General Certificate of Secondary Education
June 2008 and June 2009

SCIENCE CENTRE ASSESSED UNIT **4460/TN**

4461 Science A
4462 Science B
4463 Additional Science
4411 Biology
4421 Chemistry
4451 Physics

TEACHERS' NOTES

SET TWO

Investigative Skills Assignments (ISAs)

Valid for Use until May 2009
Valid for Moderation in June 2008, June 2009 and June 2010

For immediate release to the teacher(s) responsible for GCSE Sciences

All Centre Assessed Unit marks to be returned to AQA by 5 May in the year in which moderation is required

Introduction

- The CD with all the Investigative Skills Assignments (ISAs) will be sent to the centre's Examinations Officer. The Examinations Officer must be alerted to the importance of this CD and the password that will be sent separately. The CD **must** be kept under secure conditions. The Examinations Officer may print out **one** copy of the ISAs for the use of the Head of Science but this copy **must** also be kept under secure conditions.

- Teachers' Notes are sent out in advance of the ISA CD so that teachers can incorporate the ISAs into their schemes of work.

- Full information about conducting the ISA can be found in the 'Teachers' Guide' and in the booklet 'Guidance and Standardising Material for ISA and PSA' distributed at the standardisation meetings. An abbreviated version of the latter will be included on the ISA CD.

- ISAs have a shelf life of **two** years. ISAs must be completed and marked within this validity period, but marks may be submitted for moderation for **one** further year. The work must be held under secure conditions for the entire period.

- **Do not use the 'live' ISAs for practice purposes**

- Teachers should attach the Centre Assessed Unit (CAU) to a specific subject when making entries. Candidates should be entered in February for CAU moderation in the following June. A mark is not needed at the time of entry but should be submitted to AQA and the moderator by 5th May. The marks must be submitted on the Centre Mark Form (CMF) and in addition to the CMF the moderator should receive a spreadsheet with candidates' ISA scores in rank order for sample selection.

- The teacher should ensure that each candidate has a mark from an ISA that relates to the subject being entered.

- The following table shows the codes needed for CAU entry and the ISAs that may be used:

Subject	**Code to Enter for CAU**	**ISAs to be used**		
Science A and Science B	SCYC	B1	C1	P1
Additional Science	ASCC	B2	C2	P2
Biology	BLYC	B1	B2	B3
Chemistry	CHYC	C1	C2	C3
Physics	PHYC	P1	P2	P3

- Please refer to the Teachers' Guide for further explanation of the choices that can be made about when to certificate for each subject.

- Centres need to submit an entry code for certification for a particular subject. The codes are:

Subject	**Code**
Science A	4461
Science B	4462
Additional Science	4463
Biology	4411
Chemistry	4421
Physics	4451

Biology 1 ISA 1.3 – *Microorganisms*

Teachers' Notes

This ISA relates to Unit B1: Science A (4461), Science B (4462), Biology (4411) Section 11.4.

Area of investigation
This work should be carried out during the teaching of the section relating to:
What causes infectious diseases and how can our bodies defend themselves against them?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning where microorganisms can be found.

One simple way to do this is to place samples of water from different sources (eg tap, pond, stream, puddle) onto sterile agar and incubate appropriately before counting colonies of bacteria.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Biology 2 ISA 2.1 – *Enzymes and Temperature*

Teachers' Notes

This ISA relates to Unit B2: Biology (4411) Section 12.6, Additional Science (4463) Section 11.6.

Area of investigation
This work should be carried out during the teaching of the section relating to:
What are enzymes and what are some of their functions?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the effect of temperature on the action of an enzyme. For example: small pieces of potato could be added to hydrogen peroxide and the number of bubbles produced in a fixed time interval recorded.
The investigation should be carried out in such a way as to show the full range of thermal effects on enzyme action.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Biology 2 ISA 2.2 – *Photosynthesis*

Teachers' Notes

This ISA relates to Unit B2: Biology (4411) Section 12.3, Additional Science (4463) Section 11.3.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do plants obtain the food they need to live and grow?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs. The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning how a factor affects the rate of photosynthesis.

One simple way to do this is to submerge a freshly cut leafy stem of pondweed (*Elodea*), upside-down in a boiling tube of sodium hydrogen carbonate solution, which is standing in a Pyrex beaker containing tap water. The investigation could be carried out at a number of light intensities created by changing the distance between plant and a standard bench lamp. (Candidates are **not** expected to determine values of light intensity using the inverse square law or to use a light meter.)

It would be wise to check that the pondweed is 'active' before the investigation is carried out. Pondweed that has been freshly collected or purchased from an aquatic centre will prove to be most effective for the investigation. The pondweed should be well illuminated prior to the investigation.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Biology 3 ISA 3.1 – *Transpiration*

Teachers' Notes

This ISA relates to Unit B3: Biology (4411) Section 13.1.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do dissolved materials get into and out of animals and plants?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning how a factor affects transpiration.

One simple investigation would be to attach a freshly cut, leafy twig (with about a dozen leaves) of a woody plant such as privet (*Ligustrum* sp.) to a piece of water-filled capillary tube. A meniscus should be seen to rise steadily up the capillary tube. The movement of the meniscus should be measured over time. Factors such as the effect of light, temperature, wind or humidity could be investigated.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Biology 3 ISA 3.2 – *Pulse Rate and Exercise*

Teachers' Notes

This ISA relates to Unit B3: Biology (4411) Section 13.3.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How does exercise affect the exchanges taking place within the body?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out. Candidates with disabilities or with known heart or breathing problems are not expected to carry out the exercise component of the practical work, but should observe and record others.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the effect of exercise on pulse rate.

Candidates are likely to be familiar with taking pulse rate. A pulse count should be recorded for 15 seconds after the candidate has sat still for three minutes. Candidates should complete a light exercise, then sit down and retake their pulse immediately. A recovery/sitting period should be allowed before continuing. The exercise regime should then be increased and the pulse rate recorded again. Candidates will need to collect data from at least two other candidates.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 1 ISA 1.3 – *Testing Concrete*

Teachers' Notes

This ISA relates to Unit C1: Science A / B (4461/2) Section 12.1, Chemistry (4421) Section 11.1.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do rocks provide building materials?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.
The teacher's attention is particularly drawn to the irritant nature of cement.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the strength of concrete.

The investigation should include changing the proportions of cement, sand, water and crushed rock or pebbles used to make concrete and relating this to the strength of the concrete made.
Candidates could use moulds to make small test blocks of concrete, preferably quite narrow and long, to allow for easier testing. The dependent variable will assess the strength of the concrete blocks. The simplest way would be to bridge a gap between two supports and suspend masses from the centre of the block until it breaks. It may be easier to make cement blocks without crushed rock or pebbles although the use of a garden sieve can give reasonable control over the size of any aggregate used. The centre will need to carry out some preliminary testing to match the size and breaking points of the blocks to the equipment available.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.
The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.
Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 1 ISA 1.4 – *Testing Emulsions*

Teachers' Notes

This ISA relates to Unit C1: Science A / B (4461/2) Section 12.5, Chemistry (4421) Section 11.5.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How can plant oils be used?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.
The teacher's attention is particularly drawn to the allergic nature of some nut oils.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation which should include finding the effectiveness of emulsifiers in making a stable emulsion using vegetable oils and water.

Candidates could mix oil and water together and add increasing amounts of emulsifier until a stable emulsion is formed. The mixture will need to be shaken or stirred to form the emulsion. A stable emulsion is achieved when the oil and water do not separate in a defined time. The centre will need to carry out some preliminary testing to establish the volumes of oil and water to use and to find a suitable emulsifier. Common washing liquids can be used but may form foams which make the practical work more difficult.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 2 ISA 2.1 – *Controlling Reactions*

Teachers' Notes

This ISA relates to Unit C2: Additional Science (4463), Chemistry (4421) Section 12.4.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How can we control the rates of chemical reactions?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation measuring the rate of a reaction at different concentrations.

Any standard rate of reaction experiment, eg acid and magnesium ribbon, acid and calcium carbonate, or acid and sodium thiosulfate, can be used.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate should draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 2 ISA 2.2 – *Electrolysis*

Teachers' Notes

This ISA relates to Unit C2: Additional Science (4463), Chemistry (4421) Section 12.6.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How can we use ions in solution?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out. The teacher's attention is particularly drawn to the poisonous nature of copper (II) sulfate, the corrosive nature of dilute acids and the combination of electricity and aqueous solutions during electrolysis. Suitable precautions must be taken to ensure their safe use.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation into the electrolysis of copper sulfate or water.

A solution of copper sulfate can be electrolysed using copper, metal or carbon electrodes and the change in mass of the electrode(s) measured. Alternatively, a dilute acid can be electrolysed using carbon or inert metal electrodes and the volume of the gas produced measured. After the practical work, the candidate should be able to plot a graph of mass change or volume change against time. Alternatively, the procedure could be carried out using different currents but the same time intervals.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 3 ISA 3.1– *Substances dissolved in water*

Teachers' Notes

This ISA relates to Unit C3: Chemistry (4421) Section 13.3.

Area of investigation
This work should be carried out during the teaching of the section relating to:
What is in the water we drink?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to investigate how the hardness of water varies with geographical location.

This can be done by preparing samples of different hardness and labelling them or by using samples brought in by the candidates if they are not all connected to the same water supply. Alternatively, the variation of hardness with calcium ion concentration could be investigated.

Hardness of water is usually measured by titrating a known volume of hard water with a standard soap solution until a permanent lather is obtained.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Chemistry 3 ISA 3.2 – *Burning Fuels*

Teachers' Notes

This ISA relates to Unit C3: Chemistry (4421) Section 13.4.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How much energy is involved in chemical reactions?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out. The teacher's attention is particularly drawn to the flammable nature of fuels. Suitable precautions must be taken to ensure their safe use particularly when burning the fuels.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation to compare the energy given out by burning two or more different alcohols.

Candidates may use spirit burners filled with different alcohols to heat a metal calorimeter containing a known mass of water. The energy change will be related to the loss in mass of the alcohol and the temperature rise of the water. The energy change for different alcohols can then be compared.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Physics 1 ISA 1.3 – *The efficiency of light bulbs*

Teachers' Notes

This ISA relates to Unit P1: Science A / B (4461/2) Section 13.2, Physics (4451) Section 11.2.

Area of investigation
This work should be carried out during the teaching of the section relating to:
What is meant by the efficient use of energy?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs. The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the efficiency of light bulbs.

They can carry out this investigation by using the following method. Use a 12-volt SBC bulb in a holder and suspend it so that the glass part of the bulb is immersed in a beaker of water. Take care that the holder itself is not immersed in the water. Candidates can then measure the temperature rise in the water when the bulb is switched on. Alternatively, they could use a data logger and put the lamp and temperature probe inside an insulated box. Whichever method they use, candidates are in a sense measuring the *inefficiency* of the lamp, ie they are measuring its efficiency as a heater.
To avoid the need for any calculations involving efficiency, the following method could be adopted. Use a number of different bulbs, eg 6 watt, 12 watt, 24 watt, 36 watt and 48 watt connected to a 12 volt supply. If the p.d. is maintained at a constant 12 volts (either by using a continuously variable power supply, or by using a potentiometer and voltmeter) it can be assumed that the power input to the bulb will be as stated on the bulb. Candidates will need to have explained to them that, for example, a 12 watt bulb will have an input of 12 joules of energy every second. Candidates can then record the temperature rise in a fixed volume of water over a fixed period of time.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit. The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA. Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Physics 2 ISA 2.1 – *Resistance*

Teachers' Notes

This ISA relates to Unit P2: Additional Science (4463) Section 13.6, Physics (4451) Section 12.6.

Area of investigation
This work should be carried out during the teaching of the section relating to:
What does the current through an electrical circuit depend on?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the resistance of any conductor, ohmic or non-ohmic. For example, they could investigate how the resistance of a wire (or the current through a wire) depends on its length, cross-sectional area or type of material. Alternatively they could be given, say, a 15 ohm wire-wound resistor with the markings covered over. They could then be asked to find the value of the 'unknown' resistance. The meters to be used may be digital or analogue. Candidates may use either a combination of voltmeter and ammeter or a multimeter set to measure resistance.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Physics 2 ISA 2.2 – *Average velocity of an object falling through air*

Teachers' Notes

This ISA relates to Unit P2: Additional Science (4463) Section 13.2, Physics (4451) Section 12.2.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do we make things speed up or slow down?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the average velocity of an object falling through air. It is not necessary that the object reaches terminal velocity, nor that this should be measured, although this may form part of the investigation if the teacher so wishes. The falling object may be anything suitable, eg a ping-pong ball, a parachute, or a toy helicopter. The only requirement is that, over the distance through which the object is falling, the time between start and finish is sufficient to allow the candidates to measure the time with reasonable accuracy. The timing may be carried out in a number of ways, eg using a stopwatch, ticker-tape or light-gates.

There are many possibilities for the independent variable, eg the height of drop, the mass or shape of the object being dropped, the area of the object, sail or canopy.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Physics 3 ISA 3.1 – *Generators*

Teachers' Notes

This ISA relates to Unit P3: Physics (4451) Section 13.8.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do generators work?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning the generator effect. Candidates may investigate the effect on the output p.d. of changing the speed of movement, the strength of the magnetic field, the number of turns on the coil or the area of the coil.
The simplest way to do this would be to drop a magnet through a coil of wire and record the maximum value of the induced p.d., using either an oscilloscope, data logger or analogue voltmeter. The easiest variable to change would be the number of turns on the coil. Alternatively, if they are investigating the speed of rotation they may use a small, commercially available d.c. motor as a generator.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

Physics 3 ISA 3.2 – *Transformers*

Teachers' Notes

This ISA relates to Unit P3: Physics (4451) Section 13.9.

Area of investigation
This work should be carried out during the teaching of the section relating to:
How do transformers work?

RISK ASSESSMENT
It is the responsibility of the centre to ensure that a risk assessment is carried out.

The Practical Work
For this part of the investigation candidates may work individually or in groups.

A suggested method is described below, but centres may adapt this method to suit their own needs.

The teacher must always complete the ISA Explanation Sheet. An ISA Explanation Sheet must be included with each piece of candidates' work that is sent to the moderator. Instructions of a general nature may be given to the candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

Candidates should be given the opportunity to carry out an investigation concerning transformers. Candidates may make their own coils by winding insulated wire around laminated iron C-cores, or they may use pre-wound, commercially available coils. Whichever method is used, they should investigate how the ratio of turns affects the output p.d.

Candidates need to produce a table for the results and draw a graph or bar chart to show their results. They will need to have collected sufficient data to display in such a format. (Refer to the Teachers' Guide for further clarification.)

The Data Processing
For this part of the investigation candidates must work individually under direct supervision.

Each candidate must draw up his or her own table for the results and should process the data in an appropriate way, eg charts, graphs, diagrams, line of best fit.

The candidates' work must be collected by the teacher at the end of this session and returned to the candidates only when they undertake the subsequent ISA.

Candidates' work must **not** be annotated with additional information, by either the teacher or the candidate, which would give them an unfair advantage during the ISA, eg the use of the terms independent/dependent variable.

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AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

ISA Explanation Sheet

to accompany each ISA
(You will need to fill in more than one of these sheets if different students have carried out different methods)

Centre Number						Date Practical Carried Out
ISA Code						Name of Teacher
ISA Title						
Independent Variable						Dependent Variable

Did you make any changes to the suggested method?

YES / NO

If YES give details of any changes made to the suggested method, the equipment, the chemicals etc. for this investigation.

Any other information:

Teacher Signature:	**Please attach any experimental worksheet or outline used by the candidates to carry out the investigation if available.**