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EDEXCEL GCSE SCIENCES 2011

Support*Plus* guide

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Welcome to our Support*Plus* guide

We know that good help and support matter more than ever when delivering a brand-new qualification. That's why we've put together a first-class support programme to make it as easy as possible for you to plan and teach our new GCSEs in Science.

Our new Support*Plus* service will give you access to a wealth of resources and support all in one place. Materials can be found at **www.edexcel.com/science2011supportplus**, and we will be adding to the site throughout the year. This guide is just a taste of what you can expect to receive, including:

- exemplar course plans
- sample schemes of work
- worksheets to support our schemes of work
- an interactive scheme of work planner to help you plan courses including multiple pathways
- information on:
  - extra quality assured mocks which will be made available during the year
  - our free ResultsPlus and ResultsPlus Mocks Analysis services – giving unrivalled insight into candidate performance (see Assessment guide)
  - the personal support available to you from our Science Subject Advisor service
  - the free training and seminars we are running to help you learn about, plan, teach and assess our science qualifications
  - local support you may be able to call upon.

You can also get updates on our development from scienceteamupdates@edexcel.com, including GCSE and BTEC links materials to help you deliver multiple pathways for candidates (see GCSE & BTEC Links guide).

Sample course plan

Aim:

for students starting their GCSE separate sciences in the summer of Year 9, aiming to certificate in June of Y11.

This is just a suggested plan to show how the GCSE teaching could be chunked, and is based on the Edexcel suggested schemes of work. The plans are based on approximate term dates and examination dates only and do not account for any lost time in the school calendar.

Based on: Summer Year 9 start

Three lessons a week (one for each subject) in Year 9, rising to four lessons a week in Years 10 and 11 (one for each subject plus an extra lesson on rotation between biology, chemistry and physics changing on a termly basis).

Controlled assessment to take four lessons. Time is allowed for completion of all suggested practicals.

Summer 2011
3 weeks 9 hours
Biology: Classification, Vertebrates and invertebrates, Species
Chemistry: The early atmosphere, A changing atmosphere, Oxygen in the atmosphere
Physics: The Solar System, Refracting telescopes

Summer 2011
6 weeks 18 hours
Biology: Variation, Evolution, Genes, Inheritance, Genetic disorders
Chemistry: Today's atmosphere, Rocks and their formation, Limestone and its uses, Chemical reactions, Reactions of calcium compounds
Physics: Reflecting telescopes, Waves, Beyond the visible, EM spectrum, Uses and dangers of EM

Autumn 2011

7 weeks
28 hours

Biology:
Homeostasis, Sensitivity, Responses to stimuli, Hormones, Diabetes, Controlling diabetes, Tropisms, Uses of plant hormones, Effects of drugs, Smoking, Alcohol

Chemistry:
Indigestion, Neutralisation, Electrolysis, The importance of chlorine, Electrolysis of Chlorine, Ores

Physics:
Ionising radiation, The Universe, Exploring the Universe, Alien life, Life-cycles of stars, Theories about the Universe

Autumn 2011

7 weeks
28 hours

Biology:
Ethics and transplants, Pathogens, Antiseptics and antibiotics, Interdependence, Parasites and mutualists, Pollution, Pollution indicators, Carbon cycle, Nitrogen cycle, B1 revision, **B1 mock**

Chemistry:
Oxidation and reduction, Recycling, Metals and their properties, Alloys, Crude oil, Crude oil fractions, Combustion

Physics:
Red shift, Infrasound, Ultrasound, Seismic waves, Detecting earthquakes, Renewable energy resources

Spring 2012

5 weeks
20 hours

Biology:
Plant and animal cells, Inside bacteria, DNA, DNA discovery

Chemistry:
Incomplete combustion, Acid rain, Climate change, Biofuels, Choosing fuels, Alkanes and Alkenes, Cracking, Polymerisation, Polymers and problems

Physics:
Non-renewable energy resources, Generating electricity, Transmitting electricity, Paying for electricity

Spring 2012

6 weeks
24 hours

Biology:
B1 exam, Genetic engineering, Mitosis and meiosis, Clones, Stem cells, Protein manufacture, Mutations

Chemistry:
C1 mock, C1 exam, Discovering chemistry, Mendeleev, Discovering the atom, The modern periodic table, Electron shells, Ionic bonds, Ionic compounds, Properties of ionic compounds, Solubility, Precipitates, Ion tests

Physics:
Power consumption, Reducing energy use, Energy transfers, Efficiency, The Earth's temperature

Summer 2012

7 weeks
28 hours

Biology:
Photosynthesis, Enzymes, Enzyme action, Aerobic respiration, Anaerobic respiration

Chemistry:
Covalent bonds, Comparing chemicals, Properties of covalent substances, Immiscible and miscible liquids, Chromatography, Chemical classification, Transition metals

Physics:
P1 mock, Static electricity, Uses and dangers of static electricity, Electric currents, Currents, Voltage and resistance, Transferring energy, Vectors and velocity, Acceleration, Velocity-time graphs, Forces, Resultant forces, Forces and acceleration

Summer 2012

6 weeks
24 hours

Biology:
Photosynthesis (continued), Limiting factors, Water transport, Osmosis, Organisms and their environment

Chemistry:
Alkali metals, Halogens, Displacement reactions, Noble gases, Temperature changes

Physics:
P1 exam, Forces and acceleration, Terminal velocity, Momentum and safety, Crumple zones, Work and power, Potential and kinetic energy, Isotopes, Isotopes and radiation, Nuclear reactions

Autumn 2012

7 weeks
28 hours

Biology:
Fossils and evolution, Growth, Blood, Heart, Circulatory system, Digestive system, Breaking down food, Villi, Digestive enzymes, Pro and pre-biotics,
BCA controlled assessment

Chemistry:
Rates of reaction, Kinetic theory, Catalysts, Relative masses, Percentage composition

Physics:
Nuclear power, Nuclear fusion, Nuclear waste, Half-life, Background radiation

Autumn 2012

7 weeks
28 hours

Biology:
B2 mock, **B2 exam**, Rhythms, Plant defences, Vaccines, Antibodies, Kidneys, Menstrual cycle, Fertilisation, Sex determination, Courtship, Behaviour

Chemistry:
Yields, Industrial yields, **C2 mock**, **C2 exam**, Water testing, Safe water, Ion identification, Safe limits

Physics:
P2 mock, **P2 exam**, **PCA controlled assessment**, Uses of radiation

Spring 2013

5 weeks
20 hours

Biology:
Learned behaviour, Animal communication, Plant behaviour, Human evolution and migration

Chemistry:
Water solutes, Determining dry mass, Particles and moles, Preparing soluble salts, Titration, Titration and calculations, Electrolysis, Electrolysis of brine and salts

Physics:
Radiation in medicine, How eyes work, Sight problems, Lenses

Spring 2013

6 weeks
24 hours

Biology:
Biotechnology, Microorganisms for food, Enzyme technology

Chemistry:
CCA controlled assessment, Mass changes in electrolysis, Uses of electrolysis, Determining a molar volume, Fertilisers, Fermentation, Ethanolic drinks, Ethanol production

Physics:
Reflection and refraction, TIR, critical angles, x-rays

Summer 2013

6 weeks
28 hours

Biology:
Global food security, GM, Biology revision

Chemistry:
Homologous series, Ethanoic acid, Esters, soap, Chemistry revision

Physics:
x-rays, ECGs and pulse oximetry, Beta radiation, Alpha and gamma radiation, Stability curve, Quarks, Dangers of ionising radiation, Radiation treatments, Collaboration and circular motion, Collisions, PET scanners, Kinetic theory, Gases

NB it may be worth using some time set aside for Biology or Chemistry revision to ensure you cover all the Physics

Summer 2013

Biology:
B3 exam, B1/B2 re-sits,
Submit BCA controlled assessment

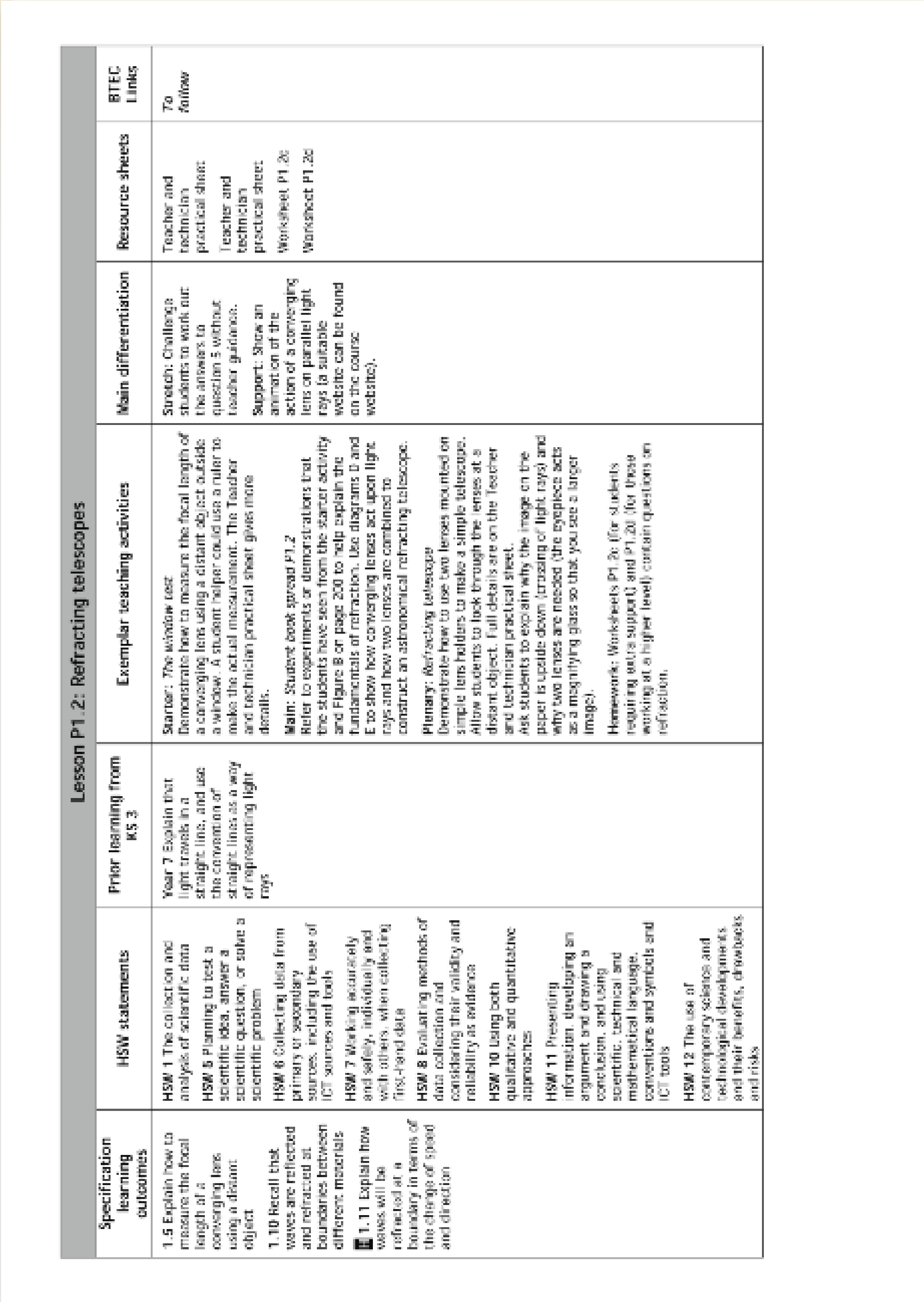
Chemistry:
C3 exam, C1/C2 re-sits,
Submit CCA controlled assessment

Physics:
P3 exam, P1/P2 re-sits,
Submit PCA controlled assessment

Sample scheme of work...

Lesson P1.1: The Solar System						
Specification learning outcomes	**HSW statements**	**Prior learning from KS 3**	**Exemplar teaching activities**	**Main differentiation**	**Resource sheets**	**BTEC Links**
1.1 Describe how ideas about the structure of the Solar System have changed over time, including the change from the geocentric to the heliocentric models and the discovery of new planets 1.2 Demonstrate an understanding of how scientists use waves to find out information about our Universe, including: a) the Solar System; b) the Milky Way 1.3 Discuss how Galileo's observations of Jupiter, using the telescope, provided evidence for the heliocentric model of the Solar System 1.4 Compare methods of observing the Universe using visible light, including the naked eye, photography and telescopes	**HSW 1** The collection and analysis of scientific data **HSW 2** The interpretation of data, using creative thought, to provide evidence for testing ideas and developing theories **HSW 3** Many phenomena can be explained by developing and using scientific theories, models and ideas **HSW 14** How uncertainties in scientific knowledge and scientific ideas change over time and the role of the scientific community in validating these changes	**Year 7** Describe, using a simple model, how the relative positions of the Sun and Earth change over the course of time **Year 8** Describe the relative positions of celestial bodies in the solar system **Year 8** Recognise how data are gathered from Space that provide an insight into the nature of the solar system, e.g. satellites, telescopes, interplanetary probes **Year 9** Explain some of the strengths and weaknesses of the models used to explain the relative movement of celestial bodies in the solar system, e.g. the Earth and Moon in night and day, and the seasons **Year 9** Use models, patterns or data to explain the relative motion of the Earth and other planets	**Starter:** *Solar System model* Ask students to draw the Solar System as they understand it. This should be a straightforward introductory task to get them thinking about cosmological models. Follow up by asking why they believe this is the way things are and then why scientists believe in this model. The discussion could then extend to the currently accepted model of the whole Universe. **Main:** *Comparing astronomical observations* Discuss comparisons between naked-eye, telescope and photographic observations of celestial bodies. Ask students to complete Worksheet P1.1b after the discussion, classifying observations. **Plenary:** *Information from light* Students write a list of all the types of information that astronomers can get from the light waves we receive from the Universe. They then compare the list with a partner to generate a complete list, such as naked-eye, telescope and photographic records of planets, stars and galaxies. **Homework:** Worksheets P1.1c contains questions on the Solar System.	**Stretch:** Ask students to add in further observations that they have heard about from other sources. **Support:** Limit the exercise to sorting the observations by type.	Worksheet P1.1b Worksheet P1.1c	*To follow*

...available to download from www.edexcel.com/science2011



Lesson P1.2: Refracting telescopes						
Specification learning outcomes	**HSW statements**	**Prior learning from KS 3**	**Exemplar teaching activities**	**Main differentiation**	**Resource sheets**	**BTEC Links**
1.5 Explain how to measure the focal length of a converging lens using a distant object 1.10 Recall that waves are reflected and refracted at boundaries between different materials H 1.11 Explain how waves will be refracted at a boundary in terms of the change of speed and direction	**HSW 1** The collection and analysis of scientific data **HSW 5** Planning to test a scientific idea, answer a scientific question, or solve a scientific problem **HSW 6** Collecting data from primary or secondary sources, including the use of ICT sources and tools **HSW 7** Working accurately and safely, individually and with others, when collecting first-hand data **HSW 8** Evaluating methods of data collection and considering their validity and reliability as evidence **HSW 10** Using both qualitative and quantitative approaches **HSW 11** Presenting information, developing an argument and drawing a conclusion, and using scientific, technical and mathematical language, conventions and symbols and ICT tools **HSW 12** The use of contemporary science and technological developments and their benefits, drawbacks and risks	**Year 7** Explain that light travels in a straight line, and use the convention of straight lines as a way of representing light rays	**Starter:** *The window test* Demonstrate how to measure the focal length of a converging lens using a distant object outside a window. A student helper could use a ruler to make the actual measurement. The Teacher and technician practical sheet gives more details. **Main:** *Student book spread P1.2* Refer to experiments or demonstrations that the students have seen from the starter activity and Figure B on page 200 to help explain the fundamentals of refraction. Use diagrams D and E to show how converging lenses act upon light rays and how two lenses are combined to construct an astronomical refracting telescope. **Plenary:** *Refracting telescope* Demonstrate how to use two lenses mounted on simple lens holders to make a simple telescope. Allow students to look through the lenses at a distant object. Full details are on the Teacher and technician practical sheet. Ask students to explain why the image on the paper is upside down (crossing of light rays) and why two lenses are needed (the eyepiece acts as a magnifying glass so that you see a larger image). **Homework:** Worksheets P1.2c (for students requiring extra support) and P1.2d (for those working at a higher level) contain questions on refraction.	**Stretch:** Challenge students to work out the answers to question 5 without teacher guidance. **Support:** Show an animation of the action of a converging lens on parallel light rays (a suitable website can be found on the course website).	Teacher and technician practical sheet Teacher and technician practical sheet Worksheet P1.2c Worksheet P1.2d	*To follow*

Sample scheme of work continued...

Lesson P1.3: Lenses practical						
Specification learning outcomes	HSW statements	Prior learning from KS 3	Exemplar teaching activities	Main differentiation	Resource sheets	BTEC Links
1.6 Investigate the behaviour of converging lenses, including real and virtual images 1.7 *Investigate the use of converging lenses to: a) measure the focal length using a distant object b) investigate factors which affect the magnification of a converging lens (formulae are not needed)*	**HSW 1** The collection and analysis of scientific data **HSW 3** Many phenomena can be explained by developing and using scientific theories, models and ideas **HSW 5** Planning to test a scientific idea, answer a scientific question, or solve a scientific problem **HSW 6** Collecting data from primary or secondary sources, including the use of ICT sources and tools **HSW 7** Working accurately and safely, individually and with others, when collecting first-hand data **HSW 8** Evaluating methods of data collection and considering their validity and reliability as evidence **HSW 9** Recalling, analysing, interpreting, applying and questioning scientific information or ideas	N/A	*To follow*	*To follow*	*To follow*	*To follow*

Lesson P1.4: Reflecting telescopes

Specification learning outcomes	HSW statements	Prior learning from KS 3	Exemplar teaching activities	Main differentiation	Resource sheets	BTEC Links
1.8 Explain how the eyepiece of a simple telescope magnifies the image of a distant object produced by the objective lens (ray diagrams are not necessary) **1.9** Describe how a reflecting telescope works **1.10** Recall that waves are reflected and refracted at boundaries between different materials	**HSW 11** Presenting information, developing an argument and drawing a conclusion, and using scientific, technical and mathematical language, conventions and symbols and ICT tools **HSW 12** The use of contemporary science and technological developments and their benefits, drawbacks and risks	**Year 7** Explain that light travels in a straight line, and use the convention of straight lines as a way of representing light rays	**Starter:** *Remembering refraction* Give students the answers to a number of questions about refraction and the astronomical telescope. Then ask them to write the questions that go with these answers. It may be a good idea to start this off by doing one with the class first – give then an answer and three questions and ask which of the questions best fits the answer. Examples are: 'focal length'; 'change direction'; 'appears to be in the wrong place'; 'towards the normal'; H ' because the waves speed up'. **Main:** *Build a reflecting telescope* Using Worksheet P1.4a Build a reflecting Telescope, students can put together a very simple Newtonian design reflecting telescope. Full details are on the Teacher and technician practical sheet. **Plenary:** *Telescopes true/false* Ask students to work in small groups to write a set of five statements about refracting and reflecting telescopes, three of which are to contain errors. They then swap statements with another group to identify the incorrect statements and write correct versions. **Homework:** Worksheets P1.4b (for students requiring extra support) and P1.4c (for those working at a higher level) contain questions on telescopes.	**Stretch:** Students build the telescope without assistance, determining the relative positions of the mirror and lens. **Support:** Show the apparatus already set up and assist students in finding the focal length of their lens and concave mirror.	Teacher and technician practical sheet Worksheet P1.4a Worksheet P1.4b Worksheet P1.4c	*To follow*

Sample scheme of work continued...

Lesson P1.5: Waves						
Specification learning outcomes	**HSW statements**	**Prior learning from KS 3**	**Exemplar teaching activities**	**Main differentiation**	**Resource sheets**	**BTEC Links**
1.12 Describe that waves transfer energy and information without transferring matter 1.13 Use the terms of frequency, wavelength, amplitude and speed to describe waves 1.14 Differentiate between longitudinal and transverse waves by referring to sound, electromagnetic and seismic waves 1.15 Use both the equations below for all waves: wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m) $v = f \times \lambda$ Wave speed (metre/second, m/s) = distance (metre, m)/time (second, s) $v = \frac{x}{t}$	**HSW 3** Many phenomena can be explained by developing and using scientific theories, models and ideas **HSW 10** Using both qualitative and quantitative approaches **HSW 11** Presenting information, developing an argument and drawing a conclusion, and using scientific, technical and mathematical language, conventions and symbols and ICT tools	**Year 7** Use simple models, e.g. slinky, to represent the characteristics of sound waves **Year 8** Use a simple particle model to explain how sound travels through solids, liquids and gases **Year 8** Evaluate the strengths and weaknesses of simple models used to represent the characteristics of sound waves **Year 8** Use qualitative models to describe motion in terms of speed, distance and time **Year 9** Relate quantitative measures of sound intensity to energy transfer **Year 9** Use 2D representations of sound waves as a model to explain and quantify observed phenomena	**Starter:** *Wave lists* Ask students to work individually to list all the types of wave they can think of. The list could be extended by accepting any oscillatory motion. Students then contribute to a class list that is developed on the board. Ask how the various suggestions are similar or different, highlighting the ideas to be met in this topic, particularly the difference between transverse and longitudinal waves. **Main:** *Wave properties worksheet* Students answer the questions on Worksheet P1.5b *Amplitude, frequency and wavelength*, which reinforces the concepts of the wave properties explained in the Student Book. **Plenary:** *Agreeing definitions* Put the following words on the board: amplitude, frequency, hertz, longitudinal waves, sound waves, transverse waves, wave speed, wavelength. Students work in pairs to generate sentences using at least two of the words/phrases. They then join with another pair and the four attempt to come up with a pair of sentences in which all eight words/phrases are used. **Homework:** Worksheets P1.5c (for students requiring extra support) and P1.5d (for those working at a higher level) contain questions on wave speeds.	**Stretch:** Challenge students to create some similar questions of their own. Or possibly assign students to mentor a less able pupil to help them complete these worksheets. **Support:** Worksheet P1.5a is at a lower level so some students might complete only this worksheet.	Worksheet P1.5a Worksheet P1.5b Worksheet P1.5c Worksheet P1.5d	*To follow*

Exemplar worksheets

The pages that follow contain a selection of worksheets from the Edexcel GCSE Science Teacher and Technician Planning Pack and the Activity Pack, which form part of our suite of published resources. Visit www.edexcel.com/science2011 for more information.

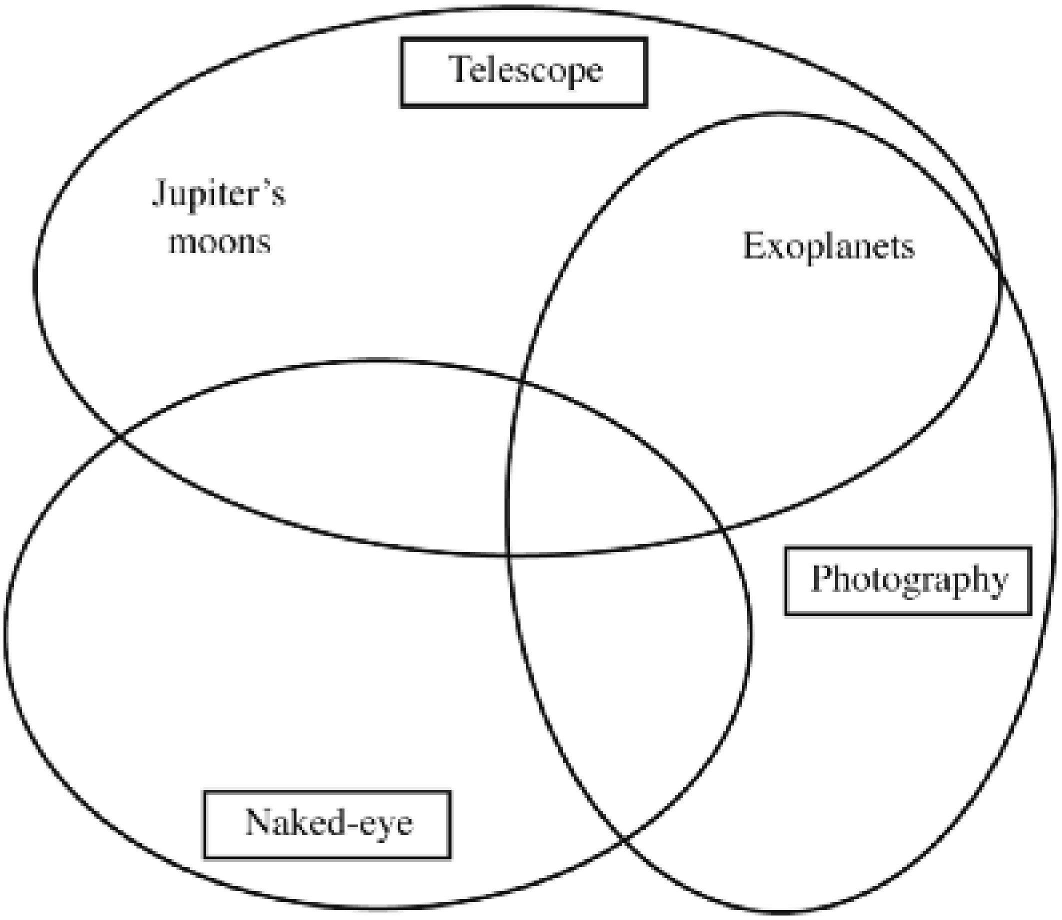
P1.1b Comparing astronomical observations

Name________________________________ Class__________ Date__________

You are going to sort astronomical observations into groups depending on the way that they are made.

Grouping observations

Sort the list of astronomical observations on the second sheet into the right groups in this diagram. If they are only naked-eye observations, or only telescope observations, or only photographic observations, then put them into the area covered by just those headings. If they use more than one type of observation, then put them into the overlap areas that match those types. The first two examples have been done for you.



Sheet 1 of 2

P1.1b Comparing astronomical observations

Astronomical observations

Sort these observations according to the way they were first observed. Use the third column in the table below to make notes about your choices.

observation	summary for Venn diagram	naked-eye, telescope or photography
In 1610, Galileo discovered four of Jupiter's moons.	Jupiter's moons	telescope
In January 2010 NASA announced that its Kepler space telescope had recently found five exoplanets, those outside our Solar System.	exoplanets	photography and …
Every full moon is a public holiday in Sri Lanka.	full moon	
On a clear night, Venus may be seen as a bright point of light near the horizon just after sunset.	Venus	
To protect your eyes, a solar eclipse can be viewed by taking a picture of it.	solar eclipse	
Sometimes collections of meteors provide a fiery light show as they fall to Earth.	meteors	
Neptune was discovered by local observatories following predictions by John Couch Adams and Urbain le Verrier in 1846.	Neptune discovery	
The ancient Mayan Pyramid of Kukulcan was constructed with parts that line up at certain times to complex Sun and star formations. These formations would have taken years for their astronomers to measure.	Mayan pyramid	
Photos of nebulae from the Hubble Space Telescope showed where young stars are born.	nebulae	
In 2005, NASA's Cassini spacecraft sent back pictures of Saturn's moon called Tethys.	Saturn's moon Tethys	
Time-lapse photography allows us to observe the movements of the stars across the sky over a whole night. In the UK, the result is a set of concentric circles with the North Star at the centre.	all-night stars	
Ptolemy worked out a geocentric model of the Universe by looking up at the sky and noting down what he saw.	Ptolemy	

P1.1c New planet discovered

*Name*__________________________________ *Class*_________ *Date*________________

Look at the website page printed below and then answer the questions which follow. It is a news article from the NASA website from 2005. NASA is America's space research group and the article is about finding a new 'planet' in our Solar System. Since the discovery, the International Astronomical Union has re-classified this as a dwarf planet called Eris.

10th Planet Discovered

Astronomers have found a new planet in the outer reaches of the solar system.

July 29, 2005: "It's definitely bigger than Pluto." So says Dr. Mike Brown of the California Institute of Technology who announced today the discovery of a new planet in the outer solar system.

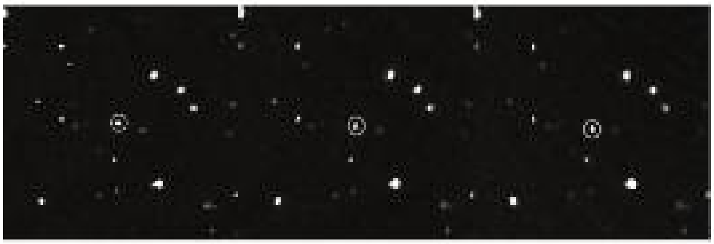
The planet, which hasn't been officially named yet, was found by Brown and colleagues using the Samuel Oschin Telescope at Palomar Observatory near San Diego. It is currently about 97 times farther from the sun than Earth, or 97 Astronomical Units (AU). For comparison, Pluto is 40 AU from the sun.

This places the new planet more or less in the Kuiper Belt, a dark realm beyond Neptune where thousands of small icy bodies orbit the sun. The planet appears to be typical of Kuiper Belt objects--only much bigger. Its sheer size in relation to the nine known planets means that it can only be classified as a planet itself, Brown says.

Backyard astronomers with large telescopes can see the new planet. But don't expect to be impressed: It looks like a dim speck of light, moving very slowly against the starry background. "It is currently almost directly overhead in the early-morning eastern sky in the constellation Cetus," notes Brown.

The planet was discovered by, in addition to Brown, Chad Trujillo, of the Gemini Observatory in Mauna Kea, Hawaii, and David Rabinowitz, of Yale University, New Haven, Connecticut. They first photographed the new planet with the 48-inch Samuel Oschin Telescope on October 31, 2003. The object was so far away, however, that its motion was not detected until they reanalyzed the data in January of this year. In the last seven months, the scientists have been studying the planet to better estimate its size and its motions.

"We are 100 percent confident that this is the first object bigger than Pluto ever found in the outer solar system," Brown adds.



Above: The new planet, circled in white, moves across a field of stars on Oct. 21, 2003. The three photos were taken about 90 minutes apart. Image credit: Samuel Oschin Telescope, Palomar Observatory

Telescopes have not yet revealed the planet's disk. To estimate how big it is, the astronomers must rely on measurements of the planet's brightness. Like all planets, this new one presumably shines by reflecting sunlight. The bigger the planet, generally speaking, the bigger the reflection. The reflectance, the fraction of light that bounces off the planet, is not yet known.

P1.1c New planet discovered (cont.)

Nevertheless, it is possible to set limits on the planet's diameter:
"Even if it reflected 100 percent of the light reaching it, it would still be as big as Pluto," says Brown. Pluto is 1400 miles (2300 km) wide. "I'd say it's probably [about] one and a half times the size of Pluto, but we're not sure."

The planet's temporary name is 2003 UB313. A permanent name has been proposed by the discoverers to the International Astronomical Union, and they are awaiting the decision of this body before announcing the name. Stay tuned!

Source: NASA Press Release| Editor: Dr Tony Philips | Credit: Science@NASA

Article reproduced by kind permission of NASA

1 Look through the text and underline all the actual quotes from Professor Brown.

2 Circle words that tell us how and where the pictures were taken.

3 Highlight explanations about the size of the new planet.

4 When was the first picture of this planet taken?

5 The Samuel Oschin telescope was built high in the mountains, above many weather systems. Suggest how this might make observing the sky easier.

6 The Earth is 150 million km from the Sun. How far was this new planet from the Sun when the article was written?

7 How large does Brown estimate the planet probably is?

8 What is the Kuiper belt and where is it?

9 List:

a the observations made

b the conclusions drawn from these observations.

10 The International Astronomical Union is a group of the world's top astronomers. Suggest one reason why the name of the new dwarf planet had to be agreed by the IAU.

P1.2 (1) Refracting telescopes

Teacher and technician sheet

Starter 1: The window test Demo/Prac	Time
Demonstrate how to find the focal length of a convex lens. Students may be offered the chance to try it themselves afterwards.	10 mins

Specification coverage

1.6 Explain how to measure the focal length of a converging lens using a distant object

This practical covers **HSW statements 5, 6, and 10**.

- Health and safety
- If they use glass lenses, students will need to take care not to drop or damage them; and take special care if they are already damaged.
- Do not use the Sun as an object to focus, and do not look at the Sun through the glass lens.

Apparatus

round convex lenses, various focal lengths (f = 10 to 40 cm) *(The greater the variety the better.)*	metre rulers
window or bright filament lamp *(If pupils use the lamp, use a low voltage type, e.g. 12V)*	white screens *(Plain paper could be used, either held in a stand or wall mounted.)*

Running the activity

1. Demonstrate holding the lens in front of a screen and focusing a clear image of a distant object (outside the window, or a bright lamp at one end of the room) onto the screen. Note that the image is inverted (appears upside down).
2. An assistant holds up a metre ruler to measure the distance from lens to screen.
3. Students may be given time with a partner to measure the focal length of a lens (or various lenses). However, students will investigate focal lengths further in the Core Practical (P1.4).

Expected results

Students should observe that a clear colour image can be focussed on the paper. They should be able to measure the focal length with a ruler to within about 0.5 cm accuracy, depending on the actual focal lengths used.

P1.2 (2) Refracting telescopes
Teacher and technician sheet

Exploring 1: Refraction experiments Prac	Time
Students shine a single ray of light through glass blocks to observe refraction.	30 mins

Specification coverage

1.10 Recall that waves are *reflected and* refracted at boundaries between different materials

H **1.11** Explain how waves will be refracted at a boundary in terms of the change of speed and direction

This practical covers **HSW** statements **5**, **6**, **7** and **10**.

Health and safety

- Rayboxes often get very hot and students need to be warned of the dangers of burns and fires.
- If they use glass blocks or lenses, students will need to take care not to drop or damage them; and take special care if they are already damaged.
- Some rayboxes now use laser diodes. Make sure they are no higher than class 2 lasers, and remind students that they should never look directly into a laser beam or its mirror-like reflections.

Apparatus (per group)

glass or plastic blocks *(various shapes)*	power supply
plain paper *(A3 is best – underneath the whole experiment for observation and drawing on.)*	raybox, single slit *(If necessary, a convex lens adjacent to the slit can make the ray thin and straighter.)*

Other resources

Worksheet P1.2a *Refraction experiments*

Running the activity

1. Students follow the instructions on Worksheet P1.2a.
2. The activity is open-ended in that students could do as many or as few tests as you have time and equipment for, and their ability dictates.

Stretch: Students could investigate how the angle of incidence and angle of refraction are connected, for example by measuring the change in angle of refraction as the angle between the normal and the ray increases. (Recall of laws of refraction and use of sine angle are not required.) Tell students that it is not easy to measure the speed of light in materials. Ask them to suggest an experiment in which they could measure speed of waves, and hence test how the direction of refraction depends upon the change in speed of waves. (This hints at measuring or comparing speed of water waves in a ripple tank.)

3. Students are instructed to produce diagrams of their observations, including the predicted direction for refracted rays. Pages 210 from the Student Book may help students work out the direction for refracted rays.

Support: Provide students with ready-made outlines of the blocks with the incident rays marked.

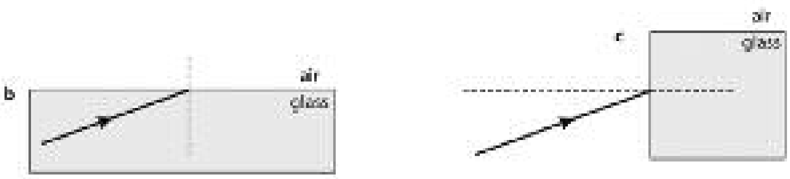
Expected results

Students should find that rays bend towards the normal on entering the glass and away from the normal on leaving the glass. For rectangular blocks the ray should emerge parallel to its line of entry. For the stretch activity, sin (angle of incidence) is proportional to sin (angle of refraction) and the constant of proportionality is called the refractive index, *n*. For glass, n = 1.5.

P1.2d Refraction challenge

*Name*____________________________________ *Class*_________ *Date*__________

1 Continue the ray in each of the diagrams to show what happens when the ray of light reaches the boundary.



2 Imagine you have found an old pair of glasses with converging lenses. Draw a diagram to show how you would find the focal length of the lenses.

H 3 The table shows how fast light travels in different materials.

Material	Speed of light (m/s)
air	300 000 000
glass	200 000 000
water	225 000 000

a What happens to the speed of light when it travels from air into water?

____

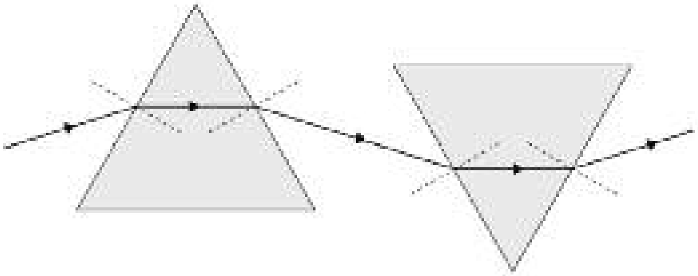
b Will light be refracted more when it goes from air to glass or from air to water? Explain your answer.

____

____

P1.2d Refraction challenge

H 4 The diagram shows a ray of red light passing through two prisms.



Copy the diagram.

a What do the dashed lines represent? ______________________

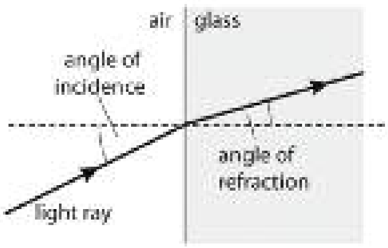
b Mark with an X two places where light is slowing down.

c Mark with a Y two places where light is speeding up.

d Show what happens to a ray of violet light passing through the two prisms.

Hint: violet light is refracted through a bigger angle than red light when it enters a prism.

H 5 The diagram shows a ray of light going through a glass block. Use the information on the diagram to help you to fill in the gaps in the paragraph below.



When light travels from air into ______________ the wave speed ______________. The light ray bends ______________ the normal. When the light re-enters the air its speed ______________ and it bends ______________ from the normal. This is an example of ______________ occurring.

P1.4 (2) Reflecting telescopes

Teacher and technician sheet

Explaining 2: Liquid mirror telescopes (LMTs) Demo	**Time**
Using a water based model, demonstrate the idea that spinning a tray of liquid mercury can provide a very smooth curved surface, which can be used as the primary mirror in a reflecting telescope.	15 mins

Specification coverage

1.9 Describe how a reflecting telescope works

1.10 Recall that waves are reflected and refracted at boundaries between different materials

This practical covers **HSW 12**.

Health and safety

- Water spillage health and safety precautions should be taken.
- Plastic Petri dishes will minimise breakage hazards.

Apparatus

Petri dish(es)	**Optional:** turntable
Optional: large bowl	

Running the activity

1. Explain to the class that a clever idea for producing a flawless concave mirror surface is to spin a dish containing a reflective liquid like mercury. This is a very cheap solution for producing a large primary mirror for a reflecting telescope, and the largest is at the University of British Columbia with a 6 m mirror in which a pan of liquid mercury rotates at about 8 rpm. Note: it may be necessary to show a picture/video of some mercury in order to familiarise students with the substance. Or show some information from the website www.astro.ubc.ca/lmt/lzt which includes a photo of testing the 6 m mirror using water, exactly as in this demo.
2. Fill a Petri dish less than half full of water and attempt to spin it gently to produce a parabolic surface shape.
3. This is intended to be a fun, messy practical. Where appropriate, you may invite pupils to try it, possibly in a competitive way to see who can generate the smoothest 'mirror' surface.
4. As with real astronomy, an attempt could be made to increase the size of the mirror created, perhaps using a washing up bowl on a turntable.

Stretch: Ask students to suggest how and why liquid mercury might behave differently to the water.

Support: Remind students of work they have previously done in which a curved mirror was needed to build a reflecting telescope.

Expected results

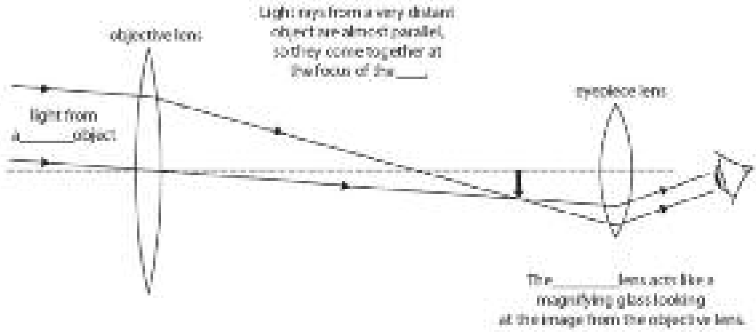
Students should observe that the water surface can be made to be concave with careful uniform rotation of the Petri dish.

P1.4b Refracting and reflecting telescopes

Name ______________________ *Class* __________ *Date* __________

Refracting telescopes

1 The diagram shows how a refracting telescope works. Complete the labels on the diagram.



2 When Galileo made a telescope like this, he built the lenses into a light-proof tube. Why would this be a good thing to do?

____

____

3 Astronomers want to make telescopes as large as possible. Suggest why they might want to do this.

____

____

4 What problems would there be in trying to make a telescope with very large lenses?

____

____

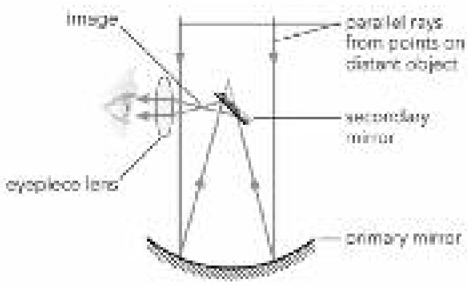
Reflecting telescopes

5 The diagram shows how a reflecting telescope works.

a Label the diagram to show the eyepiece lens, the primary mirror and the secondary mirror.

b What is the job of the curved mirror?

c What is the job of the eyepiece lens?



6 Suggest one reason why astronomers usually build telescopes with large mirrors rather than with large lenses.

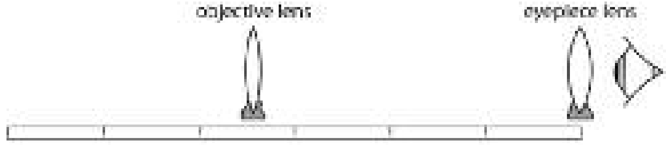
____

____

P1.4c Hamid's telescopes

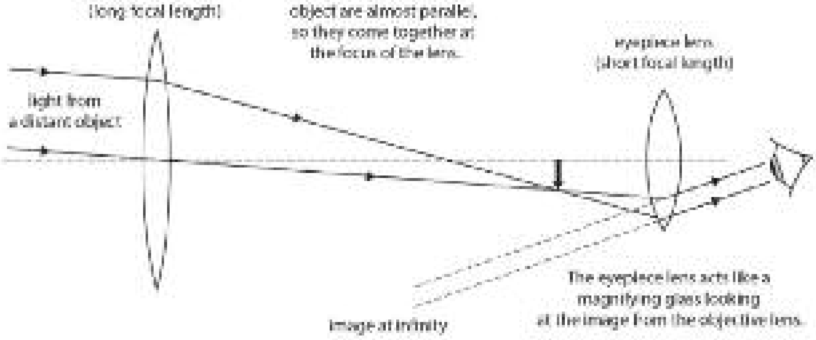
Refracting telescopes

1 Hamid made a simple telescope in his science class using two lenses as in this picture.



If he used the telescope to look at a distant tree, describe the image he would see compared with how it looks without the telescope: would it be in colour or black and white; upside-down or the right way up; magnified or diminished?

2 The diagram shows how a refracting telescope works.



a What does the objective lens do?

b What is the job of the eyepiece lens?

Reflecting telescopes

3 Hamid decided he would like to compare his telescope with a reflecting telescope.

a What items would he need to construct a reflecting telescope?

b Draw a sketch to show how he would set them up.

4 For small telescopes like Hamid's, refracting telescopes can often work more effectively. Suggest which type of telescope is better when you want to build a large one to observe a very faint star and why this type has to be used.

Extra challenge questions

5 For his refracting telescope, Hamid used a simple method for finding the focal lengths of his lenses. How did he then know how far apart to put the lenses?

6 Why would the telescope lenses normally be held in a tube?

P1.5a What are waves?

Name________________________________ Class________ Date________

1 Unscramble the letters to find the missing words.

a ____________________ transfer energy from one place to another. | save w |

b ____________________ energy reaches us from the Sun. | lt hig |

c Water waves and waves on ropes are _______________ waves. | ravens rest |

d Sounds waves are _______________ waves. | unlit loading |

2 Use the words in the box to fill in the missing words in the sentences below.

slower	longitudinal	matter	transverse

a This is not transferred when waves move through it. ______________

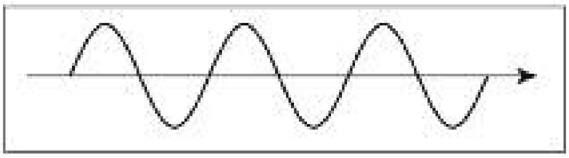
b Sound waves travel ______________ than light waves.

c Light waves, and all electromagnetic waves are ______________ .

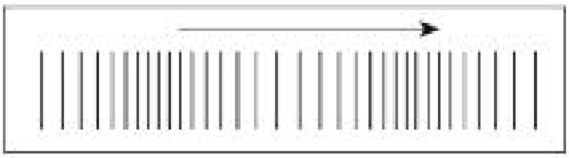
d Earthquake waves may be ______________ or transverse.

3 Match up the waves below with the correct words in the boxes.

longitudinal



transverse



P1.5b Amplitude, frequency and wavelength

*Name*____________________________________ *Class*__________ *Date*__________

1 Fill in the gaps using words from the box.

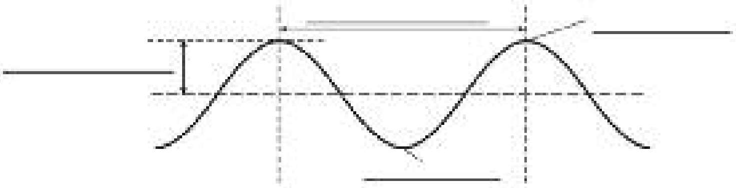
The distance between two successive peaks of a wave is the _______________ of the wave.

The _______________ is the number of waves produced by the source each second.

The distance from the usual position to a trough is called the _______________ of the wave.

amplitude	frequency	wavelength

2 Label the transverse wave below.

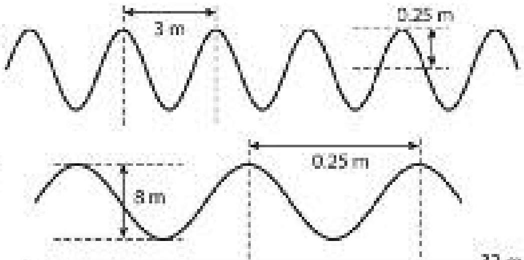


wavelength
amplitude
peak
trough

3 Look at the following waves. For each wave, write down the wavelength and the amplitude:

i the wavelength ii the amplitude.

a



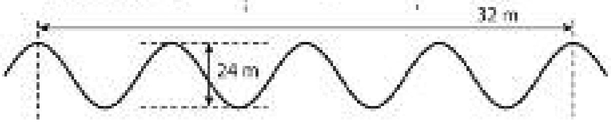
a i _______________

ii _______________

b i _______________

ii _______________

c



i _______________

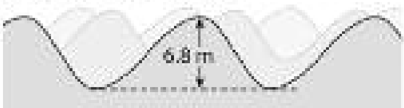
ii _______________

4 The frequency of a sound produced by a guitar string is 440 Hz. What does this mean?

____

____

5 The vertical distance from the trough of a water wave at sea to its crest is 6.8 m. What is the amplitude of the wave?



6 A boy notices that 450 complete waves travel past him in one and a half minutes. What is the frequency of these water waves?

____

____

P1.5c Wave speed

1 In each sentence, delete the wrong words. The first one has been done for you.

a Waves transfer energy and information without transferring *matter/disease*.

b The amplitude of a wave is the distance from the rest position to the *least/furthest* distance of a point on the wave.

c Sound waves are *transverse/longitudinal*.

d Electromagnetic waves are *transverse/longitudinal*.

e *Earthquake/light* waves can be transverse or longitudinal.

f Wave *speed/amplitude* = $\frac{\text{distance travelled}}{\text{time taken}}$

2 Use the information in the diagram below to fill in the gaps.

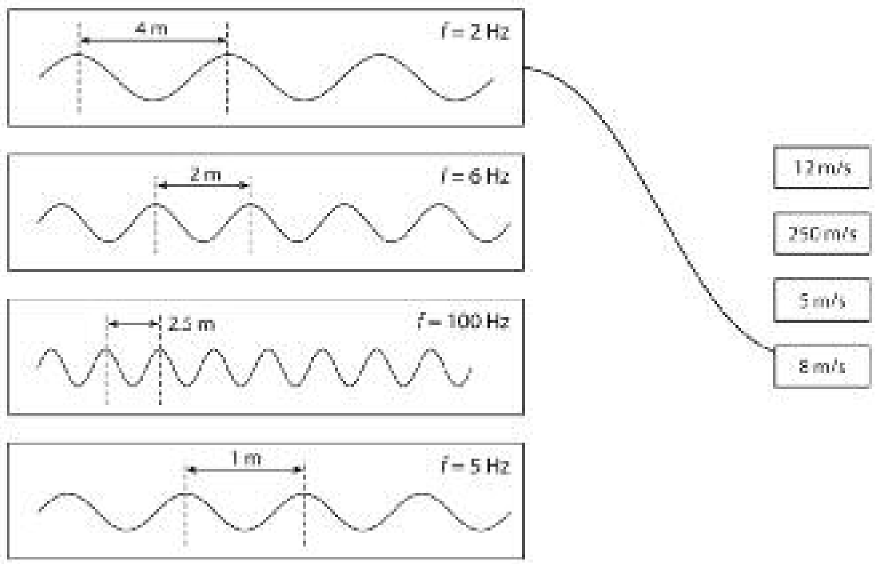
This wave has a wavelength of __________ m and a frequency of __________ Hz.

Its speed = frequency × ________________

= __________ × __________

= __________ m/s

3 Match the waves on the left to their speeds on the right. The first one has been done for you.



P1.5d The wave equations

Use the following information to help you answer the questions below.

- The units needed for wave calculations are metres, seconds, metres per second and hertz.

  1 kHz = 1000 Hz 1 MHz = 1 000 000 Hz 1 m = 100 cm = 1000 mm.
- The speed of light in a vacuum (and air) is 3×10^8 m/s.
- The speed of sound in air is 330 m/s.
- wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m)

  $v = f \times \lambda$
- wave speed (metre/second, m/s) = distance (metre, m) / time (second, s)

  $v = \frac{x}{t}$

1 Two sound waves have frequencies of 250 Hz and 17 600 Hz, respectively. Calculate the wavelengths of both of these waves.

2 Red light has a wavelength of 7.5×10^{-7} m in air and blue light has a wavelength of 4.0×10^{-7} m in air. Use the wave equation to find:

a the frequency of red light

b the frequency of blue light

c how many more blue waves are produced than red waves each second.

3 Ripples on the surface of water are noticed to travel 560 cm in 54 seconds. Calculate the speed of these waves.
Hint: Remember to convert the units to metres.

4 The wavelength of a sound wave is 2.8 cm. Calculate the frequency of the waves in hertz.

5 Convert the following wavelengths into metres:

a a radio wave of wavelength 3.5 km

b a microwave of wavelength 5 cm

c a sound wave of wavelength 120 mm.

6 Use your answers from question **5** to calculate the frequency of each of the three waves.

d From question 5, identify which are longitudinal waves and which are transverse waves.

7 The frequency of radio waves from a local radio station is 92.6 MHz. What is the wavelength of these waves?

8 a What is the speed of a sound wave that has a wavelength of 10 m and a frequency of 33 Hz?

b Explain whether or not it is travelling in air.

9 Light waves travel from air into glass. The speed of the wave decreases to a speed of 2×10^8 m/s, but the frequency remains constant at 5×10^{14} Hz. Find the wavelength of the light wave in the glass.

10 A sound wave has a frequency of 4.2×10^4 Hz. What will its wavelength be in air?

Extra challenge question

11 For the waves in questions **7** and **10**, calculate how long it will take them to travel 2000 km.

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About Stephen

"I spent 20 enjoyable years as a teacher in four different types of school, and was Head of Science at my last three schools. During my two final years of teaching I was Director of Assessment and Examinations in a selective school as well as working as a County Advisor, supporting science departments in raising their performance.

In 2008, I took on the role of Science Subject Advisor here at Edexcel, where I now help the science examination system work smoothly in centres across the country."

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Sample scheme of work continued...

Lesson P1.3: Lenses practical						
Specification learning outcomes	HSW statements	Prior learning from KS 3	Exemplar teaching activities	Main differentiation	Resource sheets	BTEC Links
1.6 Investigate the behaviour of converging lenses, including real and virtual images 1.7 *Investigate the use of converging lenses to: a) measure the focal length using a distant object b) investigate factors which affect the magnification of a converging lens (formulae are not needed)*	**HSW 1** The collection and analysis of scientific data **HSW 3** Many phenomena can be explained by developing and using scientific theories, models and ideas **HSW 5** Planning to test a scientific idea, answer a scientific question, or solve a scientific problem **HSW 6** Collecting data from primary or secondary sources, including the use of ICT sources and tools **HSW 7** Working accurately and safely, individually and with others, when collecting first-hand data **HSW 8** Evaluating methods of data collection and considering their validity and reliability as evidence **HSW 9** Recalling, analysing, interpreting, applying and questioning scientific information or ideas	N/A	*To follow*	*To follow*	*To follow*	*To follow*