RECOGNISING ACHIEVEMENT

INSET Training Materials

OCR GCSE Twenty First Century Science (J241 – J245):

Get started - guidance for first delivery of the 2011 specifications

Name:		**Date Attended:**	

Contents/Order of Documents

Course overview

Course aims

The aim of this course is that you should:

- understand the changes to the content of the units
- consider the implications of new assessment rules
- understand the changes to the exam papers.

Course objectives

This course will:

- provide an overview of the qualification structure and details of unit content
- consider the assessment of candidates
- review sample assessment materials and specimen candidate answers
- briefly review the support and resources we offer
- enable delegates to network and share ideas for best practice.

This course is similar to the 'Get Started' courses that ran in Spring 2011, but with updated content related to the accredited specifications and a look at specimen assessment materials.

Programme

Morning courses

09.45	Welcome and introduction
10.00	**Session 1 – the GCSE Twenty First Century Science suite for 2011**
10.45	Tea/coffee break
11.00	**Session 2 – What's different in Twenty First Century Sciences?**
12.30	Lunch
13.30	Close

Afternoon courses

12.30	Lunch
13.30	Welcome and introduction
13.45	**Session 1 – the GCSE Twenty First Century Science suite for 2011**
14.30	Tea/coffee break
14.45	**Session 2 – What's different in Twenty First Century Sciences?**
16.15	Close

Aims

- Understand the changes to the content of the units
- Consider the implications of new assessment rules
- Understand the changes to the exam papers

TWENTY FIRST CENTURY science

Twenty First Century Science Suite

- GCSE Science
- GCSE Additional Science
- GCSE Biology
- GCSE Chemistry
- GCSE Physics

TWENTY FIRST CENTURY science

Twenty First Century Science

- Motivates and inspires students
- Balances Issues for Citizens with Big Questions in science to provide exciting and relevant contexts
- Integrates How Science Works into the science content for all specifications
- Offers flexibility in the scheme of assessment

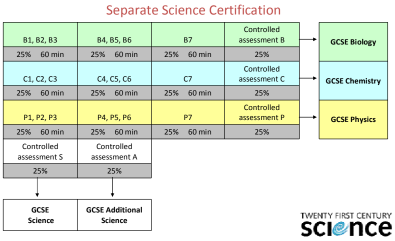
TWENTY FIRST CENTURY science

Assessment model

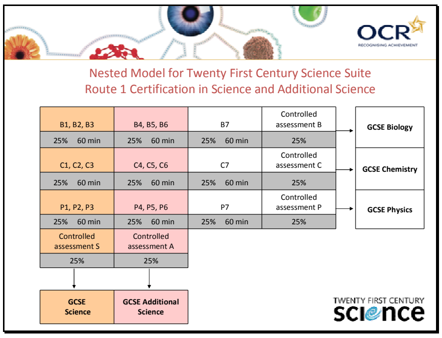
- three equally weighted written papers (each 25%)
- controlled assessment 25%
  - Science: Data Analysis and Case Study
  - Additional Science, Biology, Chemistry and Physics: Investigation
  - Task topics provided by OCR
  - More controlled conditions than previously

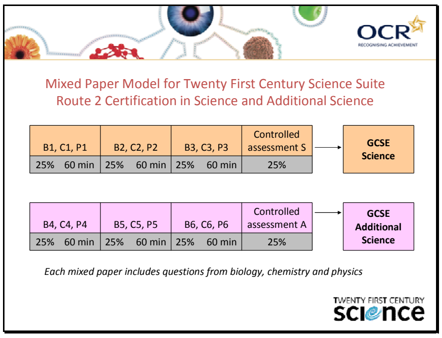
TWENTY FIRST CENTURY science

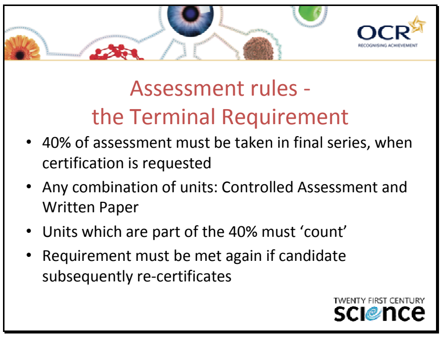
Nested Model for Twenty First Century Science Suite Separate Science Certification



TWENTY FIRST CENTURY science


OCR
RECOGNISING ACHIEVEMENT
Nested Model for Twenty First Century Science Suite
Route 1 Certification in Science and Additional Science
B1, B2, B3
25% 60 min
B4, B5, B6
25% 60 min
B7
25% 60 min
Controlled assessment B
25%
GCSE Biology
C1, C2, C3
25% 60 min
C4, C5, C6
25% 60 min
C7
25% 60 min
Controlled assessment C
25%
GCSE Chemistry
P1, P2, P3
25% 60 min
P4, P5, P6
25% 60 min
P7
25% 60 min
Controlled assessment P
25%
GCSE Physics
Controlled assessment S
25%
Controlled assessment A
25%
GCSE Science
GCSE Additional Science
TWENTY FIRST CENTURY
science


OCR
RECOGNISING ACHIEVEMENT
Mixed Paper Model for Twenty First Century Science Suite
Route 2 Certification in Science and Additional Science
B1, C1, P1
25% 60 min
B2, C2, P2
25% 60 min
B3, C3, P3
25% 60 min
Controlled assessment S
25%
GCSE Science
B4, C4, P4
25% 60 min
B5, C5, P5
25% 60 min
B6, C6, P6
25% 60 min
Controlled assessment A
25%
GCSE Additional Science
Each mixed paper includes questions from biology, chemistry and physics
TWENTY FIRST CENTURY
science


OCR
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Assessment rules -
the Terminal Requirement
• 40% of assessment must be taken in final series, when certification is requested
• Any combination of units: Controlled Assessment and Written Paper
• Units which are part of the 40% must 'count'
• Requirement must be met again if candidate subsequently re-certificates
TWENTY FIRST CENTURY
science

Assessment rules – Re-sit rules for units

- Only one re-sit permitted of each unit, so:
  - one attempt at F and one at H…or
  - two attempts at F…or
  - two attempts at H

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Key issues

- When will my students do the Controlled Assessment?
- When will they cash in?
- Will I offer re-sits – if so when?
- How will my students meet the Terminal Requirement?
- What if students want to re-sit units after cashing in?

TWENTY FIRST CENTURY science

Curriculum models

Series model

- Science in year 10 – all assessment completed by June
- Additional Science / Additional Applied Science in Year 11

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Series model - advantages

- The choice as to which Additional Science to take can be deferred to Year 10
- Bigger, more conceptual topics are taught as one concentrated block
- Better for students who transfer school towards the end of Year 10 / start of Year 11

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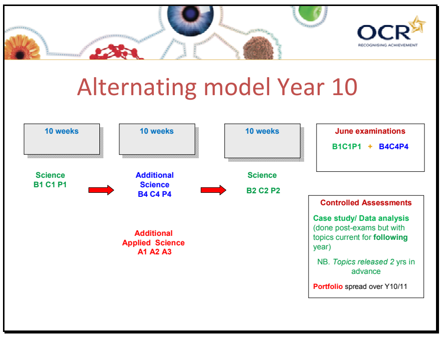
Series model - disadvantages

- Taught in isolation, Science may provide less variety in classroom activities than the parallel models
- Curriculum managers may find it convenient to change staff between Year 10 and Year 11
- Some KS3 scientific concepts absent from Science are picked up again in Additional or Additional Applied Science after a significant break
- It is more difficult to cater for Separate Sciences

TWENTY FIRST CENTURY SCIENCE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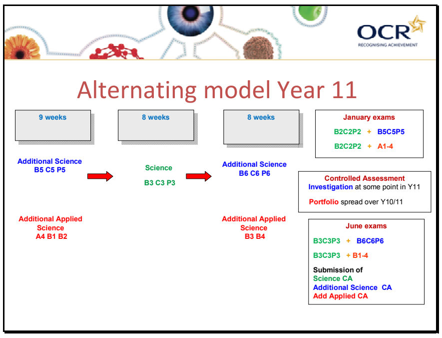
Alternating model Year 10
10 weeks
10 weeks
10 weeks
June examinations
B1C1P1 + B4C4P4
Science
B1 C1 P1
Additional
Science
B4 C4 P4
Science
B2 C2 P2
Additional
Applied Science
A1 A2 A3
Controlled Assessments
Case study/ Data analysis (done post-exams but with topics current for following year)
NB. Topics released 2 yrs in advance
Portfolio spread over Y10/11


OCR
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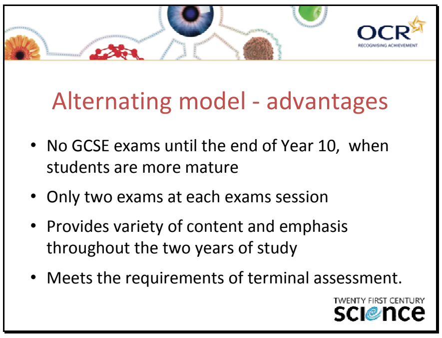
Alternating model Year 11
9 weeks
8 weeks
8 weeks
January exams
B2C2P2 + B5C5P5
B2C2P2 + A1-4
Additional Science
B5 C5 P5
Science
B3 C3 P3
Additional Science
B6 C6 P6
Controlled Assessment
Investigation at some point in Y11
Portfolio spread over Y10/11
Additional Applied
Science
A4 B1 B2
Additional Applied
Science
B3 B4
June exams
B3C3P3 + B6C6P6
B3C3P3 + B1-4
Submission of
Science CA
Additional Science CA
Add Applied CA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Alternating model - advantages
• No GCSE exams until the end of Year 10, when students are more mature
• Only two exams at each exams session
• Provides variety of content and emphasis throughout the two years of study
• Meets the requirements of terminal assessment.
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science

Alternating model - disadvantages

- Needs careful year planning and timetabling
- May not fit so well with the new Additional Applied which is in 8 modules with 2 examinations
- Need to decide in year 10 which two courses students are following but could be left as late as Autumn half-term

Implementation of new specifications

- September 2011 – 'official' start to teaching in Y10
- January 2012 – first exams
- Summer 2012 – GCSE Science first moderation of Controlled Assessment and first certification
- Summer 2013 – first moderation of Controlled Assessment and first certification for all other qualifications

Timetable for new Science assessments

Route 1 – separate science papers

	Unit A161	Unit A171	Unit A181	Controlled Assessment	Certification?
January 2012	✓	✓	✓		
June 2012	✓	✓	✓	✓	✓
January 2013	✓	✓	✓		✓
June 2013	✓	✓	✓	✓	✓

NOTE Two Units must be taken in the series in which the qualification is certified. One of these may be the Controlled Assessment.
Additional Science and the Separate Sciences follow behind Science; see section 8 of each Specification.

Timetable for new Science assessments

Route 2 – Mixed (PCB) papers

	Unit A141	Unit A142	Unit A143	Controlled Assessment	Certification?
January 2012	✓	✓			
June 2012	✓	✓	✓	✓	✓
January 2013	✓	✓	✓		✓
June 2013	✓	✓	✓	✓	✓

NOTE Two Units must be taken in the series in which the qualification is certified. One of these may be the Controlled Assessment.
Additional Science and the Separate Sciences follow behind Science; see section 8 of each Specification.

TWENTY FIRST CENTURY SCIENCE

Timetable for new Additional Science assessments

Route 1 – separate science papers

	Unit A162	Unit A172	Unit A182	Controlled Assessment	Certification?
January 2012					
June 2012	✓	✓	✓		
January 2013	✓	✓	✓		
June 2013	✓	✓	✓	✓	✓

NOTE Two Units must be taken in the series in which the qualification is certified. One of these may be the Controlled Assessment.

TWENTY FIRST CENTURY SCIENCE

Timetable for new Additional Science assessments

Route 2 – Mixed (PCB) papers

	Unit A151	Unit A152	Unit A153	Controlled Assessment	Certification?
January 2012					
June 2012	✓	✓			
January 2013	✓	✓			
June 2013	✓	✓	✓	✓	✓

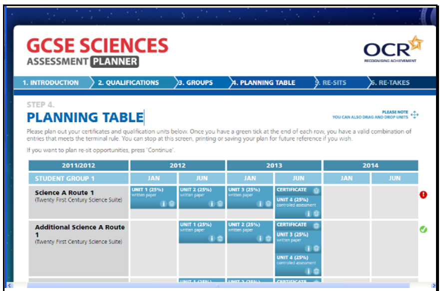
NOTE Two Units must be taken in the series in which the qualification is certified. One of these may be the Controlled Assessment.

TWENTY FIRST CENTURY SCIENCE

Timetable for new Biology, Chemistry, Physics assessments

	Unit A161 A171 A181	Unit A162 A172 A182	Unit A163 A173 A183	Controlled Assessment	Certification?
January 2012	✓				
June 2012	✓	✓			
January 2013	✓	✓			
June 2013	✓	✓	✓	✓	✓

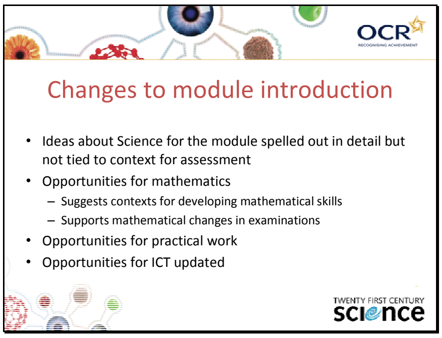
NOTE Two Units must be taken in the series in which the qualification is certified. One of these may be the Controlled Assessment.



http://www.scienceplanner.ocr.org.uk/index.htm

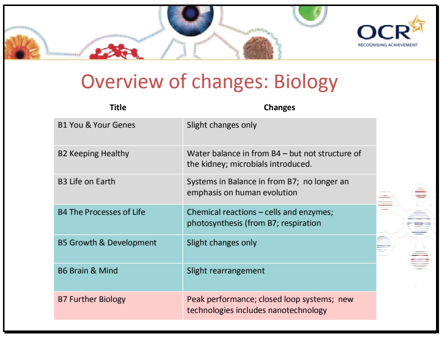
Unit introduction - new

- Identifies the Modules that will be covered in the unit of assessment
- Ideas about Science for the unit cover those identified in the modules in that unit
- Assessment of Ideas about Science not tied to context of the modules
- Ideas about Science now feature in ALL modules, not just 1 – 3.



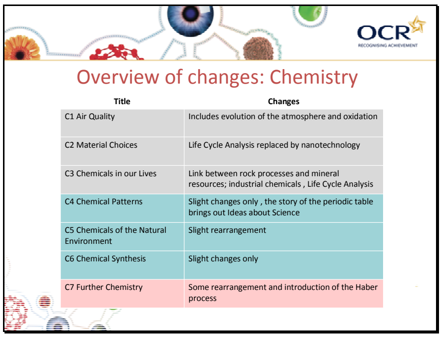
Changes to module introduction

- Ideas about Science for the module spelled out in detail but not tied to context for assessment
- Opportunities for mathematics
  - Suggests contexts for developing mathematical skills
  - Supports mathematical changes in examinations
- Opportunities for practical work
- Opportunities for ICT updated



Overview of changes: Biology

Title	Changes
B1 You & Your Genes	Slight changes only
B2 Keeping Healthy	Water balance in from B4 – but not structure of the kidney; microbials introduced.
B3 Life on Earth	Systems in Balance in from B7; no longer an emphasis on human evolution
B4 The Processes of Life	Chemical reactions – cells and enzymes; photosynthesis (from B7; respiration
B5 Growth & Development	Slight changes only
B6 Brain & Mind	Slight rearrangement
B7 Further Biology	Peak performance; closed loop systems; new technologies includes nanotechnology



Overview of changes: Chemistry

Title	Changes
C1 Air Quality	Includes evolution of the atmosphere and oxidation
C2 Material Choices	Life Cycle Analysis replaced by nanotechnology
C3 Chemicals in our Lives	Link between rock processes and mineral resources; industrial chemicals , Life Cycle Analysis
C4 Chemical Patterns	Slight changes only , the story of the periodic table brings out Ideas about Science
C5 Chemicals of the Natural Environment	Slight rearrangement
C6 Chemical Synthesis	Slight changes only
C7 Further Chemistry	Some rearrangement and introduction of the Haber process

Overview of changes: Physics

Title	Changes
P1 The Earth in the Universe	Properties of waves replaces asteroid impacts and alien life.
P2 Radiation and Life	Includes using electromagnetic radiation for communications from old P6
P3 Sustainable Energy	A quantitative look at choices of energy sources
P4 Explaining Motion	Includes acceleration
P5 Electric Circuits	Motors replace domestic electricity.
P6 Radioactive materials	Material from old P3 but more depth and detail; fission and fusion; $E=mc^2$
P7 Studying the Universe	Includes a quantitative approach to the Gas Laws; diffraction, exoplanets, SETI

Changes to examinations

- Examination time 40 minutes ⇒ 60 minutes
- Objective-style questions continue, but only 40% of the paper
- Free-response questions increase to 60% – some for 6 marks
- Quantitative work is more than just interpretation of data; now about 20-25%

NB - All specifications include fewer '*recall that* ..' statements and more '*understand that* ….'

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Coursework changes

- All items now are Controlled Assessment Tasks
  - Task topics provided by OCR
  - More controlled conditions than previously
- Science: Data Analysis and Case Study
- Additional Science, Biology, Chemistry and Physics: Investigation

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Support and training

- Comprehensive programme of INSET
- Published schemes of work and lesson plans
- Teacher support handbooks
- Cluster networks
- Active Results

Published Textbooks

- **Oxford University Press**
  - Twenty First Century Science
  - Additional Applied Science
  - Entry Level

  www.twentyfirstcenturyscience.com

Other publishers are also likely to produce new materials

Supplements to cover new content may also be available.

Implementation of new specifications

- September 2010 - start of teaching in Y9 (for a 3 year course ending in 2013)
- September 2011 – start of teaching in Y10
- January 2012 – first exams
- Summer 2012 – GCSE Science first moderation of Controlled Assessment and first certification
- Summer 2013 – first moderation of Controlled Assessment and first certification for all other qualifications

Final sessions for old (legacy) specifications

- Last full examination series is June 2012
- There are likely to be **re-sit** opportunities in 2013

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Keeping in touch

- Visit the website:

  www.gcse-science.com
- Register for cluster support
- Access: specifications, presentations, support documents, details of INSET meetings
- Sign up for e-alerts at **www.ocr.org.uk/2011signup**

TWENTY FIRST CENTURY science

Routes through

GCSE Science A

4 Assessment of GCSE Science A

4.1 Overview of the assessment in GCSE Science A

There are **two** alternative routes to achieve GCSE Science A:

- route 1 using Unit A161 from Biology A, Unit A171 from Chemistry A and Unit 181 from Physics A (separate science papers)
- route 2 using Units A141, A142 and A143 from Science A (mixed science papers).

Route 1

GCSE Science A J241	
Unit A161: *Modules B1, B2, B3*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules B1, B2 and B3 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A171: *Modules C1, C2, C3*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules C1, C2 and C3 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A181: *Modules P1, P2, P3*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules P1, P2 and P3 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A144: *Controlled assessment*	
25% of the total GCSE Controlled assessment 6–7 hours 64 marks	This unit: • comprises a case study task and a practical data analysis task • is assessed by teachers, internally standardised and then externally moderated by OCR • assesses the quality of written communication.

Route 2

GCSE Science A J241	
Unit A141: *Modules B1, C1, P1*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules B1, C1 and P1 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A142: *Modules B2, C2, P2*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules C1, C2 and C3 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A143: *Modules B3, C3, P3*	
25% of the total GCSE 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers • assesses Modules P1, P2 and P3 • uses both objective style and free response questions (there is no choice of questions) • assesses the quality of written communication.
Unit A144: *Controlled assessment*	
25% of the total GCSE Controlled assessment 6–7 hours 64 marks	This unit: • comprises a case study task and a practical data analysis task • is assessed by teachers, internally standardised and then externally moderated by OCR • assesses the quality of written communication.

GCSE Science A

Route 1

3.3 Summary of Biology A Unit A161: *Modules B1, B2, B3*

Unit A161 is the unit within assessment route 1 to GCSE Science A where the biology content is assessed. It assesses the content of Modules B1, B2 and B3 together with their associated Ideas about Science. The other route 1 units are Unit A171 (Section 3.4) and Unit A181 (Section 3.5).

The modules in Unit A161 offer students the chance to develop the scientific literacy needed by active and informed citizens in a modern democratic society where science and technology play key roles in shaping our lives. The course content has a clear focus on scientific literacy. Teachers can use a wide range of teaching and learning styles, challenging students to consider critically the issues and choices raised by technology and science. Students will appreciate what science has to say about people, the environment and the Universe.

Ideas about Science in Unit A161

Modules B1, B2 and B3 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A161 can assess any of the Ideas about Science linked to Modules B1, B2 and B3, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A161, within any of the scientific contexts introduced by Modules B1, B2 and B3, are:

Cause-effect explanations
IaS 2.3 – 2.7
Developing scientific explanations
IaS 3.1 – 3.4
The scientific community
IaS 4.1 – 4.4
Risk
IaS 5.1 – 5.7
Making decisions about science and technology
IaS 6.1 – 6.6

3.4 Summary of Chemistry A Unit A171: *Modules C1, C2, C3*

Unit A171 is the unit within assessment route 1 to GCSE Science A where the chemistry content is assessed. It assesses the content of Modules C1, C2 and C3 together with their associated Ideas about Science. The other route 1 units are Unit A161 (Section 3.3) and Unit A181 (Section 3.5).

The modules in Unit A171 offer students the chance to develop the scientific literacy needed by active and informed citizens in a modern democratic society where science and technology play key roles in shaping our lives. The course content has a clear focus on scientific literacy. Teachers can use a wide range of teaching and learning styles, challenging students to consider critically the issues and choices raised by technology and science. Students will appreciate what science has to say about people, the environment and the Universe.

Ideas about Science in Unit A171

Modules C1, C2 and C3 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A171 can assess any of the Ideas about Science linked to Modules C1, C2 and C3, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A171, within any of the scientific contexts introduced by Modules C1, C2 and C3, are:

Data: their importance and limitations
IaS 1.1 – 1.6
Cause-effect explanations
IaS 2.1 – 2.5
Developing scientific explanations
IaS 3.3
The scientific community
IaS 4.1 – 4.4
Risk
IaS 5.1 – 5.7
Making decisions about science and technology
IaS 6.1 – 6.4

3.5 Summary of Physics A Unit A181: *Modules P1, P2, P3*

Unit A181 is the unit within assessment route 1 to GCSE Science A where the physics content is assessed. It assesses the content of Modules P1, P2 and P3 together with their associated Ideas about Science. The other route 1 units are Unit A161 (Section 3.3) and Unit A171 (Section 3.4).

The modules in Unit A181 offer students the chance to develop the scientific literacy needed by active and informed citizens in a modern democratic society where science and technology play key roles in shaping our lives. The course content has a clear focus on scientific literacy. Teachers can use a wide range of teaching and learning styles, challenging students to consider critically the issues and choices raised by technology and science. Students will appreciate what science has to say about people, the environment and the Universe.

Ideas about Science in Unit A181

Modules P1, P2 and P3 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A181 can assess any of the Ideas about Science linked to Modules P1, P2 and P3, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A181, within any of the scientific contexts introduced by Modules P1, P2 and P3, are:

Cause-effect explanations
IaS 2.3 – 2.7
Developing scientific explanations
IaS 3.1 – 3.4
The scientific community
IaS 4.1 – 4.4
Risk
IaS 5.1 – 5.7
Making decisions about science and technology
IaS 6.1 – 6.3, 6.5, 6.6

GCSE Science A

Route 2

3.6 Summary of Science A Unit A141: *Modules B1, C1, P1*

Unit A141 is the first unit for GCSE Science A and forms part of assessment route 2 to this qualification. It assesses the content of Modules B1, C1 and P1 together with their associated Ideas about Science. The other route 2 units are Unit A142 (Section 3.7) and Unit A143 (Section 3.8).

Ideas about Science in Unit A141

Modules B1, C1 and P1 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A141 can assess any of the Ideas about Science linked to Modules B1, C1 and P1, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A141, within any of the scientific contexts introduced by Modules B1, C1 and P1, are:

Data: their importance and limitations
IaS 1.1 – 1.6
Cause-effect explanations
IaS 2.1, 2.3 – 2.5
Developing scientific explanations
IaS 3.1 – 3.4
The scientific community
IaS 4.1 – 4.4
Making decisions about science and technology
IaS 6.3 – 6.6

3.7 Summary of Science A Unit A142: *Modules B2, C2, P2*

Unit A142 is the second unit for GCSE Science A and forms part of assessment route 2 to this qualification. It assesses the content of Modules B2, C2 and P2 together with their associated Ideas about Science. The other route 2 units are Unit A141 (Section 3.6) and Unit A143 (Section 3.8).

Ideas about Science in Unit A142

Modules B2, C2 and P2 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A142 can assess any of the Ideas about Science linked to Modules B2, C2 and P2, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A142, within any of the scientific contexts introduced by Modules B2, C2 and P2, are:

Data: their importance and limitations
IaS 1.1 – 1.6
Cause-effect explanations
IaS 2.2 – 2.7
The scientific community
IaS 4.1, 4.2
Risk
IaS 5.1 – 5.7
Making decisions about science and technology
IaS 6.4 – 6.6

3.8 Summary of Science A Unit A143: *Modules B3, C3, P3*

Unit A143 is the third unit for GCSE Science A and forms part of assessment route 2 to this qualification. It assesses the content of Modules B3, C3 and P3 together with their associated Ideas about Science. The other route 2 units are Unit A141 (Section 3.6) and Unit A142 (Section 3.7).

Ideas about Science in Unit A143

Modules B3, C3 and P3 present learning opportunities for a number of the Ideas about Science. The start of each module details the particular Ideas about Science that can be introduced or developed within the contexts covered in the module. Specific examples of contexts within which Ideas about Science can be taught are given in the OCR scheme of work for GCSE Science A (published separately).

However, it is not intended that understanding and application of Ideas about Science should be limited to the context in which they are taught; they should be applicable to any appropriate scientific context.

Accordingly, questions in Unit A143 can assess any of the Ideas about Science linked to Modules B3, C3 and P3, and these Ideas about Science may be assessed in the context of any of the learning outcomes covered in the three modules.

In summary, the Ideas about Science that can be assessed in Unit A143, within any of the scientific contexts introduced by Modules B3, C3 and P3, are:

Developing scientific explanations
IaS 3.1 – 3.4
The scientific community
IaS 4.3, 4.4
Risk
IaS 5.1 – 5.7
Making decisions about science and technology
IaS 6.1 – 6.6

Ideas about Science

B Appendix B: Ideas about Science

The specifications within the Twenty First Century Science suite are unique in having interpreted and extrapolated the principles of 'How Science Works' into a series of 'Ideas about Science'. It is intended that the Ideas about Science will ensure students understand how scientific knowledge is obtained, how it is reported in the world outside the classroom, and the impacts of scientific knowledge on society.

GCSE Science A aims to develop students' understanding of the Ideas about Science alongside their growing understanding of scientific ideas and explanations of the behaviour of the natural world.

Why are Ideas about Science important?

In order to make sense of the scientific ideas that students encounter in lessons and read or hear about outside of school, they need to develop an understanding of science itself – of how scientific knowledge is obtained, the kinds of evidence and reasoning behind it, its strengths and limitations, and how far we can therefore rely on it. They also need opportunities to reflect on the impacts of scientific knowledge on society, and how we respond individually and collectively to the new ideas, artefacts and processes that science makes possible.

Reports of scientific claims, inventions and discoveries are prolific in the media of the twenty first century, and an understanding of the Ideas about Science will ensure that students are well-equipped to critically evaluate the science stories they read and hear.

The kind of understanding of science that we would wish students to have by the end of their school science education might be summarised as follows:

How science works

The aim of science is to find explanations for the behaviour of the natural world. There is no single 'method of science' that leads automatically to scientific knowledge. Scientists do, however, have characteristic ways of working. In particular, data from observations and measurements are of central importance. All data, however, have to be interpreted, and this is influenced by the ideas we bring to it. Scientific explanations do not 'emerge' automatically from data. Proposing an explanation involves creative thinking. So, it is quite possible (and may be quite reasonable) for different people to arrive at different explanations for the same data.

Causes and effects

Scientists often look for cause-effect explanations. The first step is to identify a correlation between a factor and an outcome. The factor may then be the cause, or one of the causes, of the outcome. In many situations a factor may not always lead to the outcome, but increases the chance (or the risk) of it happening. In order to claim that the factor causes the outcome we need to identify a process or mechanism that might account for the observed correlation.

Theories, explanations and predictions

A scientific theory is a general explanation that applies to a large number of situations or examples (perhaps to all possible ones), which has been tested and used successfully, and is widely accepted by scientists. A scientific theory might propose a model involving objects (and their behaviour) that cannot be observed directly, to account for what we observe. Or it might define quantities and ways of measuring them, and state some mathematical relationships between them.

A scientific explanation of a specific event or phenomenon is often based on applying a scientific theory (or theories) to the situation in question.

A proposed scientific explanation (whether it is a very general scientific theory or a more specific explanation) is tested by comparing predictions based on it with observations or measurements. If these agree, it increases our confidence that the explanation might be correct. This can never be conclusively proved, but accumulating evidence can bring us to the point where it is hard to imagine any other possible explanation. If prediction and data disagree, then one or other must be wrong. Data can never be relied on completely because observations may be incorrect and all measurements are subject to uncertainty, arising from the inevitable limitations of the measuring equipment or the person using it. If we believe the data are accurate, then the prediction must be wrong, lowering our confidence in the proposed explanation.

Science and scientists

The scientific community has established robust procedures for testing and checking the claims of individual scientists, and reaching an agreed view. Scientists report their findings to other scientists at conferences and in peer-reviewed journals. Claims are not accepted until they have survived the critical scrutiny of the scientific community. In some areas of enquiry, it has proved possible to eliminate all the explanations we can think of but one – which then becomes the accepted explanation (until, if ever, a better one is proposed).

Where possible, scientists choose to study simple situations in order to gain understanding. This, however, can make it difficult to apply this understanding to complex, real-world situations. So there can be legitimate disagreements about scientific explanations of particular phenomena or events, even though there is no dispute about the fundamental scientific knowledge involved.

Science and society

The application of scientific knowledge, in new technologies, materials and devices, greatly enhances our lives, but can also have unintended and undesirable side-effects. Often we need to weigh up the benefits against the disadvantages – and also consider who gains and who loses. An application of science may have social, economic and political implications, and sometimes also ethical ones. Personal and social decisions require an understanding of the science involved, but also involve knowledge and values that go beyond science.

How can Ideas about Science be developed in teaching?

Within this Appendix all of the Ideas about Science are listed together, in an order that shows clearly how they relate to one another and build up the understanding of science that we would like students to develop.

In addition to this Appendix, specific Ideas about Science are identified at the start of each module within the specification, to indicate that there are good opportunities within the content of the module to introduce and develop them. The OCR scheme of work for GCSE Science A (published separately) will also highlight teaching opportunities for specific Ideas about Science.

What are the Ideas about Science?

The following pages set out in detail the Ideas about Science and what candidates should be able to do to demonstrate their understanding of them. The statements in the left-hand column specify the understandings candidates are expected to develop; the entries in the right-hand column are suggestions about some ways in which evidence of understanding can be demonstrated.

B

1 Data: their importance and limitations

Data are the starting point for scientific enquiry – and the means of testing scientific explanations. But data can never be trusted completely, and scientists need ways of evaluating how good their data are.

	Candidates should understand that:	A candidate who understands this can, for example:
1.1	• data are crucial to science. The search for explanations starts from data; and data are collected to test proposed explanations.	• use data rather than opinion if asked to justify an explanation • outline how a proposed scientific explanation has been (or might be) tested, referring appropriately to the role of data.
1.2	• we can never be sure that a measurement tells us the true value of the quantity being measured.	• suggest reasons why a given measurement may not be the true value of the quantity being measured.
1.3	• if we make several measurements of any quantity, these are likely to vary.	• suggest reasons why several measurements of the same quantity may give different values • when asked to evaluate data, make reference to its repeatability **and/or reproducibility.**
1.4	• the mean of several repeat measurements is a good estimate of the true value of the quantity being measured.	• calculate the mean of a set of repeated measurements • from a set of repeated measurements of a quantity, use the mean as the best estimate of the true value • explain why repeating measurements leads to a better estimate of the quantity.
1.5	• from a set of repeated measurements of a quantity, it is possible to estimate a range within which the true value probably lies.	• from a set of repeated measurements of a quantity, make a sensible suggestion about the range within which the true value probably lies **and explain this** • **when discussing the evidence that a quantity measured under two different conditions has (or has not) changed, make appropriate reference both to the difference in means and to the variation within each set of measurements.**
1.6	• if a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy.	• identify any outliers in a set of data • treat an outlier as data unless there is a reason for doubting its accuracy • **discuss and defend the decision to discard or to retain an outlier.**

2 Cause-effect explanations

Scientists look for patterns in data, as a means of identifying correlations that might suggest possible cause-effect links – for which an explanation might then be sought.

	Candidates should understand that:	A candidate who understands this can, for example:
2.1	• it is often useful to think about processes in terms of factors which may affect an outcome (or input variables which may affect an outcome variable).	• in a given context, identify the outcome and factors that may affect it • in a given context, suggest how an outcome might alter when a factor is changed.
2.2	• to investigate the relationship between a factor and an outcome, it is important to control all the other factors which we think might affect the outcome (a so-called 'fair test').	• identify, in a plan for an investigation of the effect of a factor on an outcome, the fact that other factors are controlled as a positive design feature, or the fact that they are not as a design flaw • explain why it is necessary to control all the factors that might affect the outcome other than the one being investigated.
2.3	• if an outcome occurs when a specific factor is present, but does not when it is absent, or if an outcome variable increases (or decreases) steadily as an input variable increases, we say that there is a correlation between the two.	• suggest and explain an example from everyday life of a correlation between a factor and an outcome • identify where a correlation exists when data are presented as text, as a graph, or in a table. ⓘ *Examples may include both positive and negative correlations, but candidates will not be expected to know these terms.*
2.4	• a correlation between a factor and an outcome does not necessarily mean that the factor causes the outcome; both might, for example, be caused by some other factor.	• use the ideas of correlation and cause when discussing data and show awareness that a correlation does not necessarily indicate a causal link • identify, and suggest from everyday experience, examples of correlations between a factor and an outcome where the factor is (or is not) a plausible cause of the outcome • explain why an observed correlation between a given factor and outcome does not necessarily mean that the factor causes the outcome.
2.5	• in some situations, a factor alters the chance (or probability) of an outcome, but does not invariably lead to it. We also call this a correlation.	• suggest factors that might increase the chance of a particular outcome in a given situation, but do not invariably lead to it • explain why individual cases do not provide convincing evidence for or against a correlation.

	Candidates should understand that:	A candidate who understands this can, for example:
2.6	• to investigate a claim that a factor increases the chance (or probability) of an outcome, scientists compare samples (eg groups of people) that are matched on as many other factors as possible, or are chosen randomly so that other factors are equally likely in both samples. The larger the samples, the more confident we can be about any conclusions drawn.	• discuss whether given data suggest that a given factor does/does not increase the chance of a given outcome • evaluate critically the design of a study to test if a given factor increases the chance of a given outcome, by commenting on sample size and how well the samples are matched.
2.7	• **even when there is evidence that a factor is correlated with an outcome, scientists are unlikely to accept that it is a cause of the outcome, unless they can think of a plausible mechanism linking the two.**	• **identify the presence (or absence) of a plausible mechanism as reasonable grounds for accepting (or rejecting) a claim that a factor is a cause of an outcome.**

3 Developing scientific explanations

The aim of science is to develop good explanations for natural phenomena. Initially, an explanation is a hypothesis that might account for the available data. As more evidence becomes available, it may become an accepted explanation or theory. Scientific explanations and theories do not 'emerge' automatically from data, and cannot be deduced from the data. Proposing an explanation or theory involves creative thinking. It can then be tested – by comparing its predictions with data from observations or measurements.

	Candidates should understand that:	A candidate who understands this can, for example:
3.1	• scientific hypotheses, explanations and theories are not simply summaries of the available data. They are based on data but are distinct from them.	• in a given account of scientific work, identify statements which report data and statements of explanatory ideas (hypotheses, explanations, theories) • recognise that an explanation may be incorrect even if the data agree with it.
3.2	• an explanation cannot simply be deduced from data, but has to be thought up creatively to account for the data.	• identify where creative thinking is involved in the development of an explanation.
3.3	• a scientific explanation should account for most (ideally all) of the data already known. It may explain a range of phenomena not previously thought to be linked. It should also enable predictions to be made about new situations or examples.	• recognise data or observations that are accounted for by, or conflict with, an explanation • give good reasons for accepting or rejecting a proposed scientific explanation • identify the better of two given scientific explanations for a phenomenon, and give reasons for the choice.
3.4	• scientific explanations are tested by comparing predictions based on them with data from observations or experiments.	• draw valid conclusions about the implications of given data for a given scientific explanation, in particular: – understand that agreement between a prediction and an observation increases confidence in the explanation on which the prediction is based but does not prove it is correct – understand that disagreement between a prediction and an observation indicates that one or the other is wrong, and decreases our confidence in the explanation on which the prediction is based.

4 The scientific community

Findings reported by an individual scientist or group are carefully checked by the scientific community before being accepted as scientific knowledge.

	Candidates should understand that:	A candidate who understands this can, for example:
4.1	• scientists report their claims to other scientists through conferences and journals. Scientific claims are only accepted once they have been evaluated critically by other scientists.	• describe in broad outline the 'peer review' process, in which new scientific claims are evaluated by other scientists • recognise that there is less confidence in new scientific claims that have not yet been evaluated by the scientific community than there is in well-established ones.
4.2	• scientists are usually sceptical about claims that cannot be repeated by anyone else, and about unexpected findings until they have been replicated (by themselves) or reproduced (by someone else).	• identify the fact that a finding has not been reproduced by another scientist as a reason for questioning a scientific claim • explain why scientists see this as important.
4.3	• if explanations cannot be deduced from the available data, two (or more) scientists may legitimately draw different conclusions about the same data. A scientist's personal background, experience or interests may influence his/her judgments.	• show awareness that the same data might be interpreted, quite reasonably, in more than one way • suggest plausible reasons why scientists in a given situation disagree(d).
4.4	• an accepted scientific explanation is rarely abandoned just because some new data disagree with its predictions. It usually survives until a better explanation is available.	• discuss the likely consequences of new data that disagree with the predictions of an accepted explanation • **suggest reasons why scientists should not give up an accepted explanation immediately if new data appear to conflict with it.**

5 Risk

Every activity involves some risk. Assessing and comparing the risks of an activity, and relating these to the benefits we gain from it, are important in decision making.

	Candidates should understand that:	A candidate who understands this can, for example:
5.1	• everything we do carries a certain risk of accident or harm. Nothing is risk free. New technologies and processes based on scientific advances often introduce new risks.	• explain why it is impossible for anything to be completely safe • identify examples of risks which arise from a new scientific or technological advance • suggest ways of reducing a given risk.
5.2	• we can sometimes assess the size of a risk by measuring its chance of occurring in a large sample, over a given period of time.	• interpret and discuss information on the size of risks, presented in different ways.
5.3	• to make a decision about a particular risk, we need to take account both of the chance of it happening and the consequences if it did.	• discuss a given risk, taking account of both the chance of it occurring and the consequences if it did.
5.4	• to make a decision about a course of action, we need to take account of both its risks and benefits, to the different individuals or groups involved.	• identify risks and benefits in a given situation, to the different individuals and groups involved • discuss a course of action, with reference to its risks and benefits, taking account of who benefits and who takes the risks • can suggest benefits of activities that are known to have risk.
5.5	• people are generally more willing to accept the risk associated with something they choose to do than something that is imposed, and to accept risks that have short-lived effects rather than long-lasting ones.	• offer reasons for people's willingness (or reluctance) to accept the risk of a given activity.
5.6	• **people's perception of the size of a particular risk may be different from the statistically estimated risk. People tend to over-estimate the risk of unfamiliar things (like flying as compared with cycling), and of things whose effect is invisible or long-term (like ionising radiation).**	• **distinguish between perceived and calculated risk, when discussing personal choices** • **suggest reasons for given examples of differences between perceived and measured risk.**
5.7	• governments and public bodies may have to assess what level of risk is acceptable in a particular situation. This decision may be controversial, especially if those most at risk are not those who benefit.	• discuss the public regulation of risk, **and explain why it may in some situations be controversial.**

6 Making decisions about science and technology

To make sound decisions about the applications of scientific knowledge, we have to weigh up the benefits and costs of new processes and devices. Sometimes these decisions also raise ethical issues. Society has developed ways of managing these issues, though new developments can pose new challenges to these.

	Candidates should understand that:	A candidate who understands this can, for example:
6.1	• science-based technology provides people with many things that they value, and which enhance the quality of life. Some applications of science can, however, have unintended and undesirable impacts on the quality of life or the environment. Benefits need to be weighed against costs.	• in a particular context, identify the groups affected and the main benefits and costs of a course of action for each group • **suggest reasons why different decisions on the same issue might be appropriate in view of differences in social and economic context.**
6.2	• scientists may identify unintended impacts of human activity (including population growth) on the environment. They can sometimes help us to devise ways of mitigating this impact and of using natural resources in a more sustainable way.	• identify, and suggest, examples of unintended impacts of human activity on the environment • explain the idea of sustainability, and apply it to specific situations • use data (for example, from a Life Cycle Assessment) to compare the sustainability of alternative products or processes.
6.3	• in many areas of scientific work, the development and application of scientific knowledge are subject to official regulations.	• in contexts where this is appropriate, show awareness of, **and discuss**, the official regulation of scientific research and the application of scientific knowledge.
6.4	• some questions, such as those involving values, cannot be answered by science.	• distinguish questions which could in principle be answered using a scientific approach, from those which could not.
6.5	• some forms of scientific research, and some applications of scientific knowledge, have ethical implications. People may disagree about what should be done (or permitted).	• where an ethical issue is involved: – say clearly what this issue is – summarise different views that may be held.
6.6	• in discussions of ethical issues, one common argument is that the right decision is one which leads to the best outcome for the greatest number of people involved. Another is that certain actions are considered right or wrong whatever the consequences.	• in a given context, identify, **and develop**, arguments based on the ideas that: – the right decision is the one which leads to the best outcome for the greatest number of people involved – certain actions are considered right or wrong whatever the consequences.

Mathematics requirements

Appendix C: Mathematics skills for GCSE science qualifications

C

Candidates are permitted to use calculators in all assessments.

Candidates should be able to:

- understand number, size and scale and the quantitative relationship between units
- understand when and how to use estimation
- carry out calculations involving +, – , ×, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers,
- provide answers to calculations to an appropriate number of significant figures
- understand and use the symbols =, <, >, ~
- understand and use direct proportion and simple ratios
- calculate arithmetic means
- understand and use common measures and simple compound measures such as speed
- plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes
- substitute numerical values into simple formulae and equations using appropriate units
- translate information between graphical and numeric form
- extract and interpret information from charts, graphs and tables
- understand the idea of probability
- calculate area, perimeters and volumes of simple shapes

In addition, higher tier candidates should be able to

- **interpret, order and calculate with numbers written in standard form**
- **carry out calculations involving negative powers (only –1 for rate)**
- **change the subject of an equation**
- **understand and use inverse proportion**
- **understand and use percentiles and deciles.**

Specimen Assessment Materials

SPECIMEN **F**

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A141/01**

SCIENCE A

Unit A141: Modules B1, C1, P1 (Foundation Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✐).
- A list of useful relationships is included on page 2.
- The number of marks for each question is given in brackets **[ ]** at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	**Mark**
1	**5**	
2	**8**	
3	**6**	
4	**6**	
5	**9**	
6	**6**	
7	**6**	
8	**4**	
9	**6**	
10	**4**	
TOTAL	**60**	

 OCR is an exempt Charity **Turn over**

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x current

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

momentum = mass x velocity

change of momentum = resultant force x time for which it acts

work done by a force = force x distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

power = voltage x current

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

Answer **all** the questions.

1 In the future it may be possible to repair damaged body parts using stem cells.

(a) Use the words provided to complete the sentences.

active	**altered**	**clones**	**genes**	**illnesses**
inactive	**infections**	**living**	**specialised**	**unspecialised**

Embryonic stem cells can develop into any kind of cell because

they are ....

During the development of multicellular organisms, cells usually

become ....

Scientists hope that research into stem cells will lead to treatment

for some... .

[2]

(b) Stem cells can also be used to produce clones.

Put a tick (✓) in the box next to the **correct** description of what clones are.

Clones…

…contain only specialised cells, for example skin cells. ☐

…can only be produced by sexual reproduction. ☐

…are genetically identical cells or organisms. ☐

…are cells that are the same size and perform the same function. ☐

[1]

(c) Using human embryos to produce stem cells has caused a lot of argument and discussion.

Suggest **two** arguments **against** the use of human embryonic stem cells.

....

.... **[2]**

[Total: 5]

2 Read the information about phenylketonuria (PKU).

PKU is an inherited disorder.

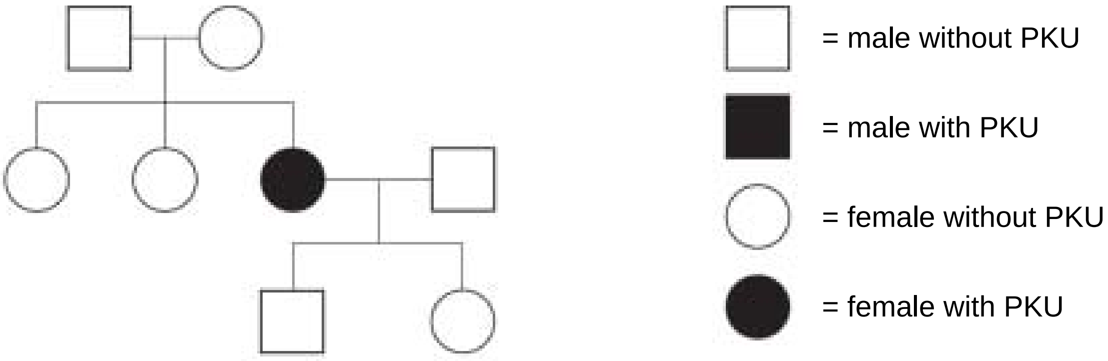
PKU is caused by a faulty gene.

A chemical called phenylalanine builds up in the bodies of people with PKU.

Too much phenylalanine causes serious health problems.

Serious health problems can be avoided with a controlled diet. The sooner this diet is started after birth, the less harm is caused.

(a) Look at the family tree.



Draw straight lines to link the correct **description** of the inheritance of PKU with the **two** correct **explanations.**

You should join **one** description with **two** explanations.

description	explanation
	Parents can be carriers of PKU.
PKU is inherited in a similar way to cystic fibrosis.	
	PKU is caused by a dominant allele.
PKU is inherited in a similar way to Huntington's disease.	
	Parents cannot be carriers of PKU.
PKU is inherited in a different way from cystic fibrosis and Huntington's disease.	
	PKU is caused by a recessive allele.

[2]

(b) **About** 1 in 10 000 babies born in the UK has PKU.

(i) Testing a baby for PKU costs the NHS £6.

Calculate the cost to the NHS in 2008 of giving PKU tests to the 710 000 babies born that year.

answer = £.. **[2]**

(ii) The Office for National Statistics reported that 710 000 babies were born in the UK in 2008.

How many babies born in the UK in 2008 would you expect to have been born with PKU?

Show your working.

answer = ... **[1]**

(iii) Doctors have said that it is right to test all babies for PKU even though it costs the NHS money.

Use the information about PKU and your answers to parts **(i)** and **(ii)** to suggest reasons why the doctors have come to this conclusion.

....

....

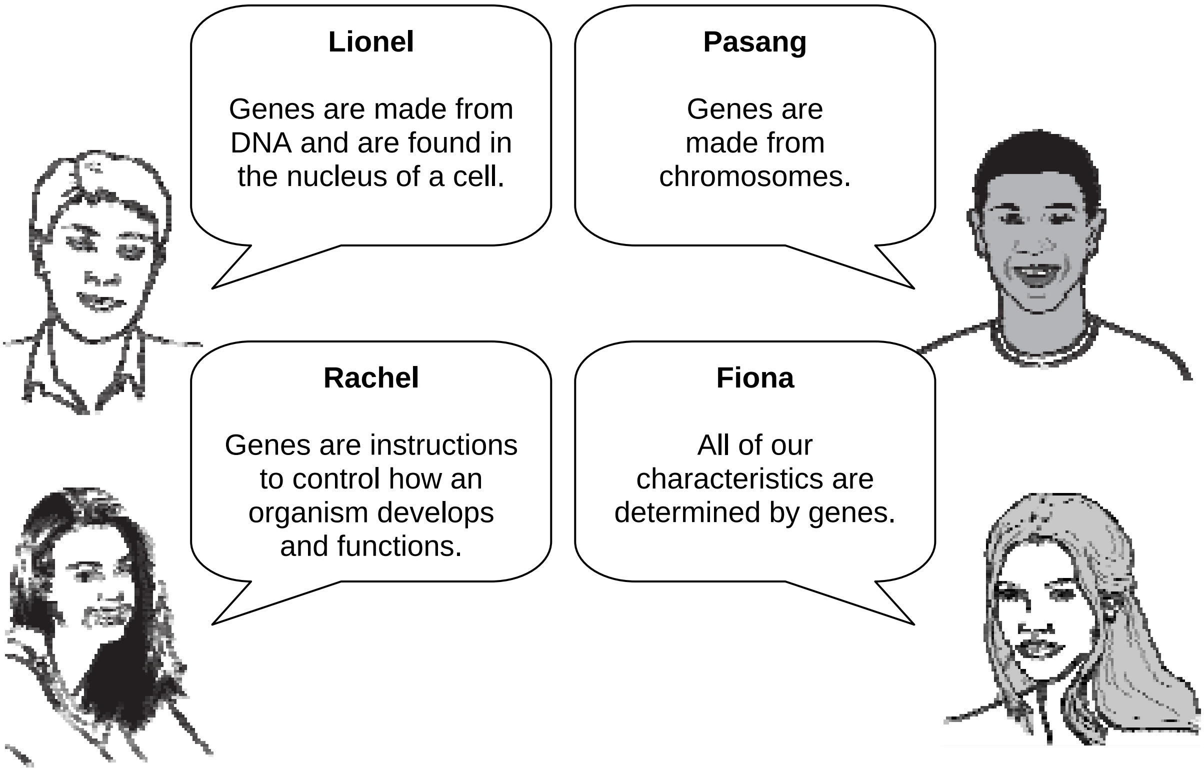
....

....

.... **[2]**

(c) PKU is a genetic disorder.

After a science lesson about genetics, some friends discuss what they think genes are.



Write down the names of the **two** people who make correct statements.

answers .... and .... **[1]**

[Total: 8]

3 Jadzia has similarities to her mother and similarities to her father, but is **not** identical to either of them.

Use your knowledge of genes, sexual reproduction and the environment to explain why.

✎ *The quality of written communication will be assessed in your answer to this question.*

....

....

....

....

....

....

....

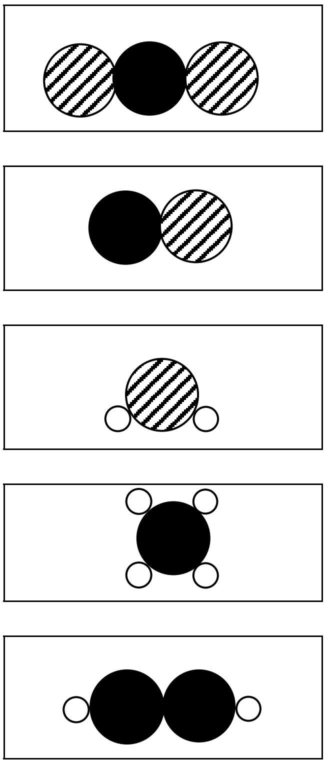
....**[6]**

[Total: 6]

4 Ethene is used as a fuel. It is obtained from crude oil.

(a) Carbon dioxide and water are produced when ethene burns completely.

Draw a straight line from each **product** to the **diagram** representing its molecule.

product	**diagram**
carbon dioxide	
water	

Key: 

[2]

(b) A scientist analyses the products of combustion of ethene.

He collects all the products of the reaction.

His results are shown in the table.

	mass in g
carbon dioxide	82.0
water vapour	70.2
carbon monoxide	52.0
carbon	2.0
total	**206.2**

(i) The scientist calculates that carbon dioxide made up 39.8% of the mass of the total products.

What is the percentage by mass of carbon monoxide?

percentage by mass = ... % **[1]**

(ii) What can be concluded from these results about the conditions in which combustion occurred?

Explain your answer.

....

....

.... **[2]**

(iii) Carbon monoxide is a dangerous gas.

How could the scientist change the conditions to prevent carbon monoxide from being formed when ethene burns?

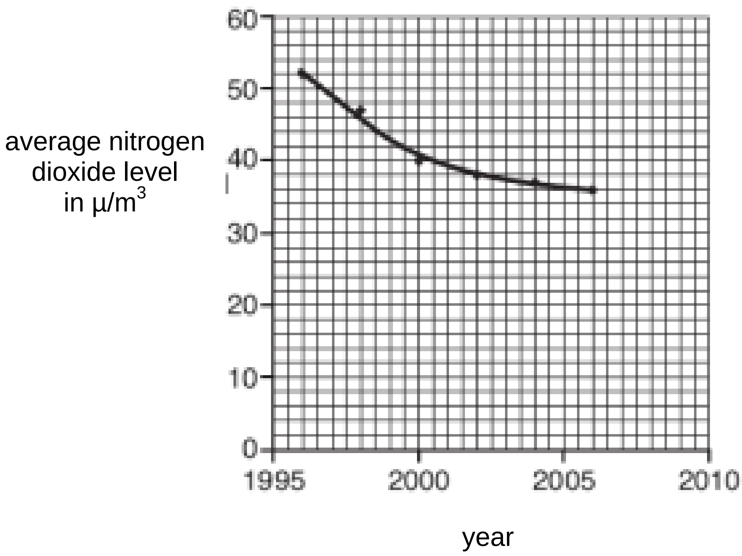
.... **[1]**

[Total: 6]

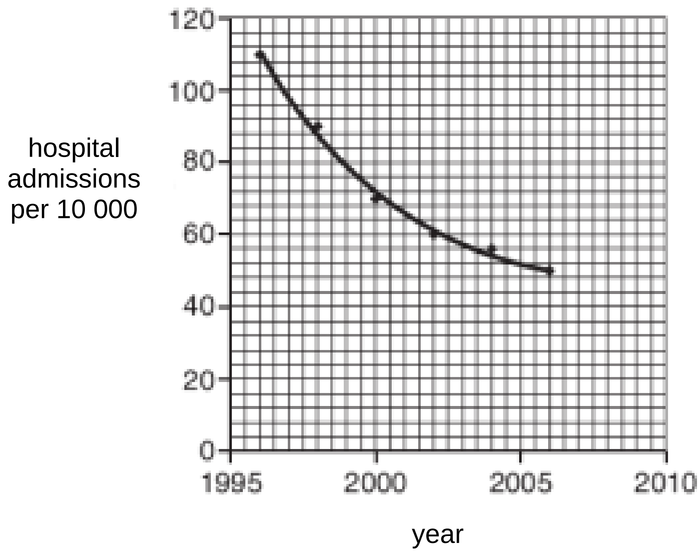
5 This question is about air pollution.

The graphs show nitrogen dioxide pollution in the air and the number of hospital admissions for asthma between 1996 and 2006.

average nitrogen dioxide levels in UK towns



hospital admissions for asthma



(a) **(i)** What was the average nitrogen dioxide level in UK towns in 2000?

answer = ... µg / m^3 **[1]**

(ii) In what year did hospital admissions reach 60 per 10 000 people?

year = ... **[1]**

(b) **(i)** The graphs, **when taken together**, show a correlation between two factors.

Write a sentence to describe this correlation.

....

.... **[1]**

(ii) Scientists looking at the graphs suggest that nitrogen dioxide in the air may cause asthma.

What extra information would support this suggestion?

Put ticks (✓) in the boxes next to the **two** correct answers.

how nitrogen dioxide is made in a car engine	☐
nitrogen dioxide levels in the countryside	☐
how nitrogen dioxide affects breathing	☐
similar data from other countries	☐
how many asthma inhalers are prescribed by doctors	☐

[2]

(c) The number of cars and lorries on the roads increased between 1996 and 2006.

During this time, the amount of pollution by nitrogen dioxide decreased.

Describe and explain how nitrogen dioxide pollution from cars and lorries has been reduced.

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.... **[4]**

[Total: 9]

6 The atmosphere of Venus was originally formed from gases released from inside the planet.

It is nearly completely made of carbon dioxide (96.5%).

The surface temperature is about 464°C.

How does the atmosphere of the Earth compare with the atmosphere of Venus?

Suggest similarities and differences in

- how the atmosphere formed
- the way this affected what the atmosphere is now made of.

✎ *The quality of written communication will be assessed in your answer to this question*.

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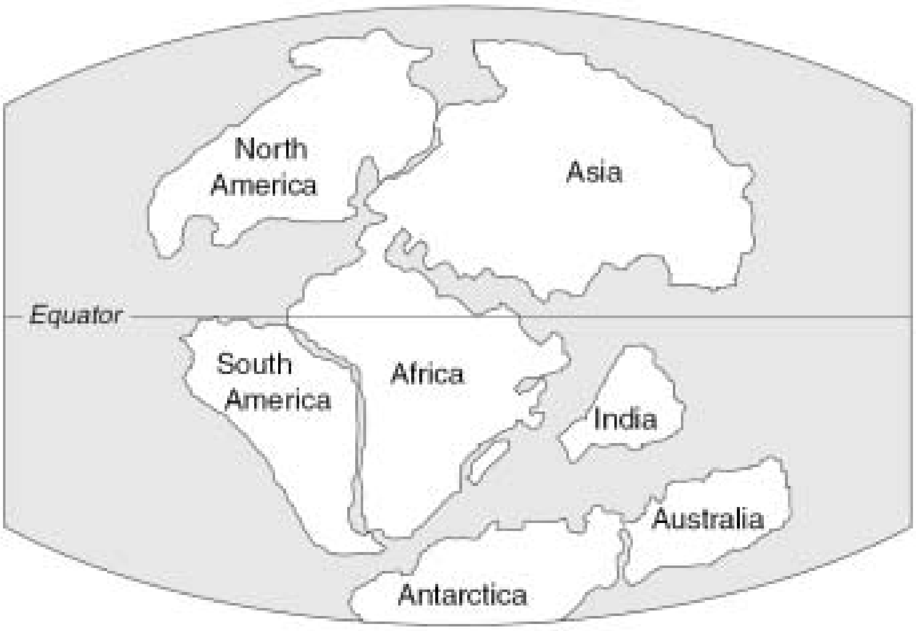
.... **[6]**

[Total: 6]

7 Wegener proposed his theory of continental drift in 1915.



Wegener's theory was not accepted by geologists when he first suggested it.

Wegener's theory became accepted in the 1960s.

Explain why Wegener thought the continents had moved, why geologists rejected his ideas, and how the theory became accepted.

✎ *The quality of written communication will be assessed in your answer to this question.*

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.... **[6]**

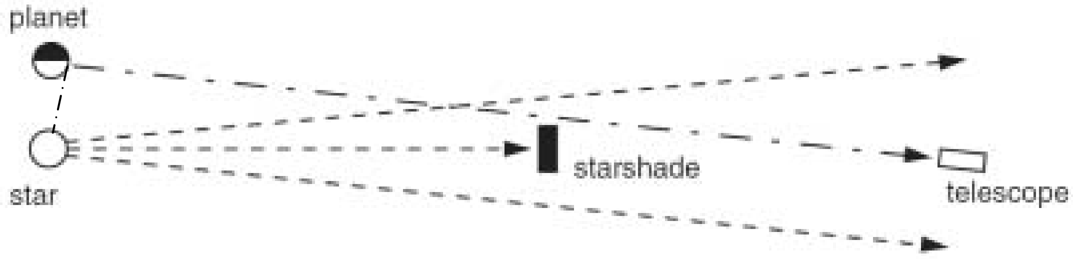
[Total: 6]

8 Read the article.

'Starshade' could help us see planets around other stars

The giant 'starshade' would be launched into space together with a space telescope, and would orbit the Earth at a distance of around 1 million kilometres. The 'starshade' and the telescope would be around 15 000 kilometres apart from each other.

Small thruster rockets, fired by remote control from Earth, would allow scientists to move the 'starshade' in front of a star they wanted the telescope to look at. The 'starshade' will allow light reflected from planets orbiting the star to be seen.



(a) Read the following statements.

Put ticks (✓) in the boxes next to the **two** correct statements.

The 'starshade' will block out the light from the star. ☐

The 'starshade' will reflect light to the telescope. ☐

The 'starshade' will be fixed to a space telescope. ☐

The 'starshade' and space telescope will be launched separately. ☐

The space telescope will be able to detect light from distant planets. ☐

[2]

(b) Most telescopes are on the Earth's surface.

This telescope and 'starshade' will be put into orbit a long way from the Earth.

Which of these statements are correct reasons for doing this?

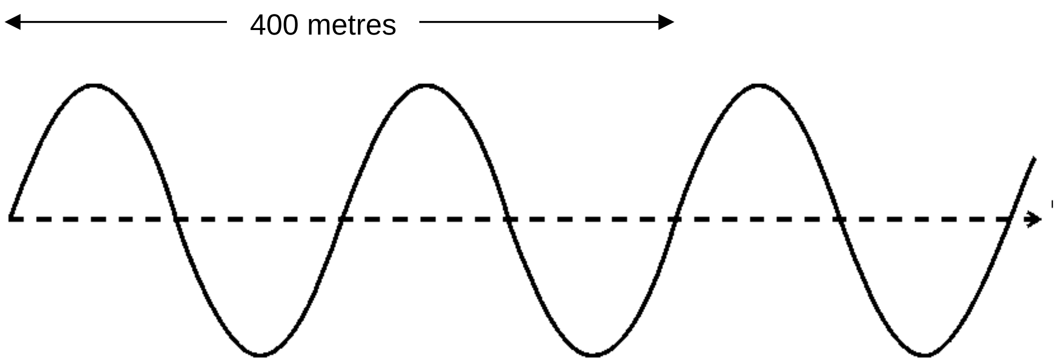
Put ticks (✓) in the boxes next to the **two** correct statements.

Light pollution from Earth will not affect the telescope if it is in space.	☐
It is too expensive to put the telescope and the 'starshade' on Earth.	☐
The telescope and 'starshade' would take up too much room on the Earth's surface.	☐
The Earth's atmosphere will not reduce the quality of the image if the telescope is in space.	☐

[2]

[Total: 4]

9 The diagram shows a seismic wave.



(a) Calculate the wavelength of this wave.

wavelength = ... m **[1]**

(b) Another wave has a wavelength of 500 metres.

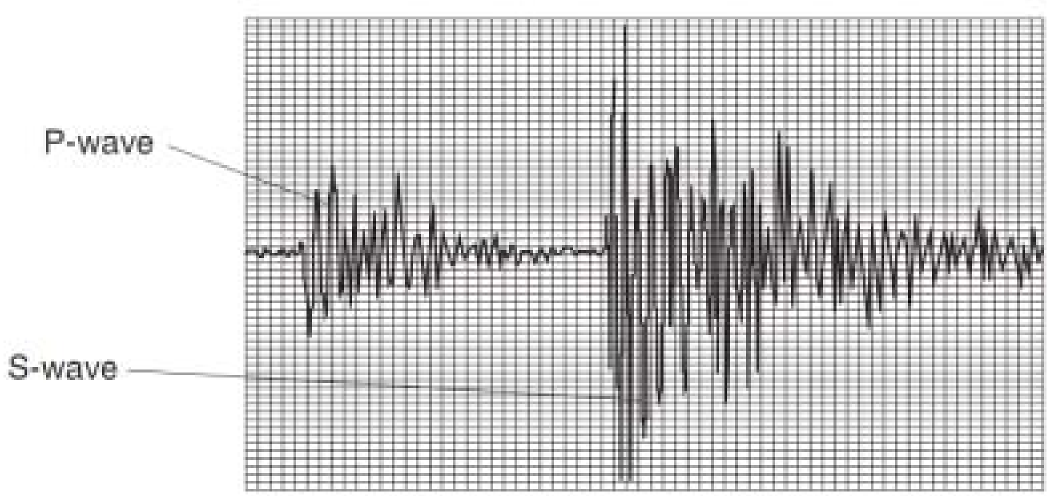
This wave has a frequency of 4 hertz.

Calculate the speed of this wave.

speed = ... m/s **[2]**

(c) The diagram shows a recording from an earthquake detector.

It has detected a P-wave and an S-wave from an earthquake.



What conclusion can you draw from the diagram about the damage caused by S-waves compared to the damage caused by P-waves?

Explain how you reach your conclusion.

Use the correct scientific terms to compare the waves.

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....

....

.... **[3]**

[Total: 6]

10 The Solar System consists of many different objects.

The Earth, the Moon, the Sun and asteroids are some of these objects.

The table shows the diameters of four objects in the Solar System.

object	diameter in km	type of object
A	756	
B	12 742	
C	1 392 000	
D	3474	

(a) Complete the table to identify what each object is **most likely** to be from the data provided.

Choose from this list.

an asteroid **the Earth** **the Moon** **the Sun**

[2]

(b) Suggest why it is **not** possible to be certain of the identity of all of these objects from the data provided.

....

....**[2]**

[Total: 4]

[Paper Total: 60]

END OF QUESTION PAPER

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SPECIMEN F

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

SCIENCE A **A141/01**

Unit A141: Modules B1, C1, P1 (Foundation Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 16 pages

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant - applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>.	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)
work done = 0 marks
work done lifting = 1 mark
change in potential energy = 0 marks
gravitational potential energy = 1 mark

5. Annotations:
The following annotations are available on SCORIS.

✓	= correct response
×	= incorrect response
bod=	benefit of the doubt
nbod	= benefit of the doubt **<u>not</u>** given
ECF	= error carried forward
^	= information omitted
I	= ignore
R	= reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

   Eg
   For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

   Put ticks (✓) in the two correct boxes.

   This would be worth 0 marks.

   Put ticks (✓) in the two correct boxes.

   This would be worth one mark.

   Put ticks (✓) in the two correct boxes.

   This would be worth one mark.

8. The list principle:
   If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:

   Always check the additional guidance.

   If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.
   If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.
   Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

   Eg If a question requires candidates to identify a city in England, then in the boxes

Edinburgh	
Manchester	
Paris	
Southampton	

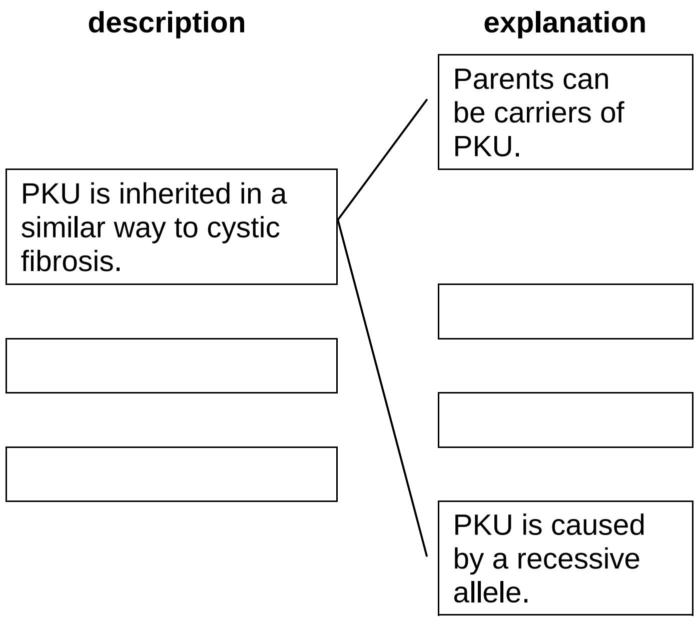
   the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:

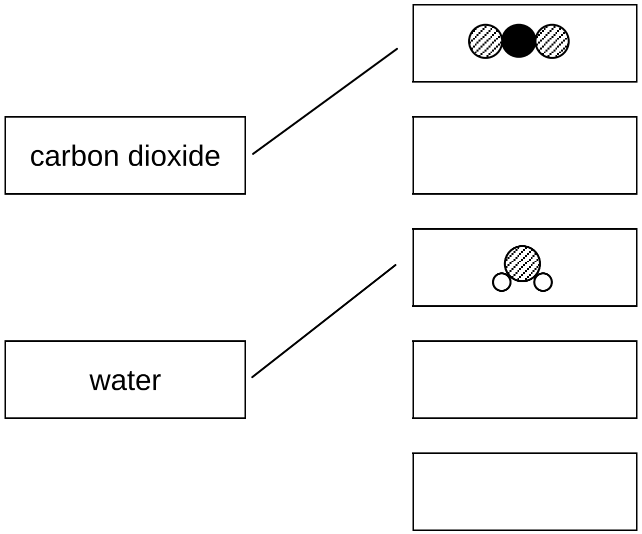
- Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
- Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
- *For a general correlation between quality of science and QWC*: determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
- *For high-level science but very poor QWC*: the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
- *For very poor or totally irrelevant science but perfect QWC*: credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.

Question			Expected answers	Marks	Additional guidance
1	(a)		unspecialised specialised illnesses	[2]	all three correct = 2 marks one or two correct = 1 mark
	(b)		☐ ☐ genetically identical cells or organisms ☑ ☐	[1]	tick in any other box = 0 marks
	(c)		**any two from:** it is 'playing God' / religious objection embryos killed / lives wasted some actions are wrong whatever the consequences may lead to reproductive cloning benefit does not outweigh , cost / named arguments against	[2]	
			Total	[5]	

Question			Expected answers	Marks	Additional guidance
2	(a)			[2]	choice of only top left box = 1 mark any line from the top left box indicates the candidates choice then look at the right hand boxes to award second mark **both** top and bottom “explanation” boxes selected = 1 mark no extra boxes allowed

Question			Expected answers	Marks	Additional guidance
2	**(b)**	**(i)**	£60 000	**[2]**	
		(ii)	71	**[1]**	
		(iii)	idea that benefits outweigh costs one life worth more than £60 000 / 71 lives improved/owtte each year can start treatment very early to limit damage / this saves (NHS) money in the long run (because it is expensive to treat people who get ill due to PKU) / idea that parents have the right to know or can start preparing for child with PKU	**[2]**	**accept** some actions are right whatever the cost **allow** ecf from parts **(i)** and **(ii)**
	(c)		Lionel and Rachel	**[1]**	**both** needed either order
			Total	**[8]**	

Question			Expected answers	Marks	Additional guidance
3		✎	**[Level 3]** Answer clearly explains why children have similarities to both parents **and** why they are not identical to either of them. Answer considers genetic **and** environmental factors. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer gives limited genetic explanations for the similarities and differences **OR** explains just one side (similarities or differences), but in detail. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer discusses only similarities or differences, not both, and lacks detail **OR** answer considers only environmental factors without explaining genetic basis of inheritance. Not much detail is provided in the explanation and little consideration is given to the role of genes in sexual reproduction. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** she has similarities to her parents because: • children , inherit / get , their genes from their mother and father • half of her , genes / alleles , are from her mother and half are from her father • genes , control / code for / are instructions for , characteristics • **accept** examples of characteristics, eg hair colour, eye colour • behavioural , traits / characteristics , are learned from parents • **accept** references to 'inheritance' of behavioural characteristics (nurture) she is not identical to them because: • idea that , egg / sperm / gametes , only contain half of the genetic material of each parent • combination / mixture , of , genes / alleles / chromosomes , from both parents gives different , characteristics / phenotype • child may inherit (recessive) alleles that were not expressed in the parents • she inherited X from father (and X from mother) so is female, unlike father • different environmental factors • **accept** examples of environmental factors that would certainly differ between parents and child, eg diet, amount of exercise, etc • **ignore** references that make assumptions about superficial differences, eg she wears different clothes, wears spectacles, has a different hair cut, dyes her hair, had plastic surgery, etc
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
4	(a)			[2]	1 mark for each correct answer
	(b)	(i)	25.2	[1]	
		(ii)	there was a lack of oxygen since carbon monoxide and carbon were produced due to incomplete combustion	[2]	for full marks the explanation must be linked to the conclusion
		(iii)	provide more oxygen	[1]	
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
5	(a)	(i)	41	[1]	**allow** 40 - 42
		(ii)	2002	[1]	**allow** 2003
	(b)	(i)	as nitrogen levels decrease, the number of hospital admissions decreases / ORA	[1]	**ignore** correlations with time
		(ii)	☐ ☐ how nitrogen dioxide affects breathing ✓ similar data from other countries ✓ ☐	[2]	
	(c)		**any two of the following for two marks each** • more efficient engines; which burn less fuel so make less nitrogen dioxide • catalytic converters; that reduce nitrogen monoxide to nitrogen and oxidise carbon monoxide to carbon dioxide • enforced legal limits to emissions; which make people maintain efficient engines	[4]	**ignore** references to sulfur **ignore** references to public transport
			Total	**[9]**	

Question			Expected answers	Marks	Additional guidance
6		✎	**[Level 3]** Similarities and differences between the present atmospheres (for the factors mentioned in the question) fully described and related to similarities and differences in the formation of the atmospheres. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5-6 marks) **[Level 2]** Similarities and differences in atmosphere composition and formation partially described with an attempt to relate these to one another. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3-4 marks) **[Level 1]** Limited description of similarities and differences with little or no attempt to relate differences in formation to differences in composition. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1-2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** *composition* • both contain carbon dioxide and nitrogen • much less CO_2 in Earth's atmosphere and much more N_2 *formation* • both originally formed from gases released from inside planet/volcanic activity • original atmosphere of both was mainly carbon dioxide • as the Earth cooled water vapour condensed to form the oceans, but Venus may have been too hot for water to condense (this is a 'suggest' question so reasonable suggestion should be credited) • on Earth carbon dioxide dissolved in oceans, but no oceans on Venus (reasonable suggestion) • plants evolved on Earth but not on Venus • (on Earth) as the trees and plants grew they photosynthesised to make their own food • (on Earth) absorbed carbon dioxide • (on Earth) produced oxygen • (on Earth) carbon dioxide decreased in the atmosphere • (on Earth) oxygen increased in the atmosphere • (on Earth) water vapour decreased in the atmosphere • but on Venus carbon dioxide not reduced and oxygen not increased since no plants/photosynthesis
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
7		✎	**[Level 3]** Includes most relevant points in each category in the answer. Explains Wegener's idea, objections to his theory, and acceptance following further evidence in terms of a causal mechanism. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Outlines Wegener's idea with some evidence, and makes reasonable suggestions why his contemporaries did not accept it. The idea of a mechanism for continental drift likely to be absent. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Outlines Wegener's idea with little supporting evidence. Objections by contemporaries likely to be personal rather than scientific. 1960s evidence likely to be missing. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** *Wegener's evidence* • continents 'fit together' • similar rock layers in different continents • similar fossils in different continents *his contemporaries' objections* • Wegener was an outsider/not a geologist • no continental movement detectable • existing theories (land bridges) explained fossils • no mechanism proposed for movement *for subsequent acceptance* • idea that a plausible mechanism is reasonable grounds for accepting the theory • sea-floor spreading provided a mechanism • movements in mantle as underlying cause **accept** description of magnetic stripes on seabed as evidence for seafloor spreading **ignore** references to mountain chains, unless specifically to chains on the West coast of North and South America **reject** objections to Wegener based on personality
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
8	(a)		starshade will block out light ☑ ☐ ☐ ☐ space telescope will be able to detect… ☑	[2]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
	(b)		Light pollution will not affect … ☑ ☐ ☐ Earth's atmosphere will not … ☑	[2]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
			Total	**[4]**	

Question			Expected answers	Marks	Additional guidance
9	**(a)**		200 m	**[1]**	
	(b)		speed = 4 Hz × 500 m = 2000 metres/second	**[2]**	correct answer with no working gets 2 marks **accept** 2km/s
	(c)		S-waves cause more damage (than P-waves) because the graph shows that S-waves are 'larger' / have greater amplitude (than P-waves) therefore they have more energy (than P-waves)	**[3]**	throughout, **credit** reverse argument for P-waves
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
10	**(a)**		A - asteroid B - Earth C - Sun D - Moon	**[2]**	all correct = 2 marks 2 or 3 correct = 1 mark 1 or 0 correct = 0 marks
	(b)		**any two from:** asteroids vary in size asteroids overlap in size with other objects there are other objects in the Solar System in this range of sizes	**[2]**	
			Total	**[4]**	

Assessment Objectives (AO) Grid

(includes quality of written communication ✐)

Question	AO1	AO2	AO3	Total
1(a)	2			**2**
1(b)	1			**1**
1(c)		2		**2**
2(a)	1	1		**2**
2(b)(i)		2		**2**
2(b)(ii)		1		**1**
2(b)(iii)		1	1	**2**
2(c)	1			**1**
3 ✐	5	1		**6**
4(a)	2			**2**
4(b)(i)		1		**1**
4(b)(ii)		1	1	**2**
4(b)(iii)		1		**1**
5(a)(i)		1		**1**
5(a)(ii)		1		**1**
5(b)(i)		1		**1**
5(b)(ii)		2		**2**
5(c)		4		**4**
6 ✐	6			**6**
7 ✐	4	2		**6**
8(a)	1	1		**2**
8(b)		2		**2**
9(a)		1		**1**
9(b)		2		**2**
9(c)			3	**3**
10(a)			2	**2**
10(b)			2	**2**
Totals	**23**	**28**	**9**	**60**

SPECIMEN **H**

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

A141/02

SCIENCE A

Unit A141: Modules B1, C1, P1 (Higher Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✐).
- A list of useful relationships is included on page 2.
- The number of marks for each question is given in brackets **[ ]** at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

For Examiner's Use		
	Max	**Mark**
1	**10**	
2	**9**	
3	**10**	
4	**6**	
5	**4**	
6	**6**	
7	**5**	
8	**7**	
9	**3**	
TOTAL	**60**	

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x current

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

Explaining Motion

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

momentum = mass x velocity

change of momentum = resultant force x time for which it acts

work done by a force = force x distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

Electric Circuits

power = voltage x current

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

Radioactive Materials

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

Answer **all** the questions.

1 Scientists think embryonic stem cells could be used to treat some illnesses for which there is currently no cure.

(a) Complete the sentences about stem cells.

Embryonic stem cells can develop into any kind of cell. Therefore, stem cells are

described as ....

During development of multi-cellular organisms, stem cells become

....

[2]

(b) Therapeutic cloning has been used to produce stem cells for the treatment of some disorders.

The flow chart illustrates the processes involved in therapeutic cloning.

Use the words provided to complete the flow chart.

Each word may be used once, more than once, or not at all.

adult **donor** **egg** **embryonic** **patient** **nucleus**

An egg cell from a donor has the .... removed.

A nucleus is taken from an adult body cell of the ....

These are combined and given an electric shock.

A mass of ……………………… stem cells is produced. The cells are genetically identical to the …………………………….. .

[2]

(c) The use of human embryos to produce stem cells has caused a lot of arguments and discussion.

Some people think that using stem cells from human **adults** would cause fewer arguments.

Discuss how using adult stem cells differs from using embryonic stem cells and why this might cause fewer arguments.

✐ *The quality of written communication will be assessed in your answer to this question.*

....

....

....

....

....

....

....

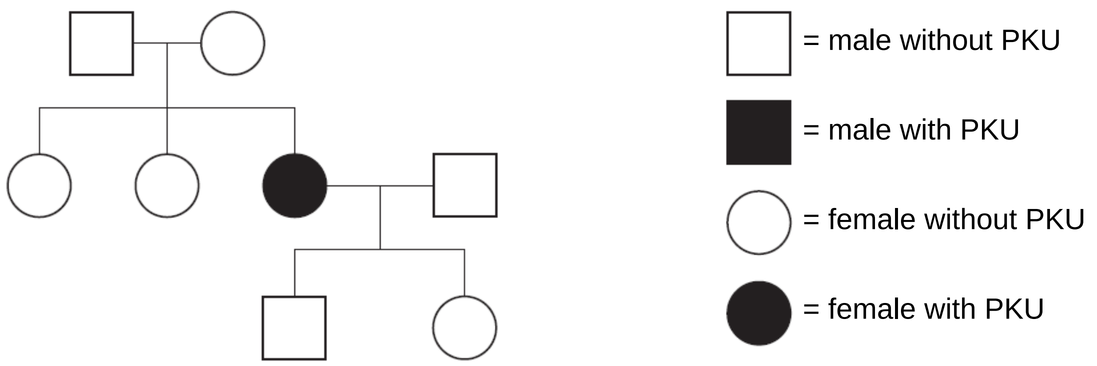
....**[6]**

[Total: 10]

2 Read the information about phenylketonuria (PKU).

PKU is an inherited disorder.
PKU is caused by a faulty gene.
A chemical called phenylalanine builds up in the bodies of people with PKU.
Too much phenylalanine causes serious health problems.
Serious health problems can be avoided with a controlled diet. The sooner this is started after birth, the less harm is caused.

(a) Look at the family tree.



Draw straight lines to link the correct **description** of the inheritance of PKU with the **two** correct **explanations.**

You should join **one** description with **two** explanations.

description

PKU is inherited in a similar way to cystic fibrosis.

PKU is inherited in a similar way to Huntington's disease.

PKU is inherited in a different way from cystic fibrosis and Huntington's disease.

explanation

Parents can be carriers of PKU.

PKU is caused by a dominant allele.

Parents cannot be carriers of PKU.

PKU is caused by a recessive allele.

[2]

(b) Use the example of PKU to describe the difference between an individual's genotype and his or her phenotype.

....

....

....

.... **[2]**

(c) Doctors estimate that between 1 in 10 000 and 1 in 12 000 babies born in the UK has PKU.

The Office for National Statistics reported that 710 000 babies were born in the UK in 2008.

(i) Estimate the lower and upper limits for the number of babies born in the UK in 2008 that you would expect to have PKU.

Show your working.

from .... to .... **[1]**

(ii) Testing a baby for PKU costs the NHS £6.

Estimate the upper and lower limits of the cost to the NHS of identifying one baby with PKU.

Show your working.

from £......................... to .... **[1]**

(iii) Doctors have said that it is right to test all babies for PKU even though it costs the NHS money. They concluded that the benefits of testing outweigh the cost.

Use the information about PKU and your answers to parts **(i)** and **(ii)** to suggest reasons why the doctors have come to this conclusion.

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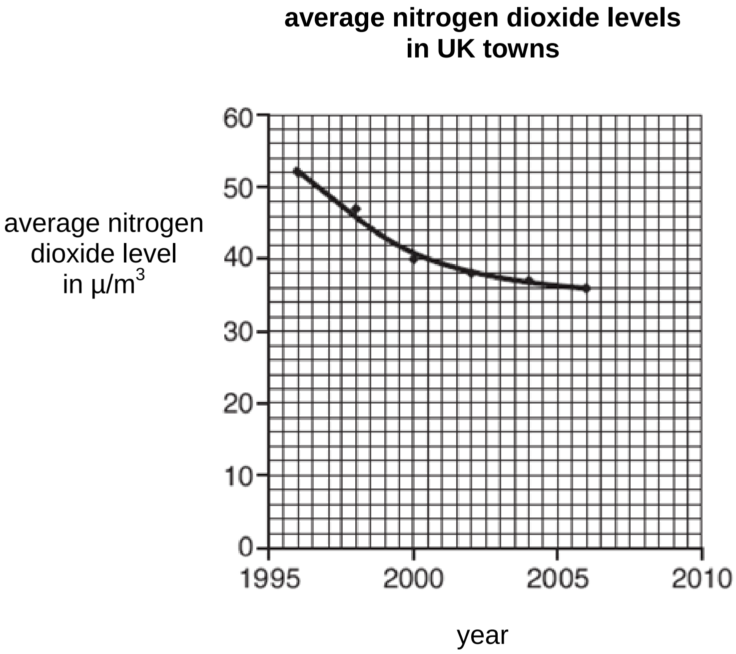
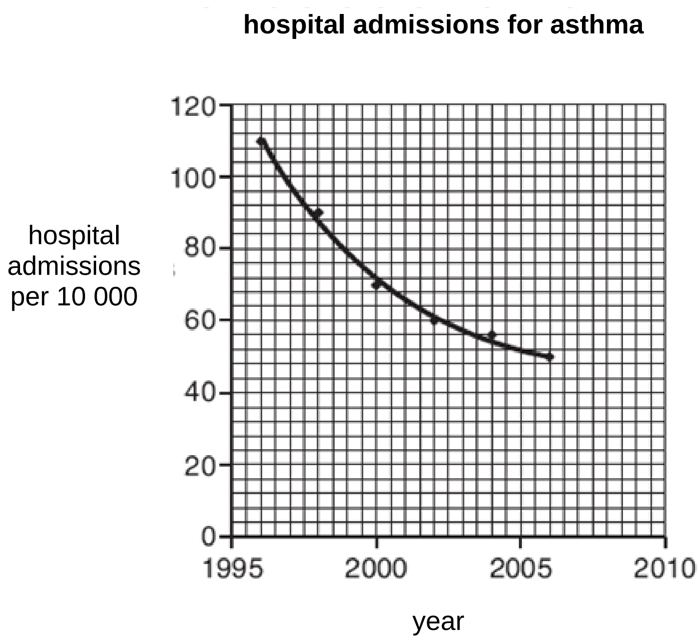
.... **[3]**

[Total: 9]

3 This question is about air pollution.

(a) The graphs show nitrogen dioxide pollution in the air and the number of hospital admissions for asthma between 1996 and 2006.





(i) What was the number of hospital admissions per 10 000 people when the average nitrogen dioxide level in towns reached 40 µg / m^3?

answer = ... **[1]**

(ii) Between 1997 and 2006 the number of hospital admissions for asthma halved.

What was the change in average nitrogen dioxide levels in that time?

answer = ... µg / m^3 **[1]**

(iii) Use the graphs to explain the difference between correlation and cause.

✐ *The quality of written communication will be assessed in your answer to this question.*

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(b) Between 1996 and 2006 the number of miles driven by motor vehicles in the UK increased by 50 %.

During this time, the amount of pollution by nitrogen dioxide decreased.

Here are five ways that pollution from vehicle exhausts could have been reduced.

1 manufacturing cars with more efficient engines

2 using low sulfur fuels

3 installing catalytic converters in cars

4 introducing congestion charges in cities

5 encouraging people to travel by public transport

Which of these ways would account for the **decrease** in nitrogen dioxide pollution even though the distance driven by vehicles **increased**?

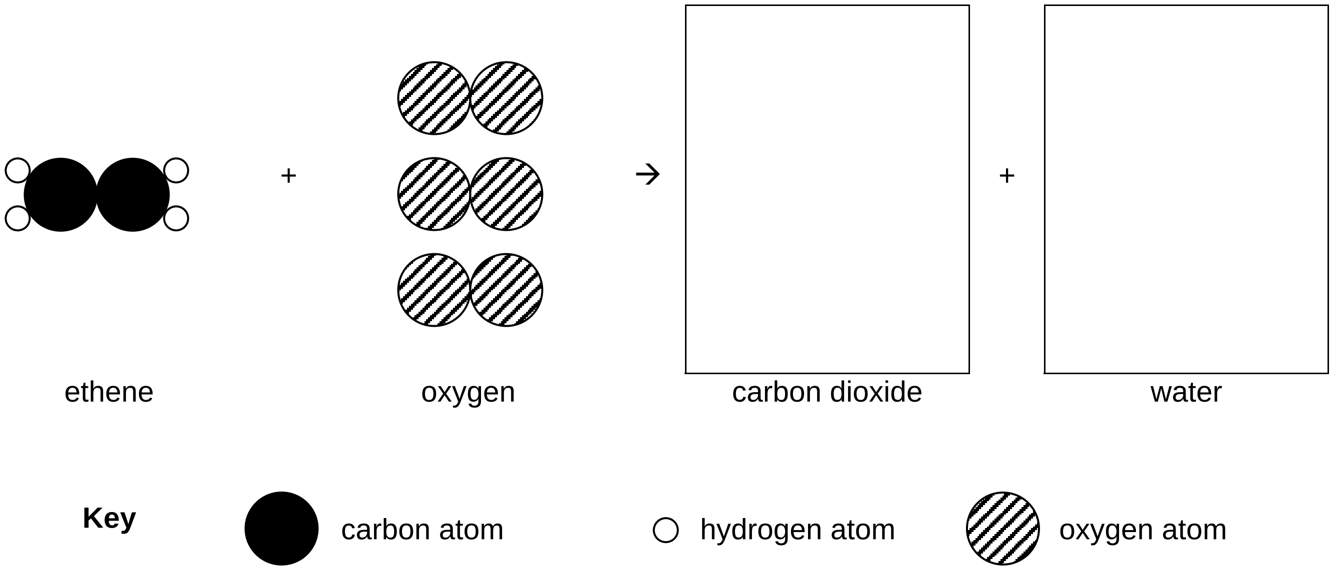
Write down the numbers of the two correct answers.

.... and .... **[2]**

[Total: 10]

4 **(a)** Ethene is a hydrocarbon. Ethene burns to make carbon dioxide and water.

Complete the diagram to show this reaction



[3]

(b) A scientist analyses the products of combustion of ethene.

He collects all the products of the reaction.

His results are shown in the table.

product	**mass in g**
carbon dioxide	82.0
water vapour	70.2
carbon monoxide	52.0
carbon	2.0
total	**206.2**

(i) What is the percentage by mass of carbon monoxide?

percentage by mass = ... % **[1]**

(ii) What can be concluded from these results about the conditions in which combustion occurred?

Explain your answer.

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.... **[2]**

[Total: 6]

5 The Earth's early atmosphere was formed by volcanic activity.

It consisted of water vapour and carbon dioxide, but no oxygen.

Explain how the amounts of carbon dioxide, water vapour and oxygen have changed from the Earth's early atmosphere to today's atmosphere.

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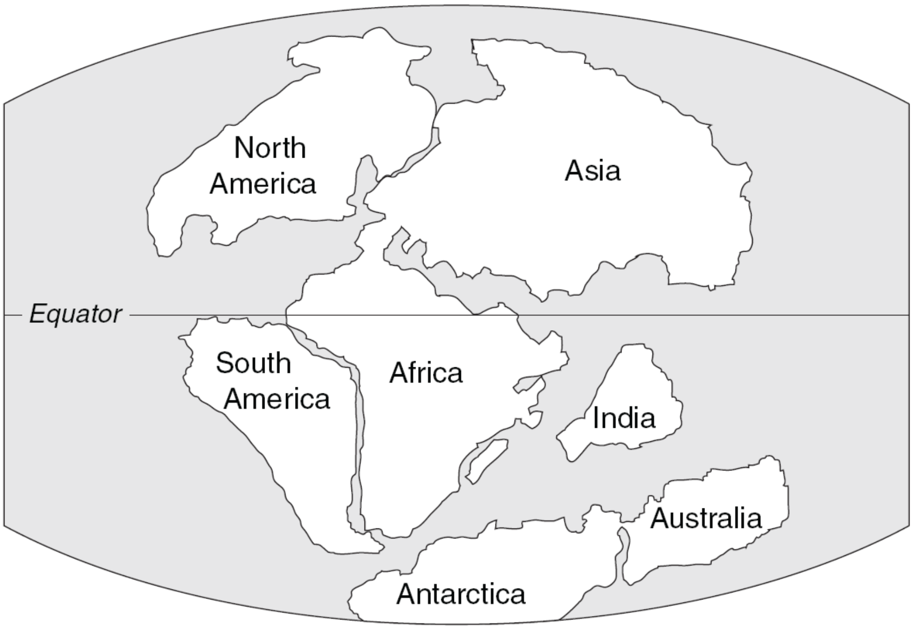
.... **[4]**

[Total: 4]

6 Wegener proposed his theory of continental drift in 1912.



Wegener's theory was not accepted by geologists when he first suggested it.

Wegener's theory became accepted in the 1960s.

Explain why Wegener thought the continents had moved, why geologists rejected his ideas, and how the theory became accepted.

✎ *The quality of written communication will be assessed in your answer to this question.*

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[Total: 6]

7 Read the article.

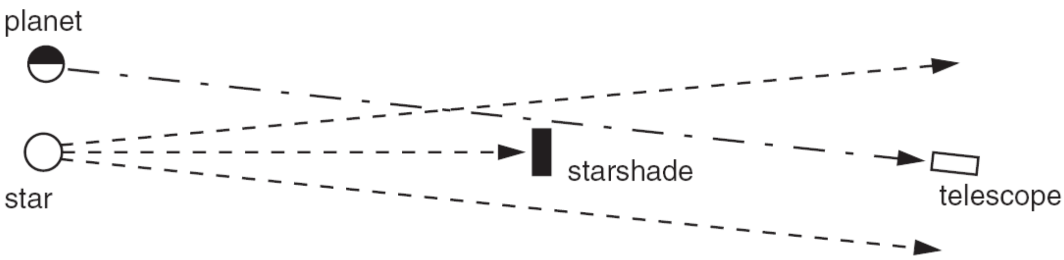
'Starshade' could help us see planets around other stars

An idea for an orbiting 'starshade' could help astronomers in the search for alien life.

The giant 'starshade' would be launched into space together with a space telescope, and would orbit the Earth at a distance of around 1 million kilometres. The 'starshade' and the telescope would be around 15 000 kilometres apart from each other.

Small thruster rockets, fired by remote control from Earth, would allow scientists to move the 'starshade' in front of a star they wanted the telescope to look at. The 'starshade' would allow light reflected from planets orbiting the star to be seen.

Scientists would be able to use the reflected light to analyse the planet's atmosphere for chemicals such as oxygen, water and methane. The presence of these chemicals could be interpreted as signs of life.



(a) Read the following statements.

Put a tick (✓) in the box next to each of the three correct statements.

The 'starshade' will block light from certain stars. ☐

The 'starshade' will be fixed to a space telescope. ☐

The 'starshade' is designed to block light from distant planets. ☐

The telescope is designed to study planets in our Solar System. ☐

The light from a planet is much dimmer than the light from its star. ☐

The light from a distant planet may show the gases in its atmosphere. ☐

[3]

(b) Most telescopes are on the Earth's surface.

This telescope and 'starshade' will be put into orbit a long way from the Earth.

Which of these statements are correct reasons for doing this?

Put a tick (✓) in the box next to each of the **two** correct statements.

There will be no light pollution. ☐

The 'starshade' will not corrode or rot. ☐

Telescopes do not need power to stay in orbit. ☐

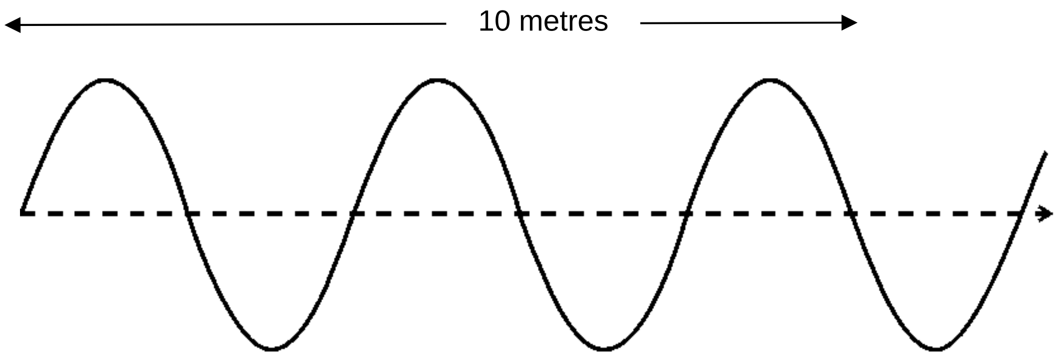
They will be closer to the distant planets that they need to observe. ☐

The Earth's atmosphere absorbs part of the electromagnetic spectrum. ☐

[2]

[Total: 5]

8 The diagram shows a wave.



(a) Calculate the wavelength of this wave.

wavelength = ... m **[1]**

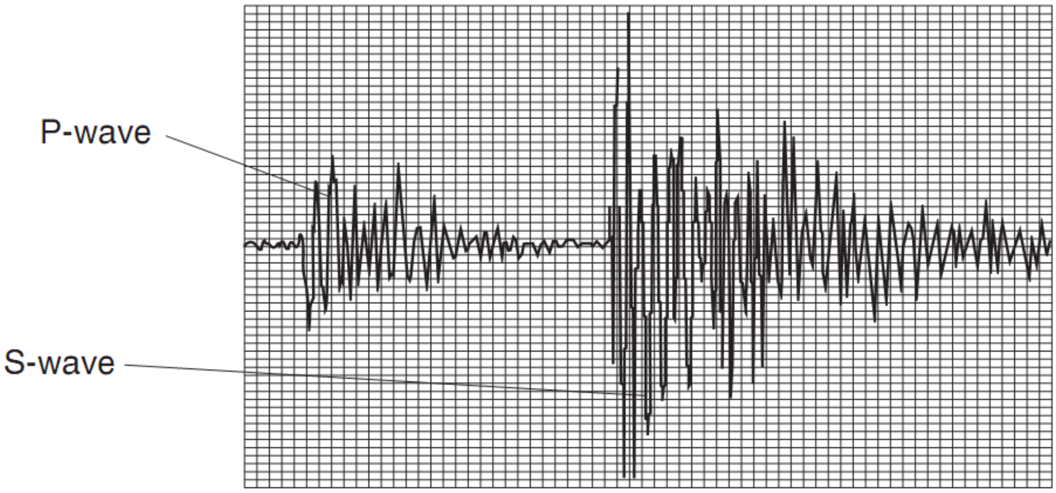
(b) Another wave has a wavelength of 5 metres.

Calculate its frequency if it has a speed of 4 m/s.

frequency = ... Hz **[2]**

(c) The diagram shows a recording from an earthquake detector.

It has detected a P-wave and an S-wave from an earthquake.



The P-wave travels at a speed of 8000 m/s, and the S-wave travels at 3000 m/s.

The two waves started at the same time from an earthquake 360 km away from the detector.

(i) Calculate the delay time between the arrival of the two waves at the detector.

delay = ... s **[2]**

(ii) Use the graph to explain why the delay between the arrival of the two waves can help save lives in the event of an earthquake.

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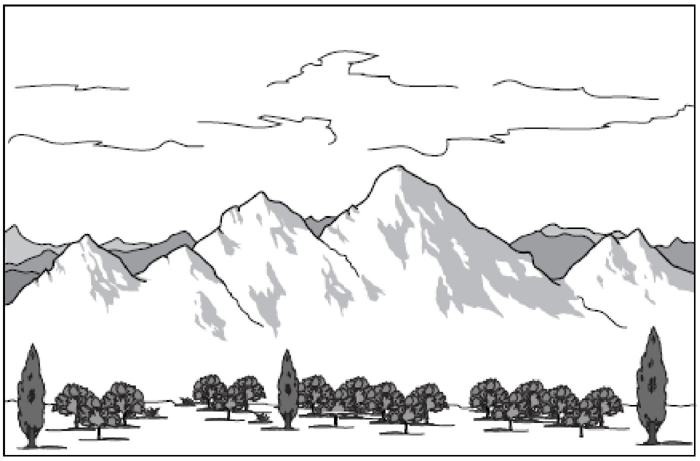
.... **[2]**

[Total: 7]

9 Scientists think that mountains must be forming all the time.



Some of the statements below are used to explain this.

A Mountains are part of the Earth's crust.

B Erosion causes mountains to be worn down.

C The Earth is older than its oldest rocks.

D If no new mountains were formed, the continents would be flat.

E Mountains exist today.

F Mountains are only formed on drifting continents.

Three of the statements, when taken together, explain why mountains must be forming all of the time.

Write down the letters of these statements.

.... and .... and .... **[3]**

[Total: 3]

[Paper Total: 60]

END OF QUESTION PAPER

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OCR
RECOGNISING ACHIEVEMENT

SPECIMEN **H**

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

SCIENCE A **A141/02**

Unit A141: Modules B1, C1, P1 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 16 pages

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.
2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.
3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).
4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant - applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)
work done = 0 marks
work done lifting = 1 mark
change in potential energy = 0 marks
gravitational potential energy = 1 mark

5. Annotations:
The following annotations are available on SCORIS.

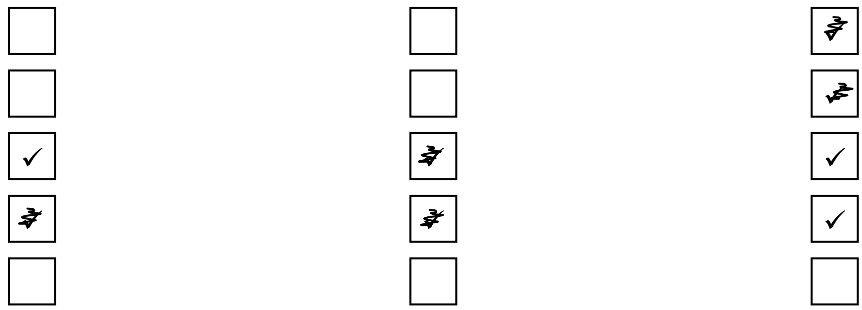
✓	=	correct response
×	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt <u>**not**</u> given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.

Eg
For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes. | Put ticks (✓) in the two correct boxes. | Put ticks (✓) in the two correct boxes.



This would be worth 0 marks. | This would be worth one mark. | This would be worth one mark.

8. The list principle:
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:

Always check the additional guidance.

If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.
If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.
Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.

Eg If a question requires candidates to identify a city in England, then in the boxes

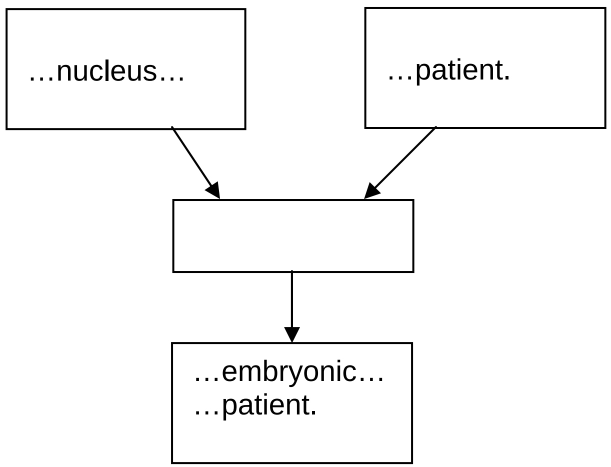
Edinburgh	
Manchester	
Paris	
Southampton	

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

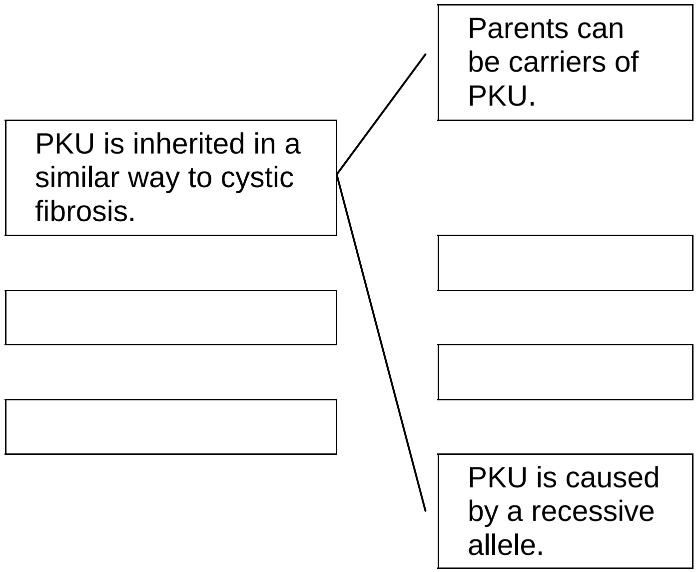
Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**NR**

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:

- Read the question in the question paper, and then the list of relevant points in the ‘Additional guidance’ column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
- Read the level descriptors in the ‘Expected answers’ column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
- *For a general correlation between quality of science and QWC*: determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
- *For high-level science but very poor QWC*: the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
- *For very poor or totally irrelevant science but perfect QWC*: credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.

Question			Expected answers	Marks	Additional guidance
1	(a)		non-specialised / unspecialised / undifferentiated / pluripotent / totipotent specialised / differentiated	[2]	**accept** “cells without a job”
	(b)			[2]	all three boxes correct = 2 marks two boxes correct = 1 mark

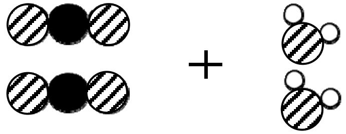
Question			Expected answers	Marks	Additional guidance
1	(c)		**[Level 3]** Answer clearly explains how adult stem cells differ from embryonic stem cells **and** gives several examples of why using adult SCs may cause arguments **and** makes a valid suggestion as to why using adult stem cells may cause **fewer** arguments than using embryonic stem cells. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer omits one of the required three sections **OR** considers all three sections but lacks detail/examples. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer only considers one or two of the sections and lacks detail/examples **OR** refers to “ethical issues” without explaining what the issues are. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**accept** “ASC” for adult stem cells, and “ESC” for embryonic stem cells **relevant points include:** *adult stem cells are different from embryonic stem cells because they* • are taken/made from adult tissues • (are unspecialised but) can only develop into a limited range of cell types **accept** examples of adult stem cells, e.g. from bone marrow *using adult stem cells may cause some arguments because* • it is ‘playing God’ / religious objection / some actions are wrong whatever the consequences • may lead to reproductive cloning • issue of obtaining informed consent from patient (e.g. brain damaged patient) • benefit(s) may not outweigh arguments against *using adult stem cells may cause fewer arguments than using embryonic stem cells because* • patient can give consent (whereas embryo cannot) • no embryos are killed/wasted **accept** “not wasting a life” **ignore** arguments based on cost
			Total	**[10]**	

Question			Expected answers	Marks	Additional guidance
2	(a)			**[2]**	choice of only top left box = 1 mark any line from the top left box indicates the candidates choice then look at the right hand boxes to award second mark **both** top and bottom “explanation” boxes selected = 1 mark no extra boxes allowed
	(b)		genotype is the two alleles inherited for PKU eg Pp or pp or PP phenotype is what characteristic is shown eg whether or not an individual has PKU	**[2]**	**accept** any letter for alleles **reject** reference to phenotype being the showing of <u>symptoms</u> (as a phenotype could equally be the presence of a non-symptomatic disease)
	(c)	(i)	59 to 71	**[1]**	
		(ii)	£60 000 to £72 000	**[1]**	**allow** 2 marks for correct answer without working shown look for error carried forward

Question			Expected answers	Marks	Additional guidance
2	**(c)**	**(iii)**	idea that benefits outweigh costs one life worth more than £60 000-£72 000 / 59-71 lives improved/owtte each year can start treatment very early to limit damage / this saves (NHS) money in the long run (because it is expensive to treat people who get ill due to PKU) / idea that parents have the right to know or can start preparing for child with PKU	**[3]**	**accept** some actions are right whatever the cost **allow** ecf from part **(i)** and **(ii)** **accept** any numbers in range
			Total	**[9]**	

Question			Expected answers	Marks	Additional guidance
3	(a)	(i)	70	[1]	**allow** any answer between 68 and 72
		(ii)	(decrease) of 13 μg/m^3	[1]	**allow** any answer between 11 and 15
		(iii)	**[Level 3]** Answer explains the difference between correlation and cause, and correctly identifies the correlation shown by the graphs. Explains clearly that nitrogen dioxide could be a cause of asthma or asthma could be caused by other factors and that more information is needed to be sure. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer does not clearly explain the difference between correlation and cause, but correctly identifies the correlation shown by the graphs. Explains that nitrogen dioxide could or could not be a cause of asthma. Understands that more information is needed to be sure. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer identifies a link shown by the graphs. Explains that nitrogen dioxide may not be a cause of asthma. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • a correlation is present when an outcome changes as an input (factor) changes / OWTTE • graphs show a (positive) correlation between levels of nitrogen dioxide in the air and hospital admissions for asthma. • as nitrogen dioxide decreases hospital admissions for asthma decrease • a correlation does not necessarily indicate a causal link • a causal link needs a known mechanism linking the input factor and the outcome / OWTTE • nitrogen dioxide in the air is a plausible cause of asthma, but need to know how it causes asthma to be sure • asthma could be caused by other factors that need to be investigated

Question			Expected answers	Marks	Additional guidance
3	(b)		1 3	[2]	either order
			Total	**[10]**	

Question			Expected answers	Marks	Additional guidance
4	(a)			[3]	1 mark for correct drawing of CO_2 molecule 1 mark for correct drawing of water molecule 1 mark for 2 CO_2 and 2 water molecules
	(b)	(i)	25.2	[1]	
		(ii)	there was a lack of oxygen since carbon monoxide and carbon were produced due to incomplete combustion	[2]	for full marks the explanation must be linked to the conclusion
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
5			water decreased because Earth cooled and water condensed into oceans CO_2 decreased by photosynthesis and CO_2 also decreased by dissolving in oceans/formation of fossil fuels oxygen increased through photosynthesis	[4]	
			Total	**[4]**	

Question			Expected answers	Marks	Additional guidance
6			**[Level 3]** Includes most relevant points in each category in the answer. Explains Wegener's ideas, objections to his theory, and further evidence in terms of a causal mechanism. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Will outline Wegener's ideas with some evidence, and make reasonable suggestions why his contemporaries did not accept it. The idea of a mechanism for continental drift likely to be absent. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Will outline Wegener's ideas with little supporting evidence. Objections by contemporaries likely to be personal rather than scientific. 1960s evidence likely to be missing. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** *Wegener's evidence* • continents 'fit together' • similar rock layers in different continents • similar fossils in different continents *his contemporaries' objections* • Wegener was an outsider/not a geologist • no continental movement detectable • existing theories (land bridges) explained fossils • no mechanism proposed for movement *for subsequent acceptance* • idea that a plausible mechanism is reasonable grounds for accepting the theory • sea-floor spreading provided a mechanism • movements in mantle as underlying cause **accept** description of magnetic stripes on seabed as evidence for seafloor spreading **ignore** references to mountain chains, unless specifically to chains on the West coast of North and South America **reject** objections to Wegener based on personality
			Total	**[6]**	

Question			Expected answers		Marks	Additional guidance
7	(a)		starshade will block light …	✓	[3]	
				☐		
				☐		
				☐		
			light from a planet is much …	✓		
			light from a distant planet …	✓		
	(b)		there will be no light …	✓	[2]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
				☐		
				☐		
				☐		
			the Earth’s atmosphere …	✓		
			Total		**[5]**	

Question			Expected answers	Marks	Additional guidance
8	(a)		wavelength = 10 m / 2.5 = 4 m	[1]	correct answer with no working gets 2 marks division of 10 m by an incorrectly counted number of wavelengths gets 1 mark is done consistently
	(b)		frequency = speed/wavelength = 4 m/s ÷ 5m = 0.8 Hz	[2]	correct answer with no working gets 2 marks
	(c)	(i)	time taken for P-wave to arrive = 360 000 m / 8000 m/s = 45 s time taken for S-wave to arrive = 360 000 m / 3000 m/s = 120 s, therefore the delay = 120 s – 45 s = 75 s	[2]	if distances and speeds correctly converted to compatible units but one arithmetic slip made, then allow 1 mark
		(ii)	P-wave has lower amplitude than S-wave so will cause less damage therefore the early arrival of the P-wave gives a warning that allows people time to take precautions before the more damaging S-wave arrives	[2]	for ‘take precautions’, accept any reasonable action that could be completed in 75 seconds, e.g. escape from building / get under table/doorway / switch off gas appliance / etc.
			Total	**[7]**	

9			**B** **D** **E**	[3]	any order
			Total	**[3]**	

Assessment Objectives (AO) Grid

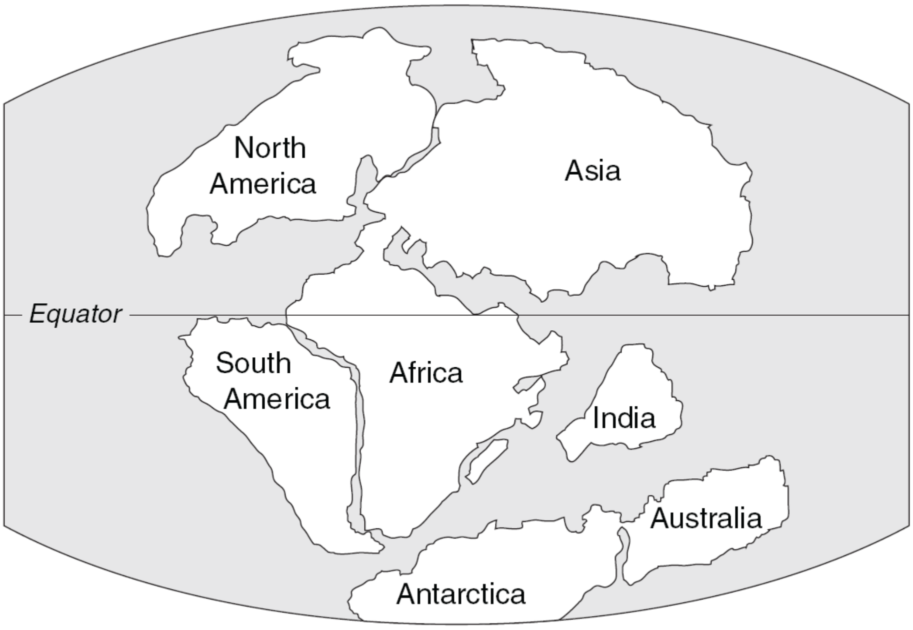
(includes quality of written communication ✎)

Question	AO1	AO2	AO3	Total
1(a)	2			**2**
1(b)	2			**2**
1(c) ✎	2	3	1	**6**
2(a)	1	1		**2**
2(b)	1	1		**2**
2(c)(i)		1		**1**
2(c)(ii)		1		**1**
2(c)(iii)		1	2	**3**
3(a)(i)		1		**1**
3(a)(ii)		1		**1**
3(a)(iii) ✎		3	3	**6**
3(b)	1	1		**2**
4(a)	2	1		**3**
4(b)(i)		1		**1**
4(b)(ii)	2			**2**
5	4			**4**
6 ✎	4	2		**6**
7(a)	2	1		**3**
7(b)	1	1		**2**
8(a)		1		**1**
8(b)		2		**2**
8(c)(i)		2		**2**
8(c)(ii)			2	**2**
9	2	1		**3**
Totals	**26**	**26**	**8**	**60**

Specimen candidate answers

Answer **all** the questions.

1 Wegener proposed his theory of continental drift in 1912.



Wegener's theory was not accepted by geologists when he first suggested it.

Wegener's theory became accepted in the 1960s.

Explain why Wegener thought the continents had moved, why geologists rejected his ideas, and how the theory became accepted.

✐ *The quality of written communication will be assessed in your answer to this question.*

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.... **[6]**

[Total: 6]

Question			Expected answers	Marks	Additional guidance
1	✎		**[Level 3]** Includes most relevant points in each category in the answer. Explains Wegener's ideas, objections to his theory, and acceptance following further evidence in terms of a causal mechanism. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Outlines Wegener's ideas with some evidence, and make reasonable suggestions why his contemporaries did not accept it. The idea of a mechanism for continental drift likely to be absent. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Outlines Wegener's ideas with little supporting evidence. Objections by contemporaries likely to be personal rather than scientific. 1960s evidence likely to be missing. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** Wegener's evidence: • continents 'fit together' • similar rock layers in different continents • similar fossils in different continents His contemporaries' objections: • Wegener was an outsider/not a geologist • no continental movement detectable • existing theories (land bridges) explained fossils • no mechanism proposed for movement For subsequent acceptance: • idea that a plausible mechanism is reasonable grounds for accepting the theory • sea-floor spreading provided a mechanism • movements in mantle as underlying cause **accept** description of magnetic stripes on seabed as evidence for seafloor spreading **ignore** references to mountain chains, unless specifically to chains on the West coast of North and South America **reject** objections to Wegener based on personality
	✎		**Total**	**6**	

Example A

They rejected him because he wasn't a geologist, he was a farmer. They also thought bridges could link the continents which would have explained the fossils. Then they also thought there was no evidence for continents moving. He thought the continents once were together because they seemed to fit together. Also Similar rocks and fossils are found on different continents seemed to link up. They eventually believed him because he explained sea floor spreading.

[6]

[Total: 6]

Commentary:
The candidate suggests Wegener's ideas were rejected because he was a farmer (not a geologist) and possible land bridges as an alternative explanation for fossils. Fossil matching, rock matching and jigsaw fit are clearly presented as supporting the theory. The candidate identifies sea floor spreading as additional data that can be explained by Wegener's idea. All ideas are clearly presented using correct scientific language. Hence level 3. However there is no explicit mention of a mechanism, although it is implicit so 5 marks awarded.

Verdict:
Level 3
5 marks

Example B

Because similar fossils were found around different continents coast lines, they rejected his ideas because they couldn't see the continents moving, it later become ~~&~~ accepted when sea-floor spreading and moving of the mantle were discovered.

[6]

Commentary:
The candidate identifies the lack of direct evidence of continental movement as the key scientific objection to Wegener's theory. This is linked to sea floor spreading and movement in the mantle providing the additional required evidence. The candidate only gives fossil matching as evidence presented by Wegener. Overall the science is presented briefly with limited examples, in one sentence - Hence level 2. The correct implicit identification of the importance of a mechanism suggests 4 marks.

Verdict:
Level 2
4 marks

Example C

He found similar fossils in differen ~~cotu~~ continents and ~~all~~ they all fit together like a jigsaw (pangaea). They rejected his ideas because he was a farmer and people accepted his theory because some othe scientist came up with seafloor speading.

[6]

Commentary:
The candidate has mentioned fossil matching and jigsaw fit. Suggests ideas rejected because he was a farmer (not a geologist) and identifies sea floor spreading as additional evidence supporting Wegener's theory. Ideas are presented clearly, if a little briefly. However there is no mention of a mechanism. Hence Level 2. The lack of scientific arguments against Wegener's theory and the rather bald statement about sea floor spreading suggest only 3 marks.

Verdict:
Level 2
3 marks

Example D

Wegner thought that the continents had moved because he found fossils on continents that looked like they would fit together these fossils were the same. Geologists rejected his idea because he was not one of them and there was no evidence. Scientists found evidence and explained how it happened so the theroy was accepted.

[6]

Commentary:

The candidate may be referring to both jigsaw fit and matching fossils in the first sentence, the idea that Wegener was not a geologist is included, but also states there was no evidence which contradicts the first statement. The final sentence may be suggesting that a mechanism was found, but the evidence is not identified. Overall the expression of ideas is very poor - Hence level 1, but the basic science is correct so 2 marks.

Verdict:
Level 1
2 marks

Example E

The Earth is bigger than the diagram. But i'll overlook that... Wegener thought this, as the ~~planets~~ continents all fit together (PANGAEA) and identical fossils were found on different continents. That is would have fit together in PANGAEA.

[6]

Commentary:

Ideas of jigsaw fit and matching fossils are present, but no mention of rejection or later discoveries. Initial comment is irrelevant and ideas are expressed with poor punctuation. Hence level 2 - 1 mark.

Verdict:
Level 1
1 mark

Example F

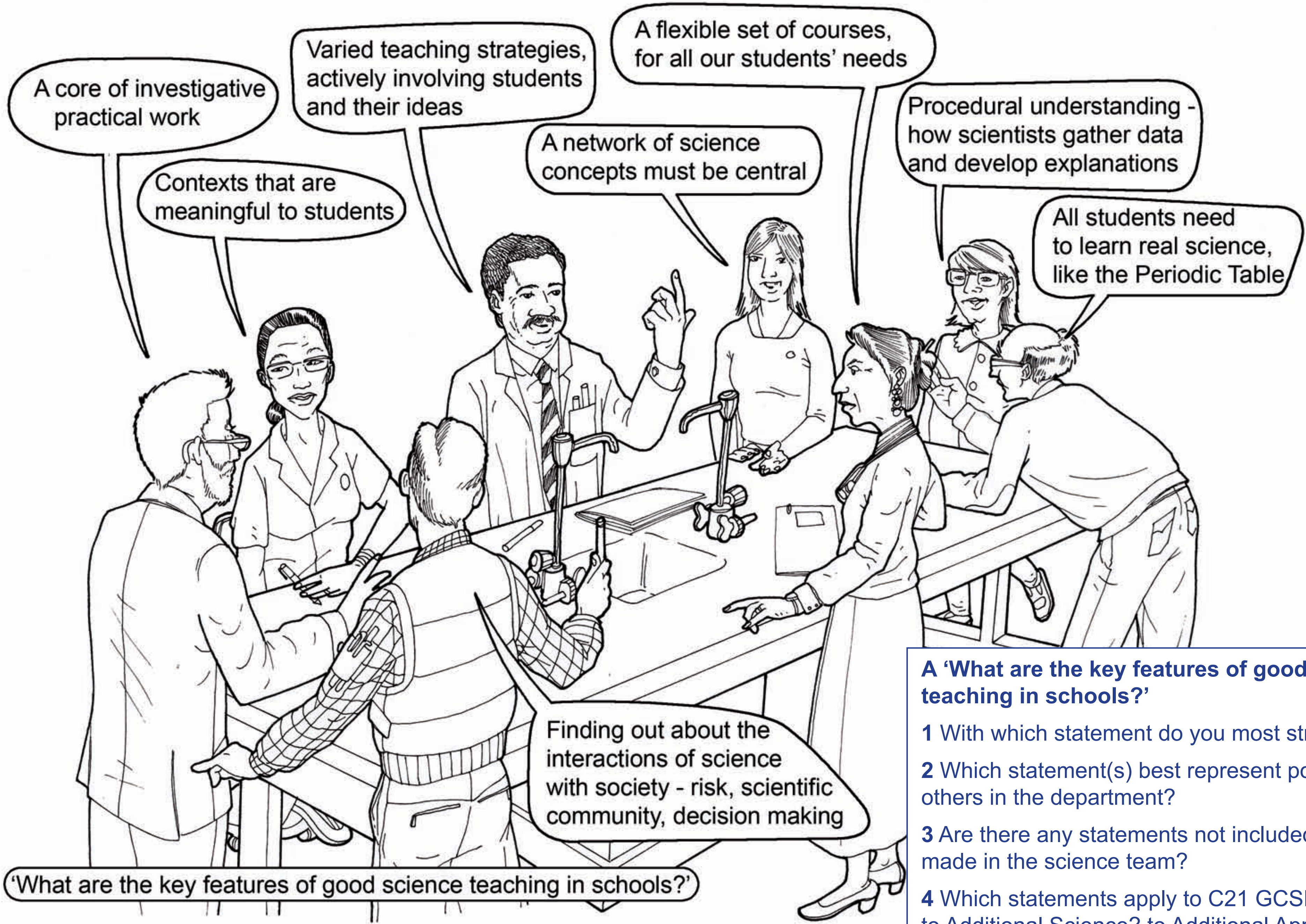
Because ~~they~~ scientists have taken samples of rocks from two ~~di~~ opplsite sides of the Earth & have shown that ~~bot~~ the rocks that cane from South America & Australia were identical.

[6]

Commentary:

Idea of matching rocks vaguely expressed with an incorrect sample. Insufficient science for any marks. Hence level 0.

Verdict:
Level 0
0 marks



A 'What are the key features of good science teaching in schools?'

1 With which statement do you most strongly identify?

2 Which statement(s) best represent positions held by others in the department?

3 Are there any statements not included that might be made in the science team?

4 Which statements apply to C21 GCSE Science? to Additional Science? to Additional Applied Science? to the Separate Sciences?

Twenty First Century Science • Discussion questions for teachers B

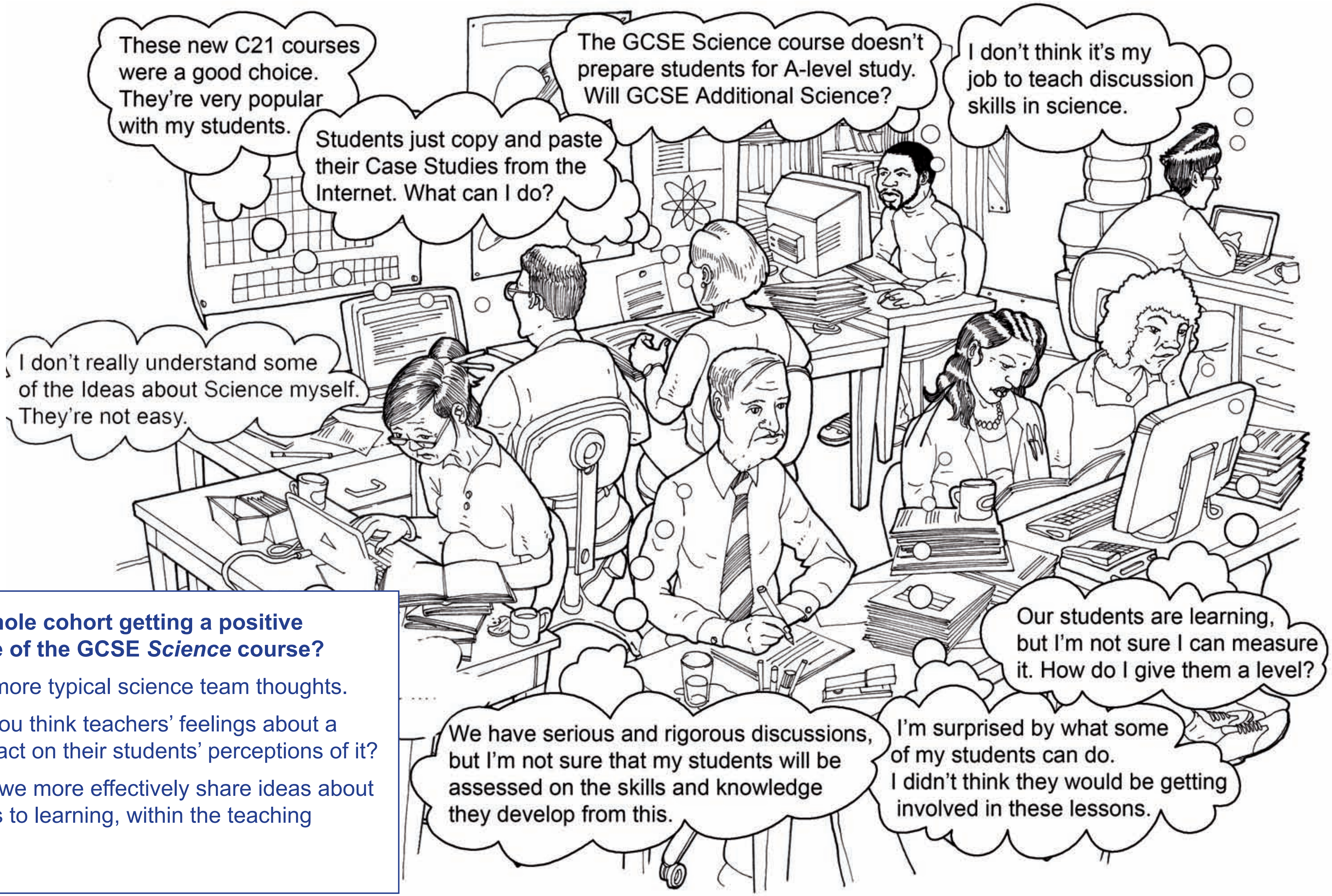
B 'What is science education for?'

1 Write down the names of three very different kinds of students you are teaching this year.

2 Briefly characterise the view of science that each has.

3 What proportion of your students generally goes on to study sciences post-16? What value does science education have for those with other interests?

4 How important do you think it is that students enjoy their experience of science at school?



C Is the whole cohort getting a positive experience of the GCSE *Science* course?

1 Add two more typical science team thoughts.

2 How do you think teachers' feelings about a course impact on their students' perceptions of it?

3 How can we more effectively share ideas about approaches to learning, within the teaching team?

TWENTY FIRST CENTURY science

Stepping stones
Activities for teaching
IDEAS ABOUT SCIENCE
2011 edition

CONTENTS

ACKNOWLEDGEMENTS

The activity ideas in this pack were developed by teachers attending Twenty First Century Science conferences in 2007 and 2008.

Editors Jenifer Burden, Emma Palmer

Contributors

A Jabbar Al-Sadoon, Derek Anderson, Lisa-Jane Armstrong, John Barker, Karen Barnett, Heather Beezley, Ian Bennett, Marie Berry, David Boddaert, Howard Boycott, Chris Brown, Dennis Brown, Harry Brown, Ian Browne, Alesha Campbell, Tony Canavan, David Corbett, Ian Coulson, Jennifer Cullen, Richard Davies, Bharati Desai, Mike Dobbyn, Yvette Douglas, John Dunai, Rosemary Dunnill, Philip Eades, Richard Eason, Edosa Egharevba, Heather Ellwood, Graham Ferguson, Richard Folk, Kay Forbes, Caroline Forster, Douglas Forteath, Paul Furey, Peter Gardner, Christina Garry, Howard Gee, Helen Geeson, Mike Gibbons, Janet Gibbs, David Gibson, Gill Greaves, Colleen Halliday, Nicola Halstead, Catherine Harding, Mark Harrison, Shauna Hennigan, Mike Hill, Michelle Hollingsworth, Jennifer Horay, Adam Horbik, Keith House, Peter Hunt, Mike Johnson, Helen Jones, Rob Jones, Alison Knowles, Martin Landles, Simon Layfield, Andrew Lee, Sarah Lee, Tima Lund, Vera Martin, Baljit Marwa, Sara Mashiri, Gerry Michaud, Liz Nastys, Dan Nicholl, Stephen Nixon, Terry O'Dea, Charlotte Partridge, Gillian Plimley, Liz Pountney, Julie Pritchard, Robert Radcliffe, Lorretta Reid, Debbie Rigby, Jane Rothman, Jim Rounsley, Joanne Sampson, Steven Scale, James Shutt, Chris Simcoe, Duncan Sloan, Vicky Smith, Anthony Snowden, Helen Stevens, Jane Storey, Mark Swallow, Mark Sykes, Angela Thorpe, Leslie Thurnell, Nick Tindall, Kathleen Todd, Caroline Tolchard, Janet Turner, Martin Walker, Helen Wall, Adrian Waltho, Patrica Ward, William Ward, Amanda Waterton, John Watson, Alastair West, Jane Wheeler, Phil White, Bethan Williams, Catherine Wilson, Michele Wilson, Sarah Wolkowski,

INTRODUCTION

Twenty First Century Science is an OCR suite of GCSE science specifications:

- Entry Level
- GCSE Science A
- GCSE Additional Science A
- GCSE Biology A
- GCSE Chemistry A
- GCSE Physics A

Learning science is not just about gaining some knowledge and understanding of the behaviour of the natural world. Learners also need to gain some understanding of the processes of scientific enquiry. They need to be able to reflect on scientific knowledge itself, including:

- the practices that have produced it;
- the kinds of reasoning that are used in developing a scientific argument; and
- on the issues that arise when scientific knowledge is put to practical use.

All of this is called 'How Science Works' in the National Curriculum and 'Ideas about Science' in Twenty First Century Science.

The GCSE Science A, GCSE Additional Science A, GCSE Biology A, GCSE Chemistry A and GCSE Physics A specifications identify six key Ideas about Science:

- IaS1 Data: their importance and limitations
- IaS2 Cause-effect explanations
- IaS3 Developing scientific explanations
- IaS4 The scientific community
- IaS5 Risk
- IaS6 Making decisions about science and technology

The materials in this booklet were produced by groups of teachers participating in 90-minute workshops. The purpose of the workshops was to identify simple ways in which the key concepts of each IaS could be presented to students, through either non-science or science-based contexts.

These activities are designed to stimulate students' thinking about particular Ideas about Science; to generate discussion about the importance of understanding Ideas about Science; and to build students' confidence in their grasp of Ideas about Science, so they may apply this understanding to new areas of science as they meet them.

Colleagues may wish to use these activities as starting points for their own lesson ideas. New activity ideas are welcome. Please email your suggestions to uyseg-c21@york.ac.uk.

Each activity is presented as explanatory notes for teachers, and may be accompanied by student sheets if required.

IaS1 Data their importance and limitations

Activity 1.1 Class attendance

Non-science context data can be used to teach the key concepts of data and its limitations. When these ideas are secure students can apply them to scientific data.

Non-science data presented to students must allow for the discussion of **outliers, mean** and **range**.

Possible learning outcomes

- I can calculate the mean, and find the range, of a set of repeated measurements.
- I can identify outliers in a set of data.
- I can compare two sets of data and use the means and ranges to comment on how similar or different they are.

Suggested approach

a Provide students with names and attendance data (in %) for a class (this can be fictional data).

b Students identify outliers, calculate range and mean, and generate a graph using Excel.

c Compare class data with data for different days and/or national data.
(National annual absence data is available from www.education.gov.uk/schools/pupilsupport/behaviour/attendance/schoolattendancedata/a009991/absence-data and www.education.gov.uk/performancetables/schools_10.shtml).

d Suggest reasons for differences between different data sets, e.g. particular day / date (potential to link with IaS2).

Activity 1.2 Sprint speed

Possible learning outcomes

- When I measure the same thing several times, the results may be different. I can give reasons for this.
- I can explain why repeating measurements of something will give me a better idea of what its real value is.

Suggested approach

a Give students the following information:

"An athlete runs the 100m sprint in 11.54 seconds on Monday, and then

12.02 seconds on Wednesday.”

Give pairs of students three minutes to predict what his time will be in the actual race on Saturday.

b Then give pairs 5 to 10 minutes to compare their prediction with another pair and:

i agree on a consensus view
ii say how confident they are about the prediction
iii explain why they feel more or less confident.

Facilitate the work of these groups of 4, and note those who make points related to the activity’s outcomes.

c Ask the spokesperson for some of the groups of four to feed back, drawing out key ideas. For example, there may be opportunities to discuss ideas of data, such as importance of replication of data, how we may decide when enough data are enough, influence of other variables, and determining the best estimate of a true value.

IaS2 Cause-effect explanations

Activity 2.1 Traffic accidents

Possible learning outcomes

- I can give an example of a correlation between a factor and an outcome.
- I can explain why a correlation between a factor and an outcome does not necessarily mean that the factor causes the outcome.

Suggested approach

a Ask students: What colour car are you most likely to have an accident in?
In small groups, give students three minutes to discuss and reach a consensus (maybe one or two colours).

b Teacher presents data from the Internet suggesting that there is a correlation between car colour and accident rate.
(Data is available at www.bbc.co.uk/northernireland/oyb/transport_travel/car_colour.shtml)

c Students return to groups and suggest:

i a reason why this pattern exists
ii a counter argument to this reason
iii what further information they would need to feel more confident that having, for example, a silver car, *caused* you to have more accidents than other colour cars

c Draw out idea of *correlation* (link between two factors) and *cause* (where there is evidence for a mechanism for how one factor could affect another).

Further information

www.theaa.com/cbg/goodadvice/commongoodadvice.jsp?menu1=0&menu2=1&fileName=colour suggests there is no evidence for a correlation between car colour and accident rate.

Activity 2.2 Football league tables

This activity also provides opportunity to practice data analysis techniques (*IaS1 Data and its limitations*).

Possible learning outcomes

- I can give an example of a correlation between a factor and an outcome.
- I can identify where a correlation exists when data are presented in a table or as a graph.

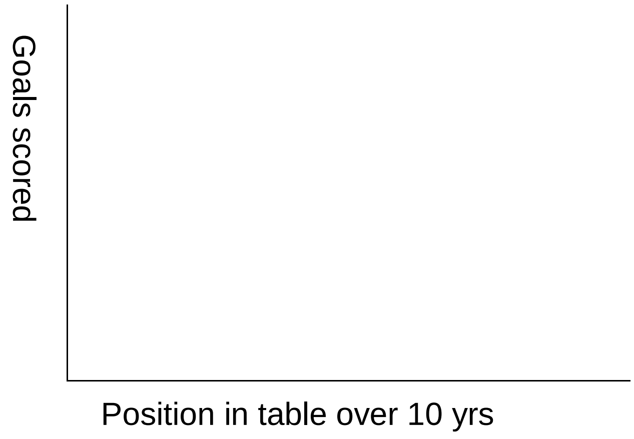
Suggested approach

a Provide students with football league table data for the start of a season, predictions for how particular teams will do in that season, and data from the end of the season.

b Students look for correlations within the data:

- Do teams which have scored more goals have a better position in the league table?
- Do teams which win more away games have a better position in the league table?
- Are there any other correlations that they think may be important?

c Provide students with data for several years. Ask them to use this to determine what does affect a team's final position. They could plot10 years of data on a graph such as that below, and find the mean and range, and spot outliers.



d Different groups could repeat the exercise for different areas of the table, e.g. top 5, middle 5, bottom 5.

ACTIVITY 2.3 FOOTBALL PLAYERS

Possible learning outcomes

- I can identify where a correlation exists when data are presented in a table or as a graph.
- I can explain why a correlation between a factor and an outcome does not necessarily mean that the factor causes the outcome.
- When there is a correlation between two sets of data I know that a mechanism is needed to explain how it happens, if I am to conclude that there is a causal link.

Suggested approach

a In pairs students collect data for one or more of the following variables at several football clubs:

- cost of individual players (for one particular club)
- position played by a player (for one particular club)
- salary of individual players (for one particular club)
- average salary of players (for all clubs in a league)
- size of ground (for all clubs in a single league)
- league position (for all clubs in a single league)
- number of goals scored per game (for all clubs in a single league)
- cost of season ticket (for all clubs in a single league)

b Pairs join together into groups of four and each group plots scatter graphs of data between two particular variables, e.g. cost of individual players vs salary of individual players, position in league vs size of ground. Students identify correlations.

c Ask students to suggest a mechanism (how it happens) for each correlation, which could be supported by data from further investigations. Emphasise that without a mechanism for how factor X causes factor Y, we cannot say that this is more than a correlation.

Students may suggest refinement of variables, e.g. for some variables plotting data for strikers only gives stronger correlations, since this removes one other major variable.

ACTIVITY 2.4 PIRATES

Possible learning outcomes

• I can give an example from everyday life of a correlation between two things.
• I can explain that even when there is a correlation between two things, this doesn't necessarily mean that one is causing the other. Something else might be causing them both ... and I can give an example to show this.

Suggested approach

a Explain to students that a fun website suggested that there is a correlation between the decreasing number of pirates on the seas and the rise in average global temperatures. They concluded: "We should encourage pirates in order to keep global temperatures low."

b Ask students whether they agree with this statement. Are they convinced that reducing the number of pirates *caused* global warming?

c Ask students to write short statement in pairs/small groups to distinguish between correlation and cause, using an example from everyday life.

ACTIVITY 2.5 IS IT A GOOD PLAN?

Possible learning outcomes

• I can judge how good an investigation plan is by seeing whether factors we are not testing have been controlled (good) or not controlled (bad).
• I can explain why it is important in an investigation to control all the factors apart from the one I want to change.
• To test whether a factor increases the chance of an outcome, we may compare two groups, e.g. affect of smoking on risk of lung cancer. To evaluate this sort of study, I look at the size of the groups and how well they are matched.

Suggested approach

a Introduce the following context:
"Some high-frequency sound generators have been installed in shopping centres in order to keep young people away from the premises after closing hours. It is claimed that younger

people (under the age of twenty) can hear these high sounds, whereas older people cannot."
You may be able to find local newspaper headlines related to this context.

b What sort of experiments would students set up to verify this? In pairs, students have ten minutes to design their study. They may ask teacher for assistance if they are unsure about whether particular equipment can be used; for instance, if students ask about a sound-proofed room, you could show them an image of anechoic chamber.

c Two pairs of students then compare ideas, and evaluate the two studies against criteria from some of the IaS2 specification statements. (See the student-speak versions of the ideas about science specification statements which you can download from www.21stcenturyscience.org.) The four students combine forces to produce an improved design for a study.

IaS3 Developing scientific explanations
and
IaS4 The scientific community

Activity 3.1 Developing explanations

Possible learning outcomes

• I know that an explanation is based on the information (observations or data) available and that when new information becomes available this may mean that the explanation changes.

Suggested approach

a Select a context dependent upon class interests, local interests, e.g. a sporting controversy headline (penalty, sending off etc). Provide two newspaper reports with opposing views of the incident (and video evidence at the end of the activity if time permits).

b Half the class read each report, without knowing that they have different articles.

c Remove source articles and ask students to line up along a continuum from definitely think decision was correct at one end, to definitely think it was incorrect at the other end.

d Pair students together (each student having read opposite article from their pair). Give each pair two to three minutes for a short discussion about what they think happened during the incident.

e Ask students to line up again, then raise their hands if they have changed their position in the line.

f Students are likely to have worked out that they had different articles. Ask them what might happen if you provided several more articles (e.g. more of them may change their position on the line). Draw out the idea that they re-evaluated their decision in light of new evidence.

g Illustrate the process of developing scientific explanations by describing a scientific context where ideas have changed with new evidence.

Activity 3.1 Alternative explanations

Possible learning outcomes

• I know that the same data might reasonably be interpreted in more than one way.
• I know that when new data is collected that agrees with an explanation, this gives scientists more confidence that the explanation is correct.

Suggested approach

a Set the scene – a young man is running away from an old lady lying on the floor, clearly very distressed. A second man in jeans and a hoody top is rummaging through her bag.

b Ask students: What conclusions can you draw from this data? What caused this set of events? Answers usually include robbery, mugging etc.

c Then offer an alternative explanation: The old lady is having an angina attack and has asked one of the men to look in her bag for her medication. The other man is running for help.

d Ask students what other information might give them more confidence in one explanation than the other.

ACTIVITY 3.2 CLUEDO

Possible learning outcomes

• I can recognize data that agrees with or conflicts with an explanation.
• I know that when new data is collected that agrees with an explanation, this gives scientists more confidence that the explanation is correct.
• I know that when new data is collected that conflicts with an explanation, this gives scientists less confidence that the explanation is correct.
• I know that an explanation is based on the information (observations or data) available and that when new information becomes available this may mean that the explanation changes.

Suggested approach

a Use a Cluedo style PowerPoint with images from a crime scene.

b Ask for an explanation of the available data – what happened at this scene?

c Provide more data (more views from the crime scene).

d Do students want to modify their explanation?

e As more data is provided, explanations may, or may not , be modified. However, at each introduction of new data the current explanation is always revisited to check whether this data supports it or not.

ACTIVITY 3.3 JUMPING TO CONCLUSIONS OR DEVELOPING EXPLANATIONS?

Possible learning outcomes

• I can identify where creative thinking (imagination) is involved in the development of an explanation
• I know that an explanation is based on the information (observations or data) available and that when new information becomes available this may mean that the explanation changes.
• I know that when new data is collected that agrees with an explanation, this gives scientists more confidence that the explanation is correct.
• I know that when new data is collected that conflicts with an explanation, this gives scientists less confidence that the explanation is correct.

Suggested approach

a Ask students to suggest an explanation for a particular situation, e.g.:

- A student arrives late to lesson smelling strongly of smoke.
- In the yard, you see lots of students running towards a large group of students all shouting.
- Why don't Australians fall off the Earth?
- Did man really go to the moon?

b Provide structure for students as appropriate, e.g.:

- What questions might you want answered to help you develop your explanation?
- What is the data?
- Are there other possible explanations as well as mine?

Quickly note down students' explanations on the board.

c Introduce further data, e.g.:

- Student has a note from their parent.
- Music can be heard coming from the large group of students.

Ask students if they wish to revise their explanation.

d Further questions:

- What is the role of imagination for each explanation?
- Which explanation is the best? Why?

ACTIVITY 3.4 THE FIGHT AGAINST MRSA

Possible learning outcomes

• I can identify examples of predictions that scientists have made, based on a scientific explanation.

• When I evaluate a scientific explanation, I look for examples of predictions that have later been confirmed. I know that these make us more confident about the explanation.

Suggested approach

Students need basic prior knowledge of 'superbugs' (for instance after they have been introduced to MRSA in Module B2 'Keeping healthy', or given a context via a short news headline or clip).

a Provide students with data of MRSA cases in a particular hospital, or national data, before and after the introduction of alcohol rub at each bed or entrance to wards.

b Ask students to put forward a possible explanation for the decline in MRSA cases, linking introduction of alcohol rubs with decline in MRSA cases.

c Show students a clear agar plate, and a plate with several days' *S. albus* bacterial growth. Emphasise that growth is not MRSA, but a different type of Staphylococcus bacterium which is safe for students to use in the laboratory.

Ask students to make a prediction, drawn from their suggested explanation, of how the presence of alcohol rub would affect *S.albus* growth on the plate. Test the prediction with a simple class practical, using *S.albus* plates prepared in advance for students.

Extension

Ask students what other explanations could be put forward for the decline in MRSA cases. Students find out what else hospitals have done to reduce MRSA infection rate.

Activity 3.5 Spot the ball!

Possible learning outcomes

- I can use creative thinking (imagination) to develop an explanation
- I know that an explanation is based on the information (observations or data) available.
- I know that the same data might reasonably be interpreted in more than one way.
- I can recognise data or observations that agree with or conflict with an explanation.
- I can give good reasons for accepting or rejecting a scientific explanation.
- I can explain why it is important for scientists to share and evaluate each other's explanations.

Suggested approach

a Ask students to study the picture. The ball has been removed from the picture. Students must decide where the ball should be.

They will need to:

- Use their imagination to develop an explanation
- Make a prediction based on the data

b Ask students to discuss in groups where they think the ball should be a reach a consensus.

They will need to:

- Share their initial predictions with others in their group
- Collaborate to share findings and help refine the explanation
- Decide whether or not to abandon their ideas if the others disagree

IaS5 Risk

Activity 5.1 Risky decisions

Possible learning outcomes

• I can assess and compare the risks of different activities, and relate these to the benefits that could be gained. I can use this to help me make decisions.

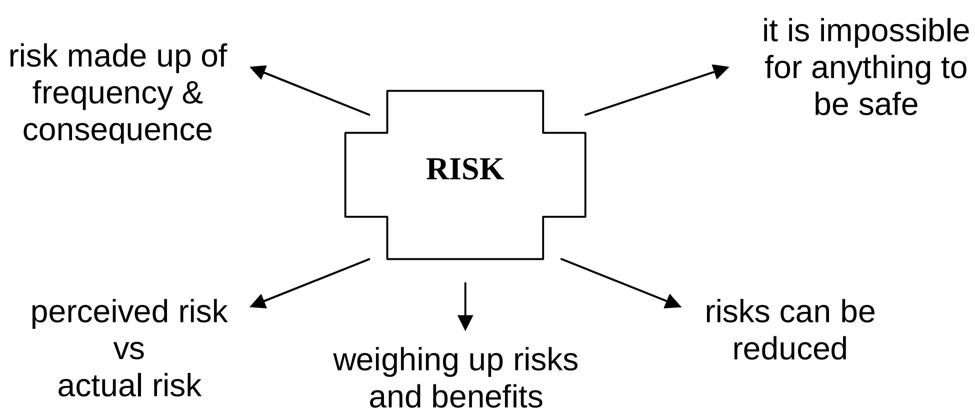
Suggested approach

a Provide students with lots of ‘Would you …?’ statements, for example:

- cross the road when the lights show a red man?
- swim in the sea straight after lunch?
- jump off a wall?
- truant a science lesson?
- miss a homework deadline?
- eat a yoghurt that is past its sell by date?
- share a can of drink with a friend?

c Students feedback their decisions with reasons, and teacher draws out concepts of risk, building up overview diagram (see below). Ask students to explain how they go about making a decision involving risk

d Students add an example of each key concept to their notes.



Activity 5.2 In deep

Possible learning outcomes

• I can identify the risks and benefits of a situation for different individuals and groups affect by it.

Suggested approach

a Ask the question ‘Would you dive into a pool not knowing how deep the water is?’

Ask students to suggest similar types of questions from their own experiences (e.g. would you cross the road at a bend where you could not see oncoming traffic?).

b Introduce the science around WiFi technology, and some of the arguments for and against. Explain that different individuals or groups might see different risks and benefits.

Students brainstorm how each group feels using jigsaw approach.

Teachers

Students

Governors

Expert scientists

Parents

Head Teacher

WiFi production company

c Groups split up and rearrange into new groups made up of one person from each of the original groups. In these new groups, each student is the ‘expert’ in their area.

In their new groups students discuss “Do we put WiFi technology into our school classrooms?”.

d Take feedback from the class, covering views of groups that agreed and disagreed. See if a consensus can be reached and whether any of the risks can be considered ‘acceptable’.

ACTIVITY 5.3 RANKING RISK

Possible learning outcomes

- I know that a risk is made up of both the chance of something happening and the consequences if it did.
- I can distinguish between perceived and calculated risk.
- I can suggest reasons why the perceived risk of a situation might be different from the calculated risk.

Suggested approach

a Give students a bank of statements, e.g. risk of getting caught ‘bunking’, getting a serious illness from smoking, getting in trouble for not doing homework.

b Ask students to put these statements in order of risk. This is the perceived risk.

c Get students to discuss the 'chance' of each statement happening and then quantify this (1 = low chance to 10 = high chance).

d Ask students to discuss the severity of the consequence of each statement and then quantify this (1 = not very severe to 10 = very severe).

e From this they can then calculate their perceived risk by multiplying the two values together.

f Students rank the statements a second time, based on the calculated perceived risk. How does this compare with their initial ranking? If there are differences why do they think this is?

Additional support

Provide laminated A4 grid, ten laminated cards (five events and five frequency cards), whiteboard pens and calculators.

Consequence	Frequency (likelihood)	Perceived Risk		Rank
10			=	
20			=	
30			=	
40			=	
50				

Students place event cards on what they think is correct relative level of consequence (10, 20, 30 etc). They then decide which frequency card to assign to each event card.

Students multiply number under event card with number on frequency card to calculate perceived risk, and then write in ranking of each event (from one to five) for relative perceived risk.

Activity 5.4 Identifying risks

Possible learning outcomes

- I can identify risks in a given situation.
- I can suggest ways of reducing a risk.

Suggested approach

a Students write a paragraph describing a very risky day or walk to school.

b For example: My day on a tropical beach
"I swam through shark infested waters … relieved to survive I sat beneath coconut tree and lit up a cigarette. Found I'd lost my suntan lotion, but could not be bothered to cover up."

c Students highlight risks in their paragraph and then rank them, explaining the reasons for their ranking.

d Small group discussion - how are you going to improve your chance of living longer?

ACTIVITY 5.5 GRAPHS

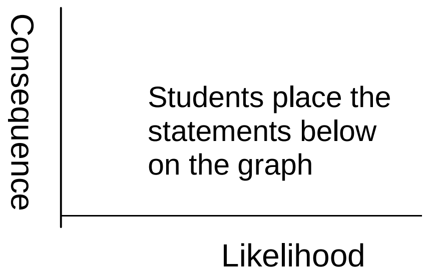
Possible learning outcomes

- I know that a risk is made up of both the chance of something happening and the consequences if it did.
- I can suggest ways of reducing a risk.

Suggested approach

a Explain to students**:** RISK = likelihood (of happening) and consequence (if it did)

b Ask students to place the statements below on the graph, considering both the seriousness of the consequence and the likelihood of it happening.



- being in a plane crash
- missing a day of school because you are ill
- cutting yourself shaving
- losing mobile phone
- returning home after curfew *
- failing your GCSE's*
- winning the lottery
- dying of heart attack/stroke
- getting bitten by a shark
- "Town Name" underwater due to global warming

*variable consequences so discuss with your group/partner

c Extension questions: Suggest ways of reducing the likelihood of the risk. Is your judgement of the size of the risk actual or perceived? Can you do anything about the consequences?

ACTIVITY 5.6 RUSSIAN ROULETTE

Possible learning outcomes

- I know that a risk is made up of both the chance of something happening and the consequences if it did.
- I can identify risks and benefits in a situation.
- I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.
- I can suggest why someone who knows the risk of a particular activity may (or may not) go ahead with it.

Suggested approach

a Describe the game Russian roulette.

The game is being played using a gun with two barrels, one with a bullet, the second chamber empty.

Consequence is high, likelihood is high.
Most people choose not to take the risk.

Offer people £100. Do students think more people would take the risk?

Offer people one million pounds. Would more people take the risk?

A new gun is developed for the game. It has 1000 barrels, still only one chamber with a bullet.

Offer people £1. Most people choose not to take the risk.

Offer £10,000. Do students think more people would take the risk? If so, why?

ACTIVITY 5.7 WOULD YOU PLAY?

- I know that a risk is made up of both the chance of something happening and the consequences if it did.
- I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.
- I can suggest why someone who knows the risk of a particular activity may (or may not) go ahead with it.

Suggested approach

a Starter: Would you play ….

Students given a series of questions and must justify why they would/wouldn't play cricket without any protective kit:

- at all
- if playing with a soft ball
- as an outfield player (with hard ball)
- as a bowler
- as a batsman
- as a batsman against a less-skilled player
- as a batsman against 1st XI player
- as a batsman against county player
- as a batsman against Flintoff?

b Make active by using Leitart Scale for students to show where they stand (from definitely yes to definitely no).

(Alternative scenario – would you play as a hockey goalie without kit?)

ACTIVITY 5.8 WHAT MAKES A RISK?

Possible learning outcomes

• When I discuss a risk, I take account of
– the chance of it happening
– how bad the effects would be if it did happen.
• I can suggest benefits of activities which have a known risk.
• I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.
• I can suggest why someone who knows the risk of a particular activity may (or may not) go ahead with it.

Suggested approach

a Students work in pairs to draw up and complete a table with the following column headings: Activity, Risk, How serious do you think the risk is? (1 to 10), Consequence (1 to 10), Likelihood (1 to 10).

The following activities should be listed in the 'activity' column and then following the instructions below complete the rest of the table.

- Not doing science homework
- Flying to Tenerife
- Eating a reheated BigMac
- Swimming with sharks
- Sunbathing on a tropical beach with no sunscreen
- Using your mobile phone ten times a day
- Changing a light bulb
- Playing with matches

- Going out with your best friend's ex
- Sitting next to someone with a cold

Instructions
1 Look at the list of activities.
2 For each of these activities, write down a risk associated with it.
3 Rank the risk from 1 to 10 (least risky to most risky).
4 Rank from 1 to 10 how serious the consequence is (from least serious to most serious).
5 Rank from 1 to 10 how likely you think the risk is to happen (from least likely to most likely).

b Ask two or three students to explain their highest and lowest choices. Use their answers to clarify meaning of 'consequence' and 'likelihood'.

c Ask students to look at their rankings and use them to answer: Does high consequence always mean high risk? Does low likelihood always mean low risk?

Extension

Suggest an activity that it is students would be unlikely to do, and ask them to explain why they would not do this. For instance, would you cross a busy road blindfolded?

Suggest an activity some students will carry out, which carries risks they will be aware of. Examples are drinking alcohol, eating high-fat diet, smoking. Ask students to list reasons why they might do this activity, despite the risks.

Draw out the link between willingness to accept a risk and the perception that potential benefits have sufficient value. This discussion could also be extended to distinguish between actual and perceived risk.

ACTIVITY 5.9 INTRODUCING COMPONENTS OF RISK

Possible learning outcomes

• When I discuss a risk, I take account of:
– the chance of it happening,
– how bad the effects would be if it did happen.
• I can tell the difference between perceived and actual risk.

Suggested approach

a Show video clips of sky-diving and young people out drinking, for example:
Sky-diving – http://www.bbc.co.uk/videonation/articles/t/tyne_skydiving.shtml
Drinking – there are several of these on sites such as YouTube, e.g.
http://uk.youtube.com/watch?v=g9J67iT6jc0,
although the language used often makes them inappropriate. (You will probably have difficulty accessing YouTube from a school computer, so if you decide to use one of these clips it would have to be downloaded in advance.)

b Define risk as being composed of size of consequence if risk outcome happens, and likelihood of the risk outcome happening. This could be either through class discussion or by sorting the following cards:

Dying as a result of being hit on the head by a falling coconut. 1 in 250,000,000	Dying as a result of a shark attack. 1 in 300,000,000	Having a minor car accident.
Catching a cold.	Having your car stolen in the next twelve months.	Winning the lottery. 1 in 14,000,000
Increased risk of developing cancer after 1000km flight. less than 1 in 1,000,000	Having a serious car accident.	Dying from a heart attack or stroke. 1 in 2.5
Catching influenza.	Dying from an asteroid collision. 1 in 500,000	Increased risk of developing cancer from having a chest X-ray. less than 1 in 1,000,000
Catching avian ‘flu. 1 in 100,000,000		

c Compare potential risks of sky-diving and drinking.

d In small groups, students make lists of activities which they believe have short, medium and long-term risks.

e Select one example for class discussion to illustrate distinction between perceived and actual risk. Students then consider other activities they have listed:

i Do you think perceived risk of this activity is more or less than actual risk?
ii What benefit would you get from taking part in this activity? Does this benefit outweigh the risk for you?

Activity 5.10 What's the risk?

Possible learning outcomes

• I can suggest reasons for choosing whether to do something, by weighing up the risks and benefits.

Suggested approach

a Use a think/pair/share approach to conduct a class survey – which activities would students think of as risky? Examples might be flying on large aircraft, car ride to school, rock climbing, bungee jumping, parachuting, walking downstairs, using school toilet.

b Ask students if anyone is a nervous flyer, or alternately tell students a personal story about someone who is nervous of flying.

c Ask students to compare risk from UK car journeys and international air travel, using the data below.

Year 2009	Serious injuries	Deaths
UK road accidents	21 997	2222
Deaths caused by airline accidents, domestic and international	0	757

Sources:
International air travel http://aviation-safety.net/statistics/
UK road accidents: www.dft.gov.uk/pgr/statistics/datatablespublications/accidents/

d With more able groups, go on to discuss which of the following data would give a better measure of risk, for

i UK road accidents
ii Airline accident deaths for each hour of travel, deaths per journey, deaths per total distance travelled

For air travel, you might also consider deaths for each flight phase (take-off, initial climb, cruising, approach, landing).

Activity 5.11 Safe as houses?

Possible learning outcome

• I can explain why every activity carries some risk, even though this may be very small.

Suggested approach

a Give students a few minutes to discuss the following scenario.
"You are wrapped in bubble-wrap, wearing a crash helmet, sitting in an ultra-soft chair in a padded room with walls and floor covered in thick foam." Are you at any risk? If so, from what?"

b Develop the idea by challenging groups to come up with the lowest risk situation they can, and describe this to rest of class.

c Do the class think any situation has reached zero risk? Draw out idea that no activity is without risk.

IaS6 Making decisions about science and technology

Activity 6.1 Fruit and vegetables

Possible learning outcomes

- I apply the idea of sustainability to specific situations.
- I can suggest examples of the unintended impacts of human activity on the environment.

Suggested approach

a Ask students what their favourite fruits and vegetables are. Select some of these and ask when they are available.

b Draw out ideas of seasonal foods. Explain that fruits & vegetables can be grown in polytunnels and/or flown from other parts of the world to the UK to give year-round availability.

c Discuss the impact of polytunnels and importing foods on the environment, people in the immediate community, and other communities.

Activity 6.7 Technology and decision making

This activity uses the context of technology in sport. It could be used to discuss several IaS:
IaS1 Limitations of the data
IaS3 Confidence in explanation/confidence in technology
IaS4 Different viewpoints, e,g, linesman, umpire, crowd, TV pundits, hawkeye

Possible learning outcomes

- Where an ethical issue is involved, I can say clearly what the issue is.
- Where an ethical issue is involved, I can summarise the different views that different people or groups might hold.

Suggested approach

This activity uses video clips of a sporting incident taken from different angles. Video footage of the disallowed England try in the 2007 Rugby World Cup final from different angles would be a very good example.

a Give students 2 cards each (red/yellow or penalty/not penalty etc). Show a short video clip of a sporting incident, e.g. penalty / foul in football, from an angle that doesn't give the full story. Stop the video before the referee indicates whether or not it was a penalty / foul. Ask students to raise a card to indicate whether they thought it was a penalty / foul or not.

b Show a series of short clips from Wimbledon (either historical and present day clips or lots of clips of the same match). Include a clip where 'Hawkeye' is used to make the decision.

c Classroom discussion: Should we use technology, e.g. 'Hawkeye', in football?

d Go back to original incident and play a video showing it from a different angle. Do the students still agree with their original decision?

ACTIVITY 6.8 PENALTY

Possible learning outcomes

• Where an ethical issue is involved, I can say clearly what the issue is.
• Where an ethical issue is involved, I can summarise the different views that different people or groups might hold.

Suggested approach

a Set the scene: "With five minutes to go in a school football match, a team mate dives and wins a penalty. Your team goes on to win the game."

b Set the following questions for students to discuss in small groups:

1. What's the controversial question in this situation?
2. Ethics is about what is right or wrong behaviour. Is this an ethical question?
3. What might be the views of:
   (a) yourself (a team mate)?
   (b) your P.E. teacher?
   (c) a player from the opposing team?
4. People may justify their ethical decisions with different reasons. Which person is most likely to use these justifications:
   (a) Some things are wrong whatever the reason.
   (b) Sometimes a behaviour is ok if it's for the good of the group, even if some people are hurt a bit by it.
   (c) Something is wrong if many people are hurt by the behaviour.

ACTIVITY 6.9 SMOKER

Possible learning outcomes

• Where an ethical issue is involved, I can say clearly what the issue is.
• Where an ethical issue is involved, I can summarise the different views that different people or groups might hold.

Suggested approach

a Ask students to imagine that they have a relative who smokes 20 cigarettes-a-day, and who has two small children.

b Students discuss the question: What is the ethical issue?

c Ask students to consider, in pairs or small groups:
What might the views be of:
(a) the smoker
(b) the children
(c) a health professional
(d) yourself?