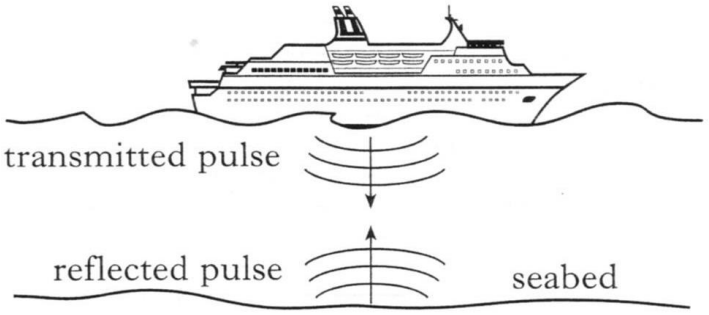
Homework 1 - Sound Echoes

1 The depth of the seabed is measured using pulses of ultrasound waves. The ultrasound waves are transmitted from a stationary ship. The waves are reflected from the seabed as shown and are detected by equipment on the ship. The transmitted ultrasound waves have a frequency of 30 kHz.



(a) One pulse of ultrasound waves is received back at the ship 0.2 s after being sent out.

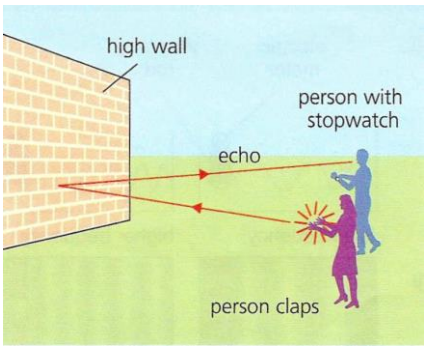
The speed of the ultrasound waves in the water is 1500ms^{-1}.

(i) Calculate the depth of the seabed. (3)

(ii) A shoal of fish swim under the boat. Give a possible echo time for the wave reflecting from the shoal. (1)

(b) The frequency of the transmitted wave is increased to 60 kHz. What happens to the time interval between the transmitted pulse and the reflected pulse?
Explain your answer. (2)

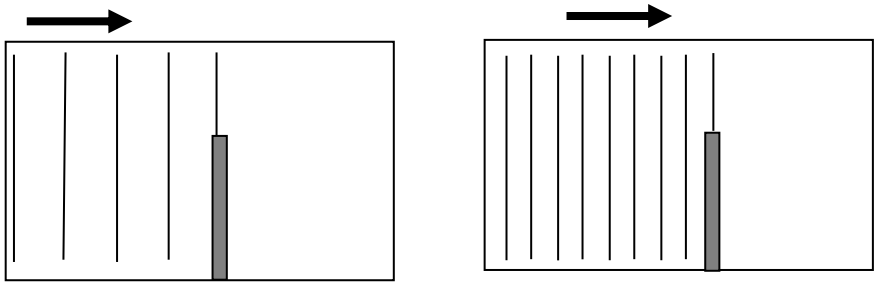
2. In the experiment to measure the speed of sound, two people stand 50 m from a high wall.
The time between the person clapping and the other person hearing the echo is 0.29 seconds.
According to their experiment, what is the speed of sound? (3)



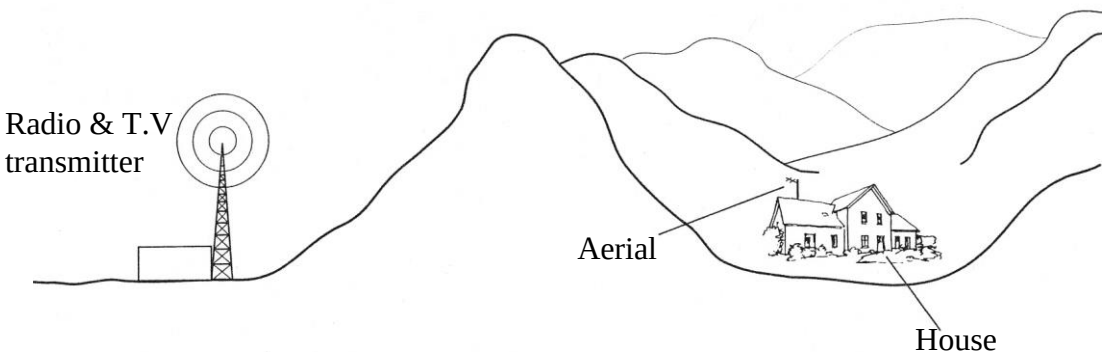
Total 10 marks

Homework 2 - Diffraction of Waves

1. Copy and complete the following diagrams to show what happens to the waves beyond the obstacle in the ripple tank. (3)



2. A house in a hilly region can't get a good reception on the television, but radio reception is perfect.
Explain why this is. (2)



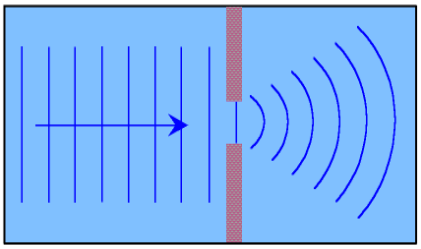
3. Water waves can be shown to diffract using a ripple tank.
As the waves diffract through the opening, what happens to

a. Their frequency? (1)

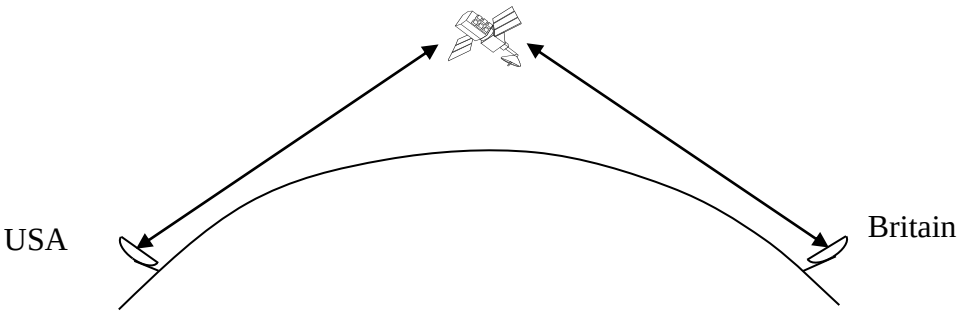
b. Their wavelength? (1)

c. Their speed? (1)

d. What could be changed to make the waves diffract more? (1)



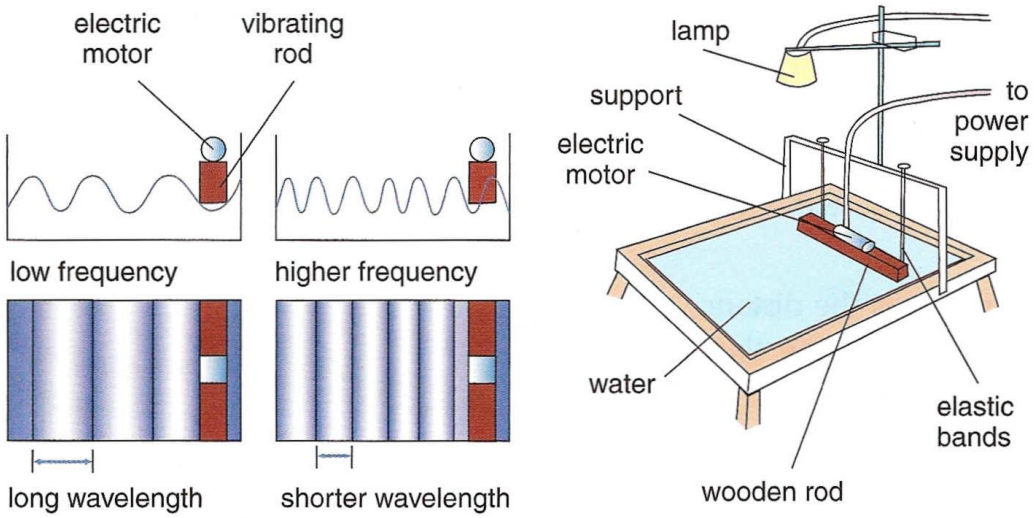
4. Why can television signals not be sent directly from Britain to America, but require to be sent by satellite? (1)



Total 10 marks

Homework 3 - Speed, Frequency, Wavelength, Distance and Time 1

1. A ripple tank was used to produce water waves as shown below.



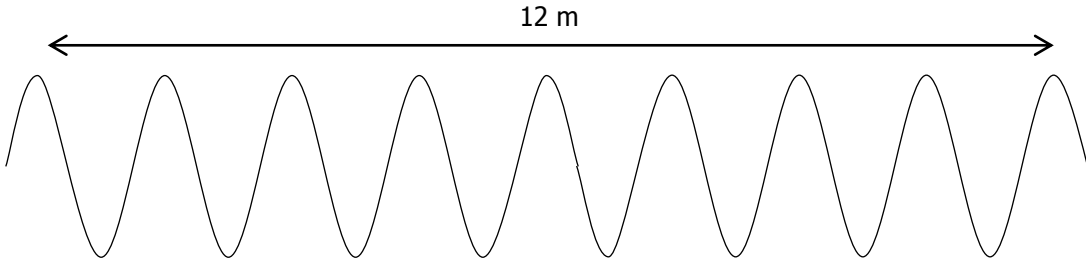
(a) What happens to the wavelength as the frequency of the waves is increased? (1)

(b) There are 3 low frequency waves produced in 4 seconds.
What is their frequency in Hertz? (2)

(c) If the wavelength is 8 cm what is the speed of the waves? (2)

(d) The distance from the bottom (trough) to the top (crest) of the higher frequency waves is 3cm.
What is the amplitude of the waves? (1)

2. The questions below refer to this diagram.



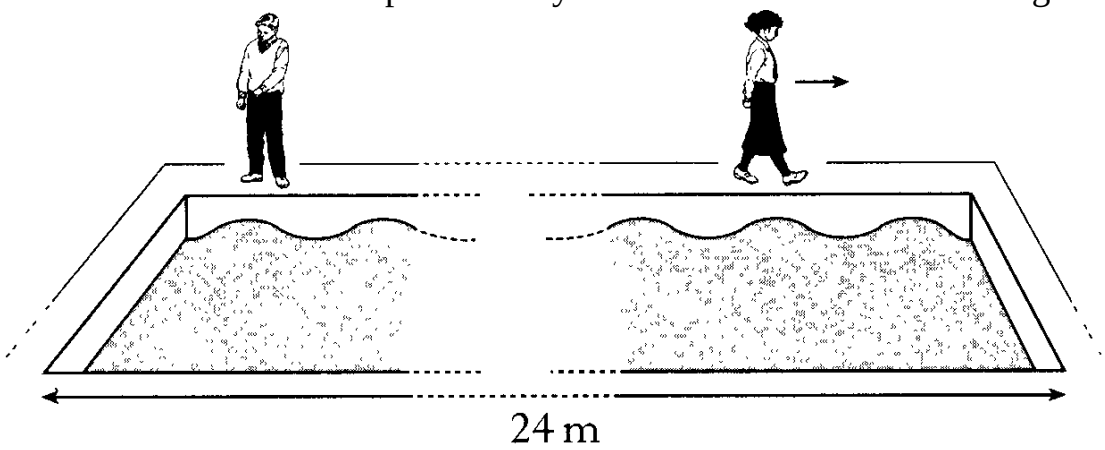
(a) Calculate the wavelength of the waves shown. (2)

(b) If the speed of the wave is 4 m/s, calculate its frequency. (2)

Total 10 marks

Homework 4 - Speed, Frequency, Wavelength, Distance and Time 2

1 Two students watch the waves produced by a wave machine at a swimming pool.



One student walks beside a wave as it travels along the pool.
The wave goes from one end of the pool to the other in 20 s.
The length of the pool is 24 m.

(a) Calculate the speed of the waves. (2)

(b) In the same time interval, the other student counts 5 waves going past the point where he is standing.
Calculate the frequency of the waves. (2)

(c) The students note that there are 5 complete waves in the pool at any time. Calculate the wavelength of the waves. (2)

2. Ultrasound is used by doctors for treatment and diagnosis.

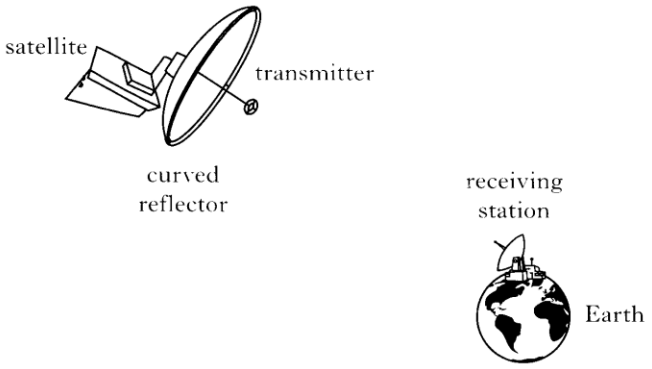
(a) Pulses of ultrasound are used to produce local heating of muscle deep inside the body. This heating effect can help relieve pain in the muscles.
Calculate the time for a pulse of ultrasound to travel through 2 cm of muscle. [Data: Speed of sound in muscle = 1 600 m/s] (2)

(b) The ultrasound pulse transmitted has a frequency of 3 MHz.
Calculate the wavelength of the ultrasound in muscle. (2)

Total 10 marks

Homework 5 - Electromagnetic Spectrum (Frequencies, Wavelength and Energies)

1. (a) All radiations in the electromagnetic spectrum travel at a speed of $3x10^8$ m/s in space.



A satellite transmits microwaves on the following three frequencies.

$1.0x10^{10}$ Hz,
$9.0x10^9$ Hz,
$8.0x10^9$ Hz

Calculate the wavelength of the microwaves with the **longest** wavelength. (3)

(b) Microwaves are part of the electromagnetic spectrum.
The diagram below shows the electromagnetic spectrum arranged in order of wavelength. Two parts of the spectrum, P and Q, have been omitted. Name the radiations P and Q. (1)

increasing wavelength →

gamma rays	*P*	*ultra violet*	*visible*	*Q*	*micro waves*	*radio + TV*

(c) In which part of the spectrum do the waves have the highest energy? (1)

(d) Name the colours of visible light from lowest to highest wavelength. (1)

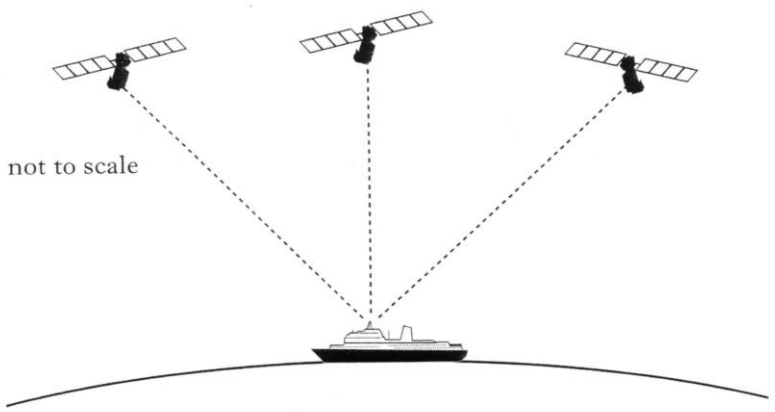
2. An **optical fibre** is used to carry a telephone message to the USA from Scotland. It travels 5000 km.
The light signals travel at a speed of 2×10^8 m/s. How long will this take? (2)

3. Absolute Radio broadcasts on a frequency of 1215 kHz.
What is the wavelength of these radio waves? (2)

Total 10 marks

Homework 6 - Electromagnetic Spectrum
(Speed, Frequency, Wavelength, Distance and Time)

1 A ship has a satellite navigation system. A receiver on the ship picks up signals from three global positioning satellites.



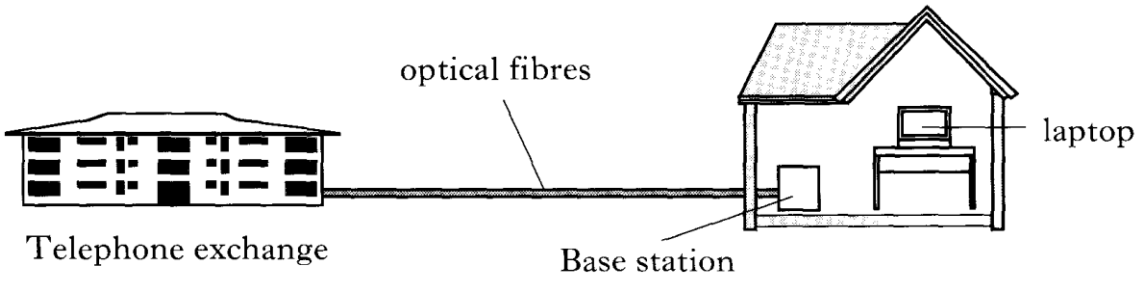
These satellites can transmit radio signals at three different frequencies
1176 MHz, 1228 MHz and 1575 MHz.
The satellites orbit at a height of 20200 km above the Earth's surface.

(a) Which satellite frequency has the longest wavelength? (1)

(b) One of the satellites is directly above the ship. Calculate how long a signal from this satellite would take to reach the ship. (2)

(c) Calculate the wavelength of the 1228 MHz signal. (2)

2. A laptop computer uses a radio signal to transfer information to a base station. The base station is connected by optical fibres to a telephone exchange.



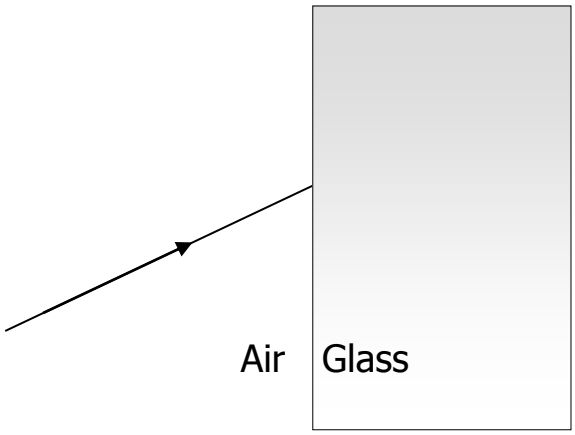
(a) The wavelength of the radio signal is 60 mm.
(i) State the speed of the radio signal. (1)
(ii) Calculate the frequency of the radio signal. (2)

(b) The telephone exchange is 40 km away from the base station. Calculate the time taken for the signal to travel along the **glass** optical fibre from the base station to the local telephone exchange. (2)

Total 10 marks

Homework 7 - Refraction

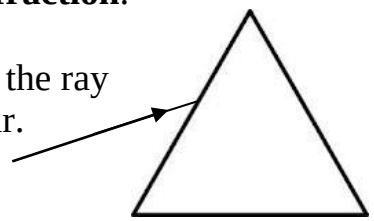
1. A ray of light passes from air to glass as shown:



(a) Copy and complete the diagram to show the path of the ray of light through the block and after it emerges from the block. (2)

(b) Label the **angle of incidence** and **angle of refraction**. (2)

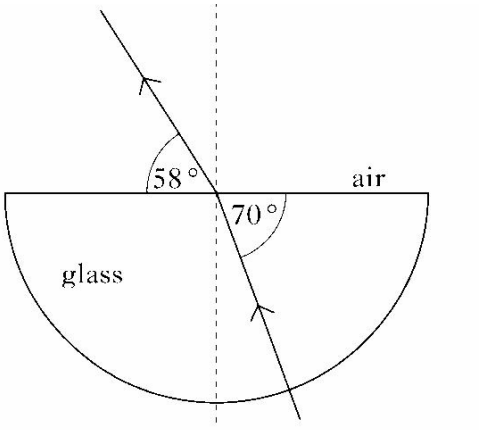
2. Copy and complete the diagram to show the path of the ray through the triangular prism and back out into the air. (2)



3. What does 'refraction' mean? (1)

4. State the speed of light as it passes through glass. (1)

5. A ray of light passes through a glass block as shown below.

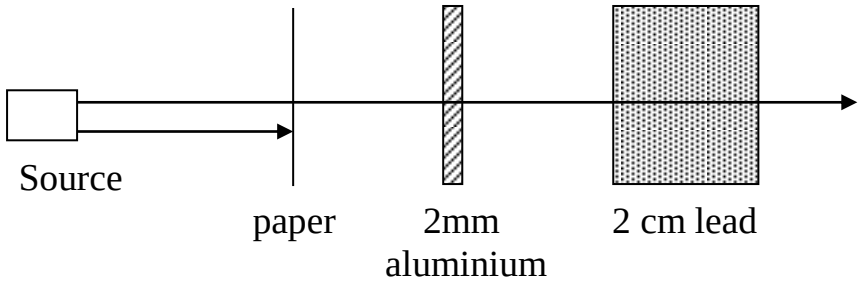


State the angle of incidence and the angle of refraction. (2)

Total 10 marks

Homework 8 - Nuclear Radiation and Types of Nuclear Reaction

1. A radioactive source emits two types of radiation, P and Q.

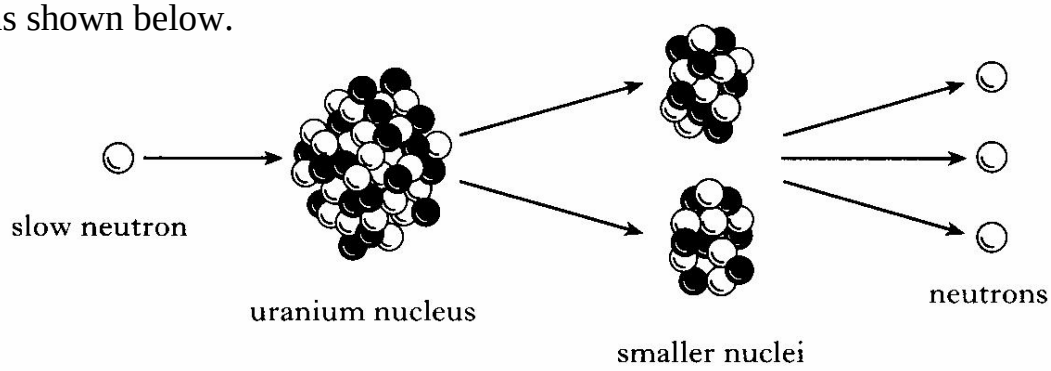


(a) Name the types of radiation, P and Q. (2)

(b) Alpha particles produce a greater ionisation density than Beta particles or gamma rays. What is meant by the term ionisation? (1)

(c) (i) State what is meant by an alpha particle. (1)
(ii) State what is meant by a beta particle. (1)

2. In a nuclear power station a uranium nucleus is bombarded by a slow neutron as shown below.



(a) A nucleus contains 2 types of particle. Name these particles. (1)

(b) What is the name given to the process shown in the diagram? (1)

(c) (i) State the name of another type of nuclear reaction. (1)
(ii) Describe the difference between the two types of reaction. (2)

Total 10 marks

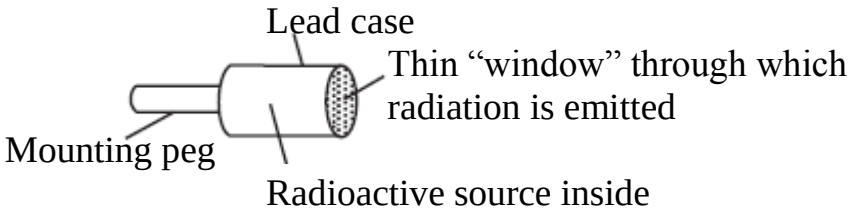
Homework 9 - Dosimetry

1. For a particular radioactive source, 1800 atoms decay in a time of 3 minutes. Calculate the **activity** of this source. (2)

2. What does the radiation weighting factor tell us about a radiation? (1)

3. What is meant by the term equivalent dose? (1)

4. A radioactivity kit includes three radioactive sources each made up as shown.



Information about these sources is given in the table below.

	Radiation Emitted	Radioactive Element
Source 1	Alpha	Americium 241
Source 2	Beta	Strontium 90
Source 3	Gamma + Beta	Cobalt 60

A technician working with Source 1 receives an absorbed dose of 5×10^{-5} Gy. The mass of the technicians hand is 500g.

(a) Calculate the total energy absorbed by the technician's hand. (2)

(b) Use the information from the table in your Problem Sheets to calculate the total equivalent dose received by the technician's hand. (2)

(c) Describe two ways in which the technician could reduce his absorbed dose. (2)

Total 10 marks

Homework 10 – Half-Life

1 A radioactive source emits alpha particles and has a half-life of 9.6 hours. The source has an initial activity of 6.4 kBq.

(a) Explain what is meant by the term half-life. (1)

(b) Calculate the activity of the source after 2 days. (2)

2. In 1969, a new element called Rutherfordium was created in America. Some tests were done to discover its half-life. The element's starting activity was measured as 20 480 Bq, and 18 seconds later, it had dropped to just 320 Bq.
Calculate the half-life of Rutherfordium from these figures. (3)

3. Living plants incorporate a radioactive isotope of carbon (C_{14}) into their living tissue. This radioactive carbon is always found in the same ratio to ordinary carbon (C_{12}) in something that is alive, but once it dies, the ratio of C_{14} to C_{12} decreases.
By comparing the ratio of the two types of carbon the age of a piece of dead plant material can be calculated. The half-life of C_{14} is approximately 5700 years. That is, after 5700 years, the ratio of C_{14} to C_{12} will be half the original value.
The amount of C_{14} left after 7 half-lives is only just detectable. This puts a limit on the maximum age that can be estimated using this technique.

(a) What is the half-life of C_{14}? (1)

(b) A piece of wood preserved in a peat bog is found to have a ratio of C_{14} to C_{12} of only $^{1}/_{16}^{th}$ that found in a living tree.
Estimate the age of the wood. (2)

(c) What the maximum age that can be estimated using this technique? (1)

Total 10 marks