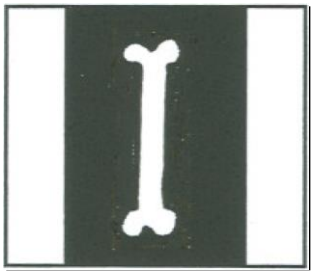
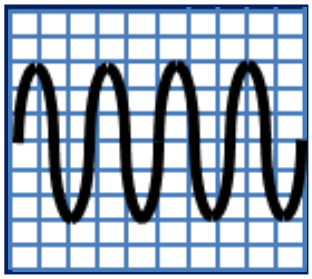
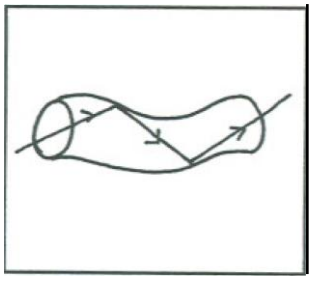
Cumbernauld Academy

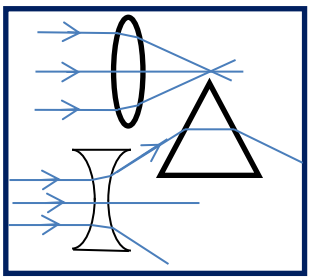
Physics

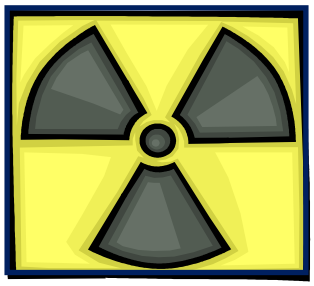
Waves and Radiation Homework Booklet

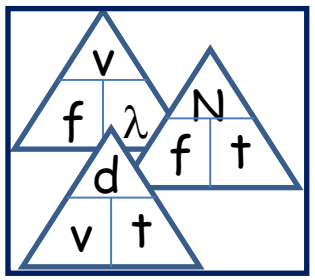


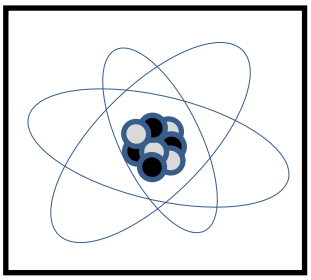


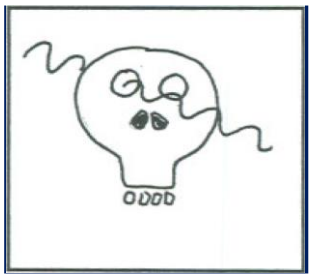












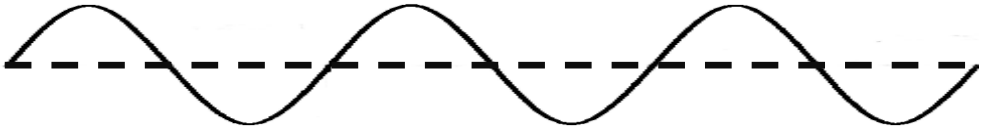
Homework 1 - Waves

1 What do all waves transfer? 1

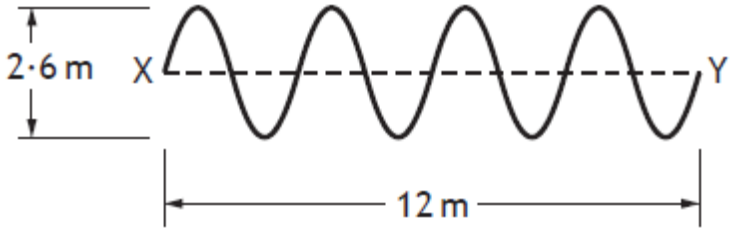
2 There are 2 types of wave.
One type of wave is a Transverse wave, what is the name of the other type of wave and give one example? 2

3 What is the definition of speed? 1

4 Draw a similar wave to the one below in your jotter and clearly identify
a) Amplitude
b) One Wavelength 2

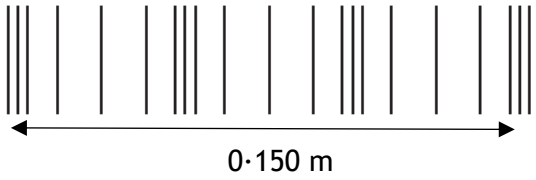


5 The diagram represents a wave travelling from X to Y.



The wave travels from X to Y in a time of 0·5 s.
a) Determine the amplitude of the wave. 1
b) Determine the wavelength of the wave. 1
c) Determine the frequency of the wave. 1

6 Determine the wavelength of the sound wave below. 1



Total 10

Homework 2 – Sound in air

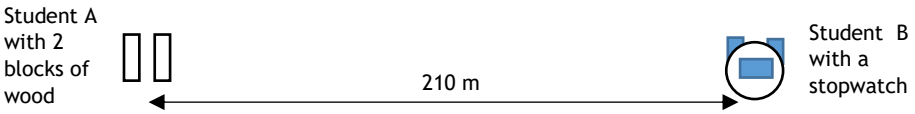
1 a) State what the speed of sound in air is. 1

b) A golfer hits a golf ball from a tee. A spectator at the green sees the golf ball being hit and then hears the sound of the golf ball being hit 0·6 s later. 3

Calculate the distance the golfer is from the spectator.

2 Students are measuring the speed of sound in air.

Student A has two blocks of wood.
Student B is 210 m away with a stopwatch.



Student A hits the two blocks of wood together. 3

Student B starts the stopwatch on seeing the blocks of wood hit each other and stops the stopwatch on hearing the blocks of wood hit each other.

Student B recorded 0·63 s on the stopwatch.

Calculate the speed of sound in air based on these measurements.

3 In a thunderstorm lightning is produced at the same time as the thunder.

Calculate the time it takes for the sound of thunder to travel 2·3 km. 3

Total 10

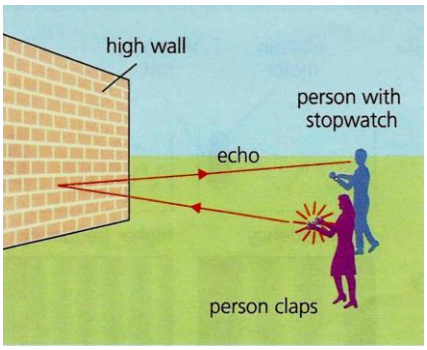
Homework 3 - Reflections

1 In an experiment to measure the speed of sound, two people stand 50 m from a high wall.

A person claps and at the same time another person starts the stopwatch.

The person with the stopwatch then stops the stopwatch when they hear the echo return.

The time recorded was 0·29 seconds.



a) Calculate the total distance the sound travels. 1

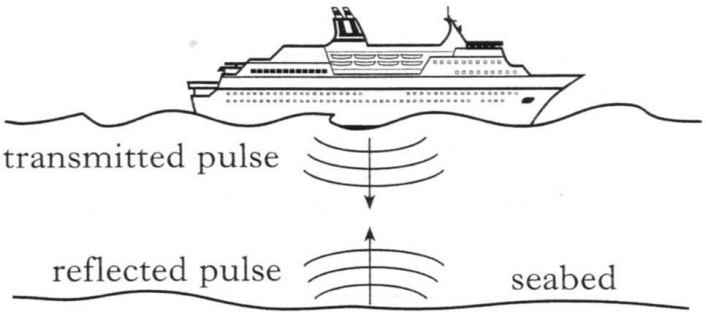
b) Calculate the speed of sound using information from this experiment. 3

2 Ultrasound waves are sound waves with a frequency above 20 kHz.

A ship is carrying out a survey of the seabed using ultrasound waves.

When stationary, the ship transmits and receives pulses of ultrasound waves.

The transmitted ultrasound waves have a frequency of 30 kHz.



a) Using your datasheet, what is the speed of ultrasound waves in water? 1

One pulse of ultrasound is received back at the ship 0·2 s after being transmitted.

b) Calculate the depth of the sea bed. 4

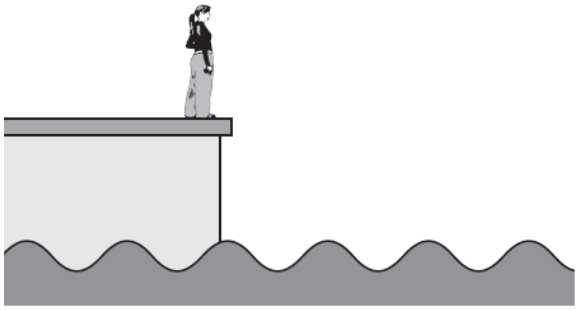
c) A shoal of fish swims under the boat.
State a possible echo time for the wave reflecting from the shoal of fish. 1

Total 10

Homework 4 - Frequency

1 State what is meant by the term *frequency*? 1

2 A student observes water waves entering a harbour.



To determine the frequency of the waves, the student measures the time taken for a wave to pass a point at the harbour entrance.
The student measures this time to be 2·5 s.

Calculate the frequency of the waves. 3

3 Water waves crash on to a beach at a frequency of 0·5 Hz.

Calculate the number of waves that crash on to the beach in 5 minutes. 3

4 A tuning fork makes a sound with a frequency of 480 Hz.

Calculate the time required to produce 2640 waves. 3

Total 10

Homework 5 – v, f and λ

1 The wavelength of a sound wave is 0·068 m.

Calculate the frequency of the sound wave in air. 3

2 a) Ultrasound pulses are used to detect imperfections in different materials.
The wavelength of the ultrasound used was 2·08 cm.
The frequency of the ultrasound used was $2{\cdot}5 \times 10^5$ Hz

i) Calculate the speed of the ultrasound in this material. 3
ii) Using the data sheet, what material(s) could this be? 1

3 A sound wave has a frequency of 260 Hz.

Calculate the wavelength of this sound wave. 3

Total 10

Homework 6 – Period of a Wave

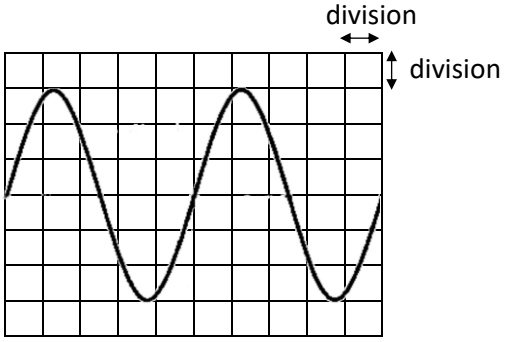
1 State what is meant by the *period of a wave*? 1

2 The frequency of a sound wave is 440 Hz.

Calculate the period of the sound wave. 3

3 The diagram below shows a wave on an oscilloscope screen.

Each division on the x-axis is 4·00 ms.
Each division on the y-axis is 3·00 V.



a) Determine the amplitude, in volts, of the wave on the oscilloscope screen. 1

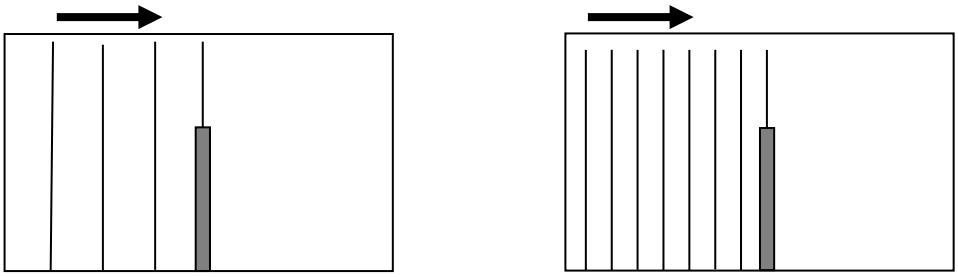
b) i) Calculate the period of the wave on the oscilloscope screen. 2

ii) Calculate the frequency of the wave on the oscilloscope screen. 3

Total 10

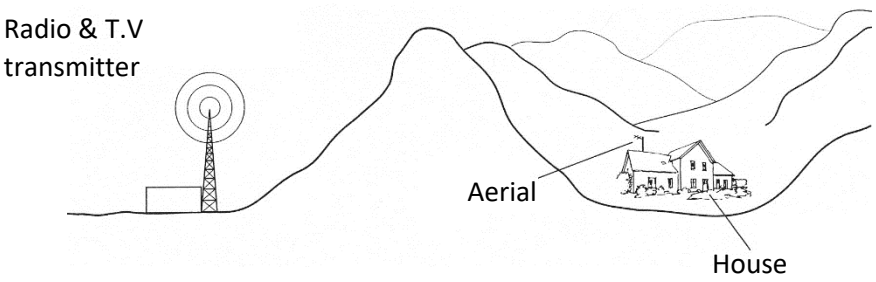
Homework 7 - Diffraction

1 Copy and complete the following diagrams to show what happens to the waves as they diffract beyond the obstacle in the ripple tank. 3

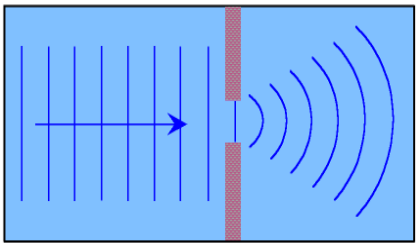


2 A house in a hilly region can't get a good reception on the television, but radio reception is perfect.

Explain why this is. 2



3 Water waves can be shown to diffract using a ripple tank.



As the waves diffract through the opening:

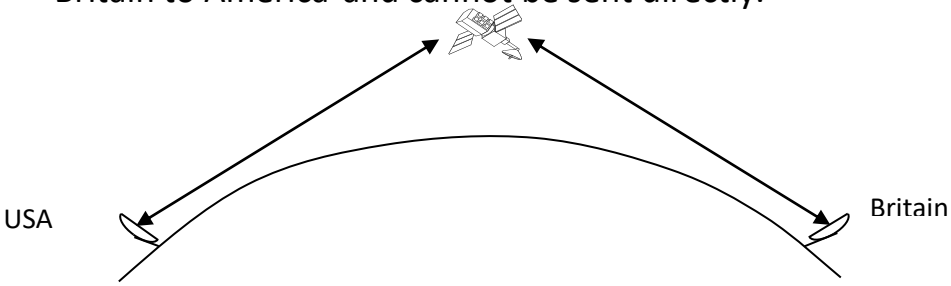
a) State what happens to the frequency of the waves. 1

b) State what happens to the wavelength of the waves. 1

c) State what happen to the speed of the waves. 1

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

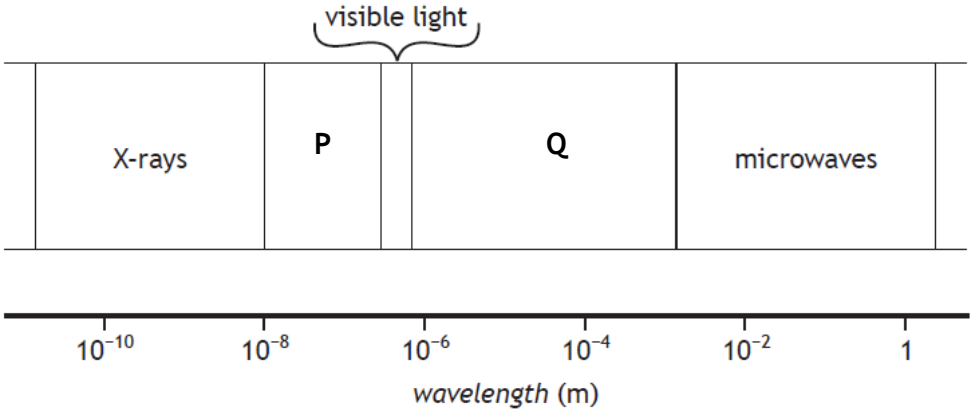
4 Explain why television signals require a satellite to be sent from Britain to America and cannot be sent directly. 1



Total 10

Homework 8 – Electromagnetic Spectrum

1. The diagram shows part of the electromagnetic spectrum arranged in order of increasing wavelength.



a) State **2** things that all parts of the electromagnetic spectrum have in common. 1
b) Name Radiation **P** 1
c) Name Radiation **Q** 1
d) Which member of the electromagnetic spectrum has the highest energy? 1
e) State a detector of infrared radiation. 1
f) State which radiation in the electromagnetic spectrum has a wavelength shorter than X-rays. 1

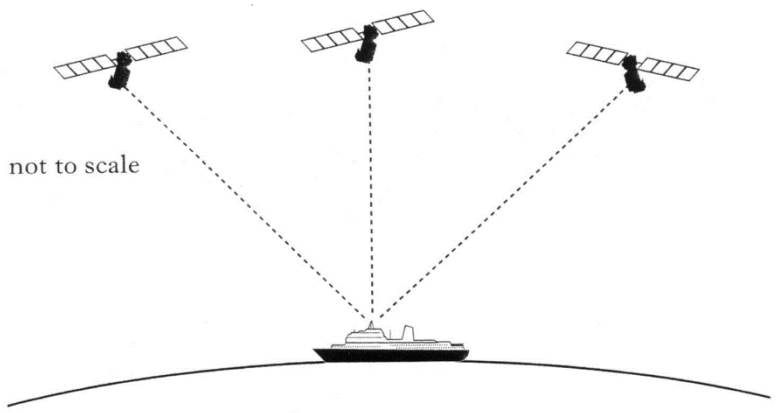
2 An electromagnetic wave has a frequency of 1·2 GHz.

a) i) Calculate the wavelength of this electromagnetic wave 3
ii) Identify the part of the electromagnetic spectrum this belongs to. 1

Total 10

Homework 9 – Electromagnetic Spectrum 2

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



The satellites transmit radio signals at three different frequencies

1 176 MHz, 1 228 MHz and 1 575 MHz.

The satellites orbit at a height of 20 200 km above the Earth's surface.

a) Which satellite frequency has the longest wavelength? 1

b) Calculate the wavelength of the 1 228 MHz signal. 3

c) One of the satellites is directly above the ship.

Calculate how long a signal from this satellite would take to reach the ship. 3

2. A radio signal has a wavelength of 60 mm.

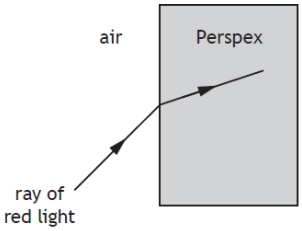
Calculate the frequency of the radio signal. 3

Total 10

Homework 10 – Refraction

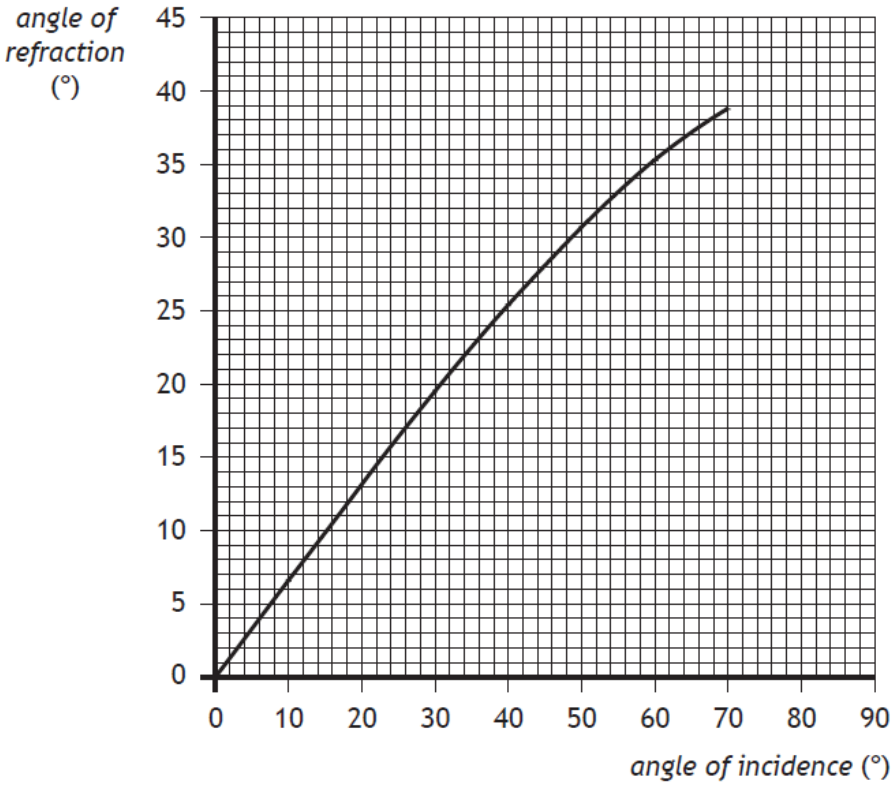
1. List the three things that can change when light passes from one medium into another. 3

2. A student directs a ray of red light into a Perspex block to investigate refraction.



a) Copy the diagram into your jotter.
On your diagram, draw and label:
(i) the normal 1
(ii) the angle of incidence *i* and the angle of refraction *r*. 1

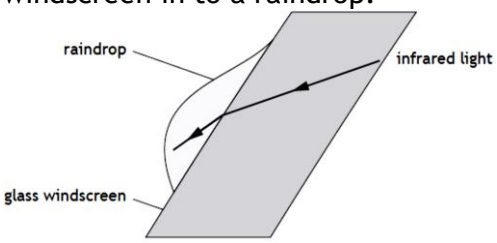
b) The student varies the angle of incidence and measures the corresponding angles of refraction. The results are plotted on a graph.



(i) Determine the angle of refraction when the angle of incidence is 12°. 1
(ii) Use the graph to predict the angle of refraction the student would obtain for an angle of incidence of 80°. 1

c) Suggest why it would be good practice for the student to repeat the investigation a further three or four times. 1

3. The path of infrared light is refracted when travelling from a glass windscreen in to a raindrop.



State whether the wavelength of the infrared light in the raindrop is less than, equal to or greater than the wavelength of the infrared light in the glass.

You **must** justify your answer. 2

Total 10

Homework 11 – Nuclear

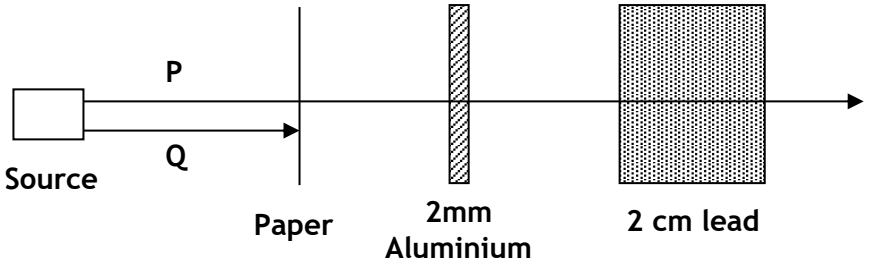
1. The nature of alpha (α), beta (ß) and gamma (γ) radiation are all different.

   a) State what an alpha particle is. 1

   b) State what a beta particle is. 1

   c) State what gamma is. 1

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



   a) Identify the type of radiation for P. 1

   b) Identify the type of radiation for Q. 1

3. State what is meant by the term *Ionisation*. 1

4. Which type of radiation has the highest ionisation density? 1

5. What are the dangers of human exposure to high levels of radiation? 1

6. State two detector of nuclear radiation. 2

Total 10

Homework 12 – Activity

1. What is meant by the term *Activity*. 1

2. For a particular radioactive source, 240 atoms decay in 1 minute.
   Calculate the activity of this source. 3

3. During the first 15 s of an experiment an alpha source has an average activity of 520 Bq.
   Calculate the number of nuclear disintegrations that occur in the source in the first 15 s of the experiment. 3

4. The activity of a source is 7200 Bq.
   $1{\cdot}44 \times 10^8$ radioactive nuclei in the source decay.
   Calculate the time that this would have taken. 3

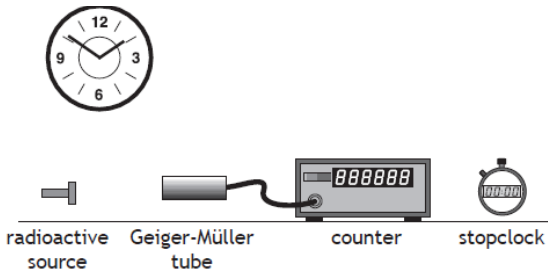
Total 10

Homework 13 – Half Life

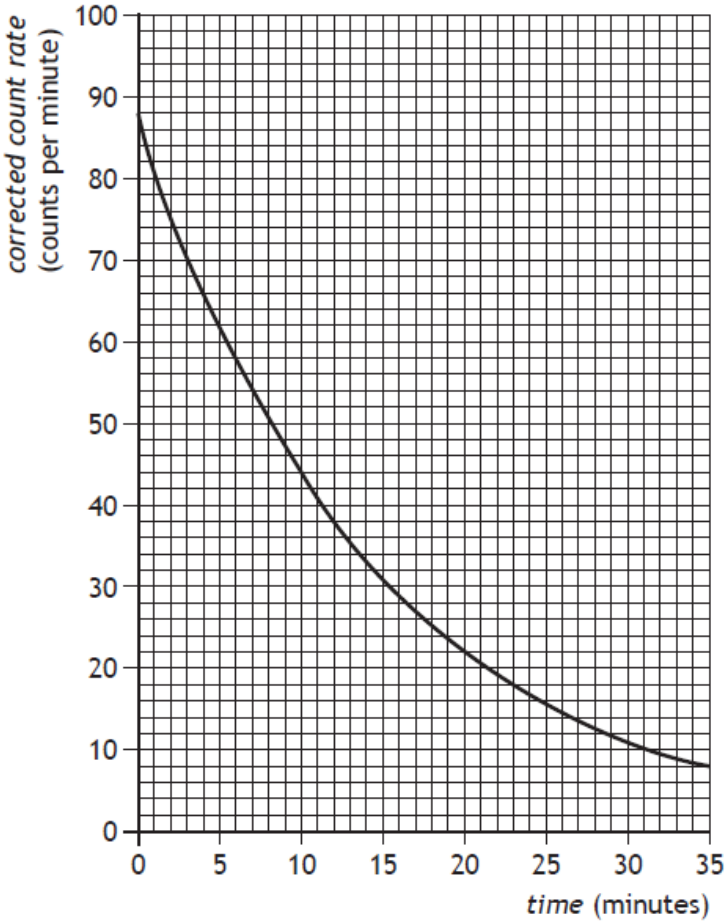
1. What is meant by the term Half-Life. 1

2. A beta source used during a test has a half-life of 36 hours.
The initial activity of the beta source is 12 kBq.
Determine the activity of the source 144 hours later. 3

3. A technician carries out an experiment, using the apparatus shown, to determine the half-life of a radioactive source.



The technician displays the data obtained from the experiment in the graph below.



a) Describe how the apparatus could be used to obtain the experimental data required to produce this graph. 3

b) Use information from the graph to determine the half-life of the radioactive source. 1

c) Determine the corrected count rate after 40 minutes. 2

Total 10

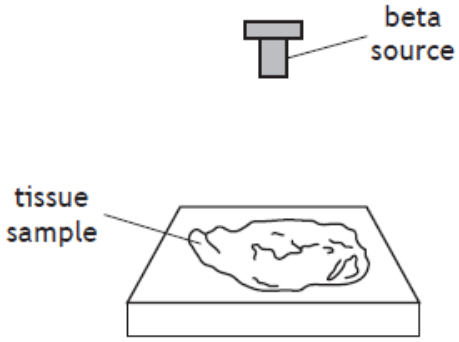
Homework 14 – Absorbed Dose

1. What is meant by the term *Absorbed Dose*. 1

2. An airport worker passes suitcases through an X-ray machine.
The worker has a mass of 80·0 kg and on a particular day absorbs 7·2 mJ of energy from the X-ray machine.
Calculate the absorbed dose received by the worker. 3

3. A tritium torch includes a sealed glass capsule containing radioactive tritium gas.
During the manufacturing process a glass capsule cracks and a worker receives an absorbed dose of 0·40 mGy throughout their body from the tritium gas.
The mass of the worker is 85 kg.
Calculate the energy of the radiation absorbed by the worker. 3

4. During medical testing a beta source is used to irradiate a sample of tissue of mass 0·50 kg from a distance of 0·10 m.
The sample absorbs $9{\cdot}6 \times 10^{-5}$ J of energy from the beta source.



Calculate the absorbed dose received by the sample. 3

Total 10

Homework 15 – Equivalent Dose

1. What is meant by the term *Equivalent Dose*. 1

2. A sample of tissue receives an absorbed dose of 15 μGy from slow neutrons.
Show that the equivalent dose received by the sample is 45 μSv 2

3. A sample of tissue receives an absorbed dose of 16 μGy from alpha particles.
Calculate the equivalent dose received by the sample. 3

4. A sample of tissue is exposed to 15 μGy of alpha radiation and 20 μGy of gamma radiation.
Calculate the total equivalent dose received by the tissue. 4

Total 10

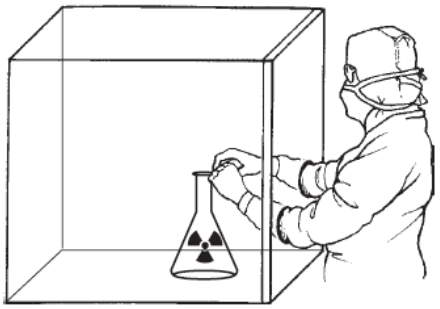
Homework 16 – Equivalent Dose Rate

1. What is meant by the term *Equivalent Dose Rate*. 1

2. A sample of tissue receives an equivalent dose rate of 0·40 mSv $h^{-1}$from a source of alpha radiation.
Calculate the equivalent dose received by the sample in 30 minutes. 3

3. When working with a radioactive source the technician is exposed to an equivalent dose rate of $2{\cdot}5 \times 10^{-6}$ Sv h^{-1}.
The annual equivalent dose limit for the technician is 20 mSv.
Calculate the maximum number of hours the technician may work with this source without exceeding this limit. 3

4. A technician is working with a radioactive source.



The technicians hands receive an absorbed dose at a rate of $4{\cdot}0 \times 10^{-6}$ Sv h^{-1} for 2 hours.
Calculate the equivalent dose received by the technicians hands in the 2 hours. 3

Total 10

Homework 17– Nuclear Safety

1. State 2 natural sources of radiation 2
2. State 2 artificial sources of radiation 2
3. State 3 safety precautions that should be followed when working with radioactive sources. 3
4. State 3 practical applications of radiation 3

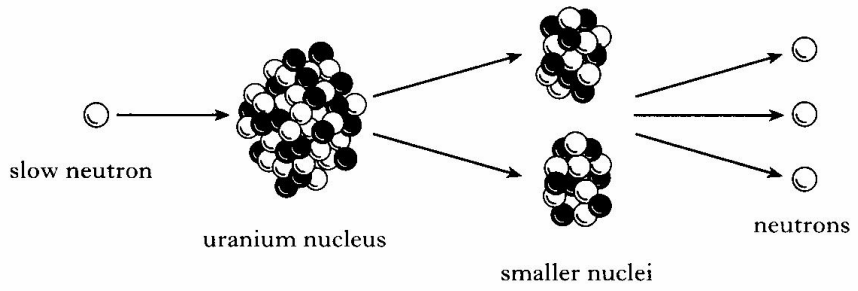
Total 10

Homework 18- Fission and Fusion

1. State what is meant by the term *Nuclear Fission* 1

2. State what is meant by the term *Nuclear Fusion* 1

3. 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. 2

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

4. What is meant by the term *chain reaction*? 1

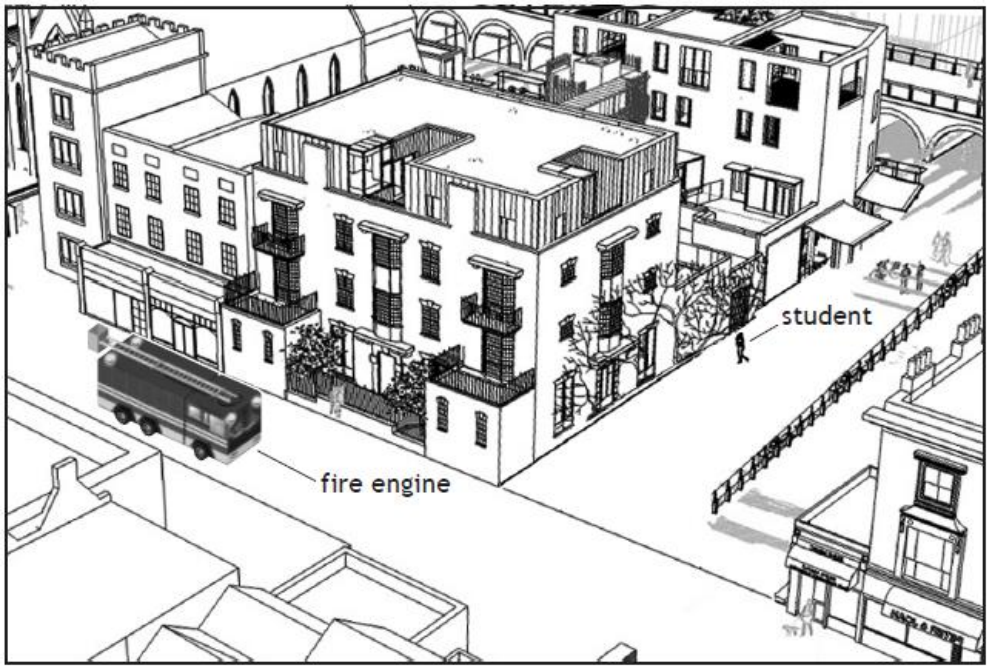
5. There are 2 types of nuclear reactions, Nuclear Fission and Nuclear Fusion. Both types of nuclear reaction give out a lot of energy.
   a) Which type of reaction does not produce any radioactive waste? 1
   b) Which type of reaction requires very high temperatures and is difficult to contain? 1

6. a) State one advantage and one disadvantage of Nuclear Fission. 1
   b) State one advantage and one disadvantage of Nuclear Fusion. 1

Total 10

Homework 19- Open Ended

1. A fire engine on its way to an emergency is travelling along a main street. The siren on the fire engine is sounding.
A student standing in a nearby street cannot see the fire engine but can hear the siren.



Use your knowledge of physics to comment on why the student can hear the siren even though the fire engine is not in view. 3

2. A Physics textbook contains the following statement.
"Electromagnetic waves can be sent out like ripples on a pond."
Using your knowledge of physics, comment on the similarities and/or differences between electromagnetic waves and the ripples on a pond. 3

3. Alpha, beta and gamma are types of nuclear radiation, which have a range of properties and effects.
Using your knowledge of physics, comment on the similarities and/or differences between these types of nuclear radiation. 3

Total 9