Prelim Revision

Waves and Radiation

1. Radio waves are part of the electromagnetic spectrum. They are split into different ranges
each of which are used to communicate with different industries. Consider the information shown in the table below:

Radio waveband	Frequency range	Use
Long Wave (LW)	**30 – 300kHz**	**Medium to long distance communication** **Radio 4 transmission**
Medium Wave (MW)	**300kHz – 3MHz**	**Both distant and local transmission** **Radio Scotland and Radio Forth**
Short Wave (SW)	**3-30(MHz)**	**Long distance communication** **Navigation** **Ship to shore communication** **Citizen's Band (CB)**
Very High Frequency (VHF)	**30-300(MHz)**	**Short distance communication** **FM Radio** **Local radio stations like Radio Clyde**
Ultra High Frequency (UHF)	**300 – 3000(MHz)**	**Short distance communication** **Four main TV Stations (BBC 1, BBC 2, ITV, Channel 4)**
Super High Frequency (SHF)	**3-30 (GHz)** **Giga (G) = 1 $\times$ 10^9**	**Long distance communication** **Microwave, radar, satellite communication.**

(a) Calculate the wavelength for the lower frequency of local radio stations.

(b) What is the frequency range of the four main TV stations

(c) People who live in hilly regions get good radio reception but the TV reception is very poor. Explain why this happens.

2. A radioactive sample has a half-life of 5 hours. A hospital technician checks its activity on its arrival. It is 800Bq.
It is to be used for a patient in 20 hours time. Its activity then will be:

A 400 Bq
B 200 Bq
C 160 Bq
D 50 Bq
E 40 Bq

3. Which of these statements about an alpha particle is/are true?

I It has the same mass as a Helium nucleus.

II It has a negative charge that is the equivalent of two electrons.

III It is weakly ionising.

A I only
B I and II only
C I and III only
D II and III only
E I, II and III

4. When a ray of light passing through air is incident on a glass surface at an angle other then 90^{o}, most of the light:

A Refracts and bends away from the normal
B Refracts and travels along the normal
C Refracts and bends towards the normal
D Travels along the boundary of the glass
E Reflects off the glass

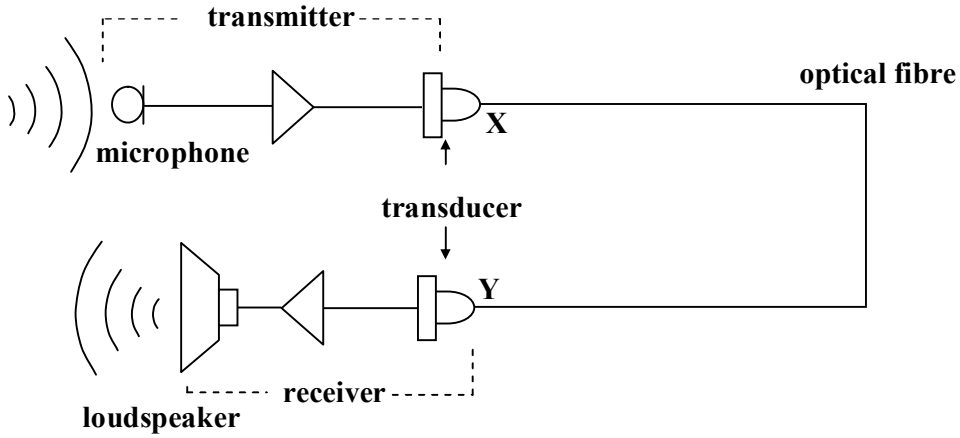
5. A man sees a lightning flash and hears a thunder clap 8 seconds later.

(a) Why does he hear the clap of thunder after the lightning flash?

(b) (i) Given that the speed of sound in air is 340m/s, calculate the distance between the man and the storm.

(ii) If one frequency of the sound from the thunder is 34H calculate the wavelength of sound wave.

(c) The transmitter and receiver of a telephone system are shown below:



(i) What is an optical fibre?

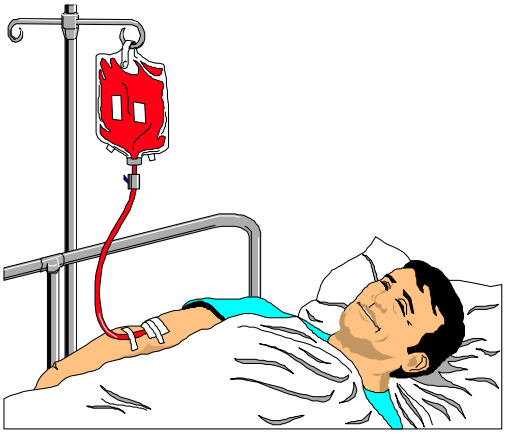
(ii) Explain, with the help of a diagram, how light travels along the optical fibre above.

6. (a) (i) Name two types of ionising radiation that could be emitted by a radioactive substance.

(ii) What does the term **ionisation** mean when referring to particular types of radiation?

(b) If 8×10^{10} atoms of plutonium break up in 40 seconds in a nuclear reactor, calculate the activity of the plutonium.

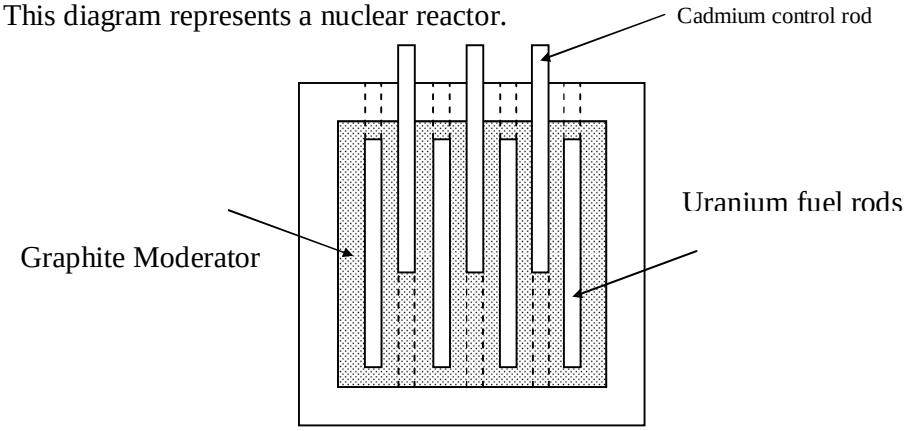
(c) A cancerous organ of mass 4·2 kg is exposed to radiation of energy 2mJ. The radiation weighting factor of the radiation is 10.



(i) Calculate the absorbed dose for this particular radiation.

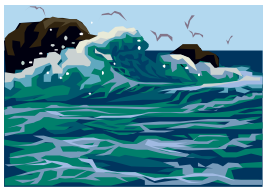
(ii) Calculate the dose equivalent.

7. This diagram represents a nuclear reactor.



Explain how the nuclear reactor produces energy. Your answer should include the phrase ñchain reactionò.

8. A tsunami wave is detected in the Pacific Ocean. Its speed is measured to be 250 m/s.



(*a*) The frequency of the wave is 5·0 Hz. Calculate the wavelength of the waves.

(*b*) The wave is first detected by a sensor 10 000 km from Hawaii.

Calculate when the wave hits Hawaii.

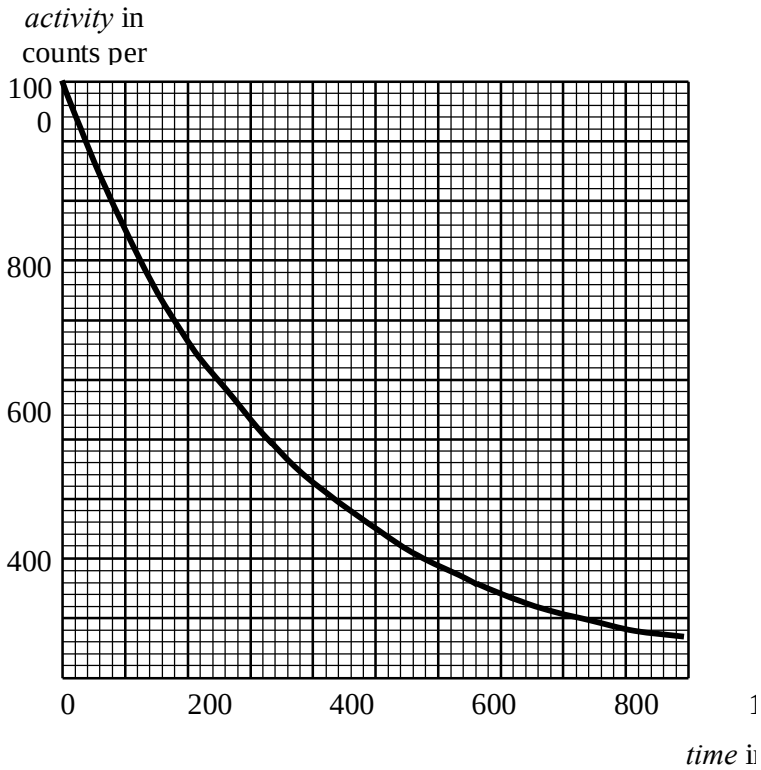
(*c*) (i) The sensor transmits the warning signal by radio waves.

Calculate how long it takes the radio waves to reach Hawaii.

(ii) Explain why most of the safety systems triggered by the warning signal need to be automatic.

9.

The following graph shows the activity of a tracer used plotted against time.



Calculate the half-life of the radioactive tracer

10. A radioactive source produces alpha particles.

Alpha particles cause ionisation.

(*a*) State what is meant by the term *ionisation*.

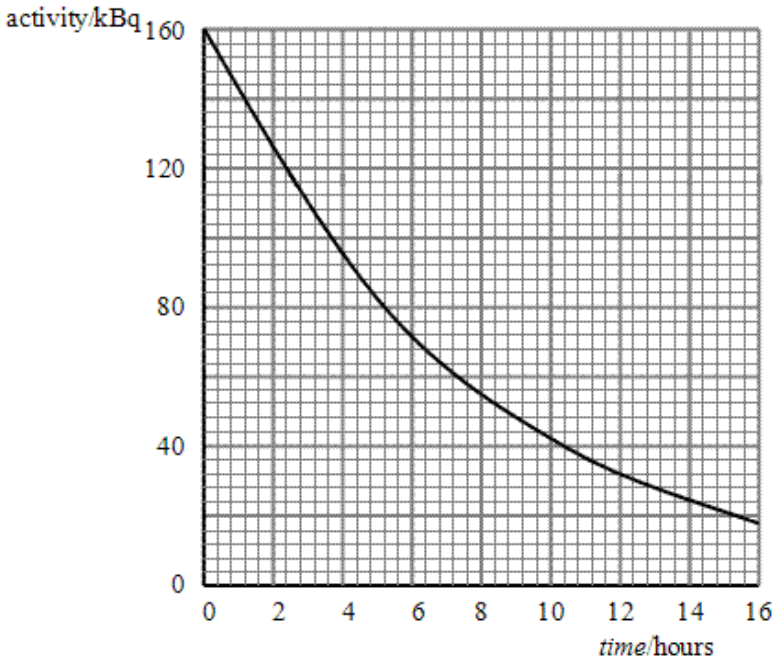
(*b*) The biological effect that ionising radiations have on living tissue is called the equivalent dose.

(i) State what units are used to measure equivalent dose.

(ii) Name **two** factors that affect the equivalent dose.

(*c*) An experiment is carried out to measure the half-life of the radioactive source. The activity of a 2·0 kg sample of the material is measured at regular time intervals. The experiment is carried out in a sealed lead box so that background radiation does not affect the results.

The graph below shows the results from the experiment.

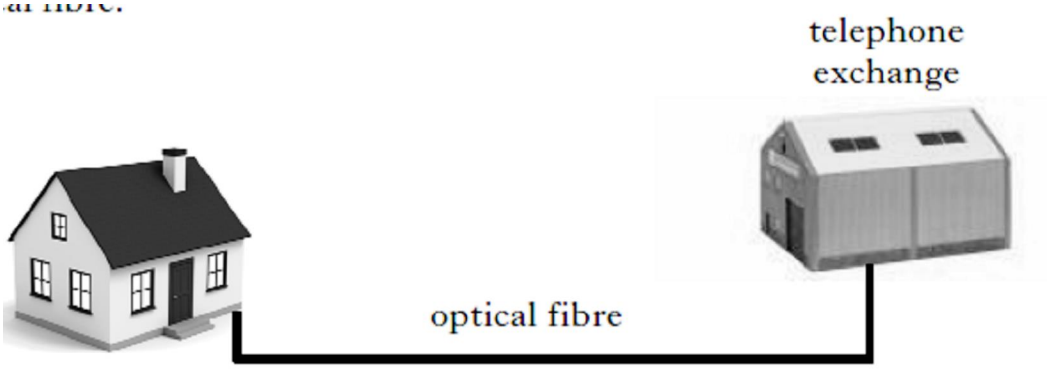


(i) Use the graph to find the half-life of the radioactive source.

(ii) A 1·0 kg source of the same radioactive material is used instead of the 2·0 kg source.

How long will it take the new sourceôs activity to fall from 160 kBq to 80 kBq?

11. A householder receives his Internet broadband signal through an optical fibre.



(*a*) State **two** advantages of an optical fibre over copper wire for the transmission of signals.

(*b*) (i) Use the data sheet to identify the speed of light in an optical fibre made of glass.

(ii) The optical fibre transmits light with a wavelength of 850×10^{-9} m.
Calculate the frequency of the light in the fibre

(iii) An optical fibre is 20 km long. Calculate the time it will take for light to travel from one end to the other.

12. A liquid containing radioactive technetium-99 can be injected into a patientôs bloodstream. The radiation emitted can be detected using a gamma camera.

(a) Why must a gamma radiation emitter be used for this procedure?

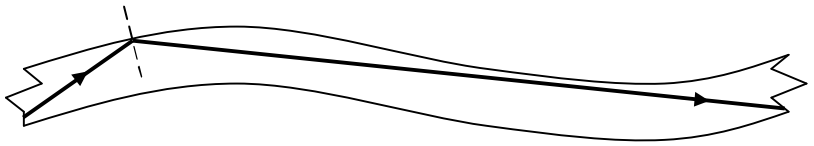
(b)The technetium-99 has a half-life of 6 hours. Explain what is meant by the term óhalf-lifeô.

(c)The radioactive technetium is injected into the patient.
Calculate the time it will take to reach one sixteenth of its original activity.

13. Fibre optic cables can be used to transmit signals over long distances.

Fibre optic cables are made of glass.

(*a*) The diagram below shows a ray of light passing through an optical fibre.



On the diagram mark on the angle of incidence with an óAô and the angle of reflection with a óBô.

(*b*) A fibre optic cable is used to send a message a distance of 60 km.

Calculate how long it takes the signal to travel through the 60 km of fibre optic cable.

(*d*) A radio is also be used to send a signal the 60 km at the same instant the signal is sent through the fibre optic cable.

Does the radio signal arrive, before, at the same time as, or after the signal in the fibre optic cable. You must justify your answer.

14. A dentist is checking a patientôs fillings using an x-ray machine.

(*a*) State a detector of X-rays.

(*b*) The equivalent dose is a measure of the biological effect of radiation.

State **two** factors which the equivalent dose takes into account.

(*c*) A single dental X-ray results in the mouth of the patient receiving an equivalent dose of 0·020 mSv. A patient is allowed to receive 0·10 mSv in one year from dental treatments.Calculate how many dental X-rays a patient can have in one year.

(*d*) Explain why the dentist has to stand behind a protective screen while the X-ray is being taken despite the fact that the equivalent dose from one X-ray is very low.

(*e*) Name **one** type of electromagnetic radiation with a higher frequency than X-rays.

15. (*a*) The table below lists detectors for four members of the electromagnetic spectrum.

Complete the table naming the types of electromagnetic radiation.

detector	*electromagnetic radiation*
photographic film	visible light
fluorescent paint	
heat sensitive paper	
aerial	

(*b*) Microwaves can be used to send signals through air. A microwave transmitter sends a signal a distance of 30 km.

Calculate how long it takes the signal to travel the 30 km.

16. Ionising radiation is incident on a sample of tissue of mass 0·40 kg. The energy absorbed by the tissue is 8·0 J.

The absorbed dose is

A 0·020 Gy

B 5·0 Gy

C 5·0 Sv

D 20 Gy

E 20 Sv.

17. The energy absorbed by a 5kg mass is 500J.

The absorbed dose is:

A 0·001 Gy
B 0·001 Sv
C 100 Gy
D 100 Sv
E 25000 Sv

18. Consider this nuclear reaction which occurs in a thermonuclear device:

$$ {}^{2}_{1}\mathrm{H} \quad + \quad {}^{3}_{1}\mathrm{H} \quad \longrightarrow \quad {}^{4}_{2}\mathrm{He} \quad + \quad {}^{1}_{0}\mathrm{n} $$

What is this type of nuclear reaction called?

19. A physics student writes the following statements about radiation dosimetry units.

I One becquerel is one decay per second.

II One gray is one joule per kilogram.

III One sievert is the power absorbed per kilogram.

Which of these statements is/are correct?

A I only
B II only
C I and II only
D II and III only
E I, II and III.