Qualification Accredited

OCR
Oxford Cambridge and RSA

AS and A Level

Practical skills handbook

# GEOLOGY

H014/H414

For first teaching in 2017

# OCR Advanced Subsidiary and Advanced GCE in Geology

Version 2.0

## Version 2.0 – January 2024

**Version 2.0 (January 2024)**

Changes to wording to improve accessibility and clarity. Minor changes to the guidance for practical skills 1.2.1(d), (e) and (f) to better support teacher assessment.

**Version 1.1**

One change of note made between Version 1.0 and Version 1.1

1. Guidance on Appendix 4: Measurements - Uncertainties

**Version 1.0**

First issue of Practical Skills Handbook for H014/H414

1. Based on Chemistry PSH v1.4 and Geology H087/H487 PSH v1.4.

- Use of geochronological principles in the field to place events in relative time sequences

Questions assessing these practical skills will be embedded in contexts relating to the content of the specification.

### Skills assessed through the Practical Endorsement

The skills assessed through the Practical Endorsement cover the areas of Planning and Implementing, specifically the following:

- Independent thinking
- Use and application of scientific methods and practices
- Research and referencing
- Instruments and equipment

Students must exemplify their skill in these areas through use of the apparatus and techniques listed in the specification, Section 1.2.2.

Centres can assess a wide range of practical activities for the Practical Endorsement, which may include our suggested practicals, centre-developed practicals, or practicals from other publishers, as long as these are appropriately mapped to the CPAC.

## AS Level students and the Practical Endorsement

There is no direct assessment of practical skills within the AS Level qualification. However, AS Level students will benefit from completing the type of practical activities recommended within the Practical Endorsement, as well as others, for the following reasons:

- completing practical activities will help to develop the practical skills that are assessed in the written examination
- completing practical activities will support understanding of the content of the specification
- students who decide to continue to take the A Level qualification after completing AS Level will be able to use their performance on Practical Endorsement activities completed in their first year towards the Practical Endorsement, as long as appropriate records have been kept.

# 3 Practical skills and fieldwork skills assessed in a written examination

## Planning

Specification Section 1.1.1.

*Students should be able to demonstrate and apply their knowledge and understanding of*:

- experimental and investigative fieldwork design, including to solve problems set in a practical context
- identification of variables that must be controlled, where appropriate
- evaluation that an experimental or investigative method is appropriate to meet the expected outcomes.

Experimental and investigative fieldwork design should include selection of suitable apparatus, equipment and techniques for the proposed experiment.

Students will benefit from having been given the opportunity to design simple experiments and fieldwork investigations and receive feedback on their plans. Additionally, they should routinely be asked to consider why experiments or investigations are performed in the way they are, and how the experimental set-up or investigative procedures contributes to being able to achieve the expected outcome. Students could be asked what might be the effect of changing aspects of the method.

## Implementing

Specification Section 1.1.2.

*Learners should be able to demonstrate and apply their knowledge and understanding of:*

- how to use a wide range of practical apparatus and techniques correctly
- appropriate units for measurements
- presenting observations and data in an appropriate format.

The practical apparatus and techniques that may be assessed are those outlined in the specification statements related to practical techniques and procedures (including 1.3.1 Practical skills developed through fieldwork) and, for A Level only, those covered in the Practical Endorsement

Students will be expected to understand the units used for measurements taken using common fieldwork and laboratory apparatus. See Appendix 4 for units commonly used in practical work in Geology.

Appropriate presentation of data includes use of correct units and correct number of decimal places for quantitative data. This skill also includes appropriate use of tables and graphs for presentation of data.

Further information on recording measurements and the use of graphs is given in Appendices 3 and 5, respectively.

## Analysis

Specification Section 1.1.3.

*Learners should be able to demonstrate and apply their knowledge and understanding of:*

- processing, analysing and interpreting qualitative and quantitative experimental results
- use of appropriate mathematical skills for analysis of quantitative data
- appropriate use of significant figures
- plotting and interpreting suitable graphs from experimental results, including:

  **(i)** selection and labelling of axes with appropriate scales, quantities and units

  **(ii)** measurement of gradients and intercepts.

Students will benefit from having practised these skills in a range of practical contexts. Many of the skills and techniques that form part of the Practical Endorsement will also be suitable for practising these skills.

Appendix 3 gives further information about the use of significant figures. Appendix 4 gives further information about the plotting of graphs. See also the Mathematical Skills Handbook for further guidance on the mathematical skills required in analysing experimental results, and in other areas of quantitative Geology such as fieldwork investigations.

## Evaluation

Specification Section 1.1.4.

*Leaners should be able to demonstrate and apply their knowledge and understanding of:*

- how to evaluate results and draw conclusions
- the identification of anomalies in experimental measurements
- the limitations in experimental procedures
- precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus
- refining experimental and investigative fieldwork design by suggestion of improvements to the procedures and apparatus.

Students will benefit from having practised these skills in a range of practical and fieldwork contexts. As a matter of course, students should be encouraged to think carefully about the procedure they are performing and how it relates to the content of the specification; this will better place them to draw appropriate conclusions, identify anomalous and unexpected results, and identify limitations in procedures. Many activities included in the Practical Endorsement, as well as others, can be extended to allow students to consider errors and uncertainties, and suggest improvements to procedures.

Appendix 3 provides further information on precision, accuracy and errors, as well as identifying anomalous results.

# Fieldwork skills

As part of the A Level Geology course, students are required to undertake fieldwork in different contexts: virtual fieldwork, local fieldwork outside the classroom and fieldwork on unfamiliar outcrop geology. Students are required to undertake a minimum of two days fieldwork at AS and four days fieldwork at A Level which should be a on a mixture of local and unfamiliar outcrop geology.

# Traditional navigation and basic field survey skills

Specification Section 1.1.2 and 1.3.1

*Learners should be able to demonstrate and apply their knowledge and understanding of*:

- how to use a wide range of practical apparatus and techniques correctly: as outlined in the skills required for the practical endorsement:
    - location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
- presenting observations and data in an appropriate format
- the collection of valid data in the field relating to the igneous, metamorphic or sedimentary processes that formed the rocks

Students should be familiar with using OS and BGS maps, 6 figure *grid references*, following a route on paths/tracks, use of *handrails* and *collecting features*, *setting the map to the ground* and *orientating the map* using a compass. Basic survey skills could be developed by recording a *traverse* along a stream section or mapping of a small area of good exposure using *contact mapping*; field surveys should record sufficient orientations and dimensions to allow a to scale *fair copy* to be drawn.

Students will benefit from having been given the opportunity to carry out simulated classroom or school ground navigation and survey exercises. Additionally, they should routinely be given opportunity to use geological maps. Digital copies of all current BGS 1:50,000 solid and drift maps can be accessed online http://www.bgs.ac.uk/data/maps/home.html or using the iGeology app http://www.bgs.ac.uk/iGeology/.

# Recording geological observations as field sketches

Specification Section 1.1.2 & 1.3.1.

*Learners should be able to demonstrate and apply their knowledge and understanding of:*

- how to use a wide range of practical apparatus and techniques correctly: as outlined in the skills required for the practical endorsement:
    - identification of geological structures in the field, recording observations as field sketches
    - production of annotated scientific drawings of fossils, or small scale features
- presenting observations and data in an appropriate format
- the measurement and description of the diagnostic properties of rocks in the field
- the measurement and description of rock deformation in the field

It is important to develop field and technical sketching skills with students and to model the skill to students both in the classroom and in the field; a mini whiteboard is an invaluable teaching prop.

Students cannot draw what they see until they have learned how to get their eye in for the geology. Many activities included in the Practical Endorsement can be extended to allow students to develop these skills.

Because students are unfamiliar with field sketches they show a pattern of drawing development similar to Piaget's four stage model:

- *fortuitous realism:* scribbled drawing may contain some geology by accident;
- *failed realism:* drawings of blobs (rock outcrops) or artistic interpretations, but no understanding of the underlying geology;
- *intellectual realism:* drawings show idealised textbook examples of features or fossils;
- *visual realism:* drawings begin to reflect some understanding of the real geologic features.

Further information is provided in the Drawing Skills Handbook.

## Use of a compass clinometer

Specification Section 1.3.1 and 3.3.1.

*Learners should be able to demonstrate and apply their knowledge and understanding of:*

- the measurement and description of rock deformation in the field
- use of a compass-clinometer

Students will benefit from having been given the opportunity to carry out simulated classroom or school ground exercises. Students are not required to make adjustment for the magnetic declination. Many activities included in the Practical Endorsement, as well as others, can be extended to allow students to develop these skills, consider errors and uncertainties, and suggest improvements to procedures.

The use of mnemonics (e.g. *putting Fred in the shed*, right hand rule forefinger–strike, thumb–dip) can help as can chalking the dip and strike symbol ┤ onto a bedding plane and then explicitly making the connection with the same symbol on a geological map. Learning to use a compass clinometer is a complex kinaesthetic operation like touch typing or manual gear shifting, students will need practice.

A common error is for a previous student to have adjusted the red north arrow using the screw on the bezel of the compass. A quick test is to ask the students to take a bearing on a distant object and then check that they all agree within a few degrees; this is much quicker than checking every compass. Separate clinometers such as the GeoMaxiclin are available and can be used in conjunction with a basic baseplate compass.

## Graphic logs

Specification Section 1.1.2, 1.3.1 and 4.1.2.

*Leaners should be able to demonstrate and apply their knowledge and understanding of:*

- how to use a wide range of practical apparatus and techniques correctly: as outlined in the skills required for the practical endorsement:
    - construction of graphic logs using appropriate scale and symbol sets
- presenting observations and data in an appropriate format
- the measurement and description of the diagnostic properties of rocks in the field
- the construction and interpretation of graphic logs of modern sediment sequences and ancient sedimentary rock

**Table 1** Practical activity requirements for the OCR Geology Practical Endorsement.

| Practical activity group (PAG) | Techniques/skills covered (minimum) |
|---|---|
| **1** Investigating minerals and rocks | • produce full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures, 1.2.2(h)[1]<br>• use of photomicrographs to identify minerals and rock textures, 1.2.2(i)<br>• use of physical and chemical testing to identify minerals to include: (i) density test (ii) Mohs hardness test, 1.2.2(k) |
| **2** Investigating seismology | • use appropriate software and tools to process data, 1.2.1(g)<br>• use of ICT to: (i) compile and analyse geological data sets to enable visualisation using geographic information system (GIS), 1.2.2(m) |
| **3** Investigating crystalline processes | • use appropriate apparatus to record a range of quantitative measurements (temperature and length), 1.2.2(j)[2] |
| **4** Investigating sedimentary processes | • use appropriate apparatus to record a range of quantitative measurements (mass, length), 1.2.2(j)[2] |
| **5** Investigating fossils | • apply classification systems using distinguishing characteristics to identify unknown fossils, 1.2.2(f)<br>• produce annotated scientific drawings of fossils, from hand samples using a light microscope, or hand lens observation, 1.2.2(g) |
| **6** Investigating geological sequences | • location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS, 1.2.2(a)<br>• identification of geological structures in the field recording observations as field sketches, 1.2.2(b)[3]<br>• use of a compass clinometer to measure two and three-dimensional geological data across a range of scales such as the dip and strike of planar surfaces, or the apparent dip of fold limbs exposed on a hillside or cliff section, 1.2.2(c)<br>• construct graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures, 1.2.2(d)<br>• use sampling techniques in fieldwork, 1.2.2(e)<br>• produce full rock descriptions of macro and micro features from unfamiliar field exposures, 1.2.2(h)[1]<br>• identification of potential hazards (risk assessment), CPAC3 |
| **7** Investigating orogenic processes | • make and record qualitative observations, 1.2.1(d)<br>• use of ICT to collect, process and model geological data, 1.2.2(m) |
| **8** Investigating fluid movement | • 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations |
| **9** Site investigations | • identification of geological structures in the field recording observations as field sketches, 1.2.2(b)[3] |
| **10** Investigating geological resources | • use appropriate software and tools to carry out research and report findings, 1.2.1(g) |
| **11** Investigation | • apply investigative approaches and methods to practical work, 1.2.1(a) |
| **12** Research skills | • use online and offline research skills, including websites, textbooks and other printed scientific sources of information, 1.2.1(h)<br>• correctly cite sources of information, 1.2.1(i) |

[1,2,3] These techniques/skills may be covered in *either* of the groups indicated.

Table 1 refers mainly to learning outcomes in Section 1.2 of the specification. In a few instances, references are included to the Common Practical Assessment Criteria (CPAC), to ensure coverage of criteria that are not explicitly stated in the learning outcomes.

Some of the learning outcomes in Section 1.2 are generic and they could be covered in many different activities. These have not been explicitly included in Table 1.

It is expected that there will be ample opportunities to develop and demonstrate the following skills across the whole practical course, regardless of the exact selection of activities:

- safely and correctly use a range of practical equipment and materials, 1.2.1(b) (though note identifying hazards has been explicitly included in PAG6)
- follow written instructions, 1.2.1(c)
- make and record observations/measurements, 1.2.1(d) (though note *qualitative* observations are explicitly included in PAG8)
- keep appropriate records of experimental activities, 1.2.1(e)
- present information and data in a scientific way, 1.2.1(f)
- use appropriate tools to process data, carry out research and report findings, 1.2.1(g)
- use a wide range of experimental and practical instruments, equipment and techniques, 1.2.1(j).

## Practical Activity Support

We do not require specific activities to be completed for the Practical Endorsement. Centres may select activities of their own, or provided by third parties, and map these against the requirements.

You can contact us at science@ocr.org.uk with any queries regarding selection of activities for the Practical Endorsement.

## Our activities

We have produced three suggested activities for each PAG, comprising student sheets and teacher/technician guidance. You may use these directly, adapt them to your requirements, or merely use them as reference for the types of activity that would satisfy the criteria for each PAG and the Endorsement as a whole.

The suggested activities are available on Teach Cambridge.

Table 2 lists the activity titles of the OCR suggested activities for A Level Geology. Our Practical Activities Support Guide provides more detailed guidance these suggested activities and how you may adapt them.

# 6 Guidance on practical skills

Section 1.2.1 of the specification covers the general practical skills which student should develop and practice during their course. This appendix includes suggestions about how this process of skills development can be managed.

This section provides guidance which teachers can use to assist how they teach the required skills, as well as things to look out for in assessing whether students are performing the skills competently. This section is not intended as a 'mark scheme', or statement of the minimum standard required for a pass in individual activities.

## Practical skills (specification Section 1.2.1)

### 1.2.1(a) apply investigative approaches and methods to practical work

Students are expected to be able to think independently about solving problems in a practical context. This means that students should develop their own ideas about how to approach a task, before perhaps discussing them with other students and joining together as a group to put an agreed plan into effect.

Demonstrating investigative approaches could include:

- choosing the materials, or amounts of materials, to use
- choosing which variables to measure and which to control
- deciding what measurements or observations to make and when to make them
- choosing apparatus and devising a procedure that is safe and appropriate.

Applying investigative approaches should include completing tasks that do not include complete step by step instructions. However, activities may still be structured in some form. For example:

- providing a basic method, with students asked to modify this to measure the effect of changing a certain variable
- providing a limited range of equipment, with students asked to think about how they can use what they have been given to solve a practical problem
- providing a certain amount of information, allowing students to consider how to use familiar techniques or procedures to investigate and solve a problem.

### 1.2.1(b) safely and correctly use a range of practical equipment and materials

Students should be shown how to use practical equipment when it is first met, through a demonstration by the teacher or technician. Good quality videos of many techniques are available online which could be used to complement such a demonstration. Teacher demonstration should also include the safe disposal of materials at the end of the laboratory session.

Hazards, and the ways in which risks should be minimised, should be explicitly explained to students whenever equipment is used for the first time, and on subsequent occasions as required. Students should also be shown how to handle materials safely so they adopt a standard routine whenever they need to use any materials. Some materials are associated with particular hazards and students should be clearly shown how they need to be handled to minimise the risk involved. In some cases, the hazards may be such that it is good practice for students to use the materials under the direct supervision of the teacher.

made during the laboratory session and are the primary evidence of the outcomes of experiments. Some errors/inconsistencies in the presentation of data are acceptable.

Where experimental procedures have been provided they do not need to be written out again, but they should be kept as part of the record.

Where the activities are 'investigations' there should be a suitable description of the manner in which these were carried out and why - citing which variables were dependent and which independent, whether or not ranges were adjusted to produce suitable results and how.

There should be enough detail to interpret the results produced.

The record may also show how the student has processed raw data, perhaps by using graphs or calculations, and the conclusions they have drawn. In some cases students may also evaluate their practical activity by calculating errors and/or commenting on the limitations of experimental procedures. These skills are not assessed in the Practical Endorsement but are valuable in understanding the purpose of a practical activity and will be assessed in the written examinations.

Records may be kept in a laboratory notebook, in a loose-leaf file or electronically. Students should record measurements and observations during laboratory sessions immediately, but these could be transferred to the permanent record later; for example, if there is no means of entering data into an electronic record in the lab.

### 1.2.1(f) present information and data in a scientific way

Students should present information and data in ways that are appropriate for that information or data. In many cases this will involve the use of tables. These should include an explanatory title, clear headings for columns and relevant units for measurements (see Appendix 4: Measurement and Appendix 5: Units for further details).

Graphs should be of an appropriate type for the information or data involved. Further detail about using graphs is given in Appendix 6: Graphical skills.

Some information is best presented by using clear, well labelled field sketches, technical illustrations or potentially using annotated photographs. Further detail about drawing, technical illustrations and field sketches is given in the Drawing Skills Handbook.

### 1.2.1(g) use appropriate software and tools to process data, carry out research and report findings

The most obvious tools and software used for processing data are calculators and spreadsheets. Spreadsheets provide a very effective way of processing data, particularly when the amount of data is large. They can be used to sort data, carry out calculations and generate graphs. Graphs drawn using spreadsheets should not be too small, should have a clear title and the axes should be clearly labelled. Where more than one graph is drawn using the same axes it should be clear what each graph refers to.

If records are kept electronically, students will routinely make use of a word processing package to report their findings. Short video clips can be used to show changes over time. Digital images, podcasts and PowerPoint© presentations also provide creative ways in which students can personalise their individual record of practical activities.

Experiments with very short or very long timescales of data collection lend themselves to the use of a data logger. Examples are structural geology field data collection and qualitative and quantitative modelling of processes in the laboratory. Students need training in how to use both the hardware and associated software to collect data, particularly if choices need to be made about measurement scales. In a report or in a lab book it is usually better to present collected data graphically rather than recording a large amount of raw data on paper.

## Risk assessments

In UK law, health and safety is the responsibility of the employer. Employees, i.e. teachers, lecturers and technicians, have a duty to cooperate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 2002 and the Management of Health and Safety at Work Regulations 1999, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found at

http://www.ase.org.uk/resources/health-and-safety-resources

For members, the CLEAPSS® guide, *Managing Risk Assessment in Science** offers detailed advice. Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

- *Safety in Science Education*, DfEE, 1996, HMSO, ISBN 0 11 270915 X.

  Now out of print but sections are available at

  http://www.ase.org.uk/resources/health-and-safety-resources;

- *Topics in Safety*, 3rd edition, 2001, ASE ISBN 0 86357 316 9;
- *Safeguards in the School Laboratory*, 11th edition, 2006, ASE ISBN 978 0 86357 408 5;
- CLEAPSS® *Hazcards*.*

  CLEAPSS® are in the process of updating the *Hazcards*, the latest edition being the CLP Edition, 2014. At present, CLP Hazcards have only been published for some chemicals. For other chemicals, the CHIP Hazcard is referenced and should be consulted.

- CLEAPSS® Laboratory Handbook*
- *Hazardous Chemicals*, A Manual for Science Education, 1997, SSERC Limited ISBN 0 9531776 0 2.

Where an employer has adopted these or other publications as the basis of their model risk assessments, the teacher or lecturer responsible for overseeing the activity in the school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment.

Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision is inadequate or the skills of the students are insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers' guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

Where project work or individual investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or microorganisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting CLEAPSS® (or, in Scotland, SSERC).

*These, and other CLEAPSS® publications, are on the CLEAPSS website. Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS - go to www.cleapss.org.uk. In Scotland, SSERC (www.sserc.org.uk) has a similar role to CLEAPSS®.

## A code for geological fieldwork

This code is based on the Geologists Association's Geological Fieldwork Code first published in 1975. Geologists must be seen to be using the countryside responsibly and observing the following rules:

**General**

1. Obey the Country Code and local bylaws.
2. Leave gates and property as you find them and take your litter home.
3. Don't litter fields or roads with rock fragments that could cause injury to livestock or be a hazard to vehicles or pedestrians.
4. Always seek permission before entering private land.
5. Do not disturb wildlife or plant life.
6. On coastal sections, check tides or local hazards such as unstable cliffs.
7. Make yourself familiar with any conservation rules that may be in force before visiting geological localities in statutory and local conservation sites.
8. Avoid using a hammer.

**Collecting**

1. Only collect when it is permissible to do so.
2. Do not leave exposures untidy or dangerous.
3. Students should be encouraged to observe and record and not to hammer indiscriminately. Keep collecting to a minimum.
4. Avoid removing in-situ fossils, rocks or minerals unless they are genuinely needed for serious study. The collecting of actual specimens should be restricted to those localities where there is a plentiful supply, or scree, fallen blocks and waste tips.
5. Never collect from walls or buildings.

**Safety**

1. Always wear a hard hat when working under any cliff face or in any quarry etc.
2. Always wear goggles when hammering.
3. Boots or other suitable footwear should be worn when the Leader requires them.
4. Keep clear of plant or machinery.
5. Beware of rock falls.
6. Beware of sludge lagoons or settling ponds in quarries etc.
7. Do not dislodge rocks or throw things over cliffs etc - someone may be below.
8. Keep a look out for dangers not only to yourself but for all members of your party.
9. If you go onto the fells, moors or mountains, let someone know your route and return time.
10. Always carry a first aid kit.
11. Never go onto the fells, moors or mountains without suitable clothing and equipment.
12. DO NOT ENTER a working quarry etc without permission.
13. Do not take risks on cliffs or rock faces.

The Health and Safety at Work Act requires that safety measures are strictly enforced, especially in quarries or other excavations. Protective clothing, particularly safety helmets, must be worn at all times by employees, and visitors are also expected to observe the same precautions, generally as a condition of entry to the site. In quarries, helmets must be worn at all times.

Suitable helmets are readily available and cheap to buy, and they should be part of the standard equipment of every geologist and worn wherever there is a danger of rock falls.

Leaders of a field party should ensure that the spirit of this code is followed and remind students of the need for care and consideration at all times.

# Appendix 2: Apparatus list

This appendix lists the apparatus likely to be required in order to complete a practical scheme of work that covers all requirements of the qualification. Teachers and technicians should bear in mind that activities that would support the qualification may require additional apparatus not on this list. Resources provided by OCR detail the apparatus needed for individual activities.

## Apparatus likely to be required

The following apparatus is likely to be required to complete activities covering all techniques required by the Practical Endorsement in GCE Geology (Section **1.2.2** of the specification).

## Fieldwork Equipment

- Compass clinometer (can be replaced by a baseplate compass and Maxicline®)
- Grain size card
- Dropper bottle with HCl (2 mol $dm^{-3}$)
- Hand lens
- Map (e.g. OS 1:25,000 or BGS 1:50,000 extracts)
- Survey tape (e.g. 3 m pocket steel or 10 m fibreglass)
- Safety helmet and high visibility tabard – *may be a requirement for access to some sites*

## Laboratory Equipment

- Balance reading to at least two decimal places
- Beakers (400 $cm^3$, 250 $cm^3$, 100 $cm^3$)
- Calipers or vernier measurement system
- Displacement vessels/eureka can large enough to hold mineral or rock sample
- Dropping pipettes
- Heating apparatus: water bath or electric heater or sand bath – *a water bath could consist of a beaker of water on a tripod and gauze over a Bunsen flame*
- Mass holder and slotted masses (e.g. 500 g – 9×50 g and hanger)
- Measuring cylinders (500 $cm^3$, 250 $cm^3$, 50 $cm^3$, 25 $cm^3$)
- Microscope with at least two objective lenses
- Microscope slides and coverslips
- Mohs hardness set (pencils or minerals) – *one set per class in addition to everyday substitutes (fingernail 2.5, copper 3.5, wire nail 4.5, masonry nail 5.5)*
- Retort stands and clamps
- Samples of fossils, a range of replicas, prepared and partial fossils – *the ESTA fossil kit for example contact@esta-uk.net*
- Samples of common rock forming minerals (to include quartz, plagioclase or K-feldspar, calcite and a range of others as available – *amphibole, aragonite, biotite, dolomite, kaolinite/clay, muscovite, olivine, orthoclase/ K-feldspar, plagioclase, pyroxene) –such as the GeoSupplies Silicate Mineral set for example*
- Samples of rocks, a range of igneous (with different densities), metamorphic and sedimentary (siliciclastic and calcareous) – *the ESTA rock kit for example contact@esta-uk.net*

- Samples of sand, a range with different characteristics (e.g. beach, river and dune or sharp sand, silver sand and play sand)
- Sieve stack (2 mm, 1 mm, 0.5 mm, 250 µm, 125 µm, 63 µm)
- Stop clocks/watches reading to 1 s or better.
- Streak plate or unglazed porcelain tile
- Test tubes and boiling tubes
- Test-tube holders
- Thermometers (–10 to 110 °C or equivalent, accurate to 0.5 °C)

## Apparatus potentially required

The following laboratory equipment may additionally be required to support further practical work towards the Endorsement as well as to support teaching of the specification and preparation for the written examinations.

- Bunsen burners
- Conical flasks (250 $cm^3$, 100 $cm^3$)
- Data loggers such as the app Physics Toolbox
- Digital field mapping app, such as Fieldmove Clino or eGeoCompass
- Filter funnels, or apparatus to carry out filtration under reduced pressure: Buchner flask and Buchner funnel or boiling tube with side-arm and Hirsch funnel
- Filter paper
- Heat proof mats
- LEGO® Seismometer parts kit
- Pipeclay triangles
- Pipettes and micropipettes
- Pipette fillers
- Tripods and gauze
- Volumetric flasks (250 $cm^3$ or 100 $cm^3$)
- Wash bottles with distilled water

## Additional requirements

In order to fulfil the requirements of the skills set out in Section **1.2.1** of the specification, students m require access to the following.

- Chemical data or hazard sheets
- Graph plotting and data analysis software (e.g. Microsoft Excel or GeoGebra)
- BGS GeoIndex
- GoogleMaps or ArcGIS
- Textbooks, websites and other sources of scientific information
- A means of recording practical activity undertaken towards the Practical Endorsement, for example a logbook, binder to collect loose sheets, or means to create and store digital files.

## Field Notebooks and Lab Books

Students can keep their records in any appropriate form including the use of a ring binder or other folder. Should your centre wish to purchase field notebooks or lab books there are educational suppliers who stock a wide variety of these.

# Appendix 3: Measurements

This appendix provides background information on terms used in measurement, and conventions for recording and processing experimental measurements. This information relates to skills assessed both in the written examinations and in the Practical Endorsement, notably 1.1.2(c), 1.1.3(c), 1.1.4(b), 1.1.4(d), 1.2.1(d), 1.2.1(f).

## Useful terms

***Accuracy*** is a measure of the closeness of agreement between an individual test result and the **true** value. If a test result is **accurate**, it is in close agreement with the true value. An accepted reference value may be used as the true value, though in practice the true value is usually not known.

***Anomaly (outlier)*** is a value in a set of results that is judged not to be part of the inherent variation.

***Confidence*** is a qualitative judgement expressing the extent to which a conclusion is justified by the quality of the evidence.

***Error*** (of measurement) is the difference between an individual measurement and the **true** value (or accepted reference value) of the quantity being measured.

***Precision*** is the closeness of agreement between independent measurements obtained under the same conditions. It depends only on the distribution of random errors (*i.e.* the spread of measurements) and does not relate to the true value.

***Repeatability*** is the precision obtained when measurement results are produced over a short timescale by one person (or the same group) using the same equipment in the same place.

***Reproducibility*** is the precision obtained when measurement results are produced over a wider timescale by different people using equivalent equipment in different (but equivalent) places.

***Resolution*** is the smallest change in the quantity being measured that can be detected by an instrument.

***Uncertainty*** is an estimate attached to a measurement which characterises the range of values within which the true value is asserted to lie. This is normally expressed as a range of values such as 44.0 ± 0.4.

***Validity*** can apply to an individual measurement or a whole investigation. A measurement is valid if it measures what it is supposed to be measuring. An investigative procedure is valid if it is suitable to answer the question being asked. Validity will be reduced, for example, if no negative control is included in an investigation into the efficacy of a therapeutic drug.

The ASE booklet *The Language of Measurement* (Campbell 2010) provides information on these and other terms along with examples of their use. In particular please note that **reliability** will no longer be used. As the authors of the booklet said:

> *"The word 'reliability' has posed particular difficulties because it has an everyday usage and had been used in school science to describe raw data, data patterns and conclusions, as well as information sources. On the strong advice of the UK metrology institutes, we avoid using the word 'reliability' because of its ambiguity. For data the terms 'repeatable' and 'reproducible' are clear and therefore better. For conclusions from an experiment, evaluative statements can mention 'confidence' in the quality of the evidence."*

# Uncertainties

Whenever a measurement is made, there will always be some doubt about the result that has been obtained. An uncertainty in a measurement is an interval that indicates a range within which we are reasonably confident that the true value lies.

Uncertainties technically depend on a range of factors related to measurements, including both systematic and random errors. Determining uncertainties based on the spread of data obtained is not required within the context of AS and A Level Geology. Rather, an estimation of uncertainty is made based on the characteristics of the equipment used.

## Uncertainties in apparatus and equipment

When using any apparatus, students should check whether the apparatus itself is marked with the uncertainty. This is, for example, generally the case in for volumetric glassware used to measure specific volumes of liquid, such as volumetric flasks and pipettes. The degree of uncertainty in these cases depends on the class of apparatus.

For example, a 100 $cm^3$ measuring cylinder is graduated in divisions every 1 $cm^3$.

- A Class A measuring cylinder has an uncertainty of half a division or 0.5 $cm^3$ in each measurement
- A Class B measuring cylinder has an uncertainty of a whole division or 1 $cm^3$ in each measurement.

In the absence of information provided on the equipment, the following assumptions are made regarding the uncertainty in each measurement:

- When using apparatus with an analogue graduated scale, the uncertainty is assumed to be ± half the smallest graduation.

  For example a 30 cm rule has divisions of 1 mm and an uncertainty of half a division, or 0.5 mm. When measuring a distance the uncertainty has to be taken into account twice and it is overall 1 mm.

  An analogue meter with scale markings each 0.2 V has an uncertainty of 0.1 V.

- When using digital apparatus, the uncertainty is presumed to be ± the resolution of the apparatus in each measurement.

  For example, a two-decimal place balance has an uncertainty of ±0.01 g in each measurement and a voltmeter with three significant figures which has an uncertainty of ±0.1 V in the 0-20 V range will have an uncertainty of ±1 V in the 0-100 V range.

The basis of the assumption for electronic apparatus is that the electronic circuit is designed to avoid "hunting" which is the rapid cycling from one figure to another in the final digit. This is achieved by programming the equipment to go up to the next value at a level greater than 0.5, and to go to the lower value at a level below 0.5; this could be going up at 0.7 and down at 0.3. As we are not aware of that value we can only assume ±1 digit in the final digit.

Students should be able to calculate a percentage uncertainty for a measurement from the absolute uncertainty for the apparatus used. See worked examples on the next page.

Because of the variability in uncertainties associated with equipment, assessments will frequently state the absolute uncertainty in any measurement given to allow students to calculate the percentage uncertainty. If no information is given, the uncertainty in each reading is derived from the resolution of the apparatus used as explained above.

## Measurement of time

Whilst a stopwatch measures time with a resolution of say 0.001 s, the operator reaction time is significantly longer, increasing the total uncertainty in the measurement, in which case a reasonable estimate for the uncertainty would be the reaction time of the operator.

A light gate measures time with the same resolution of 0.001 s, but has a significantly lower total uncertainty as it eliminates the reaction time of the operator.

## Examples of uncertainties

Some examples are shown below. Note that the actual uncertainty on a particular item of equipment may differ from the values given below.

- Brunton Transit compass has an uncertainty of ±0.5° in azimuth or 0.14%.
- Suunto M-3G compass has an uncertainty of ±1° in azimuth or 0.28%.

## Worked examples

The significance of the uncertainty in a measurement depends upon how large a quantity is being measured. It is useful to quantify this uncertainty as a percentage uncertainty.

$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{quantity measured}} \times 100\%$$

For example, a measurement of 2.56 g is taken using a two-decimal place balance with an uncertainty of ±0.01 g.

- percentage uncertainty = $\frac{0.01}{2.56} \times 100\% = 0.39\%$

For a mass measurement of 0.12 g, the percentage uncertainty is much greater:

- percentage uncertainty = $\frac{0.01}{0.12} \times 100\% = 8.3\%$

For individual mass measurements, it is assumed there is no uncertainty in the tare of the balance.

## Multiple measurements

Where quantities are measured by difference, there will be an uncertainty in each measurement, which must be combined to give the uncertainty in the final value. The principle of the following example for a mass measurement can be applied to other quantities measured by difference, such as temperature difference and titre.

For two mass measurements that give a resultant mass by difference, there are two uncertainties. These uncertainties are combined to give the uncertainty in the resultant mass. The formula for the percentage uncertainty is then:

$$\text{percentage uncertainty} = \frac{2 \times \text{uncertainty in each measurement}}{\text{quantity measured}} \times 100\%$$

For example, using the same two-decimal place balance as above:

| | |
|---|---|
| Mass of dry rock sample = 23.45 g | uncertainty = 0.01 g |
| Mass of sample after 24 hour soak = 24.21 g | uncertainty = 0.01 g |
| Mass gain = 0.76 g | overall uncertainty = 2 × 0.01 g |

There is a negligible percentage uncertainty in each mass measurement, but the overall percentage uncertainty in the mass loss is much greater:

percentage uncertainty in mass loss = $\frac{2 \times 0.01}{0.76} \times 100\%$ = 2.6%

### Notes

We are aware that some textbooks available do not give a consistent message regarding the treatment of uncertainties. In OCR Geology we will therefore allow both half the smallest division as the absolute uncertainty for a measuring instrument and the smallest division itself as the absolute uncertainty. This will ensure that we do not penalise students in any examination - since this ambiguity is not their fault.

The guidance on electronic instruments differs from guidance previously provided by OCR and other sources which state that the uncertainty for digital apparatus is half the resolution, e.g. ±0.005 g for a two-decimal place balance. The guidance here has been updated for consistency across the OCR suite of A level sciences. For assessment purposes, approaches correctly using either the resolution or half the resolution as the uncertainty will be considered acceptable.

## Recording measurements

When using a digital measuring device (such as a modern top pan balance or GPS receiver),

- record *all* the digits shown. (Note, when using a digital timer such as a stopwatch, do not record to more than two decimal places.)

When using a non-digital device (such as a ruler or a compass),

- record all the figures that are known for certain plus one that is estimated.

## Presentation of results

### Table headings

It is expected that **all** table column (or row) headings will consist of a quantity **and** a unit.

The quantity may be represented by a symbol or written in words. There must be some kind of distinguishing notation between the quantity and the unit. Students should be encouraged to use solidus notation, but a variety of other notations are accepted. For example:

*T* / °C    *T* (°C)    *T* in °C    $\frac{T}{°\mathrm{C}}$    are all **acceptable** as column headings.

Students should avoid notations that do not distinguish between the quantity and the unit, such as

*T* cm    $T_{\mathrm{cm}}$    just ‘cm’

The logarithm of a quantity has no units. Therefore, the heading for e.g. Mohs hardness measurements can be written simply as ‘Hardness’.

### Consistency of presentation of raw data

All raw readings of a particular quantity should be recorded to the same number of decimal places. These should be consistent with the apparatus used to make the measurement (see above).

### How many significant figures should be used?

The result of a calculation that involves measured quantities cannot be more certain than the *least* certain of the information that is used. So the result should contain the same number of significant figures as the measurement that has the *smallest* number of significant figures.

A common mistake by students is to simply copy down the final answer from the display of a calculator. This often has far more significant figures than the measurements justify.

### Rounding off

When rounding off a number that has more significant figures than are justified (as in the example above), if the last figure is between 5 and 9 inclusive round up; if it is between 0 and 4 inclusive round down.

For example, the number 3.5099 rounded to:

4 sig. figs. is 3.510

3 sig. figs. is 3.51

2 sig. figs. is 3.5

1 sig. fig. is 4

Notice that when rounding you only look at the one figure beyond the number of figures to which you are rounding, *i.e.* to round to three sig. fig. you only look at the fourth figure.

### How do we know the number of significant figures?

If the number 450.13 is rounded to 2 sig. figs., the result is 450.

However, if seen in isolation, it would be impossible to know whether the final zero in 450 is significant (and the value to 3 sig. figs.) or insignificant (and the value to 2 sig. figs.).

In such cases, standard form should be used and is unambiguous:

- $4.5 \times 10^2$ is to 2 sig. figs.
- $4.50 \times 10^2$ is to 3 sig. figs.

### When to round off

It is important to be careful when rounding off in a calculation with two or more steps.

- Rounding off should be left until the very end of the calculation.
- Rounding off after each step, and using this rounded figure as the starting figure for the next step, is likely to make a difference to the final answer. This introduces a **rounding error**.

## Errors in procedure

The accuracy of a final result also depends on the procedure used. For example, in an enthalpy experiment, the measurement of a temperature change may be precise but there may be large heat losses to the surroundings which affect the accuracy of overall result.

### Anomalous readings

Anomalies (outliers) are values in a set of results that are judged not to be part of the inherent variation. If a piece of data was produced due to a failure in the experimental procedure, or by human error, it would be justifiable to remove it before analysing the data. For example, if a dip angle is clearly different to the other readings taken for that particular outcrop, it might be judged as being an outlier and could be ignored when the mean is calculated. However, data must never be discarded simply because it does not correspond with expectation.

## References

The ASE booklet *The Language of Measurement* (ISBN 9780863574245) is the source for this section and provides additional guidance on many of the matters discussed in this above.

# Appendix 4: Units

Students are expected to use the following units for measurements made and in associated calculations during the course of the practical work carried out to support the GCE Geology qualifications. Records of measurements should always include the relevant units.

| | |
|---|---|
| angle | °<br>*Angle in geology is frequently measured as the angle below the horizontal plane, recorded to two significant figures e.g. 09°* |
| azimuth | °<br>*Azimuth is measured as a bearing clockwise from north (000°), recorded to three significant figures e.g. 009°* |
| area | $km^2$, $m^2$, $cm^2$, $mm^2$ |
| concentration | ppb, gram per tonne, g $dm^{-3}$ or mol $dm^{-3}$<br>*Mineral concentrations are by mass, solutions by volume. OCR specifications do not support the use of M (molar)* |
| distance | km, m, cm, mm, μm |
| mass | t, kg, g |
| temperature | °C or K<br>*Standard thermometers measure temperature in °C. Some practical contexts may require students to convert units.* |
| time | Ga, Ma, a, d, h, min, s<br>*Gigaannum ($10^9$ years) and Megaannum ($10^6$ years), where annum is age in years before present, are the informal SI notation supported in OCR Geology specifications* |
| volume | $km^3$, $m^3$, $cm^3$, $dm^3$ or $mm^3$<br>*Measurements using laboratory apparatus will commonly be in $cm^3$, while concentrations are expressed in terms of $dm^3$.*<br>*ml and l are not official SI units and their use is not supported in OCR specifications* |

# Appendix 5: Tables and graphs

## Tables

The following guidelines should be followed when presenting results in tables.

- All raw data in a single table with ruled lines and border.
- Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).
- Processed data (e.g. means, rates) in columns to the far right.
- No calculations in the table, only calculated values.
- Each column headed with informative description (for qualitative data) or physical quantity **and** correct units (for qualitative data); units separated from physical quantity using either brackets or a solidus (slash).
- No units in the body of the table, only in the column headings.
- Raw data recorded to a number of decimal places appropriate to the resolution of the measuring equipment.
- All raw data of the same type recorded to the same number of decimal places.
- Processed data recorded to up to one significant figure more than the raw data.

## Graphs

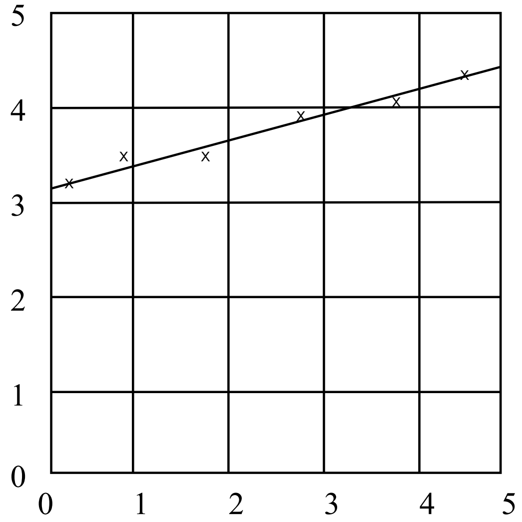
This appendix provides background information on the following graphical skills:

- choice of scale
- plotting of points
- line of best fit
- calculation of gradient
- determination of the *y*-intercept.

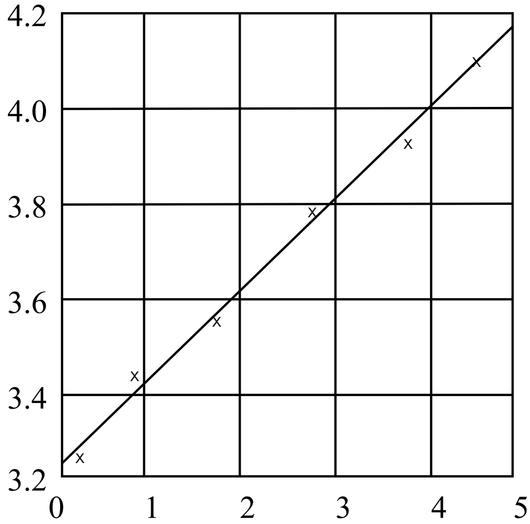
This information relates to skills assessed both in the written examinations and in the Practical Endorsement, notably 1.1.3(d) and 1.2.1(f).

## Choice of scales

Scales should be chosen so that the plotted points occupy at least half the graph grid in both the *x* and *y* directions.




Not acceptable - scale in the *y*-direction is compressed




Acceptable - points fill more than half the graph grid in both the *x* and *y* directions

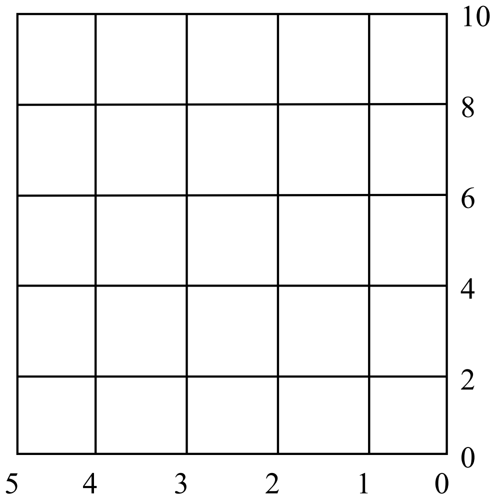
It is expected that each axis will be labelled with the quantity (including unit) which is being plotted. The quantity may be represented by a symbol or written in words. There must be some kind of distinguishing notation between the quantity and the unit. Students should be encouraged to use solidus notation, but a variety of other notations are accepted. For example:

*T* / °C  *T* (°C)  *T* in °C  $\frac{T}{°C}$

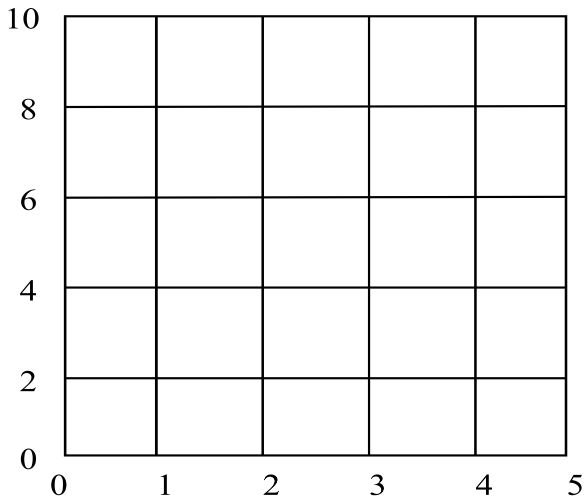
are all **acceptable** as axis labels.

The logarithm of a quantity has no units. Therefore, the axis label for e.g. pH measurements can be written simply as ‘pH’.

The scale direction must be conventional (i.e. increasing from left to right).



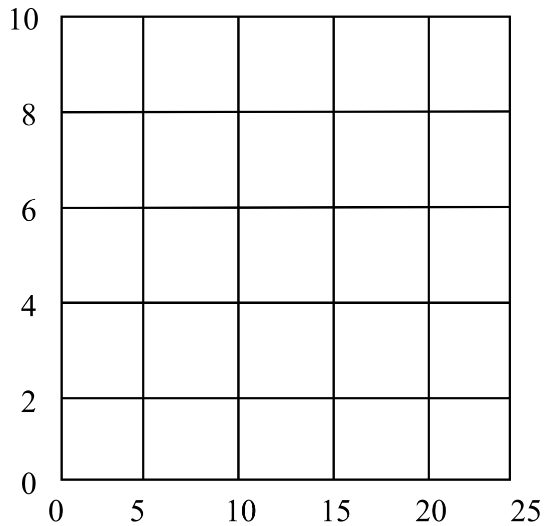

Not acceptable - unconventional scale direction



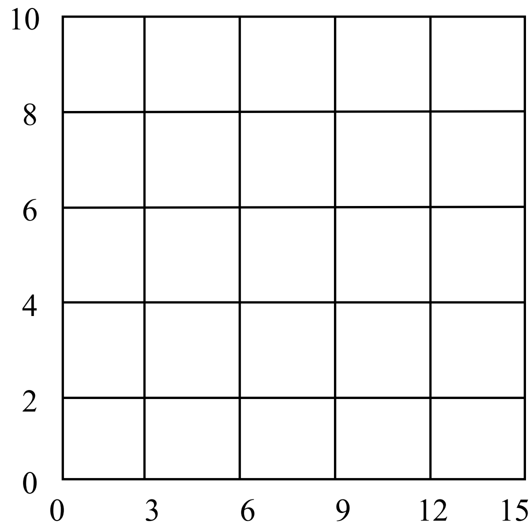

Acceptable - conventional scale direction

This problem often occurs when scales are used with negative numbers.

Students should be encouraged to choose scales that are easy to work with.



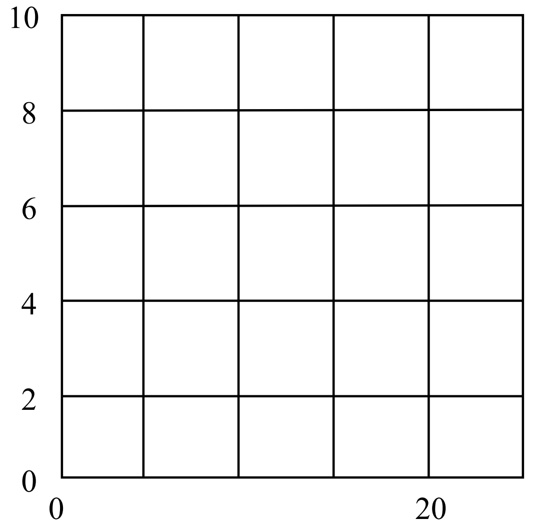

Acceptable scale divisions.



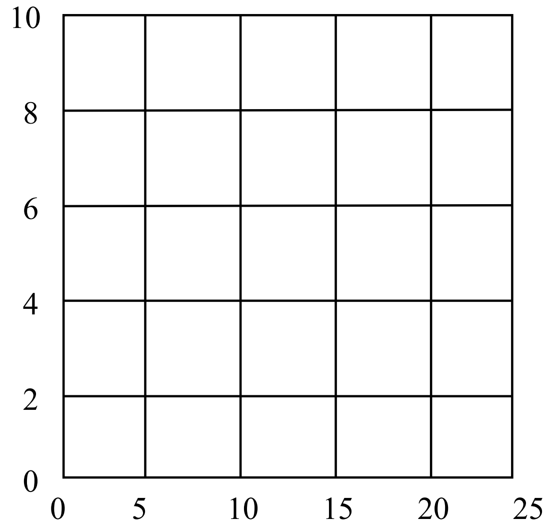

Not acceptable - awkward scale on the *x*-axis.

Students who choose awkward scales in examinations often lose marks for plotting points (as they cannot read the scales correctly) and calculation of gradient ($\Delta x$ and $\Delta y$ often misread – again because of poor choice of scale).

Scales should be labelled reasonably frequently (i.e. there should not be more than three large squares between each scale label on either axis).

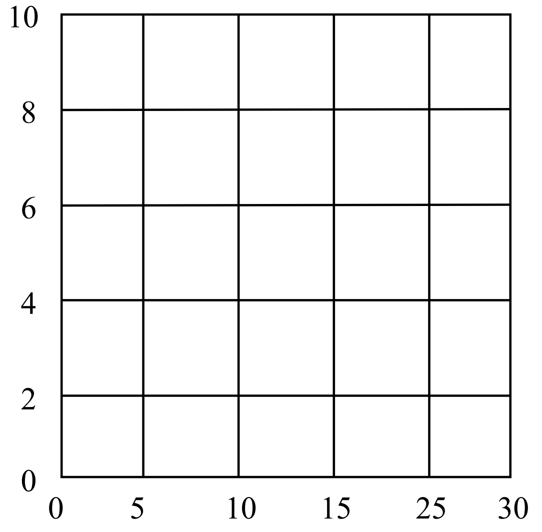



Not acceptable - too many large squares with no label

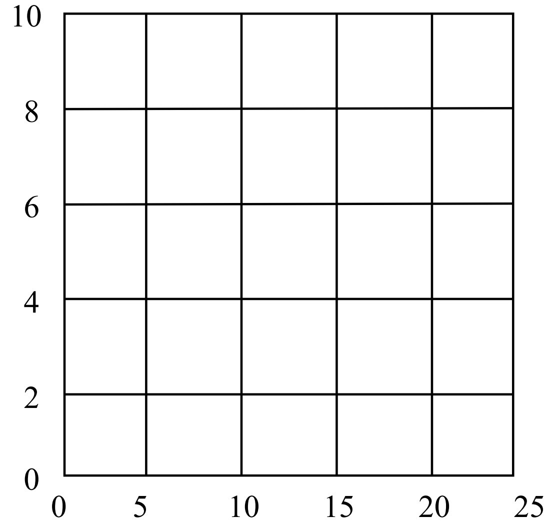



Acceptable - scales have regular labels

There should be no 'holes' in the scale.



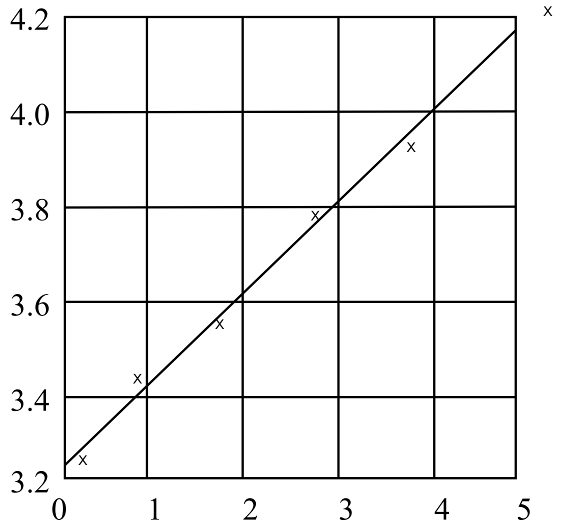

Not acceptable - non-linear scale on the *x*-axis



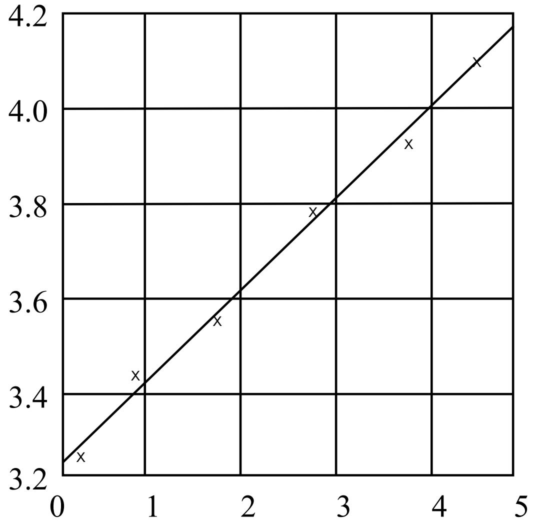

Acceptable - scale labelling is regular

# Plotting of points

Plots in the margin area are not allowed and will be ignored in examinations. Sometimes students (realising they have made a poor choice of scale) will attempt to draw a series of lines in the margin area so that they can plot the 'extra' point in the margin area. This is considered to be bad practice and would not be credited.




Not acceptable - the last point has been plotted in the margin area



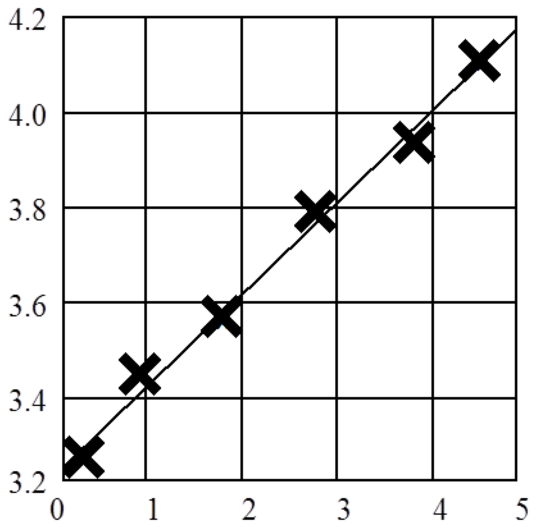

Acceptable - all plotted points are on the graph grid

It is expected that all observations will be plotted (e.g. if six observations have been made then it is expected that there will be six plots).

Plotted points must be accurate to half a small square.

Plots must be clear (and not obscured by the line of best fit or other working).

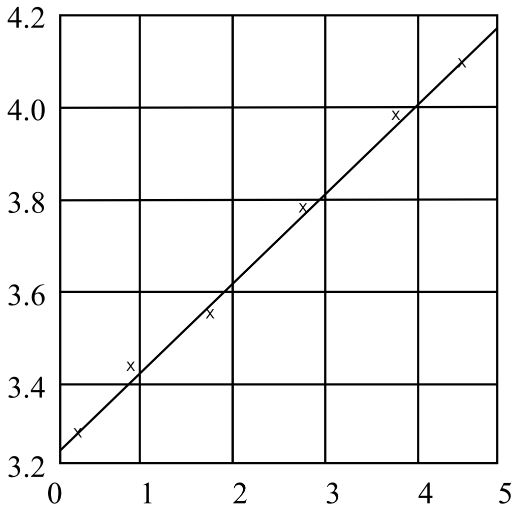
Thick plots are not acceptable. If it cannot be judged whether a plot is accurate to half a small square (because the plot is too thick) then the plotting mark will not be awarded.



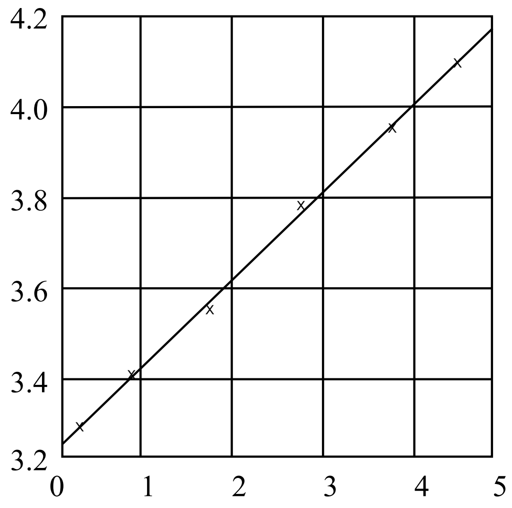

Thick plots not acceptable

## Line (or curve) of best fit

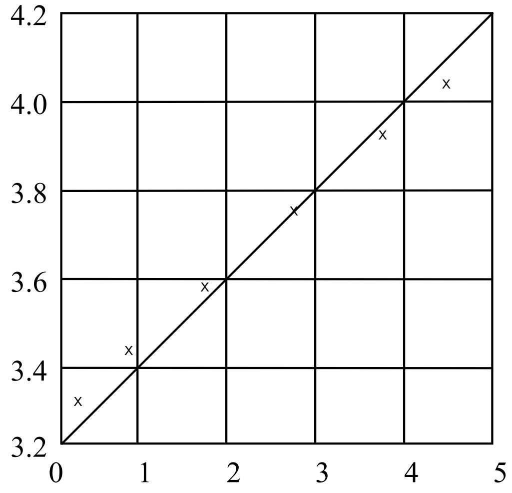
There must be a reasonable balance of points about the line. Students should use a clear plastic rule so that points can be seen which are on both sides of the line as it is being drawn.




Not acceptable - too many points above the line

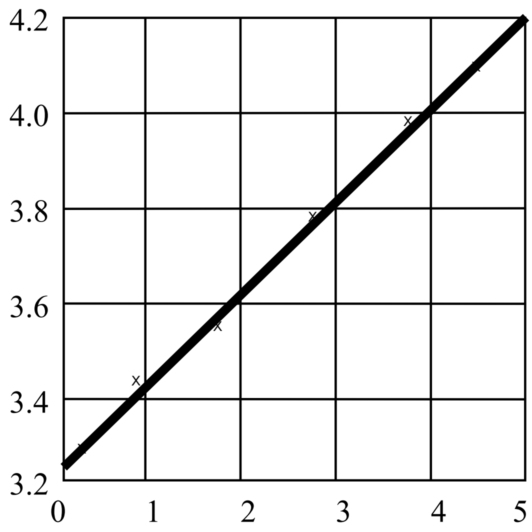



Acceptable balance of points about the line

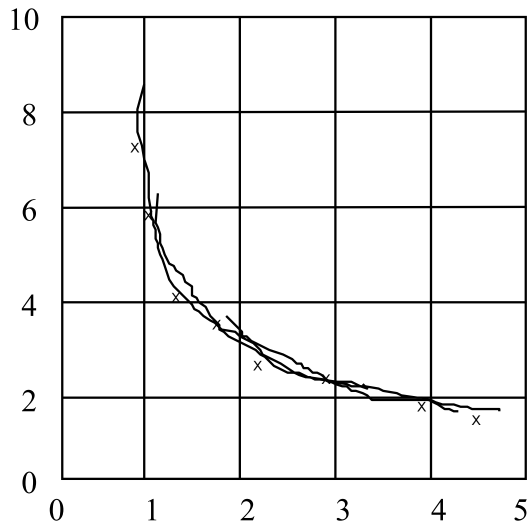



Not acceptable - forced line through the origin (not appropriate in this instance)

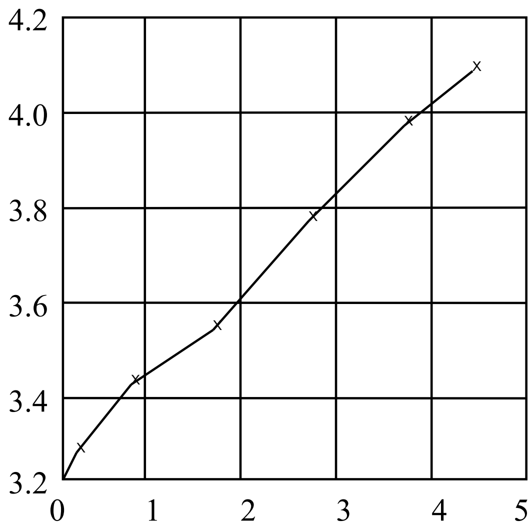
The line must be thin and clear. Thick, hairy, kinked or point-to-point lines are not credited.




Not acceptable - thick line




Not acceptable - 'hairy' curve

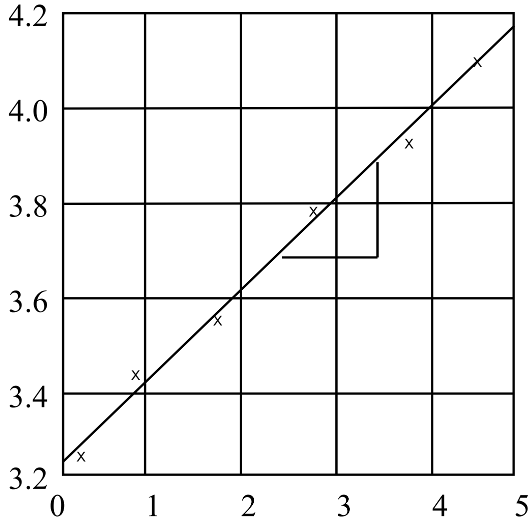



Not acceptable – joining point-to-point

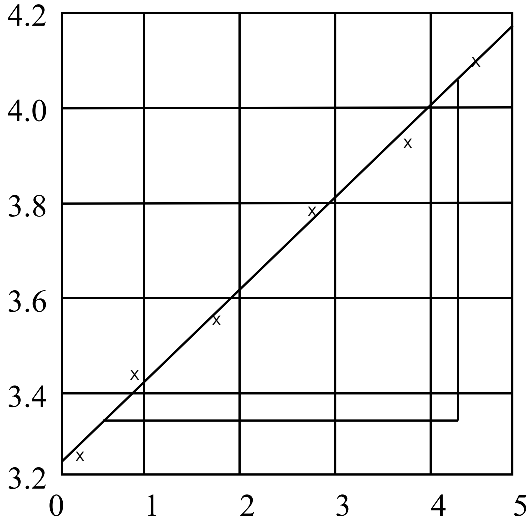
# Determining gradients

All the working must be shown. A 'bald' value for the gradient may not be credited. It is helpful to both students and examiners if the triangle used to find the gradient is drawn on the graph grid and the co-ordinates of the vertices clearly labelled.

The length of the hypotenuse of the triangle should be greater than half the length of the line which has been drawn.



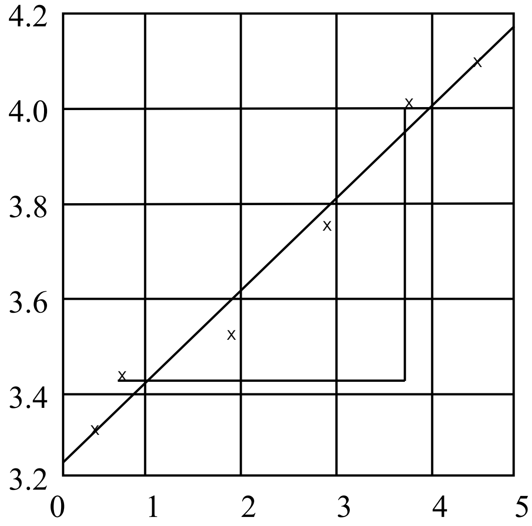

Not acceptable - the ‘triangle’ used is too small



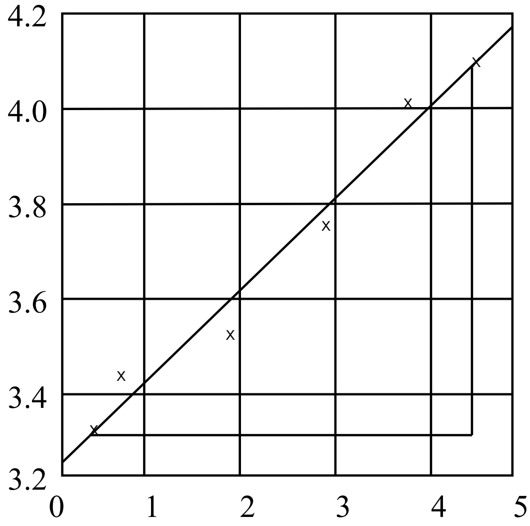

Acceptable – a large ‘triangle’ used

The values of $\Delta x$ and $\Delta y$ must be given to an accuracy of at least one small square (i.e. the 'read-off' values must be accurate to half a small square).

If plots are used which have been taken from the table of results then they must lie on the line of best fit (to within half a small square).




Not acceptable - the data points used which do not lie on the line of best fit

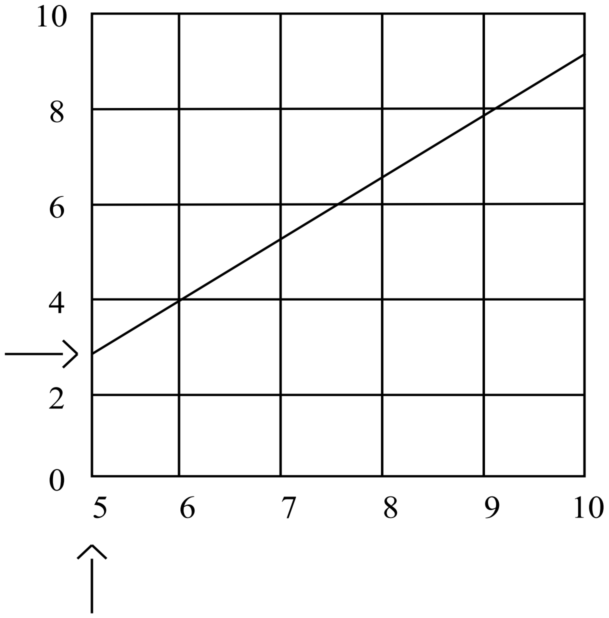



Acceptable - plots on line

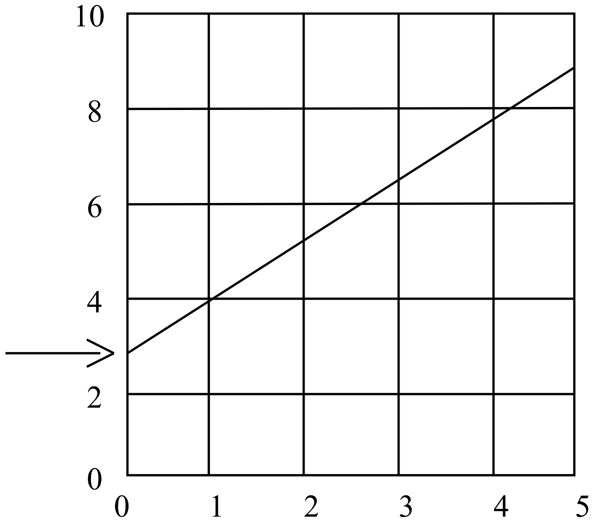
Students should remember to use appropriate units when reporting gradient values.

## Intercept

The *y*-intercept must be read from an axis where *x* = 0. It is often the case that students will choose scales so that the plotted points fill the graph grid (as they should do) but then go on to read the *y*-intercept from a line other than *x* = 0.




Not acceptable – the *y*-intercept is found from the line *x* = 5




Acceptable – the value taken from the line *x* = 0

Alternatively, the intercept value can be calculated, recognising that a straight-line graph has the basic formula *y* = *mx* + *c*. Substituting the gradient value and a set of coordinates on the line of best fit and solving the equation will give the intercept.

# Appendix 6: Referencing

One of the requirements of the Practical Endorsement is that students demonstrate that they can appropriately cite sources of information. The point of referencing is to provide the sources of information that have been used to produce the document, and to enable readers to find that information. There are many different systems of reference in use; the most important thing for students to appreciate at this level is that they should be consistent in how they reference, and that they provide sufficient information for the reader to find the source.

Use of a specific referencing system for the Practical Endorsement is not expected. However, students' referencing should be complete and consistent and allow you to accurately find the original source. If students are already using a particular referencing system in another area of study, for example for an Extended Project qualification, it would make sense if they use the same system within their Chemistry studies.

## Systems of citation

Wherever a piece of information that has been retrieved from a source is provided in a text, an in-text citation should be included that links to the full original source in the reference list.

There are two main systems of in-text citation: the Vancouver system, which uses numerical citations, and the parenthetical system (of which the Harvard system is the best-known version), in which limited reference information is given in brackets in the text.

Students are likely to find the Harvard system easier to handle. However, students should be aware of the Vancouver system as they may come across this system in their secondary research.

### Vancouver system

The Vancouver system looks like this:

> The model that explains greywacke deposits as deposition from gravity flows was developed in the 1960 based on fieldwork.[1]

The full references are given in a numbered list at the end of the document, with each number linked to the appropriate reference, e.g.:

1. Bouma, Arnold H. (1962) *Sedimentology of some Flysch deposits; a graphic approach to facies interpretation*, Amsterdam, Elsevier Publishing Co.

The references are ordered in the sequence in which they are first cited in the text. The numbers are repeated in the in-text citations as required, so the same number is always used to cite a given reference.

### Parenthetical (Harvard) system

The parenthetical system looks like this:

> The model that explains greywacke deposits as deposition from gravity flows was developed in the 1960 based on fieldwork (Bouma, 1962).

The author(s) and date of the work are included in brackets at the appropriate point in the text. In this case, the list of full references at the end of the document is ordered alphabetically, and the references are not numbered.

For multi-author works, the full list of names is usually not given in in-text references. Rather, the first name is given followed by 'et al.'. This is commonly done for works with more than three authors.

# References

While different referencing systems have minor variations in how they present complete references, the basic information provided is always very similar, and based on the principle of providing sufficient information so that the reader can find the information source.

An overview is given below of standard referencing formats for the types of sources that students are likely to cite.

## Books

General reference format:

> Authors (year), *Title*, edition (if relevant), publisher's location, publisher

For example:

> Brenchley, P.J. & Rawson, P.F. (2006), *The Geology of England and Wales*, 2nd ed., London, The Geological Society

For books that have an editor or editors, include (ed.) or (eds) after the names.

If a book does not have named authors or editors, the reference begins with the title, e.g.:

> *CLEAPSS Laboratory Handbook* (2001), Uxbridge, CLEAPSS School Science Service

## Journal articles

General reference format:

> Authors (year), 'Article title', *Journal title*, vol. no, issue no, pp. xxx–xxx

For example:

> King, C. (2017), 'Killer Facts Supporting Geology in Schools and Colleges', *Teaching Earth Science*, vol. 42, no 2, pp. 14–19

## Websites

General reference format:

> Authors (year), *Title*. [online] Last accessed date: URL

For example:

> Ford, A.K. (2011), *Dr Anjana K. Ford answers questions on the Jurassic Coast*. [online] Last accessed 20 January 2018: http://www.rgs.org/NR/rdonlyres/ED6A4A7E-7E1A-4EA8-8C32-4C9C7D11E0B6/0/JurassicCoast.pdf

Webpages and online resources frequently do not have individual authors. In that case, the name of the organisation is given.

Similarly, it is often not possible to find the year in which online material or documents were produced. In that case, use the year in which the information was sourced.

> Mineralogical Society of America (2018), *Mineral Identification Key II*. [online] Last accessed 20 January 2018: http://www.minsocam.org/msa/collectors_corner/id/mineral_id_keyi1.htm

If no author or organisation can be found, reference the website by title. However, in that case due consideration should be given as to whether the website is a trustworthy source!

# Appendix 7: Resources

## General resources

There are many resources available to help teachers provide support to students. These include both books and websites.

Useful websites are:

- Association for Science in Education (ASE) www.schoolscience.co.uk
- CLEAPSS www.cleapss.org.uk
- Earth Science Teachers Association (ESTA) https://earth-science-teachers.uk/
- ESTA/University of Liverpool Fieldwork Skills videos https://geohubliverpool.org.uk/fieldwrk/video%20clips.htm
- The Geological Society at www.geolsoc.org.uk/schools
- Geologists Association https://geologistsassociation.org.uk/education/
- Arran Geopark Project www.arrangeopark.co.uk/
- BGS Discovering Geology https://www.bgs.ac.uk/discovering-geology/
- Field Studies Council www.field-studies-council.org/
- Jurassic Coast Trust jurassiccoast.org/learning/
- London Pavement Geology (not just London) londonpavementgeology.co.uk/
- Rockwatch www.rockwatch.org.uk/
- Urban Geology www.ucl.ac.uk/~ucfbrxs/Homepage/UrbanGeology.htm

Useful books:

- Coe, Angela L. (2010) *Geological Field Techniques*, Milton Keynes, The Open University & Blackwell
- Cliff, Peter (2006) *Mountain Navigation*, 6th ed., Crake, Peter Cliff
- Mee, Pat & Mee, Brian (2010) *Outdoor navigation: Handbook for Tutors*, Stirling, NNAS

## Professional Development

OCR runs Professional Development courses every year, and these include sessions to support the Practical Endorsement. More details about Professional Development provision are available on Teach Cambridge.

## Subject Advisor support

OCR Subject Advisors are available to offer support and guidance on all aspects of the practical endorsement. Direct queries regarding the Practical Endorsement to the OCR Science Team through: science@ocr.org.uk.

**Need to get in touch?**

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- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

**We really value your feedback**

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

**I like this** **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

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