Edexcel core science Physics P1b

*Items in **bold** are for higher tier only*

Topic 11 — Now You See it, Now You Don't

There are many different types of waves and these have many uses. For example, in the natural world, light waves enable us to see objects; sound waves enable us to communicate aurally; infrared waves from the Sun provide the Earth with the thermal energy that is needed to sustain life. This topic explores how specific types of waves are suited for particular applications, for example, X-rays for examining the human body, ultrasound for scanning a fetus in the womb, ultraviolet waves for detecting forged banknotes and microwaves and infrared waves to monitor the weather.
This topic provides the opportunity to demonstrate that there are some questions that cannot yet be answered by science, for example, is the radiation used by mobile phones safe? This can lead to ethical considerations, for example, the building and positioning of mobile phone masts.

Have you ever wondered?
- Why does helium make your voice go high?
- Why do scientists believe there could be an even more catastrophic tsunami than the last one in 2004?
- How do we know the Moon is 380,000 km away?
- How do you see an unborn baby?
- How can forged bank notes be detected?
- How do X-rays work?
- How can microwaves be used to forecast the weather?
- Is too much exposure to mobile phone radiation dangerous?
- Why is the picture better on a digital TV?
- Do the night vision goggles you see in the movies and on TV really work?
- Why does your skin burn quicker in the midday Sun?
- Why is music often saved in a digital format, eg on CDs?

Some facts:
- Different types of waves have similar properties.
- Waves carry energy.
- The reflection and absorption of waves can be used for a variety of scanning applications.
- Wave energy can be a risk to health.

Glossary

Absorption	vacuum	scanning	emission
frequency	analogue	waves	mutation
radiation	infrared	electromagnetic	transverse
ultraviolet	refraction	spectrum	fluorescent
amplitude	wavelength	microwave	optical
gamma-rays	digital	seismic waves	fibres
reflection	longitudinal	X-rays	ultrasound

You should be able to:
- evaluate the evidence that microwave radiation from mobile phones or
- masts may pose health risks, and discuss how this has been reported in the media
- explain the characteristics of ultraviolet light in terms of amplitude,

- frequency, energy and wavelength and relate them to the dangers of overexposure, eg UVA, UVB, UVC
- describe the detrimental effects to a person, of excessive exposure to the following waves **and explain this in terms of increasing frequency and energy**:
    - microwaves: internal heating of body tissue
    - infrared: skin burns
    - X-rays and gamma-rays: mutation or destruction of cells in the body
- describe the factors that cause waves to be reflected/refracted explain scanning by reflection in different applications using:
    - ultrasound, eg medical uses, sonar
    - optical, eg iris recognition, fingerprint recognition

  and evaluate the advantages/disadvantages of such technology
- explain how scanning by absorption enables:
    - X-rays to see bone fractures
    - microwaves to monitor rain
    - ultraviolet light to detect forged bank notes by fluorescence
- explain how scanning by emission enables the use of infrared sensors to monitor temperature
- **discuss the benefits and drawbacks to society of a technology that is based on the properties of waves**
- describe the advantages of sending information in the form of a digital signal compared with an analogue signal
- describe how the production of digital signals has created a range of music technologies, including synthesised instruments and the effect that this has had on the way we listen to and distribute music
- explain how the property of total internal reflection of light waves allowed optical fibres to transfer large amounts of information over longer distances
- compare the properties of longitudinal and transverse waves, giving examples of each type, including sound waves, ultrasound, seismic waves and electromagnetic waves
- **suggest reasons why scientists find it difficult to predict earthquakes and tsunami waves even with suitable data**
- explain the terms:
    - amplitude
    - frequency
    - wavelength
    - speed of a wave
- use the relationship: speed = frequency × wavelength
- use the equation: speed = distance/time
- including applications where waves are reflected back to source
- **use data about seismic waves passing through the Earth to explain its structure**
- describe similarities and differences of waves in the electromagnetic spectrum
- recall that all electromagnetic waves travel at the same speed in a vacuum.

Topic 12 — Space and its Mysteries

Scientists have made it possible for people to land on the Moon and have launched missions to explore Mars and other planets and moons. It may not be long before people are able to take holidays in space, perhaps on the Moon! This topic encourages students to think about conditions that space travellers will meet, how spacecraft will be powered, and the problems associated with space travel including the maintenance of medical fitness. Students will be able to use data sources to investigate conditions on different planets and draw conclusions on requirements for survival — it is important to be able to find out information about the Universe without travelling there. To navigate, pilots will need to recognise that the solar system is part of the Milky Way and relate this to other galaxies in the Universe. An understanding of the motion of asteroids and meteors will help the navigator to avoid the paths of these potentially dangerous objects. Navigators will also need to take into account the orbital motion of moons and planets caused by gravity. Strong gravitational regions in space caused by black holes and other objects will need to be avoided!

The study of the Big Bang theory, the expanding Universe and the evolution of a star is also included in this topic. There is scope for discussing the social and economical benefits of knowledge about the Universe and the technological developments that may be gained from its exploration.

Have you ever wondered?

- Is it worth £25 billion to put astronauts on Mars, when we could just send robots?
- How do we know black holes exist when they're completely black?
- The risk of dying from an asteroid impact is the same as being in an air crash. How can this be?
- The Universe is full of planets where intelligent life could start, so where is everybody?
- Do physicists really have no idea what most of the Universe is made from?

Some facts:

- Planets in our solar system have different characteristics.
- The formation and evolution of the Universe and its stars.
- Requirements for travelling in space and taking a holiday on different planets.

Glossary

acceleration	asteroid	Big Bang	comet
extraterrestrial	gravitational	interplanetary	nebula
oscillating	field	red shift	star
theory	radiation	weight	dark matter
stellar	temperature	black hole	orbit
galaxy	atmosphere	mass	steady state theory
planet	gravity	SETI	
Sun	Universe	weightlessness	

You should be able to:

- describe conditions in interplanetary space in terms of atmosphere, temperature and weightlessness
- **explain how these conditions can be partly allowed for in spacecraft, including supply of air, heating/cooling, artificial gravity, exercise machines, etc**
- explain the difference between mass and weight
- use the equation: weight = mass × gravitational field strength $W = mg$
- explain how a spacecraft might be propelled in terms of action and reaction and understand the energy changes which take place as a spacecraft is being launched
- predict the behaviour of an object using the equation: force = mass × acceleration
- **discuss the possible social and economic benefits of knowledge about the Universe and the technological advances which might ensue from its exploration**

- describe and explain how data-logging and remote sensing can provide information about the Universe without us travelling there, for example, soil experiments on landers (Viking/NASA Spirit and Opportunity rovers), the Hubble Space Telescope (HST) and Search for Extraterrestrial Intelligence (SETI)
- explain the problems of long space flights, including the deterioration of bones and heart, and the dangers of radiation and suggest possible solutions
- outline the role of gravity both on Earth and in astronomy, **including the idea of black holes**
- use the unit of gravitational field strength — Newton per kilogram (N/kg)