygen production and plot a **graph** of ra…

Writing a method



• concentration of catalase + enzym substrate

nearly

Method.
Give full instructions for the method that should be used to obtain your data. You may include diagrams here. Be precise in describing what instrumentation and apparatus should be used.
(use extra paper if you wish)

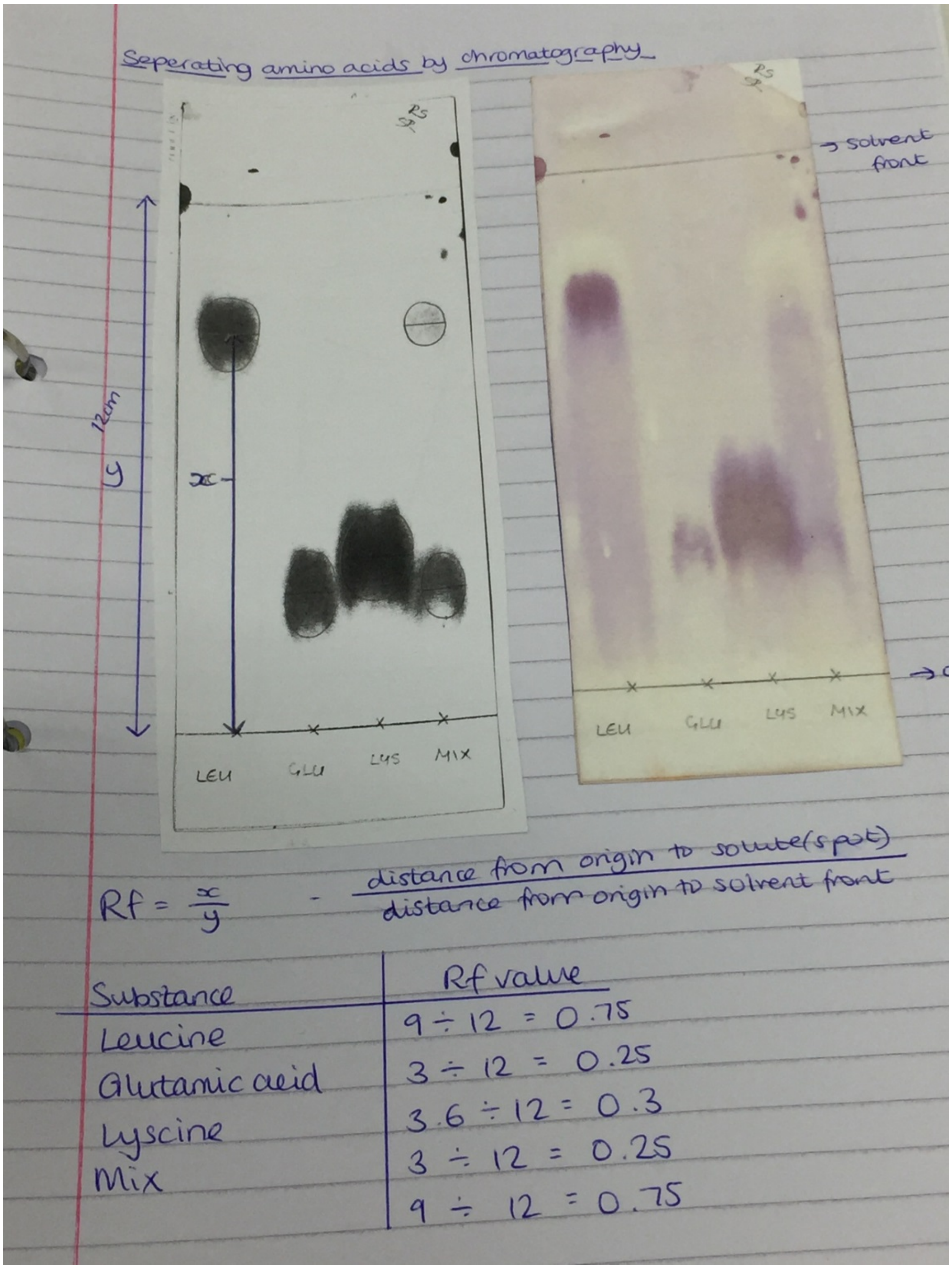
what about controlling temp?

• fill a water bath (bowl) with water
• clamp a burette filled with water to a clamp stand after turning it upside down so that the burette end is in the water (and it remains in the burette) – note down the level (number) of water in the burette.

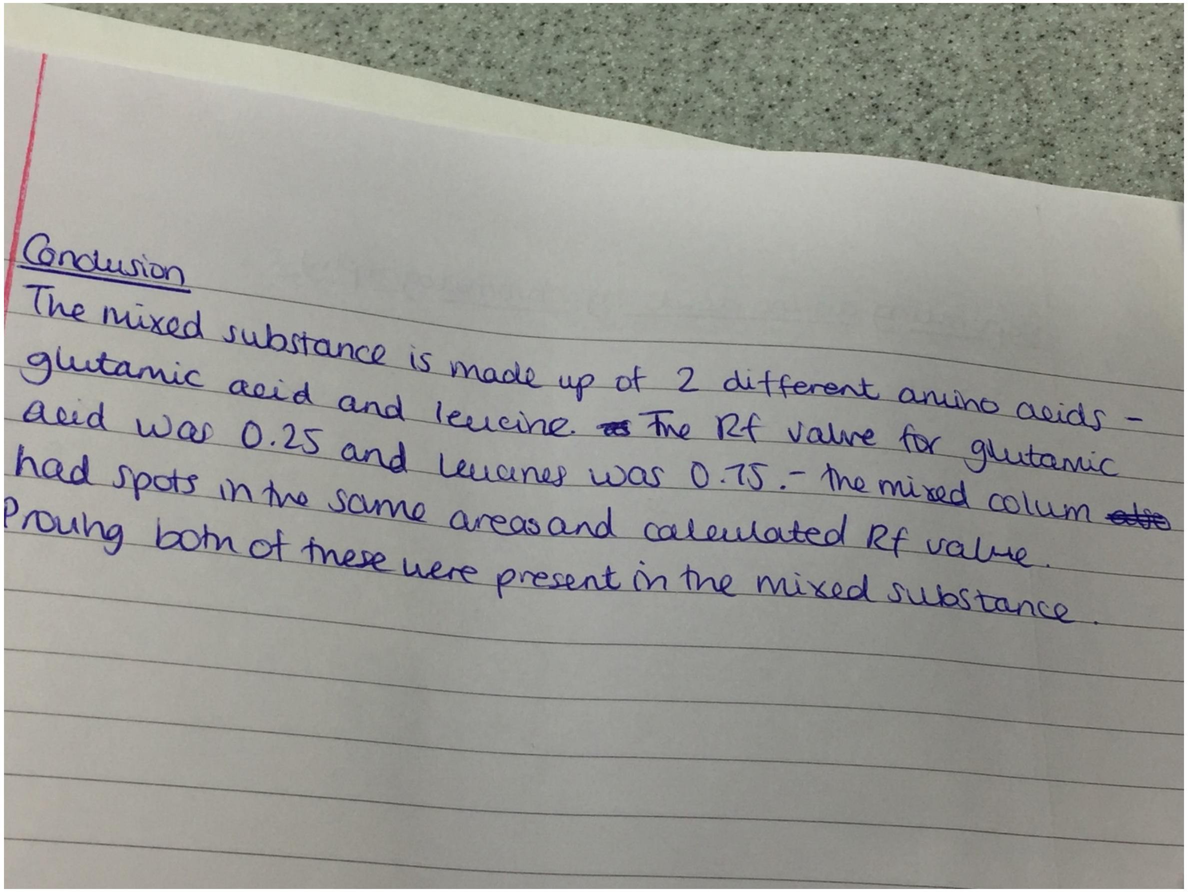
need to specify the specific size of pipette etc

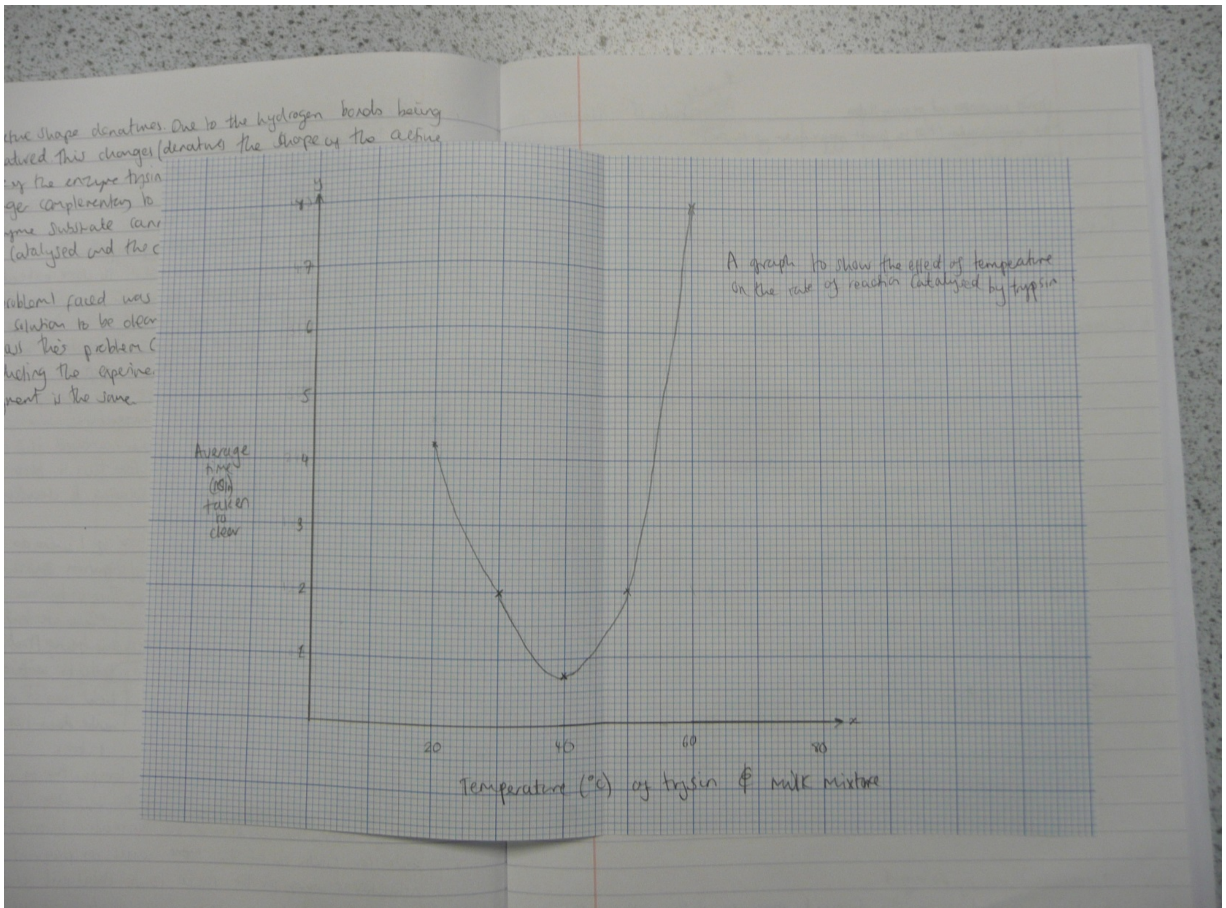
• into a test tube add 10cm3 of hydrogen peroxide buffer solution of pH 5
• add 2cm3 of catalase into the test tube and add a bung immediately with a tube - place the other end inside (push) the end of the burette in the water bath making sure the pipe has no bends, observe that there are oxygen bubbles
• start the stop clock and time for one minute
• after the one minute check the level of water and take a reading (measurement) of water left in the burette
• take away the final reading from the initial to give the volume of oxygen produced.
repeat with buffer solution

Separating amino acids by chromatography - processing data

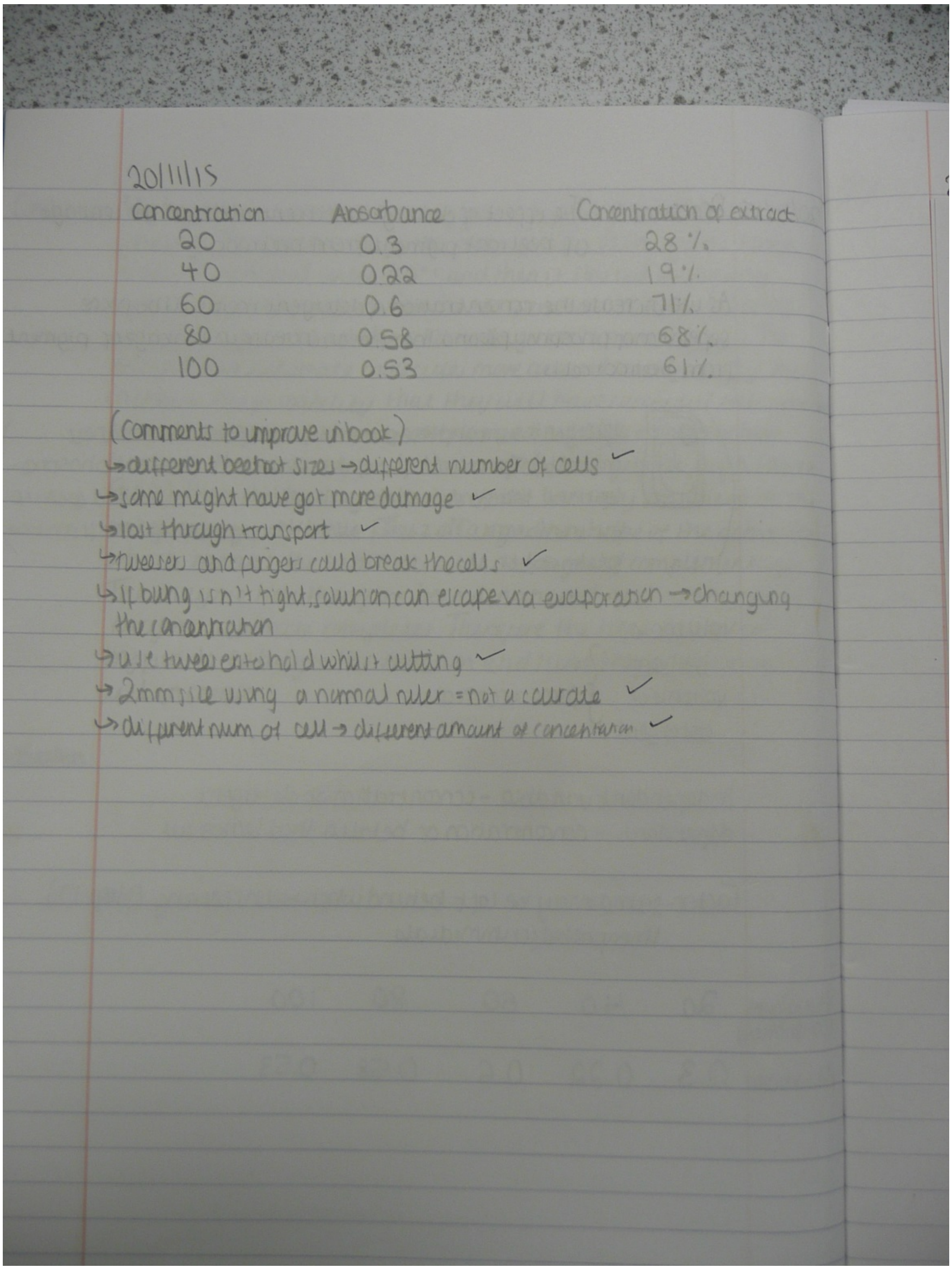


Basic conclusions




A graph to show the effect of temperature on the rate of reaction catalysed by trypsin
Average time (min) taken to clear
20
40
60
80
Temperature (°C) of trypsin & milk mixture

Suggested improvements when revisiting a practical



20/11/15

Concentration	Absorbance	Concentration of extract
20	0.3	28 %
40	0.22	19 %
60	0.6	71 %
80	0.58	68 %
100	0.53	61 %

(Comments to improve in book)

→ different beetroot sizes → different number of cells ✓
→ some might have got more damage ✓
→ lost through transport ✓
→ tweezers and fingers could break the cells ✓
→ If bung isn't tight, solution can escape via evaporation → changing the concentration
→ use tweezers to hold whilst cutting ✓
→ 2mm size using a normal ruler = not accurate ✓
→ different num of cell → different amount of concentration ✓