Student worksheets: ASC5 Investigation Task Overviews

Introduction

Teachers can print off the double-sided card for each investigation to produce a useful teaching aid, which can be issued to learners to support them in the conduct of their investigation.

Task overview

- Using secondary sources, learners research the background science to the chosen investigation, and this will include potential experimental standard procedures (SPs).
- They plan the practical investigation, justify approaches, prepare risk assessments and carry out the practical investigation.
- Learners will record and analyse data and draw conclusions. The techniques used and outcomes achieved are evaluated.
- A scientific report is produced and a presentation of the investigation is prepared for an appropriate audience.

Observation record

Laboratory work will require evidence of completed risk assessments within the portfolio of evidence, and also confirmation of the correct and safe use of practical techniques undertaken via a teacher completed Observation Record (specification p.143), together with video/photographic evidence, if appropriate. Full written records of all SPs followed and the learner's recorded results that these SPs produce are also essential supporting evidence.

Independent working

Learners should carry out the chosen scientific investigation independently and record their own results. However, it may be appropriate for wide-ranging investigations where, for instance, multiple factors are investigated, for some work to be carried out in pairs or small groups with a combination of results. However, it is essential that the origins of all recorded data are made clear and that each individual has played a full part in the investigation.

Delivery guidance

Learners will carry out an original practical investigation. Whilst it is common in many centres for all learners to carry out the same investigation, this is not a requirement. The majority of centres select one of the suggested titles in the specification (p.90), but it is acceptable for centres to choose their own investigations, in which case it is very important that they should confirm suitability with their NEA Adviser first.

It is very important that the approaches to any investigation selected are consistent with Level 3 standards in terms of the background scientific principles, the practical approaches chosen, the methodologies to be adopted and apparatus to be used. This follows through to the quality of the data recorded and the methods of data analysis employed. It applies equally to all the investigation titles listed in the Specification and those devised by the centre.

Additional points common to all investigations

- Trials are not just practice or familiarisation sessions, but are designed to test parameters in order that data recorded are accurate and reliable.
- Group work where the input of individual learners cannot be identified and/or individual practical skills cannot be assessed is not acceptable.
- The approach to P10, which requires use of the Harvard Reference system, typically involves inserting numbered references in the relevant part of the body of the report and then listing the reference in the bibliography (or footer). In the bibliography, a complete list of all the cited references used in the learner's work will then allow the reader to follow up these references and find the original text. It is common practice across a wide range of centres for the evaluation of sources and comments on their usefulness to be incorporated into the bibliography, and this approach is seen to be understood well by learners.

Investigate the factors that affect the efficiency of electroplating using copper

Task overview

Learners will investigate how the following factors affect electro-deposition rates:

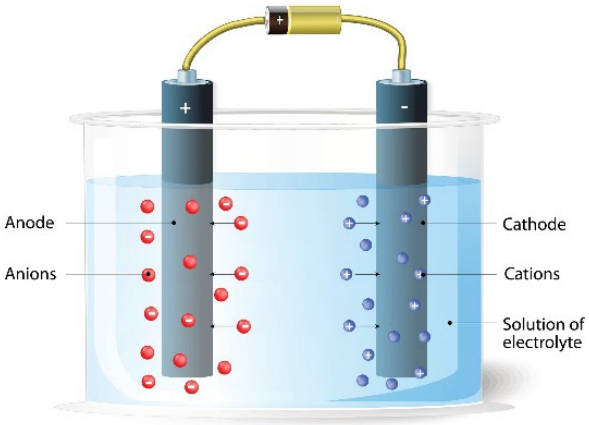
- concentration of electrolyte solution
- temperature
- presence of other ions in solution
- shape of electrode
- condition of the electrode surface.

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into electrolysis and electroplating. These scientific ideas are outlined for **P1** and the principles explained for **M1**. They will include, for instance, a consideration of:

- background and purpose of electroplating and uses in industry
- scientific principles of electrolysis
- electrode half equations
- coulombs and their relationship to current and time
- Faraday's laws, Faraday constant.



Factors that may/may not affect the rate of electro-deposition will also be explained:

- current, time, charge on the ion
- size and shape of electrodes
- effect of temperature, concentration
- nature of the electrode surface.

For **D1**, the scientific principles are detailed and are clearly based on the quantitative outcomes of electroplating. Commercial and industrial uses of electroplating and the purpose of the process are also considered in detail.

Overall, P1, M1, D1 will require wide ranging research and will demonstrate scientific knowledge and understanding relating to the various factors to be investigated and how they affect deposition rates. Uses of electroplating are many and varied and, whilst the investigation is specific to deposition of copper, commercial and industrial uses could be widened to cover other metals such as silver, gold and chromium.

Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs), and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability, validity (**D2**).

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present: hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**. Learners correctly follow SPs and use a range of equipment and materials safely for **P4**. (a centre-completed Observation Record (specification p.143) is required to support the award of P4).

Data obtained are tabulated (correct headings, units, significant figures) for **P5**. For **M4**, the methods used are assessed/evaluated for effectiveness, relating this to the recorded data and precision of recording, and the reliability, accuracy and repeatability of readings. This then leads to suggestions for improvements to the methods used to collect data and justifications for those suggested improvements for **D3**.

Examples of typical apparatus and materials required:

- copper electrodes, emery paper
- copper sulfate (s)
- balance, volumetric flasks, pipettes, beakers
- power pack, stopwatch, ammeter
- water bath, thermometer
- leads, crocodile clips
- salts of other metals (to investigate effect of 'presence of other ions').

Task 3: Analyse results

Appropriate calculations and graphs/charts, based on the data recorded, are evident for **P6**. Calculations relating to Faraday's laws and appropriate graphical representations of outcomes, as well as the use of IT, are required for **M5**. The methods and formats used to analyse and manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified (**P7**). Sources of error are explained, reasons for anomalies given, and ways to minimise errors/anomalies are explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced for **P8**. The use of primary and secondary data is reviewed, and includes a comparison of primary data with secondary data from initial research such as Faraday's laws and the value of the Faraday constant. For other investigation outcomes, additional secondary data should be sourced, for instance online (**M7**). Evaluation of the outcomes would consider their accuracy and reliability, and a detailed consideration of qualitative and quantitative errors (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction page.*

Investigate electrochemical cells

Task overview

Learners will construct a number of different electrochemical cells by pairing up various metal/metal ion half cells and then investigate how the voltage changes depending on:

- the salt concentration
- the size and shape of the electrode
- the temperature of the salt solution.

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is important that all three factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into electrochemical cells, how they are constructed and how they work. These scientific ideas are outlined for **P1** and the principles explained for **M1**.

They will include, for instance, a consideration of:

- half-cell reactions and overall cell reaction
- electrode/redox potentials and redox potential series
- purpose and nature of the salt bridge.

Factors that may/may not affect the voltage output will also be considered and explained:

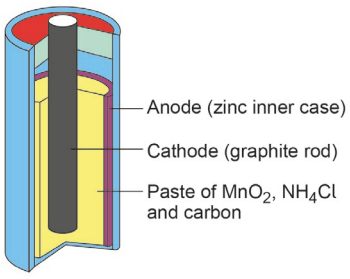
- the metal electrodes and salt solutions used
- size and shape of electrodes
- effect of temperature, concentration
- high or low resistance voltmeter.

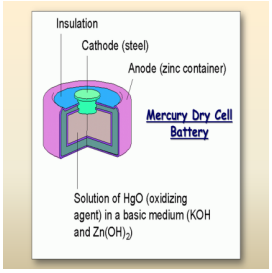
Electrode (redox) potentials
(examples only)

$Li^+(aq)$	$+ e^-$	$\leftrightarrow$	$Li(s)$	–3.03 V
$Na^+(aq)$	$+ e^-$	$\leftrightarrow$	$Na(s)$	–2.71 V
$Mg^{2+}(aq)$	$+ 2e^-$	$\leftrightarrow$	$Mg(s)$	–2.37 V
$Al^{3+}(aq)$	$+ 3e^-$	$\leftrightarrow$	$Al(s)$	–1.66 V
$Zn^{2+}(aq)$	$+ 2e^-$	$\leftrightarrow$	Zn s)	–0.76 V
$Fe^{2+}(aq)$	$+ 2e^-$	$\leftrightarrow$	$Fe(s)$	–0.44 V
$Pb^{2+}(aq)$	$+ 2e^-$	$\leftrightarrow$	$Pb(s)$	–0.13 V
$2H^+(aq)$	$+ 2e^-$	$\leftrightarrow$	$H_2(g)$	0.00 V
$Cu^{2+}(aq)$	$+ 2e^-$	$\leftrightarrow$	$Cu(s)$	0.34 V
$Ag^+(aq)$	$+ e^-$	$\leftrightarrow$	$Ag(s)$	0.08 V

For **D1**, the scientific principles are detailed (eg consideration of the Nernst equation and the variables involved, redox potential series) and are related to commercial and industrial types of cells/batteries and their uses. This could also include recent developments such as large-scale battery storage facilities.

P1, M1 and D1 will require wide-ranging research and will include scientific knowledge and understanding relating to the various factors to be investigated and how these factors affect the performance and uses of electrochemical cells.





Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs), and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability and validity (**D2**).

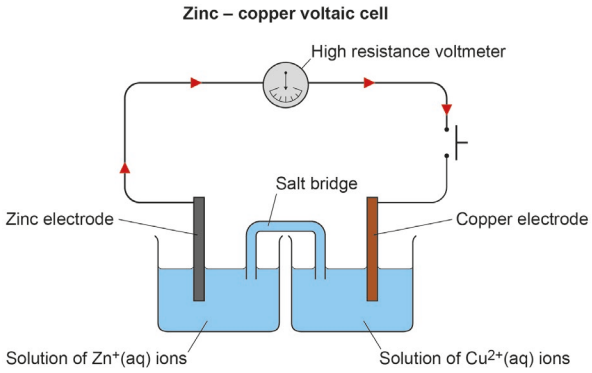
Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present: hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**. Learners correctly follow SPs and use a range of equipment and materials safely for **P4**. (a centre-completed Observation Record (specification p.143) is required to support the award of P4).

Data obtained are tabulated (correct headings, units, significant figures) for **P5**. For **M4**, the methods used are assessed/evaluated for effectiveness, relating this to the recorded data and precision of recording, and the reliability, accuracy and repeatability of readings. This then leads to suggestions for improvements to the methods used to collect data and justifications for those suggested improvements for **D3**.

Examples of typical apparatus and materials required:

- variety of metal electrodes, emery paper
- soluble metal salts
- balance, volumetric flasks, pipettes, beakers
- potassium nitrate solution and strips of filter paper
- water bath, thermometer
- leads, crocodile clips, high resistance voltmeter.



Task 3: Analyse results

Appropriate calculations and graphs/charts, based on the data recorded, are evident for **P6**. Calculations of half-cell potentials, means, graphs, use of IT and, at a high level, the Nernst equation, used (**M5**). The methods and formats used to analyse/manipulate data justified for **D4**.

Sources of error and anomalies in the data recorded are identified (**P7**). Sources of error are explained, reasons for anomalies given, and ways to minimise errors/anomalies explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced for **P8**. The use of primary and secondary data is reviewed, and includes a comparison of primary data with secondary data from initial research such as electrode potentials, cell EMFs and, at high levels, by application of the Nernst equation (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation is made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified (**D6**) – this will make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction Page.*

Investigate the factors that affect fermentation in the brewing industry

Task overview

Learners will use yeast to investigate how the following factors affect fermentation processes and can be applied to the scientific processes involved in brewing:

- different substrates/nutrients
- temperature
- pH
- yeast type
- aerobic/anaerobic conditions.

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, practical work and scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into the brewing industry, fermentation and factors that affect it, and the science behind the processes. These scientific ideas are outlined for **P1** and the principles are explained for **M1**. For **D1**, the scientific principles are considered in more detail and are also related to commercial and industrial uses of brewing. P1, M1 and D1 will require wide-ranging research and will include scientific knowledge and understanding relating to the various factors to be investigated, drawn from the list above, and how these factors affect the brewing processes.

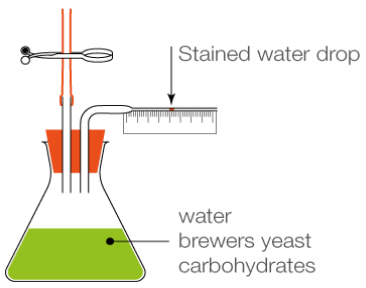
Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

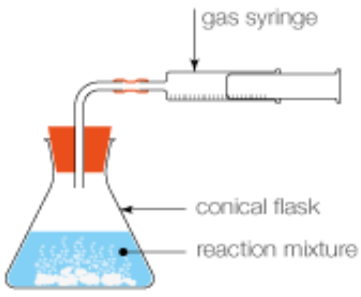
The plan includes the purpose of the investigation, researched standard procedures (SPs) for the factors being investigated, and aims of the investigation (**P2**).

Good approaches will consider procedures to measure:

- fermentation rates (typically via measuring volume of carbon dioxide over time)
- ethanol concentrations produced (by measuring specific gravity). NB: this is a relatively long-term practical which would need to be set up in the early stages of this investigation if it is to generate meaningful results.

Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs in light of results of the trials are described (**M2**). The final techniques chosen are justified based on accuracy, reliability and validity(**D2**).





NOTE: It is important that the practical techniques selected are based on suitably accurate methods for this Level 3 investigation and not a simple, low-level or inherently inaccurate approach.

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present: hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**.

Learners correctly follow SPs and use a range of equipment and materials safely for **P4** (a centre-completed Observation Record (specification p.143) is required to support the award of P4).

Quantitative data obtained are tabulated (correct headings, units, significant figures) for **P5**. For **M4**, the methods used are assessed/evaluated for effectiveness, relating this to the recorded data and precision of recording, and the reliability, accuracy and repeatability of readings. This then leads to suggestions for improvements to the methods used to collect data and justifications for those suggested improvements for **D3**.

Examples of typical apparatus and materials required:

- standard laboratory glassware
- respirometer
- hydrometer
- different varieties / strains of yeasts
- thermostatically controlled water bath, thermometer
- pH meter, buffers
- substrates, nutrients.

Task 3: Analyse results

Appropriate graphs/charts based on recorded data are evident and are analysed, for instance from gradients of lines drawn (**P6**). Data are manipulated for **M5**, for instance via calculations of reaction rates and of alcohol content from specific gravity data. Use of IT, for instance spreadsheet calculations and/or graphical representations and charts (**M5**) are evident. The methods and formats used to analyse/manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified (**P7**). This then leads to explanations of the sources of error associated with the experiments performed, and reasons for anomalies in the data. Ways to minimise the errors/anomalies are then suggested and explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced (**P8**). The use of primary and secondary data is reviewed, and could include a comparison of results from experiments (primary data) with secondary data from initial research. Further researched data to add to the comparison would also be relevant (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors associated with the experiments carried out (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference to secondary data, and correct scientific terminology is also evident (**M8**). The relevance of the investigation and the results to appropriate industrial processes in the brewing industry is identified (**D6**). This will make use of, and link to, the initial research from PO1 and any further research carried out.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction Page*.

Investigate the use of immobilised cells in bioreactors

Task overview

Learners will research and devise experiments to trap yeast cells in spheres of alginate gel. They then go on to carry out enzyme experiments using the immobilised cells. The following overview is centred on immobilised yeast cells but it would be acceptable to study other immobilised enzymes either in place of yeast or to widen the scope of the investigation.

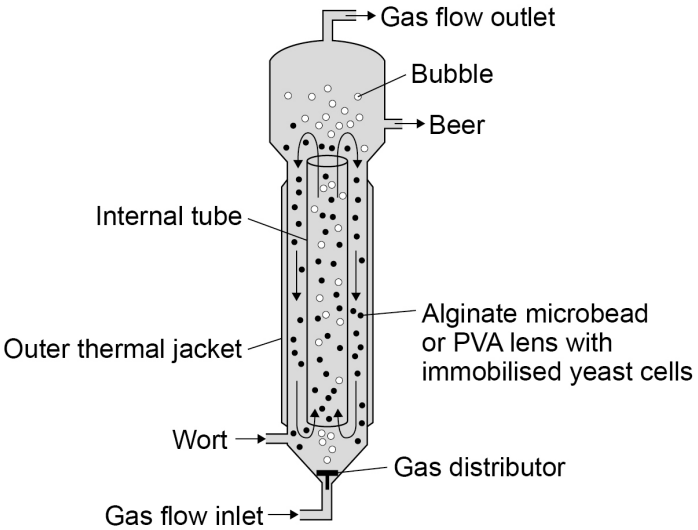
NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, practical work and scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three factors are studied (typically pH, temperature and type of substrate or type of yeast), and these should demonstrate the appropriate levels of practical and scientific demand required if the higher assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into the immobilisation of microorganisms in alginate beads. This is then followed by a consideration of enzyme activity and its importance in industry. These scientific ideas are outlined for **P1** and the principles are explained for **M1**.

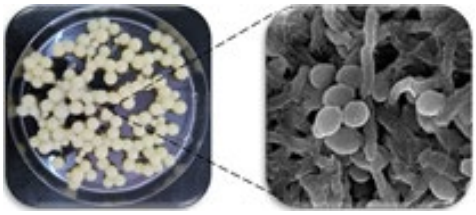
Learners should include a consideration of:

- types of microorganism, in particular yeasts/fungi
- immobilisation and its advantages; calcium alginate and its role
- enzymes, their nature and their importance; catalytic activity
- effect on enzymes of pH, temperature, and substrate
- bioreactors.



For **D1**, the scientific principles are detailed and are related to commercial and industrial uses. In addition to the science outlines for P1, learners should research the uses of immobilised enzymes, for instance in the food industry and in the manufacture of pharmaceuticals, chemicals and biofuels.

P1, M1 and D1 will require wide-ranging research and will include scientific knowledge and understanding relating to the various factors to be investigated and the industrial and commercial uses of immobilised enzymes.



Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs), and the aims of the experiments for the preparation of immobilised yeast cells and also for the enzyme experiments that follow (**P2**).

If learners wish to include a wider view of immobilisation, and time is available, they could include a comparison of immobilised yeast with 'free' yeast.

Trials are reported, including recorded results and any modifications made to the plan following the trials (**M2**). The final techniques/SPs chosen are then justified based on the accuracy, reliability, and validity of the trials (**D2**).

Task 2: Carry out the investigation and record results

The portfolio evidence will include evidence of the following:

- a learner-generated risk assessment that correctly identifies hazards and assesses risks for **P3** and then explains control measures for **M3**
- the learner correctly follows SPs and uses a range of equipment and materials safely for **P4** (centre-completed Observation Record required – specification p.143)
- tabulated data obtained from the experiments (correct headings, units, significant figures) for **P5**
- assessment/evaluation of the effectiveness of the methods used, relating this to the data for **M4** ... and leading to ...
- suggestions and justifications of improvements to the methods used to collect data (**D3**).

Typical apparatus and materials requirements:

- samples of yeast (of different types if relevant to the investigation aims)
- sodium alginate, calcium chloride
- respirometers
- buffer solutions
- water bath
- different substrates / sugars.

Task 3: Analyse results

Appropriate calculations and graphs/charts, based on the data recorded, are evident for **P6**. Data and graphs are manipulated to generate rates of enzyme activity for the various experiments and variables used. In addition, the use of IT is apparent for **M5**. The methods and formats used to analyse/manipulate data are justified for **D4**.

Identify sources of error and anomalies in the data recorded/measurements made (**P7**). Explain the sources of error; identify anomalies and give reasons for them arising; suggest ways in which errors and anomalies could be minimised (**M6**).

Draw conclusions based on the data obtained from experiments and the graphs drawn which show how rate varies with pH, temperature and type of substrate/yeast (**P8**). Review the use of primary and secondary data. This could include, for instance, a comparison of researched data and graphs with those obtained via experiments carried out and reported here (**M7**). Evaluation of the outcomes should consider the accuracy and reliability of data via a detailed consideration of qualitative and quantitative errors in the readings taken. Comparisons with published secondary data will also be relevant (**D6**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction page.*

Investigate the response of light-dependent resistors

Task overview

Learners will conduct experiments that show how the resistance of light-dependent resistors (LDRs) varies as the intensity of incident light and wavelength of light vary.

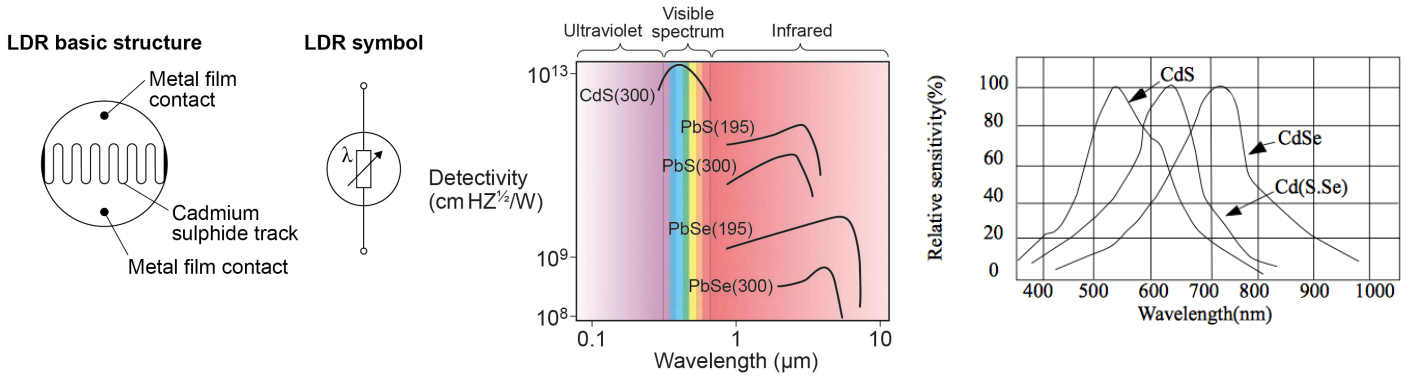
NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, practical work and scientific content of the portfolio must reflect this. It is recommended that the two factors stated in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher assessment criteria are to be met. See also Task 1b information below.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into LDRs, how they are constructed, what materials are used, and how and why resistance can vary. These scientific ideas are outlined for **P1** and the principles are explained for **M1**. This will include relevant scientific knowledge and understanding relating to the visible spectrum and light frequency. For **D1**, the scientific principles are detailed and are related to commercial and industrial uses of LDRs. In addition to the science outlined for P1, learners should research the following to provide this detailed Distinction level account:

- intrinsic and extrinsic LDRs
- semiconductors
- variation in resistance as light intensity changes
- variation in response with wavelength
- commercial and industrial uses of LDRs
- environmental issues with some semi-conductor materials.

P1, M1 and D1 require wide ranging research and will include scientific knowledge and understanding relating to the various factors to be investigated, and how these factors affect the performance and uses of LDRs.



Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs) for investigating the effects of light intensity and of wavelength on resistance, and the aims of the investigation (**P2**). Those learners aiming at the higher levels may also consider experiments for both intrinsic and extrinsic LDRs. Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified, based on the accuracy, reliability and validity of the data from the trials for **D2**.

Task 2: Carry out the investigation and record results

The portfolio evidence will include evidence of the following:

- a learner-generated risk assessment (correctly identify hazards and assess risks for **P3**, and then goes on to explain control measures for **M3**).
- the student correctly follows SPs and uses a range of equipment and materials safely for **P4** (centre-completed Observation Record is required to support the award of P4 – specification p.143).
- tabulated data obtained (correct headings, units and significant figures) for **P5**.
- assessment/evaluation of the effectiveness of the methods used, relating this to the data for **M4** ... leading to ...
- suggestions and justified improvements to the methods used to collect data for **D3**.

Typical apparatus and materials requirements:

- intrinsic and extrinsic LDRs
- light source, metre rule (or more sophisticated apparatus if available)
- gel filters
- in addition to the LDRs, circuit to include voltmeter, ammeter, multimeter as required by experimental SP chosen
- light meter/lux meter
- datalogger if available and required by the SP

Task 3: Analyse results

Calculations and graphs/charts, appropriate to the methodologies employed and data recorded, are evident for **P6**. Data are manipulated and presented as graphs or charts and the use of IT is apparent for **M5**. The methods and formats used to analyse/manipulate data are justified for **D4**.

Identify sources of error and anomalies in the data recorded/measurements made (**P7**). Explain the sources of error; identify anomalies and give reasons for them arising; suggest ways in which errors and anomalies could be minimised (**M6**).

Draw conclusions based on the data obtained and graphs produced for **P8**. Review the use of primary and secondary data. This could include, for instance, a comparison of data/graphs obtained from research with those obtained via experimental results (**M7**). Evaluation of the outcomes can consider the accuracy and reliability of the outcomes via a detailed consideration of qualitative and quantitative errors in the readings taken and comparisons with published data (**D6**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction page.*

Investigate properties of commercially available bleaches

Task overview

Learners will research and devise experiments that compare and investigate properties of a range of commercially available bleaches.

Properties to consider for investigation may include the following:

- concentration of sodium hypochlorite (sodium chlorate(I), NaOCl) in commercial household bleaches
- bleaching of dyes
- action as a disinfectant (anti-bacterial)
- minimum effective concentration to act as an effective antimicrobial.

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, practical work and scientific content of the portfolio must reflect this. It is recommended that at least three of the factors stated in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into the nature of commercial bleaches and also into any other typical secondary ingredients. How sodium chlorate(I) works, its oxidising action, and how it acts as a disinfectant should all be considered. These scientific ideas are outlined for **P1** and the principles are explained for **M1**. For **D1**, the scientific principles are more detailed and are also related to commercial and industrial uses of bleaches.

PO1 will require wide ranging research and will include scientific knowledge and understanding relating to the properties to be investigated, drawn from the list in the Task overview. How these properties relate to the chemical composition of bleaches and the principles behind their reaction with dyes and bacteria should then be explained covering, for instance, relevant principles drawn from the following:

- NaOCl as an oxidising agent
- Why are dyes coloured?
- How does bleach turn dyes colourless?
- How does bleach kill bacteria?
- Is bleach effective on different types of microorganisms?

Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs), and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability, validity for **D2**.

NOTE: it is important at this early stage that suitable approaches and experiments are selected in order to ensure work is at Level 3 standard.

This investigation will meet these requirements well via at least three of the following:

- redox titrations or other quantitative approaches to redox reactions used to determine chlorate(I) concentration

- colorimetric work relating to reactions with dyes (eg food dyes and/or fabric dyes)
- microbiology experiments on Gram+ and Gram– bacteria/agar plate experiments
- serial dilutions and minimum effective concentrations.

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present, all hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**.

Correctly follow SPs and use a range of equipment and materials safely for P4 (a centre-completed Observation Record (specification p.143) is required to support the award of P4).

Quantitative data obtained are tabulated (correct headings, units, significant figures) for **P5**. Clear photographic evidence of plates and zones of inhibition is also recommended. The methods used are assessed/evaluated for effectiveness, relating this to the recorded data and the precision of recording, reliability, accuracy, repeatability for **M4**. This then leads to suggesting improvements to the methods used to collect data and justifications for them (**D3**).

Examples of typical apparatus and materials required:

- range of commercially available bleaches
- range of food dyes and/or fabric dyes
- Gram+ and Gram– bacteria
- apparatus and glassware for titrations and or gas collection
- colorimeter, glassware for serial dilutions
- materials and apparatus for microbiology plate work.

Task 3: Analyse results

Appropriate calculations and graphs/charts based on the data recorded are evident for **P6**. Use of IT, for instance, spreadsheet calculations, graphical representations and charts is needed for **M5**. The methods and formats used to analyse/manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified (**P7**). Sources of error associated with the experiments performed are explained, reasons for anomalies given and ways to minimise errors/anomalies explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced (**P8**). The use of primary and secondary data is reviewed, and could include a comparison of primary data with secondary data from initial research such as concentration and composition of a range of commercial bleaches, expected antimicrobial action and bleaching action (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors associated with the experiments carried out (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: more details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction page*.

Investigate properties of modern shampoos

Task overview

Learners will research and devise experiments that determine a number of properties of modern shampoos, for instance:

- viscosity
- pH
- foaming ability
- cleansing effectiveness
- oil emulsification.

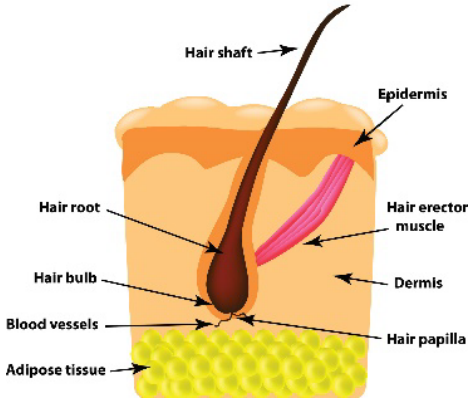
NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

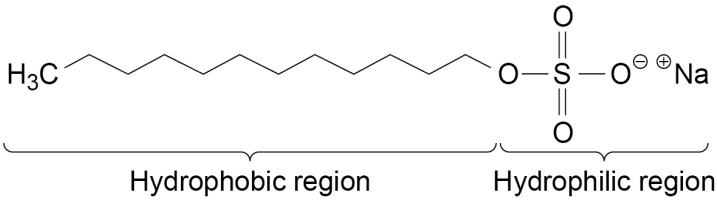
Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into the purpose, composition and action of modern shampoos. These scientific ideas are outlined for **P1** and the principles are explained for **M1**. For **D1**, the scientific principles are more detailed and are also related to commercial and industrial uses of shampoos.

PO1 will require wide-ranging research and will include scientific knowledge and understanding relating to the properties to be investigated, drawn from the list above. How these properties relate to the components and chemical composition of the shampoos and to the structure of hair should then be explained, covering, for instance:

- structure of hair, roots, cuticle, etc
- surfactants and their action
- emulsions, foams, hydrophobic and hydrophilic substances
- relevant factors such as viscosity, pH, buffers, dilution and temperature effects
- commercial ingredients of common shampoos
- the nature of sebum.





Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs) and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability and validity for **D2**.

NOTE: it is important at this early stage that suitable approaches and experiments are selected in

order to ensure work is at Level 3 standard. For example: (i) using the Stokes' Law approach to the experimental determination of viscosity; (ii) calibrating pH meters with buffers and measuring pH accurately; (iii) investigating dilution and temperature effects on pH; (iv) using an accurate gravimetric approach to cleansing effectiveness.

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present, hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**.

Correctly follow SPs and use a range of equipment and materials safely for **P4** (a centre completed Observation Record (specification p.143) is required to support the award of P4).

Quantitative data obtained are tabulated (correct headings, units, significant figures) for **P5**. The methods used are assessed/evaluated for effectiveness, relating this to the recorded data and the precision of recording, reliability, accuracy, repeatability for **M4**. This then leads to suggesting improvements to the methods used to collect data and justifications for these improvements (**D3**).

Examples of typical apparatus and materials required:

- range of modern shampoos
- graduated tubes (eg burettes), ball bearings, stopwatches for Stokes Law experiment
- pH meter, buffer solutions, volumetric flasks
- accurate balance
- standard glassware.

Task 3: Analyse results

Appropriate calculations and graphs/charts based on the data recorded are evident for **P6**. Calculations of viscosity and graphical representations of the variation of properties with dilution and temperature change. Use of IT, for instance spreadsheet calculations, graphs and charts (**M5**). The methods and formats used to analyse/manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified (**P7**). Sources of error associated with the experiments performed are explained, reasons for anomalies given, and ways to minimise errors/anomalies explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced (**P8**). The use of primary and secondary data is reviewed, and could include a comparison of primary data with secondary data from initial research such as the compositions of a range of modern shampoos and the purpose of the components. Further researched data for comparison would also be relevant (**M7**).

Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors associated with the experiments carried out (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: more details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction Page*.

Investigate the factors that affect reaction time

Task overview

Learners will research and devise experiments that use real and/or virtual reaction timers to determine the effect of a number of factors on reaction times. Suitable factors to investigate include the following:

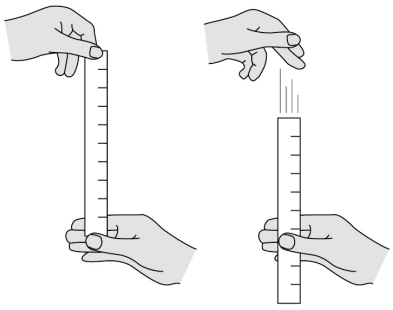
- practice
- gender
- age
- levels of concentration eg “distractions”, such as music, mobile phone use
- sources of auditory or visual stimuli.

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met. The learner should make it clear that other factors, not under investigation at the time, are controlled during experiments.

Task 1a: Prepare for a scientific investigation

For **P1**, **M1** learners carry out research into human reaction time. These scientific ideas are outlined for **P1** and the principles are explained for **M1**. For **D1**, the scientific principles are more detailed and are related to the human nervous system, nerve impulses and brain responses. There are links here to ASC4, for instance ‘structure and function of the nervous system and brain’ and ‘nerve impulses’. Distinctions between reaction times for auditory and visual responses can also be considered. D1 also requires research into commercial and industrial uses/applications, for example in sport, driving, motor sport, fighter jet pilots ...

PO1 will require wide-ranging research and it is important that the background science is at a suitable Level 3 standard.



Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs), and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability, validity for **D2**.

NOTE: The ruler test is commonly used and online reaction tests, often based on reactions while driving, produce suitable alternatives and comparisons. There are also 'push button' and 'brake pedal' tests, although these generally require more specialised equipment.

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present, hazards are correctly identified and risks are assessed for **P3**. Control measures are present and correct for **M3**.

Learners correctly follow SPs and use a range of equipment and materials safely for **P4** (a centre completed Observation Record (specification p.143) is required to support the award of P4).

Quantitative data obtained are tabulated (correct headings, units, significant figures) for **P5**. The methods used are assessed/evaluated for effectiveness, relating this to the recorded data and the precision of recording, reliability, accuracy, repeatability for **M4**. This then leads to suggesting improvements to the methods used to collect data and justifications for these improvements (**D3**).

Examples of typical apparatus and materials required:

- metre rules, 30 cm rules
- access to computer based tests
- headphones and mobile phone
- computer monitor or laptop showing pre-selected visual distraction.

Task 3: Analyse results

Appropriate calculations and graphs/charts based on the data recorded are evident for **P6**. Calculations of time from ruler drop distance measurements and graphs and/or chart-based representations of outcomes are evident. Use of IT, for instance spreadsheet calculations, graphical representations and charts (**M5**). The methods and formats used to analyse/manipulate data are justified for **D4**. If data set sizes are suitable, this might include statistical analysis of results to see if there are significant differences between those data sets.

Sources of error and anomalies in the data recorded are identified (**P7**). Sources of error associated with the experiments performed are explained, reasons for anomalies given and ways to minimise errors/anomalies explained (**M6**).

Conclusions are drawn based on the data obtained and graphs produced (**P8**). The use of primary and secondary data is reviewed, and could include a comparison of primary data with secondary data from initial research. Further researched data for comparison would also be relevant (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors associated with the experiments carried out (**D5**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: more details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction Page*.

Investigate the factors that affect the output of a wind turbine

Task overview

Learners will determine the useful energy generated by model turbines with:

- different numbers of blades
- blades of different shapes
- blades of different areas.

Additional or alternative variables which could be studied include:

- wind speed
- wind direction (relative to blade axis).

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

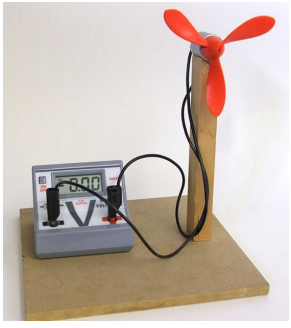
For **P1**, **M1** learners carry out research into wind turbines, how they are constructed and how they work. This will include research into electrical generators and turbines.

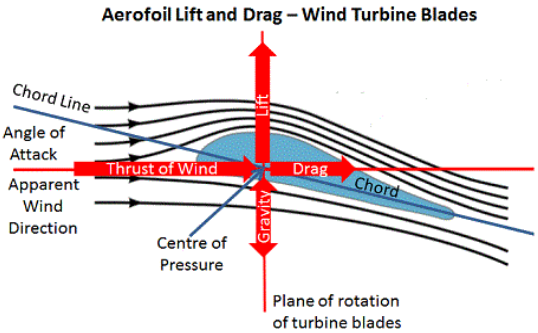
The various factors that affect the electrical output of wind turbines will also need to be considered in scientific terms:

- number of blades
- area, length, cross section (‘shape’)
- angle of attack/nacelle rotation
- use of gearboxes
- aerofoil design.

These scientific ideas are outlined for **P1** and the principles explained for **M1**.

For **D1**, the scientific principles are detailed, and learners will go on to consider, for instance, the aerodynamics of wind turbine blades and aerofoils. The commercial and industrial uses are very significant and of great importance, and learners will need to provide a clear and balanced account of ‘wind power’ and its applications.





Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs) and

aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Based on the trial data, modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability, and validity of the data for **D2**.

Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present, hazards are correctly identified, and risks are assessed for **P3**. Control measures are present and correct for **M3**. NB: it is important that all hazards are considered and this would include electrical equipment, such as hairdryers and fans, and any related air movement issues/hazards must also be investigated and considered before the investigation is started.

Learners correctly follow SPs and use a range of equipment and materials safely for **P4** (a centre completed Observation Record (specification p.143) is required to support the award of P4).

Data obtained are tabulated (correct headings, units and significant figures) for **P5**. The methods used are assessed/evaluated for effectiveness, relating this to the recorded data and the precision of recording, reliability, accuracy and repeatability for **M4**. This then leads on to improvements to the methods used to collect data, and these are suggested and justified for **D3**.

Examples of typical apparatus and materials required:

- 'wind' source (eg hair drier or fan)
- working model wind turbine
- variety of blades (length, shape, numbers)
- anemometer
- ammeter, voltmeter, multimeter.

NOTE: whilst it is possible to carry out this investigation with simple apparatus such as a dynamo/generator and cardboard blades cut to shape and 'attached', the results where such basic apparatus is used may often be poor, and this makes it difficult for subsequent stages of analysis to be completed, and for meaningful conclusions to be drawn.

Task 3: Analyse results

Appropriate calculations, graphs/charts, based on the data recorded, are evident for **P6**. Calculations of power output, means, graphs, and use of IT are expected for **M5**. The methods and formats used to analyse/manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified for **P7**. They are then explained, reasons for anomalies are given, and ways to minimise errors/anomalies are identified and explained for **M6**.

Conclusions are drawn based on the data obtained and graphs produced for **P8**. The use of primary and secondary data is reviewed, and includes a comparison of primary data with secondary data from initial research and any additional research carried out for PO3 (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors (**D6**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: more details relating to the expected content and approaches for P10 and M9 can be found on *Investigation Task Overviews Introduction page.*

Investigate the factors that affect tensile strength

Task overview

Learners will investigate the tensile strength of a range of fishing lines and factors that determine its value.

What follows is an example of this investigation based on the tensile strength of fishing lines. Centres may choose to investigate different materials if they wish, but should ensure that the performance outcomes and grading criteria can still be fully met.

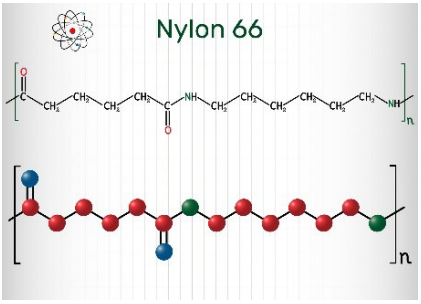
For 'fishing line' this would include a consideration of:

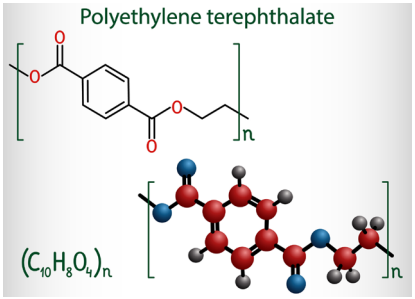
- polymer type, for example polyamide/nylon, polyethene (polyethylene), fluorocarbon, Dacron
- fishing line type including braid, monofilament, fluorocarbon
- diameter of the line
- saturation (water content and its effects).

NOTE: It is important to remember that ASC5 is an Extended Certificate unit for this Level 3 qualification and so the principles, the practical work and the scientific content of the portfolio must reflect this. It is recommended that a minimum of at least three of the factors listed in the Task overview are studied, and these should demonstrate the appropriate levels of practical and scientific demand required if the higher-level assessment criteria are to be met.

Task 1a: Prepare for a scientific investigation

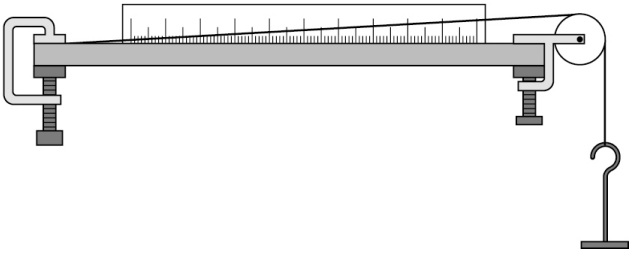
For **P1**, **M1** learners carry out research into Young's modulus, tensile strength and polymer types as well as types of fishing line. These scientific ideas are outlined for **P1** and the principles explained for **M1**. For **D1**, the scientific principles are described in detail and properties such as stress, strain, tensile strength and elastic limit are clearly understood. Relevant polymers and their structures are described in detail. The commercial and industrial uses should also be researched and described.





Task 1b: Produce a plan, identify and trial standard procedures, and justify techniques

The plan includes the purpose of the investigation, researched standard procedures (SPs) and aims (**P2**). Trials of the researched SPs are reported, results recorded and conclusions drawn. Based on the trial data, modifications made to the SPs are described (**M2**). The final techniques chosen are justified based on accuracy, reliability, validity of the data for **D2**.



Task 2: Carry out the investigation and record results

A learner-generated risk assessment is present, hazards are correctly identified, and risks are assessed for **P3**. Control measures are present and correct for **M3**. NB: it is important that all hazards are considered and this would include dangers associated with wires breaking.

Learners correctly follow SPs and use a range of equipment and materials safely for **P4** (a centre-completed Observation Record (specification p.143) is required to support the award of P4).

Data obtained are tabulated (correct headings, units, significant figures) for **P5**. The methods used are assessed/evaluated for effectiveness, relating this to the recorded data and the precision of recording, reliability, accuracy, repeatability for **M4**. This then leads on to improvements to the methods used to collect data, and these are suggested and justified for **D3**.

Examples of typical apparatus and materials required:

- samples of fishing lines made from different materials
- fishing lines with different diameters
- micrometer screw gauge
- apparatus to measure extension accurately
- mass holder and range of masses.

Task 3: Analyse results

Appropriate calculations and graphs/charts, based on the data recorded, are evident for **P6**. Calculations of Young's modulus from stress–strain graphs and subsequent calculation of tensile strength. Use of IT is also expected for **M5**. The methods and formats used to analyse/manipulate data are justified for **D4**.

Sources of error and anomalies in the data recorded are identified for **P7**. They are then explained, reasons for anomalies are given, and ways to minimise errors/anomalies are identified and explained for **M6**.

Conclusions are drawn based on the data obtained and graphs produced for **P8**. The use of primary and secondary data is reviewed, and includes a comparison of primary data with secondary data from initial research and any additional research carried out for PO3 (**M7**). Evaluation of the outcomes would consider their accuracy and reliability and a detailed consideration of qualitative and quantitative errors (**D6**).

Task 4: Present the findings of the investigation to a suitable audience

A report of the investigation (effectively the portfolio of evidence) is produced and a presentation made to a suitable audience (specification p.91) for **P9**. This is most commonly a PowerPoint presentation, but can be a booklet, leaflet, magazine article, etc. Within the report/presentation there is reference made to secondary data, and correct scientific terminology is evident (**M8**). The relevance of the investigation to appropriate industrial processes is identified for **D6** – this will also make use of, and link to, the initial research from PO1.

Sources of information used in initial research and when drawing conclusions are recorded. The Harvard Reference system is used (**P10**). Sources are evaluated in terms of their usefulness and validity (**M9**).

NOTE: More details relating to the expected content and approaches for P10 and M9 can be found on the *Investigation Task Overviews Introduction page.*