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OCR
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A LEVEL

GEOLOGY

H014, H414

For first teaching in 2017

Practical Activities Support Guide

Contents

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Introduction

This Practical Activities Support Guide is designed to provide support specifically around how our Practical Activity Group (PAG) suggested activities can be adjusted by centres and revision support for our specification's learning outcomes in 1.1 (Practical skills assessed in a written examination). This guide supplements our existing resources regarding the Practical Endorsement, including:

- Positive about Practical
  - This page features videos outlining our PAG approach to the Practical Endorsement. It also contains links to cross-board communications relating to the Practical Endorsement and monitoring.
- Practical Endorsement FAQs
- Practical Skills Handbook
  - This is a comprehensive handbook which describes the assessment of practical skills in the AS and A Level specifications, including the requirements of the Practical Endorsement and guidance on planning a practical scheme of work.
- Drawing Skills Handbook
  - This is a document which can be used to help students develop the correct drawing skills required to make geological observations related to hand specimens and field sketches.
- OCR Science Practical Endorsement Training Site
  - Lead teachers are required to have undertaken this free online training and should ensure all other teachers are familiar with the requirements. We recommend that, for the purpose of standardisation within your centre, all teachers who assess the Practical Endorsement undertake the training.
- Science Coordinator Materials
  - This is where secure documents are held including student and teacher PAG sheets, answers for the questions in the PAG student sheets and the PAG trackers.
- Specification
  - Most notably this includes:
    - Module 1.1 Practical skills assessed in a written examination
    - Module 1.2 Practical skills assessed in the practical endorsement
    - Section 5 Practical Endorsement appendix

For entries into the Summer 2021 series only

- The Practical Endorsement monitoring process 2019-2021
- Additional Practical Endorsement guidance – 2020-2021
- Practical Endorsement guidance for remote monitoring

The Practical Endorsement

Extract from the Practical Skills Handbook:

The Practical Endorsement is directly assessed by teachers and is a mandatory part of the A Level qualification. The assessment is certificated as Pass or Not-classified. As part of the Head of Centre declaration that centres must submit every year, any centre offering A Level Goelogy must declare that they have provided students with the opportunity to complete practical work towards the Practical Endorsement.

In order to achieve a Pass, candidates will need to have met the expectations set out in the Common Practical Assessment Criteria (CPAC) (see Table 2 in the specification, Appendix 5) including demonstrating competence in all the skills, apparatus and techniques in sections 1.2.1 and 1.2.2 of each specification.

Learners may work in groups, but must be able to demonstrate and record independent evidence of their competency. This must include evidence of independent application of investigative approaches and methods to practical work.

Teachers who award a Pass need to be confident that the candidate consistently and routinely exhibits the required competencies before completion of the A Level course.

The PAG Approach

Candidates can demonstrate these competencies in any practical activity undertaken throughout the course of study. The 12 OCR Practical Activity Groups (PAGs) described in the specification provide opportunities for demonstrating competence in all required skills, together with the use of apparatus and practical techniques for each subject.

Using our suggested practical activities is **not** mandatory. You can use the suggested practical activities from the Practical Activity Groups (PAGs), your own activities, or activities from other publishers to assess student practical skills. If you use activities other than our suggested practical activities, you need to ensure that you have mapped these activities to the relevant 1.2.1 and 1.2.2 criteria and the CPAC so you can track student progress in these. You are free to make changes to our suggested activities, but if these changes change which parts of 1.2.1, 1.2.2 and the CPAC you are assessing you will need to make sure this is reflected in your tracking of student progress.

In the OCR specifications, 12 PAGs are presented. Within each PAG are 3 suggested activities. None of these activities are explicitly required. Instead, the PAG approach gives some possible routes for students to learn the practical skills in the AS and A Level specifications and to achieve the Practical Endorsement.

At least 15% of the marks in examinations will assess practical skills. Examinations will not assume candidates have carried out all of these activities. However, they **will** assume that students are familiar with specific practical aspects mentioned in modules 2-7 (Geology H414) as well as those from the 1.2.2 criteria which students will have covered during the course of the Practical Endorsement. Questions may test the application of practical skills in novel and familiar contexts.

Health and safety

For additional health and safety guidance, please refer to CLEAPPS.

The CPAC and our specifications

The CPAC criteria are very closely linked to our specification learning outcomes in 1.2.1 Practical skills. Below, we have mapped out how these learning outcomes map to the CPAC criteria as well as our PAG activities.

In addition, we have also mapped out how our PAG activities relate to our specification's 1.2.2 Use of apparatus and techniques learning outcomes.

It would be beneficial to students if they have the opportunity to practice and develop their fieldwork skills before carrying out any visits to fieldwork sites. For example: completing class-based exercises in learning how to read OS maps, using a compass clinometer, drawing effective field sketches and constructing graphic logs. This means that when they use these skills in the field, their experience can be focussed on developing and demonstrating the skill, rather than learning it for the first time.

PAG vs CPAC and 1.2.1

This table shows how our suggested practical activities in the PAGs relate to both the CPAC and our specification's 1.2.1 Practical skills learning outcomes.

PAG	CPAC 1: Follows written procedures	CPAC 2: Applies investigative approaches and methods when using instruments and equipment		CPAC 3: Safely uses a range of practical equipment and materials		CPAC 4: Makes and records observations			CPAC 5: Researches, references and reports		
1.2.1	**c)** follow written instructions	**a)** apply investigating approaches to practical work	**g)** use appropriate software and tools to process data, carry out research and report findings	**b)** safely use a range of practical equipment & materials	**j)** use a wide range of experimental and practical instruments, equipment and techniques	**d)** make and record observations/ measurements	**e)** keep appropriate records of experimental activities	**f)** present information and data in a scientific way	**g)** use appropriate software and tools to process data, carry out research and report findings	**h)** use online and offline research skills including websites, textbooks and other printed scientific sources of information	**i)** correctly cite sources of information
1.1	✓			✓	✓	✓	✓	✓			
1.2	✓					✓		✓			
1.3	✓		✓	✓		✓		✓	✓	✓	✓
2.1	✓		✓	✓	✓	✓		✓	✓		
2.2	✓			✓	✓					✓	✓
2.3	✓		✓	✓	✓	✓	✓	✓	✓		
3.1	✓			✓	✓	✓		✓			
3.2	✓		✓		✓	✓		✓	✓		
3.3	✓			✓	✓	✓	✓	✓			
4.1	✓	✓	✓	✓	✓	✓	✓		✓		
4.2	✓	✓		✓		✓	✓	✓			
4.3		✓		✓		✓		✓			
5.1	✓			✓		✓		✓			
5.2	✓						✓	✓			
5.3	✓	✓				✓		✓			
6.1	✓	✓		✓	✓	✓		✓			
6.2	✓	✓		✓	✓	✓	✓	✓			
6.3	✓	✓	✓	✓	✓	✓		✓	✓		

PAG	CPAC 1: Follows written procedures	CPAC 2: Applies investigative approaches and methods when using instruments and equipment		CPAC 3: Safely uses a range of practical equipment and materials		CPAC 4: Makes and records observations			CPAC 5: Researches, references and reports		
7.1	✓			✓		✓	✓				
7.2	✓			✓	✓	✓	✓	✓			
7.3	✓	✓			✓	✓	✓	✓			
8.1	✓	✓		✓	✓	✓	✓	✓			
8.2	✓	✓		✓	✓	✓	✓	✓			
8.3	✓	✓		✓	✓	✓	✓	✓			
9.1			✓					✓	✓	✓	✓
9.2		✓		✓	✓	✓	✓	✓			
9.3		✓	✓	✓	✓	✓	✓	✓	✓		
10.1		✓		✓	✓	✓	✓	✓			
10.2			✓					✓	✓	✓	✓
10.3		✓		✓	✓	✓		✓			
11.1		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11.2		✓		✓	✓	✓	✓	✓			
11.3		✓		✓	✓	✓	✓	✓			
12.1			✓					✓	✓	✓	✓
12.2			✓					✓	✓	✓	✓
12.3			✓					✓	✓	✓	✓

PAG vs 1.2.2

This table shows how our suggested practical activities in the PAGs relate to our specification's 1.2.2 Use of apparatus and techniques learning outcomes.

1.2.2	**a)** location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS	**b)** identification of geological structures in the field, recording observations as field sketches	**c)** 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	**d)** construction of graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures	**e)** use of sampling techniques in fieldwork	**f)** application of classification systems using distinguishing characteristics to identify unknown minerals and fossils	**g)** production of annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation	**h)** production of full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures	**i)** use of photomicrographs to identify minerals and rock textures	**j)** use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature and length)	**k)** use of physical and chemical testing to identify minerals to include: **(i)** density test **(ii)** Mohs hardness test	**l)** use of methods to increase accuracy of measurements, such as timing over multiple observations, or use of a fiducial scale (in photograph/ field sketch)	**m)** use of ICT to: **(i)** compile and analyse geological data sets to enable visualisation using geographic information system (GIS) **(ii)** collect, process and model geological data.
1.1						✓				✓	✓		
1.2						✓		✓			✓		
1.3	✓	✓				✓	✓	✓					
2.1													✓
2.2										✓		✓	
2.3										✓			✓
3.1							✓			✓		✓	
3.2						✓			✓	✓		✓	
3.3	✓	✓	✓		✓	✓	✓	✓		✓	✓		
4.1										✓		✓	✓
4.2										✓		✓	
4.3	✓	✓	✓		✓					✓			
5.1						✓	✓					✓	
5.2							✓			✓		✓	
5.3		✓				✓	✓					✓	
6.1	✓	✓	✓		✓			✓		✓		✓	
6.2	✓	✓	✓		✓							✓	
6.3	✓	✓		✓				✓		✓		✓	
7.1										✓		✓	
7.2										✓		✓	
7.3	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓

1.2.2	**a)** location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS	**b)** identification of geological structures in the field, recording observations as field sketches	**c)** 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	**d)** construction of graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures	**e)** use of sampling techniques in fieldwork	**f)** application of classification systems using distinguishing characteristics to identify unknown minerals and fossils	**g)** production of annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation	**h)** production of full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures	**i)** use of photomicrographs to identify minerals and rock textures	**j)** use of appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature and length)	**k)** use of physical and chemical testing to identify minerals to include: **(i)** density test **(ii)** Mohs hardness test	**l)** use of methods to increase accuracy of measurements, such as timing over multiple observations, or use of a fiducial scale (in photograph/ field sketch)	**m)** use of ICT to: **(i)** compile and analyse geological data sets to enable visualisation using geographic information system (GIS) **(ii)** collect, process and model geological data.
8.1									✓	✓		✓	✓
8.2										✓		✓	
8.3	✓						✓	✓	✓		✓	✓	
9.1													✓
9.2										✓	✓	✓	
9.3	✓	✓	✓	✓	✓							✓	
10.1						✓					✓	✓	
10.2													✓
10.3	✓	✓			✓	✓	✓				✓	✓	✓
11.1							✓			✓		✓	✓
11.2				✓			✓			✓		✓	✓
11.3							✓			✓		✓	
12.1				✓			✓						✓
12.2													
12.3													

PAG 1: Investigating minerals and rocks

Minimum techniques/skills to be covered:

- Application of classification systems using distinguishing characteristics to identify unknown minerals
- Production of full rock descriptions.
- Production of scientific drawings from observations with annotations (Can also be covered in **PAGs 3, 4, 5, 6**.)
    - 1.2.2(g) produce annotated scientific drawings of fossils, or small-scale features, from hand samples using a light microscope, or hand lens observation
    - 1.2.2(h) produce full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures
    - 1.2.2(i) use of photomicrographs to identify minerals and rock textures
    - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (mass, time, volume, length)
    - 1.2.2(k) use of physical and chemical testing to identify minerals to include: (i) density test (ii) Mohs hardness test

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
1.1: Mineral testing	b, c, d, e, f, j	f, j, k
1.2: Describing rocks	c, d, f	f ,h, k
1.3 Geology on the street	b, c, d, f, h, i	a, b, h

Overview

This Practical Activity Group includes best practice use of standard geological identification techniques for rocks and minerals and introduces students to geological drawing skills as a method of recording observations. The Geology drawing skills handbook is a valuable resource for these skills.

PAG 1.1 covers basic mineral identification and the practical diagnostic techniques used to identify and describe mineral samples in hand specimens.

PAG 1.2 covers basic rock identification, and students need to describe and identify rock samples as listed in the specification, using standard diagnostic techniques, as well as producing scientific drawings of specimens and appropriate annotations.

PAG 1.3 uses the same identification techniques as PAG 1.2, but allows students to be out "in the field" looking at building stones and facades, and can also develop map reading and location skills.

PAGs 1.1 and **1.2** can be completed as stand-alone tasks. However, aspects of these practical tasks will likely be applicable to large amounts of the content in Module 2: Foundations in Geology, so they could be continuously used throughout the first teaching term. These practical activities would give students the opportunity to achieve skills 1.2.1(d), (e) & (f), ensuring that students record mass and volume, not just density, and that they use tables correct with headings, units and an appropriate number of decimal places. Students could also develop 1.2.1(a), investigative approaches, if they are given the choice of equipment to use, for example size of measuring cylinder to measure volume, and can justify their choice relating their answers to precision, resolution and accuracy.

These practical activities could also use data collection on spreadsheets and formula calculations as part of student's data handling skills.

PAG 1.3 allows the opportunity to introduce "outdoor" field skills such as field sketches and map-reading from an urban setting using building stones.

Possible adjustments

It is relatively straightforward to adjust this PAG to use any hand specimens of minerals available in the centre for **PAG 1.1**, or rocks available in the centre for **PAG 1.2**. Any rocks or minerals in the local area can be used for **PAG 1.3**. All the minerals and rocks listed in the specification should ideally be included, but you are not necessarily restricted to this list.

Alternative mineral and rock identification keys could be used as appropriate to the samples available.

Where hand specimens are not available for rocks and minerals listed in the specification, then virtual rock boxes could be used. Some useful links for this are provided below.

While it is not necessary to complete all of the practical activities in this PAG to meet the requirements of the endorsement, **PAGs 1.1** and **1.2** do consist of material and techniques that should be taught as part of the specification. They do not necessarily need to be completed as one-off or standalone activities, but could be completed over a series of lessons during the teaching of Module 2.

PAG 1.1 and 1.2 could be completed in a non-laboratory setting so long as the mineral and rock samples and testing kits are available.

Support resources

These resources may be useful for teachers when planning practical activities or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **VIRTUAL ROCK KIT: Earth Science Education Unit**

  https://www.earthscienceeducation.com/virtual_rock_kit/DOUBLE%20CLICK%20TO%20START.htm

  This is a comprehensive virtual rock kit which includes images of hand specimens as well as thin sections. It also includes location information of where the samples were collected, follow-up questions for students to check their understanding, and a help section explaining in more detail what they can see in each image.

- **VIRTUAL ROCK BOX: Central Illinois College**

  http://faculty.icc.edu/easc111lab/labs/labb/

  This is a very comprehensive resource. It includes sections with images of each rock group and minerals, and students can try and identify them from the image before clicking on each one for more detailed descriptions.

- **IMAGES OF ROCKS WHICH COULD BE USED: Learning Geology Outreach Website**

  http://geologylearn.blogspot.com/p/rocks.html?m=1

  This resource includes good quality images of a range of rocks, although not all are required in the specification. These could be used in PAG 1.2 for geological drawing skills, but also link to much more detailed information about each rock type to aid students with their descriptions.

- **IMAGES OF ROCKS WHICH COULD BE USED: Sand Atlas Website**

  https://www.sandatlas.org/rock-types/

  This resource includes good quality images of a range of rocks, although not all are required in the specification. These could be used in PAG 1.2 for geological drawing skills, but also link to much more detailed information about each rock type to aid students with their descriptions.

- **IMAGES OF ROCKS WHICH COULD BE USED: Historical Geology Online Textbook**

  https://opengeology.org/historicalgeology/author/cbentley/

  This resource includes good quality images of a range of rocks, although not all are required in the specification.

- **ALTERNATIVE PRACTICAL: Rock Density**
  - Calculations of rock density rather than mineral density could be carried out to meet some of the criteria from PAG 1.1 in PAG 1.2 instead.
  - The OCR Centre-based task from the H487 specification, June 2016, could be used for this purpose. These tasks are available on OCR interchange under Science Co-ordinator materials → GCE AS/A2 up to 2015 → Geology → Supporting materials → A level Geology Legacy Centre based tasks.

- **GEOHUB Liverpool University**
  - https://geohubliverpool.org.uk/resources/
  - https://geohubliverpool.org.uk/resource/rocks-in-thin-section/

  This has a wide range of resources, images and activities that could be used to support the delivery of these practical activities.

- **VIRTUAL THIN SECTIONS**

  Thin sections may not commonly be available in schools and colleges. A number of resources exist to support with this:
  - https://www.virtualmicroscope.org/content/uk-virtual-microscope
  - http://www.geosecslides.co.uk/minerals/MIAindex0.4.html#CommomM
  - https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=petro_vm
  - http://pcwww.liv.ac.uk/geo-oer/index_htm_files/ThinSectionDrawingsRocks.pdf - this document has some good examples of the types of thin sections appropriate to A-level standard Geological thin sections.
  - http://academic.sun.ac.za/natural/geology/undergraduate/G214/2006/Thin%20Section%20Sketches.pdf – this document has some useful advice for drawing thin sections.

- **Support Resource - Urban Geology Fieldwork Tours**
  - https://www.ucl.ac.uk/~ucfbrxs/Homepage/UrbanGeology.htm - Self-guided urban geology walks in London, Birmingham and Qatar.

PAG 2: Seismology

Minimum techniques/skills to be covered:

- Use of ICT/software for data collection or analysis related to seismology.
- Use of methods to record data scientifically.
    - 1.2.1(g) use appropriate software and tools to process data, carry out research and report findings
    - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (time)
    - 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations
    - 1.2.2(m) use of ICT to: (i) compile and analyse geological data sets to enable visualisation using geographic information system (GIS) (ii) collect, process and model geological data

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
2.1: Using a seismic database	b, c, d, f, g, j	m
2.2: Seismometer	b, c, e, f, h, i, j	j, l
2.3: Seismology - Mars	b, c, d, e, f, g, j	j. m

Overview

This Practical Activity Group includes involves the use of various types of ICT, databases and software that are used by seismologists.

PAG 2.1 involves the use of Google earth and the USGS database to plot earthquake data and then students can use this data to manually plot the seismic profile of a plate margin. This is potentially the most straightforward as it only requires the downloading of Google Earth Pro to any centre laptops or PCs.

PAG 2.2 involves the building of a Lego seismometer and collection of data using software. You will need to ensure that the relevant software is downloaded to any centre devices that students will use to access the data.

PAG 2.3 involves the use of downloadable seismometer apps and practical work to produce a source and plot the data using Excel. This activity requires more preparation, including students potentially downloading apps to their own devices, or if possible, downloading apps to centre devices.

These practical activities would give students the opportunity to achieve skills 1.2.1(d), (e) & (f), ensuring that students record observations and measurements correctly, and that they use tables correct with headings, units and an appropriate number of decimal places.

Possible adjustments

For **PAG 2.1** ArcGIS can be used to collect the data for earthquake depth and magnitude, and the measuring tool can be used for distance. This will not require the downloading of any software as ArcGIS is hosted solely online. The data from the USGS database can be extracted in exactly the same way as per the PAG instruction sheet, it just needs to be downloaded as a csv file. This file can then be imported into ArcGIS online and appropriate data can be selected from the layers.

PAG 2.1 can also be used for students to meet 1.2.1(a) (apply investigative approaches to practical work) as they could choose their own sampling strategy for which earthquakes to use as their data. Students may revert to random sampling, which may result in earthquake data from a too large area to be representative of the subduction pattern to be selected. They could be guided towards a transect type of sampling, possibly taking multiple transects, or systematic grid sampling over an area. Allowing students to choose the methods would meet the criteria. Students also have an additional opportunity to demonstrate skills 1.2.1(g) and 1.2.2(m) by using appropriate software, for example Microsoft Excel, to collect and record their data and produce graphs.

For **PAG 2.2**, other "homemade" seismometers could be built as an activity for students, but would not have the ability to collect data electronically, so the criteria awarded would need to be adjusted.

For **PAG 2.3** is most suitable for students who are highly competent using and downloading information from new software, and happy to manipulate data in excel spreadsheets.

Support resources

These resources may be useful for teachers when planning practical activities or for students when they are revising the practical procedures used in this PAG.

- **ArcGIS: Getting Started**

  https://www.esri.com/training/catalog/5a9ef6cee142323c622963f5/get-started-with-arcgis-online/

  This is a resource which can help newcomers to ArcGIS become more familiar with how the software works, and how layers and data can be imported and added to maps.

- **GOOGLE EARTH PRO**

  https://www.google.com/intl/en_uk/earth/versions/

  Google Earth Pro is free and available to download for desktop. Google Earth for Chrome or online can be used to display the data visually, but the desktop version would need to be used for the activity, as the online version does not have the necessary measurement tool.

- **ALTERNATIVE ACTIVITY: Mystery Detectives – Mystery Epicentre**

  http://earthguide.ucsd.edu/mystery_detectives/teach/epicenter/materials.html

  This resource gets students to use data to locate an earthquake using the method of triangulation from 3 seismic data sources. It has a range of different seismic data sets and maps, as well as graphing sheets to explain P-S wave lag time.

  This activity alone will not allow students to meet criteria 1.2.1(g) and 1.2.2(m) as it does not use ICT and software to collect and analyse the data.

- **ALTERNATIVE ACTIVITY: BGS Marsquake Locating a Crater**

  https://www.bgs.ac.uk/discovering-geology/maps-and-resources/earth-hazards/marsquake-resources/

  This resource gets students to use data to locate an impact site on Mars. There is a powerpoint and worksheet which can be downloaded, as well as additional activities modelling crater formation.

  This activity alone will not allow students to meet criteria 1.2.1(g) and 1.2.2(m) as it does not use ICT and software to collect and analyse the data.

- **ALTERNATIVE ACTIVITY: IRIS – Locating an Earthquake with Seismic Data**

  https://www.iris.edu/hq/inclass/lesson/locating_an_earthquake_with_recent_seismic_data

  This resource gets students to use data to locate an earthquake using the method of triangulation from 3 seismic data sources.

  This activity alone will not allow students to meet criteria 1.2.1(g) and 1.2.2(m) as it does not use ICT and software to collect and analyse the data.

- **BGS Seismic Monitoring Page**

  https://earthquakes.bgs.ac.uk/monitoring/home.html

  This resource gives real data from a range of seismic stations across the UK which could be used to supplement the teaching of these topics.

- **BGS Marsquake**

  https://www2.bgs.ac.uk/marsquake/

  This resource offers a range of activities related to the topic of seismology, and also contains a video explaining the use of the Lego seismometers.

PAG 3: Crystalline processes

Minimum techniques/skills to be covered:

- Use of techniques for making observations and taking measurements, and recording data.
- Application of classification systems using distinguishing characteristics to identify unknown minerals (**PAG 3.2**)
- Production of scientific drawings from observations with annotations (Can also be covered in **PAGs 1, 4, 5, 6**.)
    - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (temperature and length)
    - 1.2.2(l) use methods to increase accuracy of measurements, such as use of a fiducial scale (in photograph/field sketch)

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
3.1: Crystallisation of Salol	b, c, d, f, j	g, j, l
3.2: Virtual microscope	c, d, f, j	f ,i, j, l
3.3: Contact zone	b, c, d, e, f, j	a, b, c, e, f, g, h, j, k

Overview

This Practical Activity Group looks at crystalline processes and uses laboratory, software and field activities for students to investigate crystalline rocks.

PAG 3.1 involves using salol as an analogue model for igneous rocks to simulate the crystal sizes produced at different temperatures.

PAG 3.2 involves using a virtual microscope to examine thin sections of crystalline rocks to compare crystal sizes and textures.

PAG 3.3 is a field investigation into metamorphism around an igneous intrusion

Possible adjustments

PAG 3.1: The formation of good quality crystals can be difficult if too much salol is used. If practical laboratory work using salol is not successful, a demonstration of the technique could be shown. https://www.earthscienceeducation.com/videos/Salol.html#cold or https://www.earthlearningidea.com/Video/Salol.html has videos of the crystals forming at three different temperatures, which students could use to follow up and access the relevant content and extension questions. When students are drawing crystals from their observations it is important to ensure they use appropriate scales for the drawing.

PAG 3.2. This could be adapted to use pre-printed images of the rocks selected for the task. Also, the ESEU Virtual rock box has thin sections more aligned to the specification content and may be easier for students to navigate.
https://www.earthscienceeducation.com/virtual_rock_kit/index.htm

PAG 3.3. This is a fieldwork-based activity and could be replicated by setting up a model of a metamorphic aureole using hand specimens or pictures*.

For entries into the Summer 2021 series only: If sampling techniques cannot be addressed in fieldwork they can be addressed in a local or laboratory setting. This could involve completing a fieldwork activity on the school grounds using adjustments, or using a laboratory/classroom-based approach. For example, hand specimens or printed pictures of minerals and/or rocks could be used and mapped out to model a metamorphic aureole.

Support resources

These resources may be useful for teachers when planning practical activities or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **ALTERNATIVE PRACTICAL: Thin Section Mineral Identification**

  https://www.earth.ox.ac.uk/~oesis/micro/

  This resource has a range of high-quality thin section images with explanatory notes, which could be used as an alternative to the Virtual microscope website.

- **ALTERNATIVE PRACTICAL INSTRUCTIONS: Crystallisation of Salol**
  - https://www.geolsoc.org.uk/ks3/webdav/site/GSL/shared/pdfs/education%20and%20careers/RockCycle/Salol%20Experiment.pdf

    This resource from the Geological Society and ESTA has a simplified method that students could follow.

  - https://www.earthlearningidea.com/PDF/94_Salol.pdf

    This resource from the Earth Learning Idea website offers another method and guidance sheet.

  - https://www.youtube.com/watch?v=5X1YJNq57YQ

    This video shows an alternative method using test tubes and just gives a visual comparison of crystal sizes, useful for showing students the type of method used if laboratory work is not possible.

- **METAMORPHIC MINERALS IN THIN SECTION**
  - https://minerva.union.edu/hollochk/c_petrology/met_minerals.html
  - https://www.earth.ox.ac.uk/~oesis/atlas/metmins/

    These websites have some high-quality images of metamorphic minerals in thin section which could be used alongside PAG 3.3.

PAG 4: Sedimentary processes

Minimum techniques/skills to be covered:

- Use of appropriate apparatus and techniques to record a range of quantitative measurements of sediments and sedimentary structures.
- Use of ICT to collect data, or use of software to process data
- If not covered in **PAG 8, 9** or **10**.
  - 1.2.2(e) use sampling techniques in fieldwork
  - 1.2.2(g) produce annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation
  - 1.2.2(h) produce full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures
  - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (length) 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations, or use of a fiducial scale (in photograph/field sketch)

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
4.1: Grain size analysis	a, b, c, d, e, g, j	j, l, m
4.2: Sediment table	a, b, c, d, e, f, g	j, l
4.3: Sedimentary structures	a, b, d, f	a, b, c, e, j

Overview

This Practical Activity Group looks at sedimentary processes and the typical laboratory and field techniques used by geologists to observe, describe and record details about sedimentary rocks and sediments.

PAG 4.1 involves using a stack of sediment sieves to determine grain sizes and sorting in different types of sand. It gives students a good opportunity to discuss the limitations of practical methods through the inevitable 'loss' of sand.

PAG 4.2 involves using a desktop sediment table to model sedimentary processes in rivers and deltas and analyse the deposits formed

PAG 4.3 is a field investigation into sedimentary structures and recording their orientation to interpret paleocurrent direction.

Possible adjustments

PAG 4.1 requires access to appropriate sand/sediment sieving cylinders, but the actual coning, quartering and sieving process could be carried out as a demonstration, with students required to analyse the resultant data. Photographs of the sand samples, taken against graph paper or adjacent to a grain size card, could be used for the drawing tasks.

Prepopulated spreadsheets with partial calculations could be shared electronically if access to computers is possible.

PAG 4.2 is a flexible practical and can be carried out in a classroom rather than a lab using Gratnell trays or similar and bottles or jugs of water.

PAG 4.3 is a fieldwork activity which could be modelled within school grounds, or even within the confines of a classroom*. Models/images/details of the sedimentary structures are located around the "field" area, and students could complete a map of these and then analyse the data in the same way they would if they collected fieldwork data. This would mean that skills 1.2.2(a) (location in the field) and 1.2.2(b) (field sketches) would not be able to be awarded. If large amounts of structures to be measured or recorded are used, this could allow students to access the skill 1.2.2(e) (sampling techniques).

For entries into the Summer 2021 series only: If sampling techniques cannot be addressed in fieldwork they can be addressed in a local or laboratory setting. This could involve completing a fieldwork activity on the school grounds using adjustments, or using a laboratory/classroom-based approach. For example, hand specimens or printed pictures of sedimentary structures could be used and mapped out to model the sedimentary environment setting.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **VIDEO DEMONSTRATION (PAG 4.1): Sand Sieving**
  - https://www.youtube.com/watch?v=3Xqq1cxhD-s

    This video demonstrates how the sand sieving technique is applied in an industrial setting.

  - https://www.youtube.com/watch?v=AM-NrQoRlYY

    This video animation explains the process of sand sieving.

- **ALTERNATIVE PRACTICAL (PAG 4.1): OCR Centre Based Task 3 – June 2018**
  - These are available on OCR interchange under Science Co-ordinator materials → GCE AS/A2 up to 2015 → Geology → Supporting materials → A level Geology Legacy Centre based tasks.
  - Sand Sieving and Sedimentology.
  - The OCR Centre based task from June 2018 offers an instruction method and follow-up questions to assist students in their understanding of the analysis of sediments.

- **ALTERNATIVE PRACTICAL (PAG 4.3): Virtual outcrops – Teaching Earth Sciences Vol 45 Nos 1 and 2 2020**

  https://earthscience.org.uk/resources/teaching-earth-sciences/ (this resource does require membership to the Earth Science Teachers Association)

  An activity to teach students about how to make a geological map. This activity could be adapted to be used in school grounds or a large enough classroom, with the dip and strike element replaced by recording orientation of the sedimentary structures.

PAG 5: Investigating fossils

Minimum techniques/skills to be covered:

- Use of classification keys for identification of fossils
- Production of scientific drawings from observations.
- Use of appropriate apparatus and techniques to record a range of quantitative measurements of fossils
    - 1.2.2(f) apply classification systems using distinguishing characteristics to identify unknown minerals and fossils
    - 1.2.2(g) produce annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation
    - 1.2.2(l) use methods to increase accuracy of measurements, such as use of fiducial scale

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
5.1: Fossil identification	b, c, d, f	f, g, l
5.2: Microfossils	c, e, f	g, j, l
5.3: Fossils in the field	a, c, d, f	a, b, f, g, l

Overview

This Practical Activity Group looks at fossils, their identification and how to scientifically record observations and measurements.

PAG 5.1 involves use of classification keys to identify common fossils to the specification, and recording observations and measurements.

PAG 5.2 involves use of visual keys to identify common microfossils, and recording observations and measurements.

PAG 5.3 is a field investigation which involves use of classification keys to identify common fossils to the specification, and recording observations and measurements.

Possible adjustments

PAG 5.1 can be done using real fossils, class sets of fossil casts, or even photographs if fossil samples are not available.

PAG 5.2 requires the use of microscopes and a source of microfossils. A hand lens could be used as an alternative to microscopes but will not allow the same level of magnification.

PAG 5.3 is a fieldwork activity which covers the same skills as **PAG 5.1** but also develops fieldwork skills, so if fieldwork is not possible it is advised to revert to **PAG 5.1**.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **VIRTUAL PRACTICAL: Oxford University Museum of Natural History**

  https://oumnh.ox.ac.uk/fossil-invertebrates

  This resource allows images of appropriate invertebrate fossils to be selected and can be used for students to carry out the drawing exercise.

- **VIRTUAL PRACTICAL: 3D Fossils**

  http://www.3d-fossils.ac.uk/

  This is searchable database of fossils which could be used as an alternative to hand specimens for drawings.

- **USEFUL READING: Digitising Fossils**

  https://www.bbc.co.uk/news/science-environment-46497406

  This gives article talks about the usefulness of digitisation of fossil collections.

PAG 6: Investigating geological sequences

Minimum techniques/skills to be covered:

- Fieldwork observations and recording, including sampling techniques, field sketches and graphic logs.
- Production of scientific drawings from observations.
- Use of appropriate apparatus and techniques to record a range of quantitative measurements of rocks and geological sequences.
    - 1.2.2(a) location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
    - 1.2.2(b) identification of geological structures in the field recording observations as field sketches 1.2.2(c) 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(d) construct graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures
    - 1.2.2(e) use sampling techniques in fieldwork
    - 1.2.2(h) produce full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures
    - 1.2.2(l) use methods to increase accuracy of measurements, such as use of a fiducial scale (in photograph/field sketch)

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
6.1: Geochronology	a, b, c, d, f, j	a, b, c, e, h, j, l
6.2: Structural Geology	a, b, c, d, e, f, j	a, b, c, e, l
6.3: Logging a sequence	a, b, c, d, f, g, j	a, b, d, h, l

Overview

This Practical Activity Group looks at geological sequences and structures, their identification in the field, and how to scientifically record observations and measurements. It is a good idea to get students to attempt the field skills as a virtual activity in the classroom before going out to do fieldwork, to allow them the opportunity to practice the skills before developing them in the field.

PAG 6.1 involves the recording of a geological sequence to interpret the geological history of an outcrop.

PAG 6.2 involves the recording of geological structures in the field, using standard geological field recording techniques (compass clinometers and field sketches).

PAG 6.3 involves the construction of a graphic log in the field.

Possible adjustments

PAG 6.1 could be done using virtual outcrops or images, but would not allow students to access skill 1.2.2(a) (location in the field) or 1.2.2(c) (use of a compass clinometer).

PAG 6.2 could be done in school grounds or a classroom using "virtual outcrops", but would not allow students to access skill 1.2.2(a) (location in the field) or 1.2.2(c) (use of a compass clinometer). A similar exercise could be carried out using Google Earth or the BGS Open Geoscience geological map to collect data on the orientation of geological structures.

PAG 6.3 could be done using artificial logs creating using sand or rock samples (see details below in support resources), but again would not allow students to access skill 1.2.2(a) (location in the field) or 1.2.2(c) (use of a compass clinometer).

Support resources

These resources may be useful for teachers when planning practical activities or for students when they are revising the practical procedures used in this PAG.

Also see the Appendix of virtual field resources which could be used for the practical activities.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **ALTERNATIVE PRACTICAL (PAG 6.1): Virtual Outcrops – Teaching Earth Sciences Vol 45 Nos 1 and 2 2020**

  https://earthscience.org.uk/resources/teaching-earth-sciences/ (this resource does require membership to the Earth Science Teachers Association)

  An activity to teach students about how to make a geological map. This activity could be adapted to be used in school grounds or a large enough classroom, allowing students to access skill 1.2.2(c).

- **ALTERNATIVE PRACTICAL (PAG 6.1): Virtual Outcrops**

  https://geologypics.com/

  Marli Miller photography offers free downloads of a range of geology images that could be used for appropriate sequences that could be sketched and explained by students.

- **SUPPORT RESOURCE (PAG 6.2): Structural Geology**
  - https://www.earthlearningidea.com/PDF/Laying_down_the_principles.pdf
  - https://www.earthlearningidea.com/PDF/307_What_happened_when.pdf

  These Earth Learning Idea resources offer some activities to assist students with understanding the principles of geological sequencing.

- **SUPPORT RESOURCE (PAG 6.2): Structural Geology**

  https://geoetc.com/cross-section-activities/

  Geoetc offers a wide range of sequencing activities which could be used as practice for students, but does require a registration and subscription fee.

- **ALTERNATIVE PRACTICAL (PAG 6.3): Graphic Logs**

  https://ocr.org.uk/qualifications/as-a-level-gce-geology-h014-h414-from-2017/delivery-guide/module-ageol04-module-4-interpreting-the-past/delivery-guide-ageol04b-sedimentary-environments-in-time-surface-processes-and-products-412

  The OCR Delivery guide page has a range of resources, including a Powerpoint and Word document providing a range of graphic logs that could be drawn by students.

- **SUPPORT RESOURCE (PAG 6.3): Fieldwork Skills**

  https://geohubliverpool.org.uk/fieldwrk/video%20clips.htm

  The Geohub website by the University of Liverpool and ESTA has a range of video clips explaining fieldwork skills, including one on how to construct a graphic log.

- **VIRTUAL PRACTICAL (PAG 6.3): Using Borehole Samples**

  https://www.northseacore.co.uk/

  This website offers schools and colleges the opportunity to obtain borehole samples from the North Sea for education purposes.

  A sedimentary log could be created using a borehole sample if these are available.

- **ALTERNATIVE PRACTICAL (PAG 6.3): Model of a Sedimentary Log**

A sedimentary log could be created in a coffee jar or bottle using a variety of sands to create "beds" of rock. These could be produced for students to use as physical samples, or photographed and shared electronically. Students then use these to create a graphic log.

The same could be created in standard guttering, creating "layers" using sand or rock samples, which students could then create a graphic log.

- **SUPPORT RESOURCE: Fieldwork Skills Videos**
  - https://www.youtube.com/watch?v=3pkNsDcC61Y - How to draw a field sketch in a minute.
  - https://www.youtube.com/watch?v=NkAkmvX-BRw - How to take a dip and strike in a minute.
  - https://www.youtube.com/watch?v=UJuCqexM370 - How to describe rocks in the field in a minute.
  - http://pcwww.liv.ac.uk/geo-oer/gtmoofs/ - field sketching practice activities.

PAG 7: Orogenic processes

Minimum techniques/skills to be covered:

- Making and recording observations of scientific investigations, and keeping appropriate records during the investigation.
- Processing and presentation of data collected.
- Use of appropriate apparatus and techniques to record a range of quantitative measurements.
    - 1.2.2(f) apply classification systems using distinguishing characteristics to identify unknown minerals and fossils
    - 1.2.2(i) use of photomicrographs to identify minerals and rock textures
    - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature and length)
    - 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
7.1: Modelling rock deformation	b, c, d, e	j, l
7.2: Modelling geological structures	b, c, d, e, f, j	j, l, m
7.3: Mineralisation and metamorphism	a, c, d, e, f, j	a, b, c, e, f, g, h, j, k, m

Overview

This Practical Activity Group looks at orogenic or tectonic processes, and the geological structures and mineral deposits which may be formed as a result of these. They primarily look at modelling the structures using analogues to rocks, or on field investigation into the structures seen.

PAG 7.1 involves the use of plastic bags as an analogue model to rocks to investigate the effect of directed stress on ductile rocks, measuring extension in a similar method to Hooke's Law experiments. This practical activity would give students the opportunity to achieve skills 1.2.1(d), (e) & (f), ensuring that students record length before and after mass added, not just extension, and that they use tables correct with headings, units and an appropriate number of decimal places.

PAG 7.2 involves the modelling of compressional structures using layers of sand and flour to simulate the deformation of layers of rock.

PAG 7.3 is a field investigation which involves use of classification keys to identify common minerals, and then to record a geological map of these structures and their orientations.

Possible adjustments

PAG 7.1 can be done using any suitable plastic bags, and the clamps used can be replaced with any suitable alternative, for example bulldog clips with lollipop sticks. This is a good opportunity for students to demonstrate skill 1.2.1(a) (investigative approaches).

PAG 7.2 can be done using any suitable containers and card, and can even be carried out by students at home. A demonstration and then allowing students to use photographs or time-lapse footage would be a suitable alternative. Printouts of the photographs would enable students to carry out the measurements appropriately and achieve skills 1.2.1(d) and 1.2.1(e) (observing and recording).

PAG 7.3 is a fieldwork activity which requires a suitable field site of mineral veins. This could be replaced by dykes or other geological structures which could be measured and plotted onto a map. This activity could be simulated using a geological map, or the BGS OpenGeoscience map, to measure orientations of geological features, although this would not allow students to achieve skill 1.2.2(c) (use of a compass clinometer), 1.2.2(a) (location of features), 1.2.2(b) (field sketches), 1.2.2(f) (classification of minerals) and 1.2.2(g) (scientific drawings). All these skills can be covered in alternative practical activities.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **SIMILLAR PRACTICAL(PAG 7.1): Hooke's Law from BBC Bitesize**

  https://www.bbc.co.uk/bitesize/guides/zttfyrd/revision/9

  This resource shows the simple method of demonstrating Hooke's Law, using a spring, a common KS3 and KS4 practical activity, and would be a good resource for students to use to assist in their planning.

- **VIRTUAL PRACTICAL (PAG 7.3): BGS Open Geoscience Map and Earth Learning Idea**
  - http://mapapps.bgs.ac.uk/geologyofbritain/home.html?_ga=2.130941455.1226624427.1602425289-719854518.1601211864
  - https://www.earthlearningidea.com/PDF/129_Opengeoscience_1.pdf

  This activity could be used for students to do some virtual mapping of the orientation of igneous intrusions, using the Camasunary example from the Isle of Skye, or the southern coast of the Isle of Arran.

- **SUPPORT RESOURCE (PAG 7.3): Sandbox Model Video**

  https://www.youtube.com/watch?v=KvYLuOdf4AY

  This video shows a good example of a sandbox model, with a scale that students could use printouts of images to carry out some measurements.

PAG 8: Investigating fluid movement

Minimum techniques/skills to be covered:

- Applying investigative approaches to scientific practical methods
- Making and recording observations of scientific investigations, and keeping appropriate records during the investigation.
- Processing and presentation of data collected.
- Use of appropriate apparatus and techniques to record a range of quantitative measurements.
    - 1.2.1(g) use appropriate software and tools to process data, carry out research and report findings
    - 1.2.2(g) produce annotated scientific drawings of fossils, or small scale features, from hand samples using a light microscope, or hand lens observation
    - 1.2.2(i) use of photomicrographs to identify minerals and rock textures
    - 1.2.2(m) use of ICT to: (i) compile and analyse geological data sets to enable visualisation using geographic information system (GIS) (ii) collect, process and model geological data

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
8.1: Darcy's Law	a, b, c, d, e, f, j	i, j, l, m
8.2: Surface tension and pore pressure	a, b, c, d, e, f, j	j, l
8.3: Porosity and permeability.	a, c, d, e, f, j	a, g, h, i, k, l

Overview

This Practical Activity Group looks at fluid modelling processes, and uses sediments as models for how water will move through rocks.

PAG 8.1 involves the use of sediments in a Darcy tube or Darcy bottle as an analogue model to rocks to investigate the effect of fluid movement through rocks, measuring flow rates and calculating permeability using Darcy's Law.

PAG 8.2 involves the use of equipment to measure the surface tension of different density fluids.

PAG 8.3 is a field investigation which involves the collection of samples to carry out investigations into the porosity and permeability of these samples.

Possible adjustments

PAG 8.1 can be completed using homemade equipment, and could be set up for small groups of students to work together if possible. It could also be done as a demonstration, with students recording the results and carrying out the analysis afterwards.

PAG 8.2 can be carried out using everyday objects and is safe to carry out in a classroom environment rather than a laboratory.

PAG 8.3 is a fieldwork activity but could be adapted to be carried out using conserved hand samples. However, this would not allow students to achieve 1.2.2(a): location of geological features in the field.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **ALTERNATIVE PRACTICAL (PAG 8.1): Teaching Earth Science Magazine v43:2 – Porosity & Permeability**

  https://earthscience.org.uk/resources/teaching-earth-sciences/ (this resource does require membership to the Earth Science Teachers Association)

  This resource gives a detailed practical which can be carried out using core samples to determine true porosity and permeability using a spreadsheet.

- **ALTERNATIVE PRACTICAL (PAG 8.3): Darcy Tubes**

  https://www.deq.idaho.gov/media/60177882/rpa-lesson-plan-1.pdf

  This resource gives a detailed lesson plan of a modified version of a Darcy tube.

- **ALTERNATIVE PRACTICAL (PAG 8.3): Darcy Bottles**

  https://www.sciencebuddies.org/science-fair-projects/project-ideas/Geo_p014/geology/underground-water-flow-and-darcys-law?isb=cmlkOjEzNTE4Mzg3LHNpZDowLHA6MSxpYTpHZW8&from=TSW#summary

  This resource gives a detailed set of instructions of how to construct Darcy bottles and carry out the investigation. It is based on a US Science fair project.

- **SUPPORT RESOURCE: Porosity and Permeability of Rocks**
  - https://www.earthlearningidea.com/PDF/Space_within.pdf
  - https://www.earthlearningidea.com/PDF/Modelling_for_rocks.pdf
  - https://www.earthlearningidea.com/PDF/247_Porosity_permeability.pdf

  These resources from the Earth Learning Idea website are useful for teaching the principles of porosity and permeability.

PAG 9: Site investigations

Minimum techniques/skills to be covered:

- Applying investigative approaches to scientific practical methods
- Making and recording observations of scientific investigations, and keeping appropriate records during the investigation.
- Processing and presentation of data collected.
- Use of research and referencing techniques and GIS software. (in PAGs 9.1 and 9.3)
    - 1.2.2(a) location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
    - 1.2.2(c) 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(d) construct graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures
    - 1.2.2(e) use sampling techniques in fieldwork
    - 1.2.2(h) produce full rock descriptions of macro and micro features from conserved hand samples and unfamiliar field exposures
    - 1.2.2(j) use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature and length)
    - 1.2.2(k) use of physical and chemical testing to identify minerals to include: (ii) Mohs hardness test
    - 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations, or use of a fiducial scale (in photograph/field sketch)

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
9.1: Geotechnical desk study	, g, h, i	m
9.2: Properties of soil/rock	a, b, d, e, f, j	j, k, l
9.3: Geotechnical site investigation	a, b, d, e, f, g, j	a, b, c, d, e, l

Overview

This Practical Activity Group looks at using GIS and slope modelling to investigate the suitability of sites for engineering or resource extraction.

PAG 9.1 involves the use of GIS to research bedrock features in order to determine suitable locations for the building of wind turbines. The focus is on the use of GIS and gathering of appropriate data sources, rather than the calculations being carried out.

PAG 9.2 involves the use of equipment to measure the effect of slopes and friction on blocks of different surfaces, to model shear strength and failure within brittle rocks.

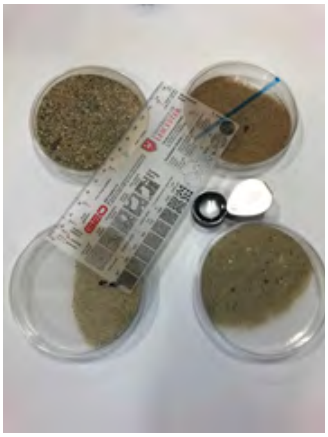
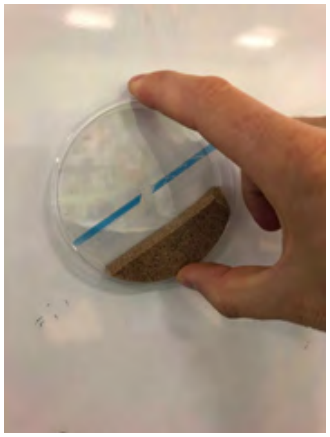
PAG 9.3 is a field investigation which involves the collection of data using surveying techniques, slope angle mapping and appropriate sampling strategies.

Possible adjustments

PAG 9.1 can be done using the BGS OpenGeoscience website, by using ArcGIS and suitable layers, or could be done using the iGeology app or the ROCKD app, to gather data on bedrock features using GIS. Although use of the mobile apps may prevent the gathering of borehole data for the depth of rocks, students could still analyse the bedrock geology in different locations and make appropriate simplified calculations using the data in the practical task instructions based on a single rock type.

PAG 9.2 can be done using any suitable bricks and a wooden slope surface. The focus is on the application of the method and recording of data. Some of the mathematics may be time consuming and complex, so these could be provided for students in a spreadsheet, with pre-populated formula, with students just required to enter the data. As with other practical activities, this could be demonstrated, with students recording and processing the data.

A similar investigation can be carried out using sediments of different sizes, sorting or composition within a sealed petri dish, and tilting to measure the angle of failure for the sediment. This method provides students with an opportunity to demonstrate skill 1.2.1(a) (investigative approaches)


PAG 9.3 is a fieldwork activity that could be carried out in school grounds, but requires the preparation and use of heavy equipment. This activity could be used as a planning exercise for students to think about investigative approaches and sampling strategies, but this would not allow students to achieve the skills associated with the implementation of the activity and processing of data.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **SUPPORT RESOURCE: Practical Skills Handbook**

  https://www.ocr.org.uk/Images/461085-practical-skills-handbook.pdf

  See appendix 7 for appropriate referencing techniques.

- **SUPPORT RESOURCE: Video - Slope Stability**

  https://www.youtube.com/watch?v=bR-z7mG344w

  This video from Rutgers OEDG shows a slope stability lab experiment, which could be used as a basis for students to carry out their own investigation. This sort of practical activity would allow students to achieve skill 1.2.1(a), applying investigative approaches.

- **SUPPORT RESOURCE: Video - Slope Stability Mathematics**

  https://www.youtube.com/watch?v=xg-Gw1NrkX8

  This video from Oregon State University Ecampus gives a detailed explanation of some of the mathematical aspects of calculating forces around slope stability.

- **USEFUL RESOURCE: ROCKD App**

  https://rockd.org/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

- **USEFUL RESOURCE: BGS iGeology App**

  https://www.bgs.ac.uk/technologies/apps/igeology-app/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

PAG 10: Geological resources

Minimum techniques/skills to be covered:

- Applying investigative approaches to scientific practical methods
- Making and recording observations of scientific investigations, and keeping appropriate records during the investigation.
- Processing and presentation of data collected.
- Use of research and referencing techniques and GIS software.
    - 1.2.1(g) use appropriate software and tools to process data, carry out research and report findings
    - 1.2.2(a) location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
    - 1.2.2(b) identification of geological structures in the field recording observations as field sketches 1.2.2(e) using sampling techniques in fieldwork
    - 1.2.2(f) apply classification systems using distinguishing characteristics to identify unknown minerals and fossils
    - 1.2.2(m) use of ICT to:(i) compile and analyse geological data sets to enable visualisation using geographic information system (GIS) (ii) collect, process and model geological data

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
10.1: Chemical testing of ores	a, b, d, e, f, j	f, k, l
10.2: BGS Geoindex	f, g, h	i, m
10.3: Mineral prospecting	a, b, d, f, j	a, b, c, e, f, g, k, l

Overview

This Practical Activity Group looks at mineral resources and the exploration for and testing of ores to determine metal content.

PAG 10.1 is a laboratory based practical which uses standard chemical tests for cations to determine the metal content of ore samples.

PAG 10.2 involves the use of GIS and the BGS GeoIndex site to carry out a desk study exploration of an area to determine mineral potential.

PAG 10.3 is a field investigation which uses sampling techniques and procedures relevant to heavy metal deposits and geochemical sampling for other deposits. Further analysis of samples collected could be carried out using PAG 10.1.

Possible adjustments

PAG 10.1 could be carried out as a planning exercise by students to determine the sequence of tests they would carry out to be most efficient, and then by providing students with the sample data to analyse and identify the metal content of the ores. This would not allow students to be awarded 1.2.2(b) (use practical equipment) and 1.2.1(d) (record observations), although students should have plenty of opportunity to complete these in other practical activities.

PAG 10.2 can be done in a classroom or at home, and requires access to web browsers (laptops or Chromebooks are most suitable for this rather than tablets or phones)

PAG 10.3 is a fieldwork investigation which requires a known suitable area and the correct sample collection equipment. This could be carried out as a planning exercise using the example given in the task, with students planning their sampling and data collection strategies. This would mean that skills 1.2.2(a) (location in the field) and 1.2.2(b) (field sketches) would not be able to be achieved. Sample minerals could be provided for students to analyse and identify afterwards allowing them to achieve skills 1.2.2(f) (classification of unknown minerals),1.2.2(g) (production of annotated drawings) and 1.2.2(k) (use of physical and chemical testing).

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **SUPPORT RESOURCE: Practical Skills Handbook**

  https://www.ocr.org.uk/Images/461085-practical-skills-handbook.pdf

  See appendix 7 for appropriate referencing techniques.

- **USEFUL RESOURCE: ROCKD App**

  https://rockd.org/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

- **USEFUL RESOURCE: BGS iGeology App**

  https://www.bgs.ac.uk/technologies/apps/igeology-app/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

- **SUPPORT RESOURCE: Testing for Metal Ions**

  https://www.bbc.co.uk/bitesize/guides/z8fgmnb/revision/4

  Useful revision using GCSE Chemistry material on testing for ions.

- **SUPPORT RESOURCE: Testing for Metal Ions**

  https://edu.rsc.org/resources/qualitative-tests-for-anions-and-cations-practical-videos-16-18-students/4012298.article

  Videos from the RSC showing of tests for metal cations can be carried out.

PAG 11: Investigation

Minimum techniques/skills to be covered:

- Applying investigative approaches to scientific practical methods
- Making and recording observations of scientific investigations, and keeping appropriate records during the investigation.
- Processing and presentation of data collected.
- Use of research and referencing techniques and GIS software.
    - 1.2.1(a) apply investigative approaches and methods to practical work
    - 1.2.2(a) location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
    - 1.2.2(b) identification of geological structures in the field recording observations as field sketches 1.2.2(c) 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(e) use sampling techniques in fieldwork
    - 1.2.2(f) apply classification systems using distinguishing characteristics to identify unknown minerals and fossils
    - 1.2.2(l) use methods to increase accuracy of measurements, such as timing over multiple observations, or use of a fiducial scale (in photograph/field sketch)

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
11.1: Lab based investigation	a, b, d, e, f, g, h, i, j	g, j, l, m
11.2: Investigating sediments	a, b, d, e, f, j	d, g, j, l, m
11.3: Investigating crystalline rocks	a, b, d, e, f, j	g, j, l

Overview

This Practical Activity Group looks at students carrying out investigations which they have designed themselves, with a key focus on skills 1.2.1(a) (investigative approaches).

PAG 11.1 is a lab-based investigation in which students need to investigate minerals, rocks or fossils. They will need to choose their own methods, equipment and sampling techniques, make and record appropriate observations and display their results scientifically. This could link to PAG 4.1 Sieving sediment, PAG 7.2 Modelling Geological structures, PAG 8.1 Darcy's Law or PAG 8.3 Porosity and Permeability.

PAG 11.2 is a field investigation in which students need to investigate sedimentary rocks or sedimentary environments. They will need to choose their own methods, equipment and sampling techniques, make and record appropriate observations and display their results scientifically. This could link to PAG 6.1 Geochronology or PAG 6.3 Logging a sequence.

PAG 11.3 is a field investigation in which students need to investigate crystalline rocks. They will need to choose their own methods, equipment and sampling techniques, make and record appropriate observations and display their results scientifically. This could link to PAG 1.2 Describing rocks if a suitable focus is developed (for example, determining composition and its effect on density.

Possible adjustments

PAG 11.1 could be carried out linked to other practical activities (PAG 4.1 Sieving sediment, PAG 7.2 Modelling Geological structures, PAG 8.1 Darcy's Law, or PAG 8.3 Porosity and Permeability) provided students are given choice over methods, equipment and sampling techniques.

PAG 11.2 could be carried out as a laboratory or classwork activity using hand samples or photographs.

PAG 11.3 could be carried out as a laboratory or classwork activity using hand samples or photographs.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **HANDBOOK: OCR – Drawing Skills Handbook**

  https://www.ocr.org.uk/Images/500028-geology-drawing-skills-handbook.pdf

  This resource explains the requirements of good geological drawings and includes a common errors activity.

- **Support RESOURCE: Practical Skills Handbook**

  https://www.ocr.org.uk/Images/461085-practical-skills-handbook.pdf

  See appendix 7 for appropriate referencing techniques.

- **USEFUL RESOURCE: ROCKD App**

  https://rockd.org/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

- **USEFUL RESOURCE: BGS iGeology App**

  https://www.bgs.ac.uk/technologies/apps/igeology-app/

  This app allows users to gather geological information, using a mobile device, about the bedrock geology beneath their feet, and could allow students to gather geological information about any location they choose.

PAG 12: Research skills

Minimum techniques/ skills to be covered:

- Processing and presentation of data collected.
- Use of research and referencing techniques and GIS software.
    - 1.2.1(h) Use online and offline research skills
    - 1.2.1(i) Correctly cite sources of information

Skills linked to other practical activities.

- 1.2.2(a) location of geological features in the field using traditional navigation and basic field survey skills without the use of GPS
- 1.2.2(b) identification of geological structures in the field recording observations as field sketches
- 1.2.2(c) 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(d) construct graphic logs using appropriate scale and symbol sets for unfamiliar geological sequences and exposures
- 1.2.2(e) use sampling techniques in fieldwork

Suggested activities	1.2.1 practical skills covered	1.2.2 apparatus and techniques covered
12.1: Integrating fieldwork into the basin model	f, g, h, i	
12.2: Critical mineral resources	f, g, h, i	
12.3: Exploring beyond the specification	f, g, h, i	

Overview

This Practical Activity Group looks at research beyond the specification and building upon other practical activities carried out, in order produce academic standard posters, factsheets or presentations, and should be the final evidence of skills 1.2.1(f) (present information in a scientific way) and 1.2.1(g) (use appropriate software and tools).

PAG 12.1 involves the use of research to build upon any fieldwork carried out, and link this to specification point 7.2 Basin analysis in practice, in order to produce an academic poster using correct referencing techniques.

PAG 12.2 involves the use of research to develop knowledge of our mineral resources, in order to produce a factsheet using correct referencing techniques.

PAG 12.3 is an activity which allows students to make a choice to research any area of the specification, or topics not covered by the specification and of personal interest, or linking topics across the specification. Students will produce a slideshow presentation and reference using standard referencing techniques.

Possible adjustments

PAG 12.1 could be carried out based upon any virtual fieldwork carried out for other practical activities, but would not allow students to access the specific geological fieldwork skills, for example 1.2.2(a) (location in the field) or 1.2.2(c) (use of a compass clinometer).

For PAG 12.2, students completing an EPQ could be credited with skills 1.2.1(h) (research) and 1.2.1(i) (referencing) from their completed project.

For PAG 12.3, students completing an EPQ could be credited with skills 1.2.1(h) (research) and 1.2.1(i) (referencing) from their completed project.

Support resources

These resources may be useful for teachers when planning PAGs or for students when they are revising the practical procedures used in this PAG.

- **SUPPORT RESOURCE: Virtual Fieldwork for PAG 12.1**

  See Appendix for virtual fieldwork resources

- **SUPPORT RESOURCE: Practical Skills Handbook**

  https://www.ocr.org.uk/Images/461085-practical-skills-handbook.pdf

  See appendix 7 for appropriate referencing techniques.

Appendix – virtual field resources

Virtual field trips from the University of Southampton (UK and abroad)

http://visualisation.soton.ac.uk/

Virtual field trips from the University of Southampton. Each virtual fieldtrip module includes a series of panoramic and 3D images on a range of scales, from satellite to microscopic. Images can be zoomed and panned to investigate the overall structure and detailed textures within rock formations. Logs of stratigraphic sections can be created via detailed sub-panoramas and close-up images.

Virtual field trips from Leeds University

http://www.see.leeds.ac.uk/structure/learnstructure/virtualfield.htm

Virtual field trips from Leeds University. These are used at Leeds to introduce and teach some of the thought processes around how to interpret the geology during a field trip.

Virtual field trips by Arizona State University

https://vft.asu.edu/#

A series of virtual field trips by Arizona State University, including the Grand Canyon, the K-Pg extinction and Mars! 3D immersive experiences. Click on the links for photographs, gigapan images and explanatory videos.

Virtual tours and resources for SW England

http://projects.exeter.ac.uk/geomincentre/geology.htm

Cambridge School of Mining Virtual Museum. Resources and virtual tours from the Southwest peninsula, including specimens and samples of the rocks types found, and detailed descriptions of the geological processes that have formed them.

Virtual field trip powerpoints

https://www.tes.co.uk/teaching-resource/Virtual-fieldwork-6016343

Three Powerpoints of virtual field trips to Carn Brea, Cligga Head and Godrevy, consisting of annotated photographs, OS maps and descriptions of fieldwork activities. (requires a TES login to download)

Virtual field trips around the world

https://www.micromyearth.com/virtual-field-trips/

Choose from 80 virtual field trips using a world map, exploring using just an internet browser.

Virtual field trips to Pembrokeshire and NW Highlands

https://www.e-rock.co.uk/field-trips

Virtual field trips to Pembrokeshire and NW Highlands, including photographs, videos, gigapan images, explanatory notes, maps, graphic logs, cross sections and annotated photographs to explain structures.

Virtual Field trip to the Column of the Giants

https://www.sciencefriday.com/educational-resources/360-degree-expedition/

Expedition to the Column of the Giants, showing columnar jointing and other key features. Includes an immersive 3D photograph and sketches, close-up images of the rocks and links to other interesting field sites.

Virtual field trip to Upheaval Dome

https://vft.asu.edu/VFTUpheavalDome/panos/UpheavalDome/UpheavalDome.html

A 3D immersive visit to the Upheaval Dome structure in Moab. Click on the links for photographs, gigapan images and explanatory videos.

Virtual field trips focussed on Sedimentary environments

http://www.virtual-geology.info/FILTER/intro.html

A range of trips focussing on sedimentary environments, created for the Filter Project. Each trip has a series of photographs, showing broad views and zooming in to microscopic images as well.

Virtual fieldwork training exercise – immersive fieldwork experience

https://www.see.leeds.ac.uk/virtual-landscapes/

Virtual Landscapes - a collaboration between the School of Earth and Environment, University of Leeds, & the Leeds College of Art to develop virtual training environments. Runs on a web browser but may take time to load.

Scottish Geology – an itinerary and detailed explanations of the Midlothian area – can be used as a virtual field trip

https://www.geolsoc.org.uk/~/media/shared/documents/education%20and%20careers/Earth%20Science%20Week/esw15/CyclingGeologyMidlothian_Small.pdf?la=en

Geological Society cycling tour itinerary, which has some photographs of localities, but then has an extensive section explaining the geology of the area and illustrating using overlays of geological maps and cross sections.

Field Guide to the Gower peninsula – can be used as a virtual field trip

https://www.geolsoc.org.uk/Gower

Geological Society field guide to the Gower peninsula. It includes detailed descriptions and photographs of a range of localities, and also has field sketches, logs, diagrams and maps to explain the geology of the area.

Support resource – Explaining geological processes that form our landscapes

https://www.geolsoc.org.uk/tectonicstories

Plate tectonics stories by the Geological Society. Photographs and descriptions of famous localities, explaining the geological processes that have formed them.

Virtual field work created by students

http://www.virtual-geology.info/vft.html

Virtual field trips constructed by geology students at Oxford Brookes University.

Urban Geology fieldwork tours

https://www.ucl.ac.uk/~ucfbrxs/Homepage/UrbanGeology.htm

Self-guided urban geology walks in London, Birmingham and Qatar.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our Customer Support Centre.

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