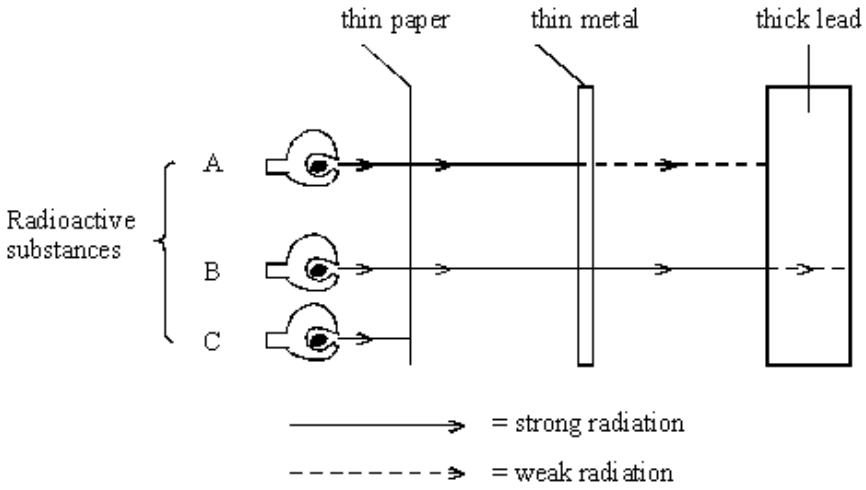
Q1. The diagram shows what happens to the radiation from three radioactive substances when different materials are put in the way.



Choose types of radiation from this list to complete the table below.

α (**alpha**) β (**beta**) γ (**gamma**) UV **(ultraviolet)**

RADIOACTIVE SUBSTANCE	TYPE OF RADIATION IT EMITS
A	
B	
C	

(Total 3 marks)

Q2. (a) Sam and Kris are arguing about alpha and gamma radiation.

Sam says that alpha radiation is more dangerous.

Kris disagrees. He thinks that gamma radiation is more dangerous. What do you think? Explain your answer as fully as you can.

.....

.....

.....

.....

.....

.....

(4)

(b) Cancer cells in a particular organ of the body can be killed by injecting a radioactive substance which is absorbed by that organ.

What other features must the radioactive substance have to make it suitable for this job?

.....

.....

(2)

(c) Radon is a radioactive gas with a half-life of 3.6 days.
It often seeps into buildings from the ground.

Estimate how long it takes for 99% of a sample of radon gas to decay.
(Show your working.)

.....

.....

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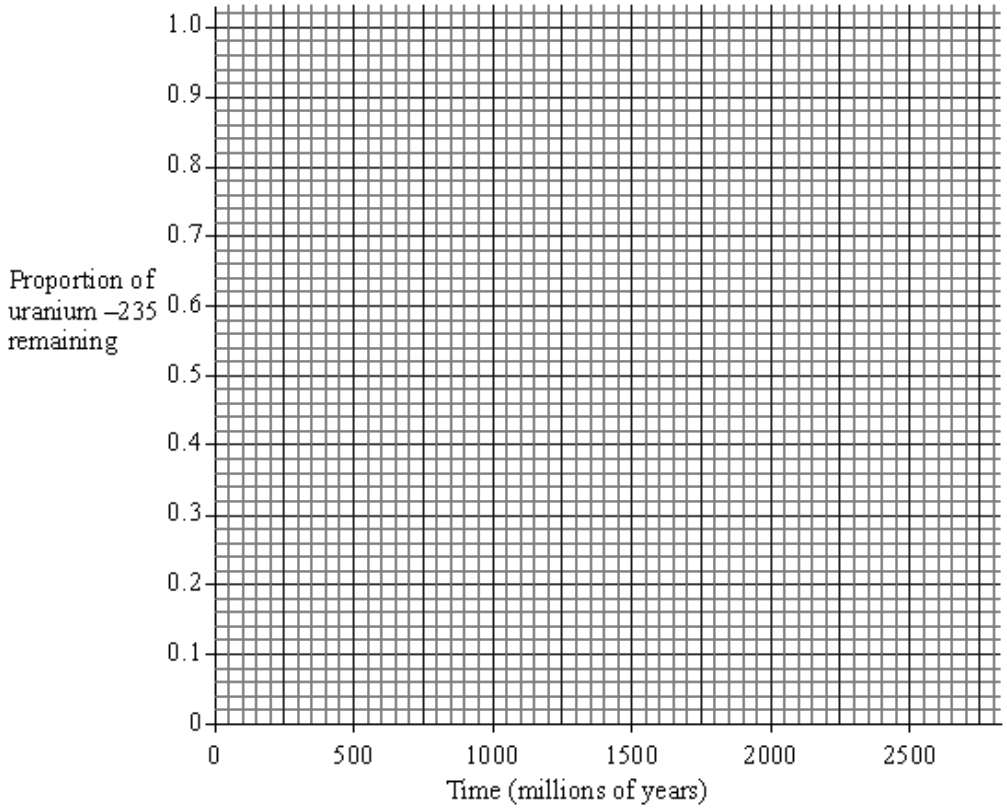
.....

(2)
(Total 8 marks)

Q3. Some rocks contain the radioactive isotope uranium–235 (^{235}U).

^{235}U has a half-life of 700 million years and, as it decays, lead–207 (^{207}Pb) is eventually formed.

(a) Draw a decay curve for ^{235}U on the graph below.



(4)

(b) Samples of an igneous rock gave an average ratio of 70 atoms of ^{235}U to 30 atoms of 207 Pb.

Use the decay curve you have drawn to estimate the age of the igneous rock.

Answer ..... million years.

(1)

(c) A sandstone rock which lies above the igneous rock contains traces of uranium-235 and of lead-207.

Why might it be unsatisfactory to use this uranium for dating the sandstone?

.....

.....

.....

.....

(2)

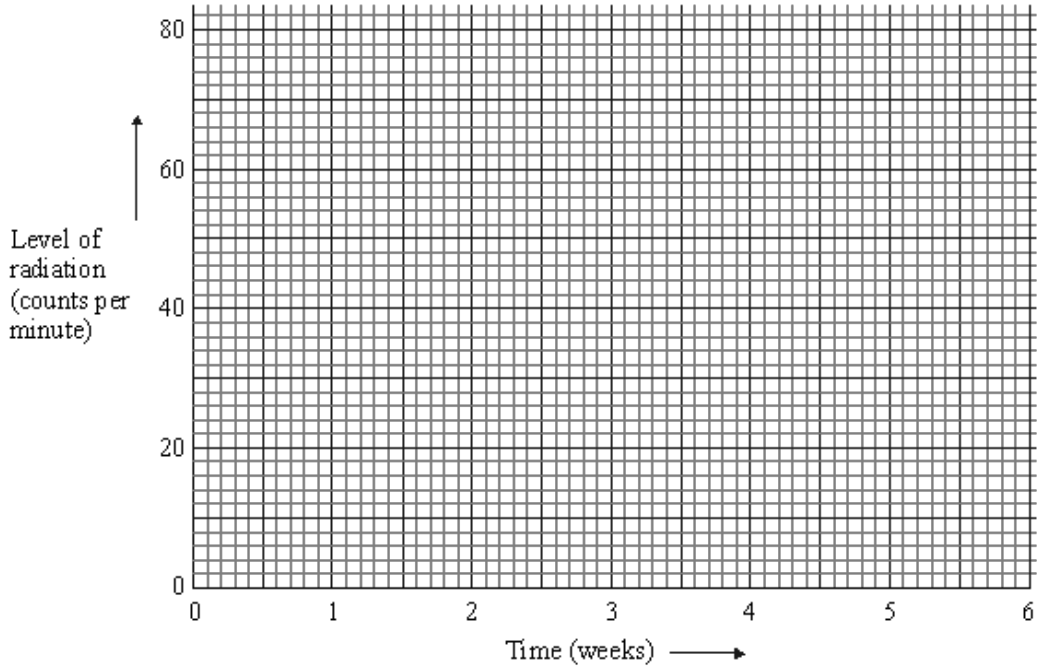
(Total 7 marks)

Q4. Some students measure the level of radiation from a radioactive source during the same lesson each week over a period of six weeks.

Here are the results. (They have been corrected for background radiation.)

Time (weeks)	start	1	2	3	4	5	6
Level of radiation (average counts per minute)	66	44	34	29	16	12	8

(a) Using the graph paper below, display these results in the most appropriate way.



(5)

(b) What overall pattern is there in the students' results?

.....

.....

.....

(3)

(Total 8 marks)

Q5. A simple spark counter can be used to detect charged particles. It is made by having two wires close together with a large voltage across them. When a charged particle passes through the gap between the wires a spark is seen.

(a) Give the names and symbols of **two** particles which will cause a spark.

(i) Name ..... Symbol .....

(2)

(ii) Name ..... Symbol .....

(2)

(b) A radioactive source was placed within 2 cm of the spark counter and lots of sparks were seen. A piece of paper was slid between the source and the counter. The sparking stopped.

(i) What type of radiation was being given off?

.....

(1)

(ii) The paper was removed and the source slowly moved away from the spark counter. Describe what will happen to the sparking.

.....

.....

.....

(2)

(c) A radioactive source gave a high reading using a Geiger-Müller tube and counter, but did not cause sparking when brought near to the spark counter. Why?

.....

.....

(1)

(Total 8 marks)

Q6. People who work in places where radiation is present, for example in X-ray departments in hospitals, have to wear a “film badge”. These badges are sent away regularly to check on the amount of radiation to which the person has been exposed. Simply described, the badge is some photographic film in a suitable holder.

(a) (i) Why is the “film badge” of little use in detecting alpha particles?

.....

(1)

(ii) How does the “film badge” show radiation has reached it?

.....

(1)

(b) Radioactivity can cause harm. It also has a number of valuable uses.

(i) How can radioactivity harm our bodies?

.....

.....

(1)

(ii) Give **two** medical uses of radioactive isotopes.

1. .....

2. .....

(2)

(c) A radioactive isotope of lead has a half-life of 10.6 hours.

A small sample of lead containing this isotope has a count rate of 8000 counts per minute.

How long will it be before the count rate is 1000 counts per minute?

.....

.....

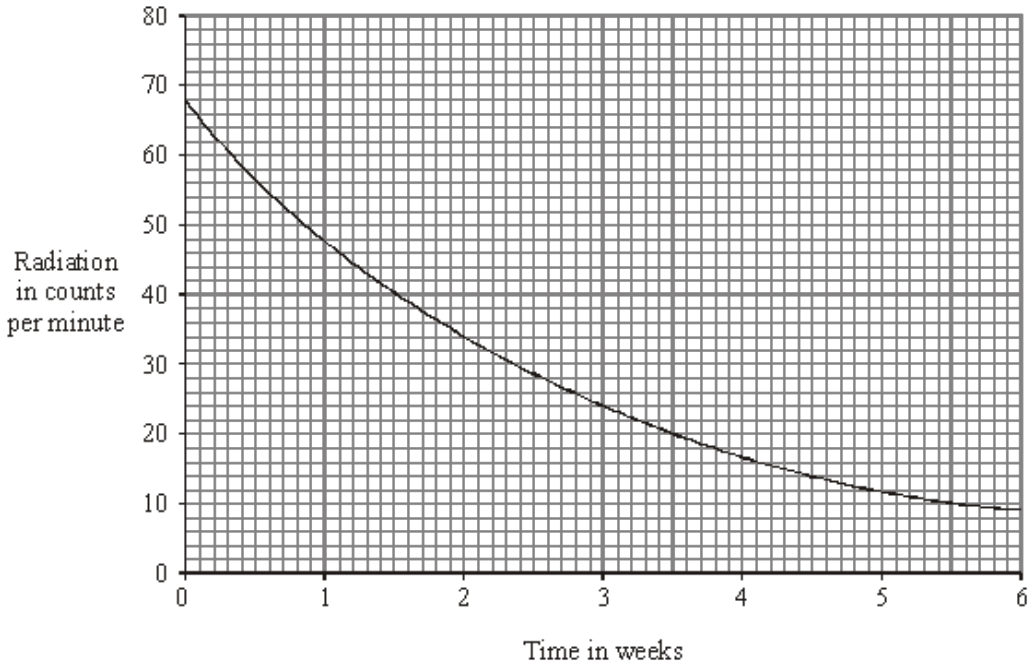
Time = ... hours

(2)

(Total 7 marks)

Q7. A teacher measured the amount of radiation from a radioactive source, during the same lesson each week, over a period of six weeks.

The results are shown on the graph.



How long does it take for the radiation to fall from 68 counts per minute to half that value?

Show clearly how you work out your answer.

.....

.....

.....

Time taken for radiation to halve .....

(Total 3 marks)

Q8. (a) Complete the sentences about atoms.

In an atom, the number of electrons is equal to the number of ..... .

All atoms of an element have the same number of ..... .

Isotopes of the same element have different numbers of ..... .

(3)

(b) Complete the sentence.

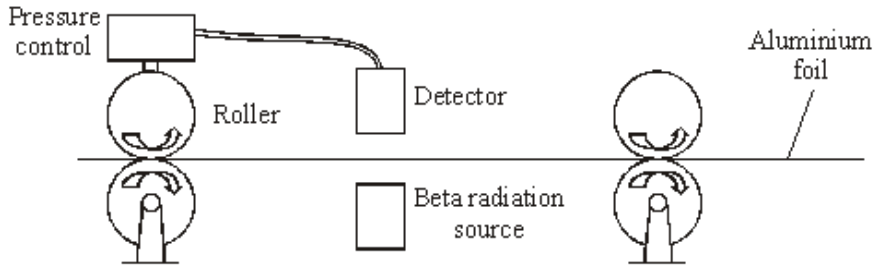
When an atom of a radioactive element emits alpha radiation, an atom of a different element is formed. A different element is formed because the radioactive element has lost

..... .

(1)

(Total 4 marks)

Q9. The diagram shows how the thickness of aluminium foil is controlled. The thicker the aluminium foil, the more radiation it absorbs.



(a) The designers used a beta radiation source for this control system.

(i) Why would an alpha radiation source be unsuitable in this control system?

.....

.....

(1)

(ii) Why would a gamma radiation source be unsuitable in this control system?

.....

.....

(1)

(b) The substance used in the beta radiation source is radioactive.

(i) Why are some atoms radioactive?

.....

.....

(1)

(ii) Explain why radiation is dangerous to humans.

.....

.....

.....

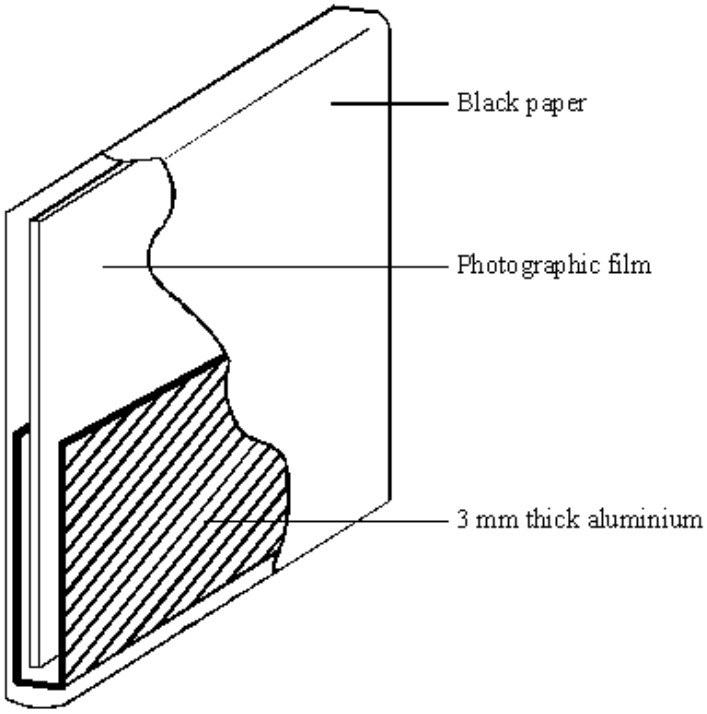
.....

(2)

(Total 5 marks)

Q10. The diagram shows a badge worn by a worker at a nuclear power station.

Part of the outer black paper has been removed so that you can see the inside of the badge.



Scientists examined the worker's badge at the end of a day's work.

They found that the top part of the badge had been affected by radiation, but the bottom half had not.

What type of radiation had the worker been exposed to? Explain the reasons for your answer.

.....

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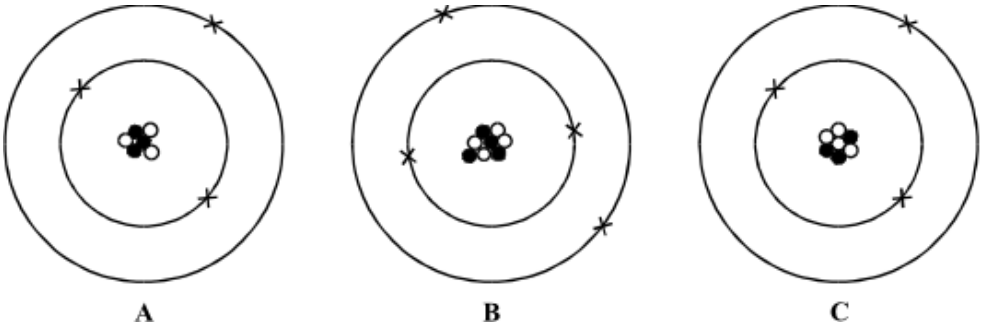
(Total 2 marks)

Q11. The diagrams below represent three atoms, **A**, **B** and **C**.



(a) Two of the atoms are from the **same** element.

(i) Which of **A**, **B** and **C** is an atom of a different element? .....

(ii) Give **one** reason for your answer.

.....

.....

.....

(2)

(b) Two of these atoms are isotopes of the same element.

(i) Which **two** are isotopes of the same element? ..... and .....

(ii) Explain your answer.

.....

.....

.....

(3)

(Total 5 marks)

Q12. Use the Data Sheet to help you answer this question.
This question is about elements and atoms.

(a) About how many different elements are found on Earth?
Draw a **ring** around the correct number.

40 50 60 70 80 90

(1)

(b) The following are parts of an atom:

electron neutron nucleus proton

Choose from the list the one which:

(i) has no electrical charge; .....

(ii) contains two of the other particles; .....

(iii) has very little (negligible) mass. .....

(3)

(c) Scientists have been able to make new elements in nuclear reactors. One of these new elements is fermium. An atom of fermium is represented by the symbol below.

$$^{257}_{100}\mathrm{Fm}$$

(i) How many protons does this atom contain? .....

(ii) How many neutrons does this atom contain? .....

(2)

(Total 6 marks)

Q13. (a) A radioactive isotope has a half-life of 10 minutes.
At the start of an experiment, the activity of a sample of this isotope was 800 counts per second after allowing for background radiation.

Calculate how long it would be before the activity fell from 800 counts per second to 200 counts per second.

.....

.....

Time ..... min.

(2)

(b) A physicist investigates a solid radioactive material. It emits alpha particles, beta particles and gamma rays.
The physicist does not touch the material.

Explain why the alpha particles are less dangerous than the beta particles and gamma rays.

.....

.....

.....

.....

(2)
(Total 4 marks)

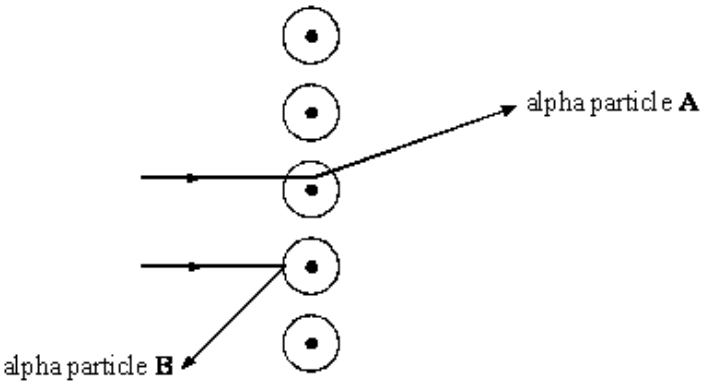
##

(a) Atoms are made up of three types of particle called protons, neutrons and electrons.
Complete the table below to show the relative mass and charge of a neutron and an electron. The relative mass and charge of a proton has already been done for you.

PARTICLE	RELATIVE MASS	RELATIVE CHARGE
proton	1	+1
neutron		
electron		

(2)

(b) The diagram below shows the paths of two alpha particles **A** and **B**, into and out of a thin piece of metal foil.



The paths of the alpha particles depend on the forces on them in the metal.
Describe the model of the atom which is used to explain the paths of alpha particles aimed at thin sheets of metal foil.

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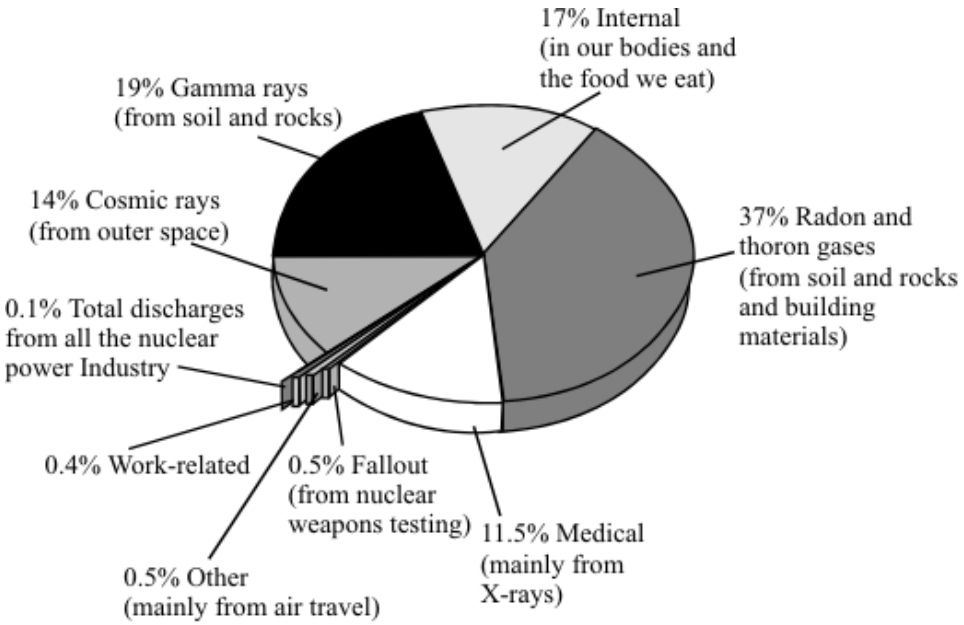
(3)

(Total 5 marks)

Q15. The chart below shows the sources of radiation in Britain.



(a) Give **two** sources of natural radioactivity from the chart.

..... and .....

(2)

(b) How might the chart be used to reassure people that nuclear power is safe?

.....

.....

.....

(1)

(c) Some material is spilled on a bench. How could you find out if this material is radioactive?

.....

.....

.....

.....

.....

(2)

(d) The table shows the proton number and mass number of two isotopes of iodine.

Iodine is found naturally in the world as the isotope I-127. Iodine-127 is not radioactive and is essential to life.
Other isotopes of iodine are formed in nuclear reactors. In the Chernobyl nuclear power station disaster in Ukraine an explosion caused a large quantity of the isotope iodine-131 to be released into the atmosphere. Iodine-131 is radioactive.

	proton number	mass number
iodine–127	53	127
iodine–131	53	131

Explain, in terms of particles found in the nucleus, how an iodine-131 nucleus is different from an iodine-127 nucleus.

.....

.....

(2)

(e) (i) Explain, as fully as you can, why iodine-131 could be harmful to our bodies.

.....

.....

.....

.....

(4)

(ii) Iodine-131 and iodine-127 have the same chemical properties. Explain why this would be a problem if iodine-131 was taken into our bodies.

.....

.....

.....

(1)

(iii) The Chernobyl disaster took place in 1986. Do you think that iodine-131 from the disaster is still a threat to us today? Explain your answer.

.....

.....

.....

(3)
(Total 15 marks)

Q16. (a) Two sources of radiation look identical. One source emits only alpha radiation, the other only beta radiation. Describe **one** way to find out which source emits the alpha radiation. You can assume a radiation detector and counter are available. You may wish to draw a diagram to help with your answer.

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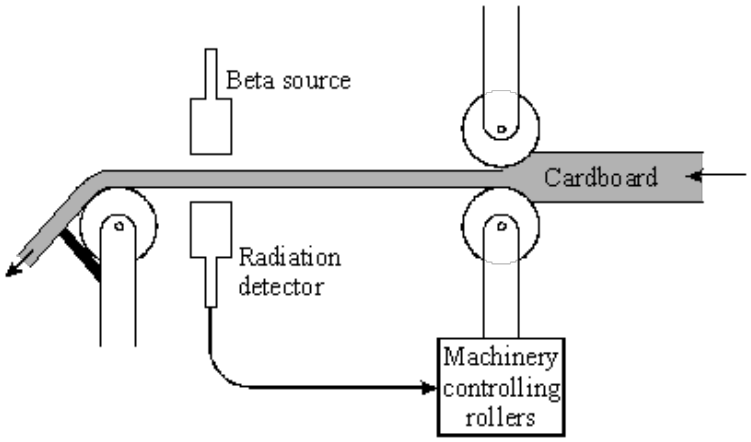
.....

.....

(3)

(b) The diagram shows a beta radiation source and detector used to measure the thickness of cardboard as it is made. The table gives the detected count rate at different times.



Time	Count rate in counts/minute
09:00	120
09:30	122
10:00	119
10:30	165
11:00	118

(i) Between 09:00 and 10:00 the cardboard is produced at the correct constant thickness. Give a reason for the small variation in count rate.

.....

.....

(1)

(ii) What can you say about the thickness of the cardboard being made at 10:30?

.....

Explain the reason for your answer.

.....

.....

.....

(3)

(iii) Explain why gamma radiation is not suitable for detecting changes to the thickness of the cardboard.

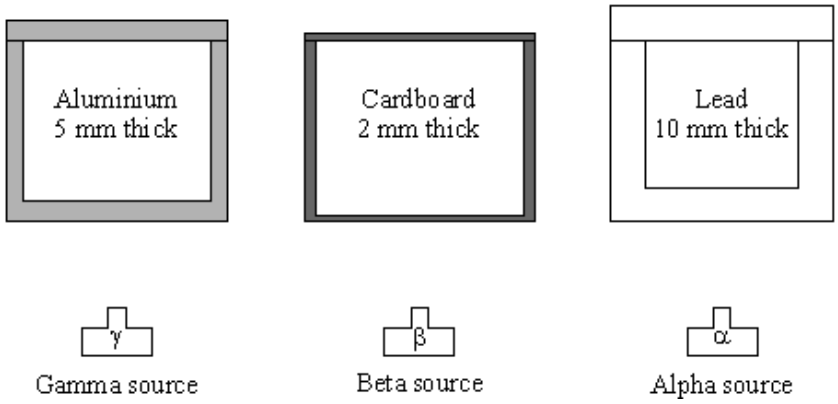
.....

.....

(1)

(Total 8 marks)

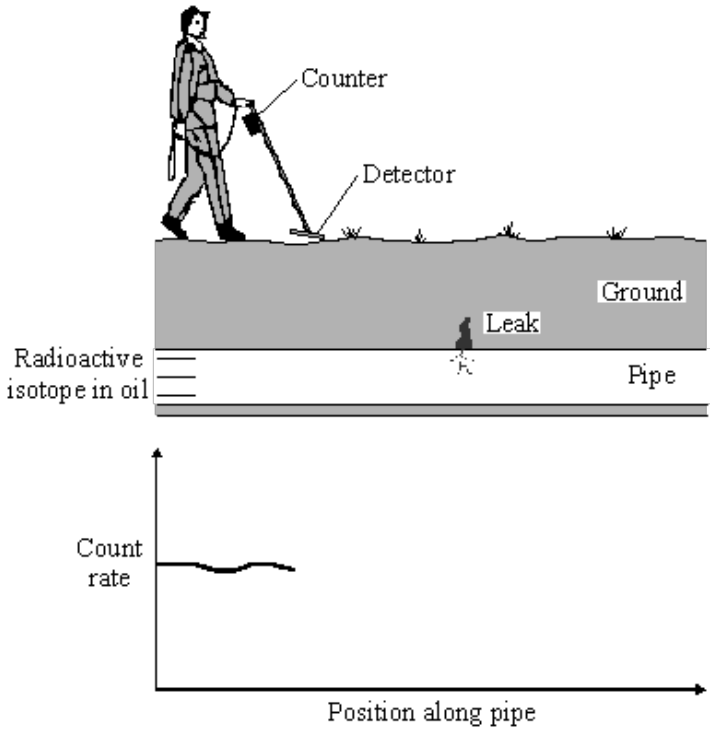
Q17. (a) The diagram shows three different boxes and three radioactive sources. Each source is stored in a different box.



Draw lines to show which source should be stored in each box so that the risk of radiation leakage is a minimum.

(2)

(b) A leak in an underground oil pipe can be found by injecting a radioactive isotope into the oil. The ground is then tested with a radiation detector and counter.



(i) State the type of detector used.

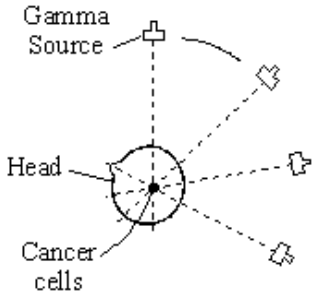
.....

(1)

(ii) Complete the sketch graph to show how the reading on the detector will change as it passes along the ground above the pipe.

(1)

(c) Gamma radiation can be used to kill cancer cells inside a person's head. During the treatment the patient is kept perfectly still while the source of gamma radiation moves in a circle.



(i) Why is a source of gamma radiation the most suitable for this treatment?

.....

(1)

(ii) Suggest why a moving source of radiation is used rather than one which is kept stationary.

.....

.....

.....

.....

(2)

(iii) Gamma radiation is an electromagnetic wave. Give **two** properties common to all electromagnetic waves.

1 .....

.....

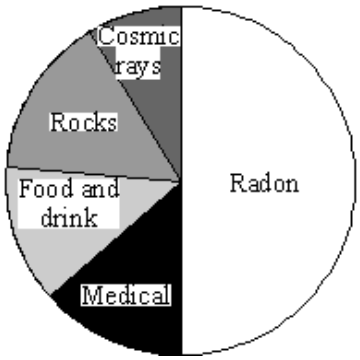
2 .....

.....

(2)

(Total 9 marks)

Q18. The pie chart shows the main sources of *background radiation.* Each source contributes to the average yearly radiation dose.



(i) What is meant by the term *background radiation?*

.....

.....

(1)

(ii) Suggest why an airline pilot is likely to get a higher than average yearly radiation dose.

.....

.....

.....

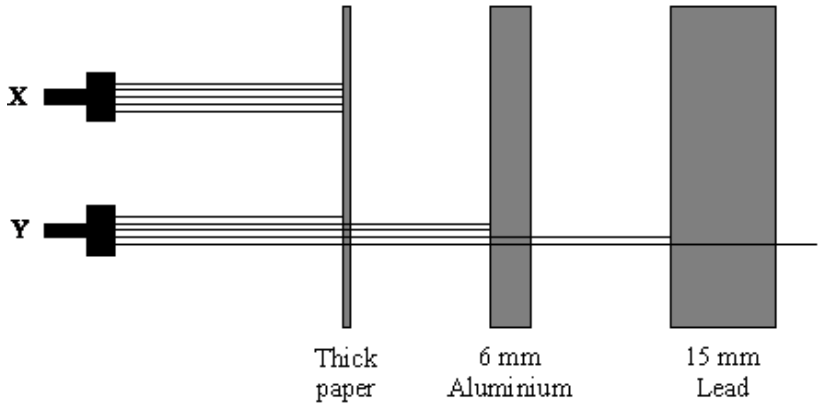
(2)

(Total 3 marks)

Q19. (a) A radioactive source can give out three types of emission:

alpha particles
beta particles
gamma radiation.

The diagram shows the paths taken by the radiation emitted by two sources, **X** and **Y**.



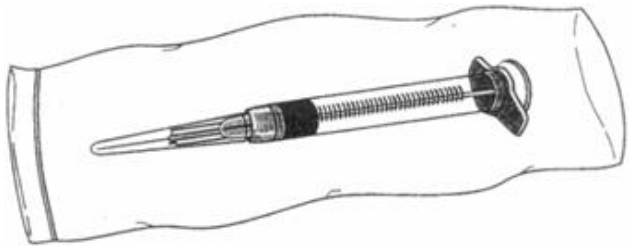
What types of radiation are emitted by each of the sources?

Source **X** emits .....

Source **Y** emits .....

(2)

(b) The diagram shows a disposable syringe sealed inside a plastic bag. After the bag has been sealed the syringe is sterilised using radiation.



Explain why radiation can be used to sterilise the syringe.

.....

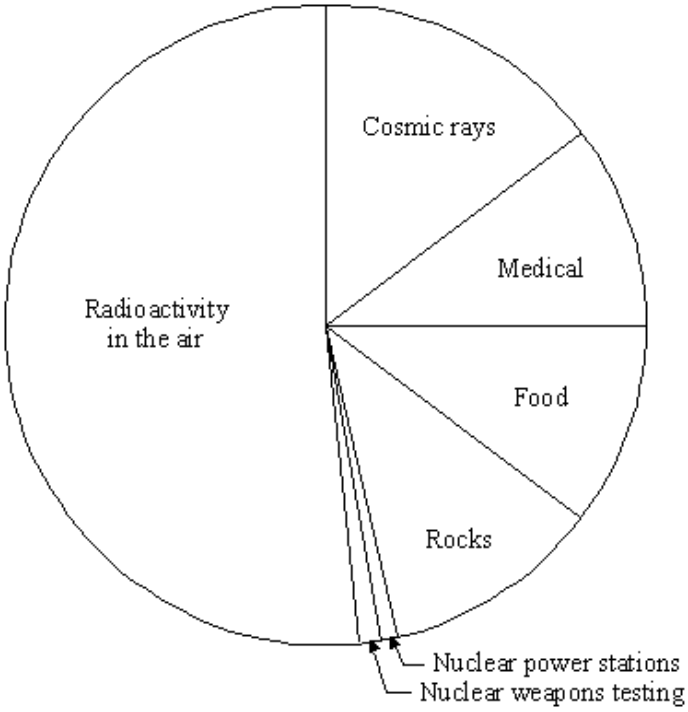
.....

.....

.....

(3)
(Total 5 marks)

Q20. The different sources of radiation to which we are exposed are shown in the pie chart. Some sources are natural and some artificial.



(i) Name **one** natural source of radiation shown in the pie chart.

.....

(1)

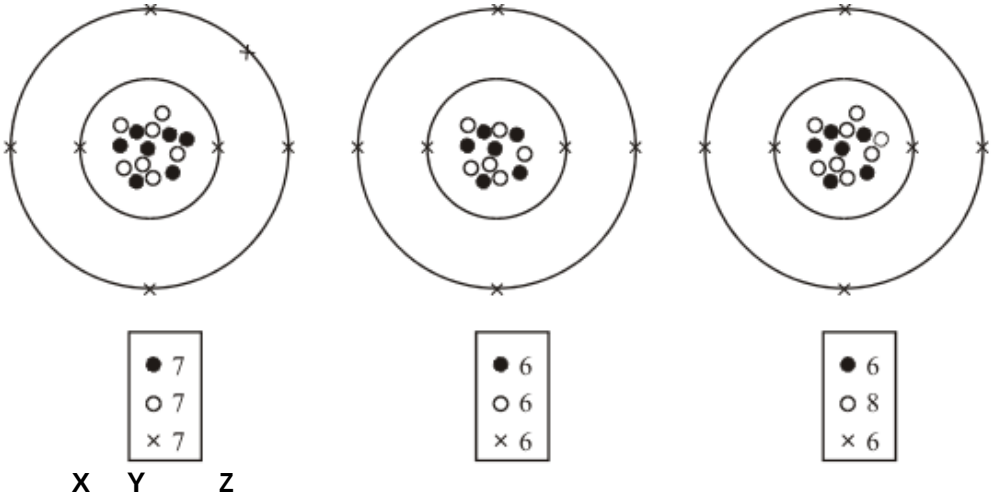
(ii) Name **one** artificial source of radiation shown in the pie chart.

.....

(1)

(Total 2 marks)

Q21. (a) The diagrams represent three atoms **X**, **Y** and **Z**.



Which **two** of the atoms are from the same element?

.....

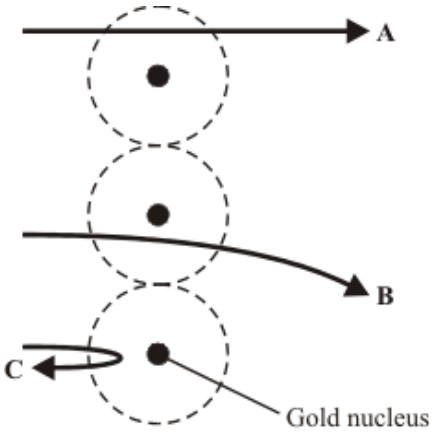
Give a reason for your answer.

.....

.....

(2)

(b) In the early part of the 20th century some scientists investigated the paths taken by positively charged alpha particles into and out of a very thin piece of gold foil. The diagram shows the paths of three alpha particles.



Explain the different paths **A**, **B** and **C** of the alpha particles.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

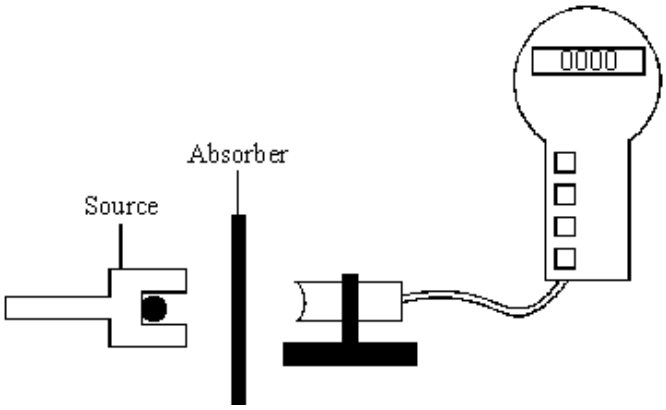
.....

.....

.....

(3)
(Total 5 marks)

Q22. The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.



Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

Absorber used	Average counts per second
No absorber	33
Card 1 mm thick	20
Metal 3 mm thick	2

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

.....

.....

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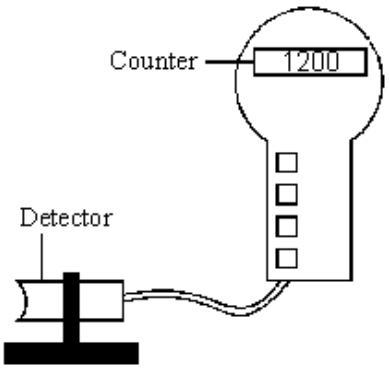
.....

(Total 3 marks)

Q23. The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.



(i) Name **one** source of background radiation.

.....

(1)

(ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

.....

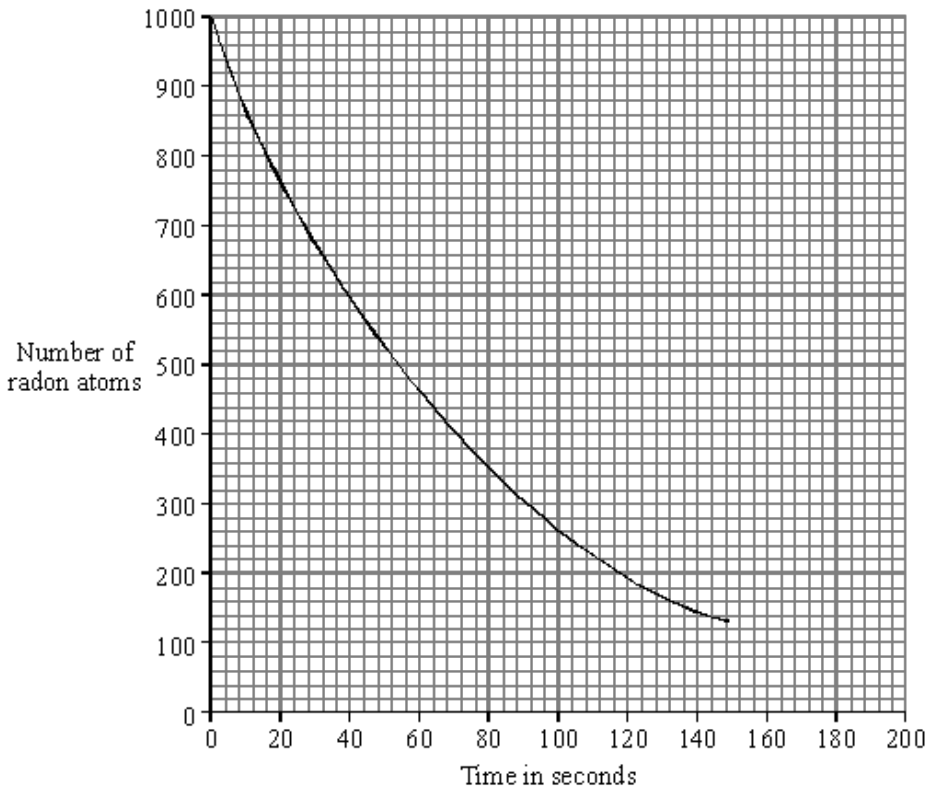
.....

Background radiation level = ... counts per second

(2)

(Total 3 marks)

Q24. Radon is a radioactive element. The graph shows how the number of radon atoms in a sample of air changes with time.



(i) How long did it take the number of radon atoms in the sample of air to fall from 1000 to 500?

Time = ... seconds

(1)

(ii) How long is the half-life of radon?

Half-life = ... seconds

(1)

(iii) Complete this sentence by crossing out the **two** lines in the box that are wrong.

As a radioactive material gets older, it emits

less
a constant level of
more

radiation per second.

(1)

(Total 3 marks)

Q25. Some types of food are treated with *gamma* radiation. Low doses of radiation slow down the ripening of fresh fruit and vegetables while higher doses of radiation kill the bacteria that make the food go off.

(a) (i) What is *gamma* radiation?

.....

(1)

(ii) Food packed in crates or boxes can be treated using this method.

Why must a source that emits *gamma* radiation be used?

.....

.....

(1)

(iii) A suitable source of gamma radiation is the isotope caesium 137.

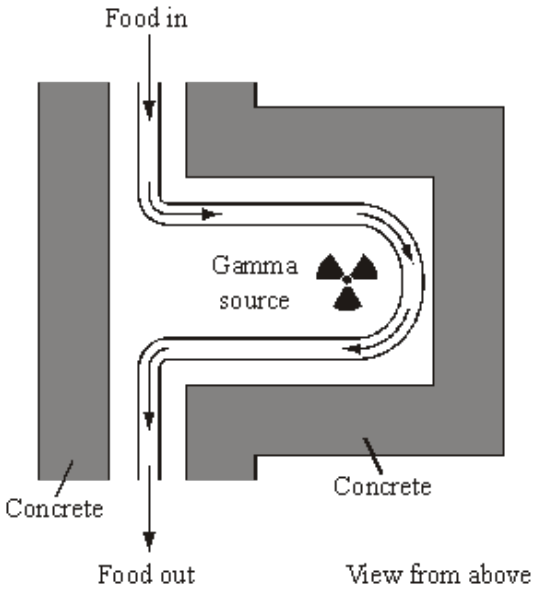
Complete the following sentence by choosing the correct word from the box.

electrons	**neutrons**	**protons**

An atom of caesium 137 has two more ..... than an atom of caesium 135.

(1)

(b) The diagram shows how a conveyor belt can be used to move food past the radioactive source.



(i) How do the concrete walls reduce the radiation hazard to workers outside the food treatment area?

.....

.....

(1)

(ii) Suggest **one** way that the dose of radiation received by the food could be increased other than by changing the radioactive source.

.....

.....

(1)

(c) Some people may not like the idea of eating food treated with radiation.

(i) What evidence could a food scientist produce to show that food treated with radiation is safe to eat?

.....

.....

.....

.....

(2)

(ii) The diagram shows the sign displayed on food treated with radiation.

Why is it important for people to know which foods have been treated with radiation?

.....

.....

(1)

(Total 8 marks)

Q26. (a) The table gives information about the radioactive isotope, radon-222.

mass number	222
atomic number	86
radiation emitted	alpha particle

(i) Complete the following sentence.

The mass number is the total number of ..... and

..... inside an atom.

(2)

(ii) Radon-222 is an isotope of radon.

How many protons are there in an atom of radon-222?

.....

(1)

(iii) When an atom of radon-222 emits an alpha particle, the radon-222 changes into an atom of polonium-218.

An alpha particle consists of 2 protons and 2 neutrons.

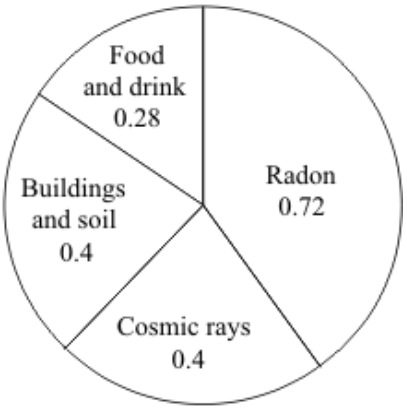
How is the structure of the nucleus of a polonium-218 atom different from the structure of the nucleus of a radon-222 atom?

.....

(1)

(b) The pie chart shows the average radiation dose that a person in the UK receives each year from natural background radiation.

The doses are measured in millisieverts (mSv).



(i) Calculate the proportion of natural background radiation that comes from radon.
Show clearly how you work out your answer.

.....

.....

Proportion of radon = ...

(2)

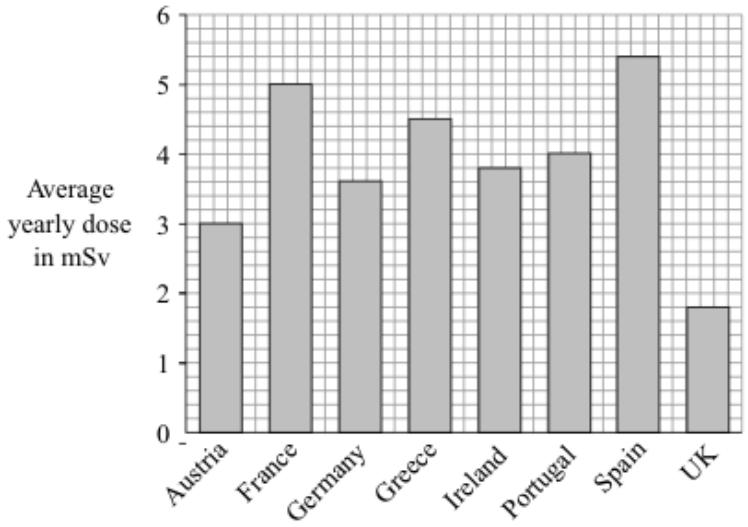
(ii) Not all background radiation is from natural sources.

Name **one** source of background radiation that is not natural.

.....

(1)

(c) The bar chart shows the average yearly dose from natural background radiation in different European countries.



(i) How many times bigger is the average annual background dose in Germany compared to the UK?

.....

(1)

(ii) The following table gives the effects of different radiation doses on the human body.

Radiation dose in mSv	Effects
10 000	Immediate illness; death within a few weeks
1 000	Radiation sickness; unlikely to cause death
50	Lowest dose with evidence of causing cancer

A family goes to Germany for a two-week holiday. Should they be concerned about the higher level of background radiation in Germany?

Draw a ring around your answer.

Yes **No**

Explain your answer.

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(2)

(Total 10 marks)

Q27. The table gives information about the three types of particle that make up an atom.

Particle	Relative mass	Relative charge
Proton		+1
Neutron	1	
Electron	very small	–1

(a) Complete the table by adding the **two** missing values.

(2)

(b) Use the information in the table to explain why an atom has no overall electrical charge.

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(2)

(c) Uranium has two natural isotopes, uranium-235 and uranium-238.
Uranium-235 is used as a fuel inside a nuclear reactor.
Inside the reactor, atoms of uranium-235 are split and energy is released.

(i) How is the structure of an atom of uranium-235 different from the structure of an atom of uranium-238?

.....

.....

(1)

(ii) The nucleus of a uranium-235 atom must absorb a particle before the atom is able to split.

What type of particle is absorbed?

.....

(1)

(iii) The nucleus of an atom splits into smaller parts in a reactor.

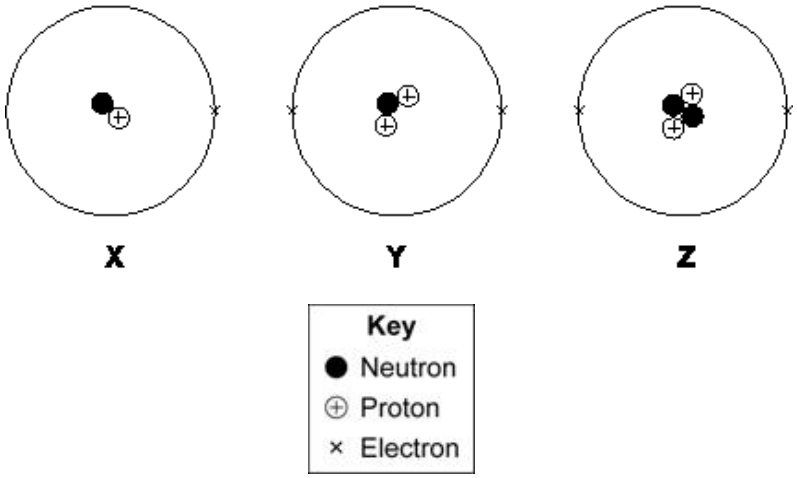
What name is given to this process?

.....

(1)

(Total 7 marks)

Q28. (a) The diagrams represent three atoms, **X**, **Y** and **Z**.



Which of these atoms are isotopes of the same element?

.....

Give a reason for your answer.

.....

.....

(2)

(b) In a star, nuclei of atom **X** join to form nuclei of atom **Y**.

Complete the sentences.

The process by which nuclei join to form a larger nucleus is called

nuclear ..... .

This is the process by which a star releases ..... .

(2)

(c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate*.

A star goes through a lifecycle.

Describe the lifecycle of a star like the Sun.

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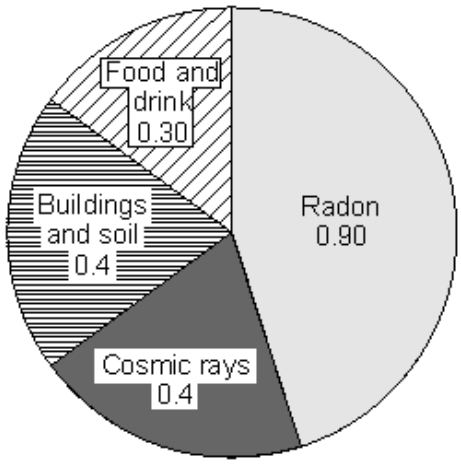
(6)
(Total 10 marks)

Q29. The pie-chart shows the average radiation dose that a person in the UK receives each year from natural background radiation.

The doses are measured in millisieverts (mSv).



(a) Some types of job increase the radiation dose a worker receives.
People working as aircrew receive an increased radiation dose due to flying at high altitude.

(i) The radiation dose from which source of background radiation is increased by flying?

.....

(1)

(ii) The following table gives the average additional radiation dose received by aircrew flying to various destinations from London.

Destination	Flight time in hours	Average additional radiation dose in mSv
Edinburgh	1	0.004
Istanbul	5	0.025
Toronto	8	0.050
Los Angeles	11	0.065
Tokyo	13	0.075

What is the relationship between flight time and average additional radiation dose?

.....

.....

(1)

(iii) A flight from London to Jamaica takes 10 hours.

Estimate the likely value for the average additional radiation dose received by people on this flight.

Average additional radiation dose = ... mSv

Give a reason for your answer.

.....

.....

(2)

(b) The following table gives the effects of different radiation doses on the human body.

Radiation dose in mSv	Effects
10 000	Immediate illness; death within a few weeks
1 000	Radiation sickness; unlikely to cause death
100	Lowest dose with evidence of causing cancer

A businessman makes 10 return flights a year from London to Tokyo.

Explain whether the businessman should be concerned about the additional radiation dose received during the flights.

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(2)

(c) In a study of 3900 aircrew it was found that 169 had developed leukaemia, a form of cancer. In a similar sized sample of non-aircrew the number of leukaemia cases was 156.

Suggest why it would be difficult to be certain that the leukaemia developed by the aircrew was caused by flying.

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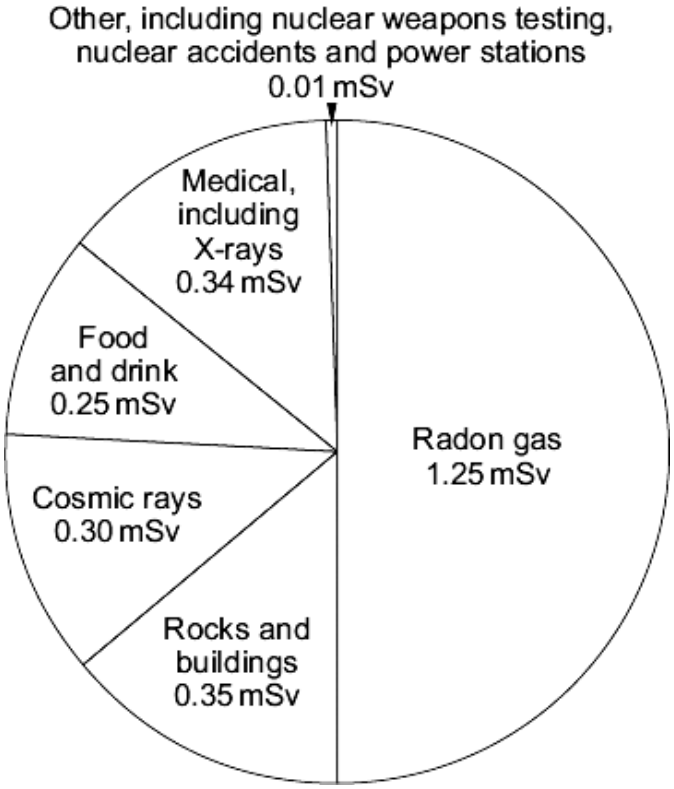
(2)
(Total 8 marks)

Q30. The pie chart shows the sources of the background radiation and the radiation doses that the average person in the UK is exposed to in one year.
Radiation dose is measured in millisieverts (mSv).



(a) (i) What is the total radiation dose that the average person in the UK receives?

.....

.....

Total radiation dose = ... mSv

(1)

(ii) A student looked at the pie chart and then wrote down three statements.

Which **one** of the following statements is a correct conclusion from this data?

Put a tick (✓) in the box next to your answer.

In the future, more people will be exposed to a greater proportion of radon gas. ☐

People that have never had an X-ray get 50% of their radiation dose from radon gas. ☐

The radiation dose from natural sources is much greater than from artificial sources. ☐

(1)

(b) The concentration of radon gas inside a home can vary from day to day. In some homes, the level can build up to produce a significant health risk. It is estimated that each year 1000 to 2000 people die because of the effects of radiation from radon gas.

(i) It is not possible to give an exact figure for the number of deaths caused by the effects of radiation from radon gas. Why?

.....

.....

(1)

The table gives data for the radiation levels measured in homes in 4 different parts of the UK. The radiation levels were measured using two detectors, one in the living room and one in the bedroom. The measurements were taken over 3 months.

Area of the UK	Number of homes in the area	Number of homes in the sample	Average radiation level in Bq/m^3	Maximum radiation level in Bq/m^3
A	590 000	160	15	81
B	484 000	130	18	92
C	221 000	68 000	162	10 000
D	318 000	35 300	95	6 900

(ii) Give **one** reason why the measurements were taken over 3 months using detectors in different rooms.

.....

.....

(1)

(iii) Use information from the table to suggest why a much higher proportion of homes were sampled in areas **C** and **D** than in areas **A** and **B**.

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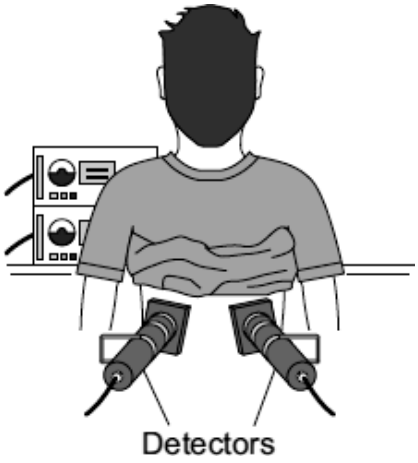
(2)
(Total 6 marks)

Q31. (a) A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.



The doctor injects a small amount of technetium-99 into the patient's bloodstream.

Technetium-99 emits *gamma radiation.*

Give **two** reasons why an isotope that emits gamma radiation is injected into the patient rather than an isotope that emits alpha radiation.

1.....

.....

2.....

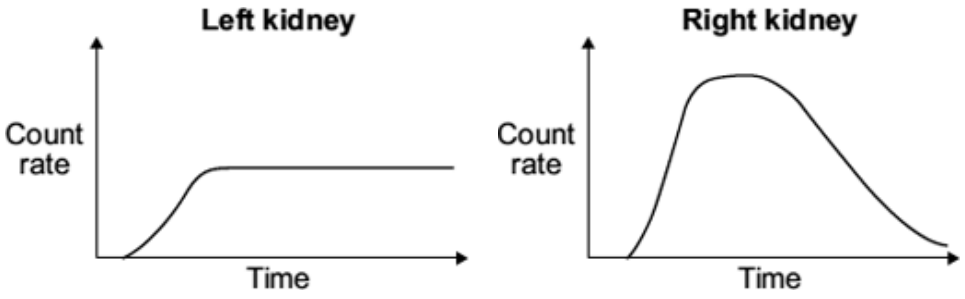
.....

(2)

(b) If the patient's kidneys are working correctly, the technetium-99 will pass from the bloodstream into the kidneys and then into the patient's urine.

Detectors are used to measure the radiation emitted from the kidneys.

The level of radiation emitted from each kidney is recorded on a graph.



(i) How do the graphs show that technetium-99 is passing from the bloodstream into each kidney?

.....

.....

(1)

(ii) By looking at the graphs, the doctor is able to tell if there is a problem with the patient's kidneys.

Which **one** of the following statements is correct?

Put a tick (✓) in the box next to your answer.

Only the right kidney is working correctly.	☐
Only the left kidney is working correctly.	☐
Both kidneys are working correctly.	☐

Explain the reason for your answer.

.....

.....

.....

.....

(3)

(c) The patient was worried about having a radioactive isotope injected into their body. The doctor explained that the risk to the patient's health was very small as technetium-99 has a short *half-life.*

(i) What does the term *half-life* mean?

.....

.....

(1)

(ii) Explain why it is important that the doctor uses an isotope with a short half-life rather than an isotope with a long half-life.

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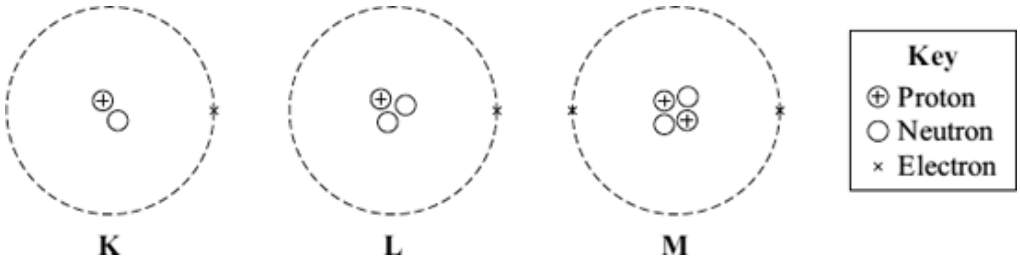
(2)
(Total 9 marks)

Q32. (a) The diagram represents 3 atoms, **K**, **L** and **M**.



(i) Which **two** of the atoms are isotopes of the same element?

..... and .....

(1)

(ii) Give a reason why the **two** atoms that you chose in part (a)(i) are:

(1) atoms of the same element .....

.....

(2) different isotopes of the same element. .....

.....

.....

(2)

(b) The table gives some information about the radioactive isotope thorium-230.

mass number	230
atomic number	90

(i) How many electrons are there in an atom of thorium-230?

.....

(1)

(ii) How many neutrons are there in an atom of thorium-230?

.....

(1)

(c) When a thorium-230 nucleus decays, it emits radiation and changes into radium-226.

$$^{230}_{90}\text{Th} \longrightarrow {}^{226}_{88}\text{Ra} + \boxed{\text{Radiation}}$$

What type of radiation, alpha, beta or gamma, is emitted by thorium-230?

.....

Explain the reason for your answer.

.....

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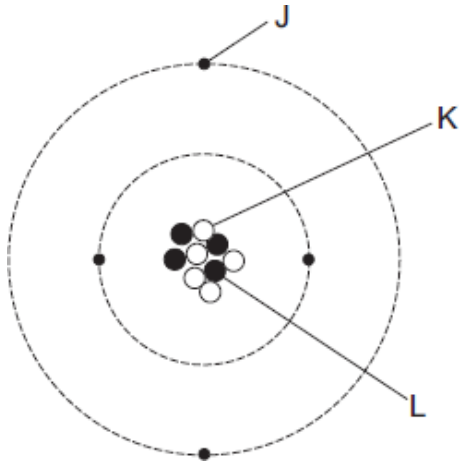
(3)
(Total 8 marks)

Q33. The diagram represents an atom of beryllium.



(a) Complete the following statements by writing one of the letters, **J**, **K** or **L**, in each box.

Each letter should be used only **once**.

The particle with a positive charge is ☐

The particle with the smallest mass is ☐

The particle with no charge is ☐

(2)

(b) Give the reason why all atoms have a total charge of zero.

.....

.....

(1)

(c) Complete the following sentence.

There are several isotopes of beryllium. Atoms of different beryllium isotopes will have different numbers of .....

(1)

(d) What happens to the structure of an atom to change it into an ion?

.....

.....

(1)
(Total 5 marks)

Q34. (a) Background radiation is all around us all the time.

(i) Radon is a natural source of background radiation.

Name another natural source of background radiation.

.....

(1)

(ii) X-rays are an artificial source of background radiation.

Name another artificial source of background radiation.

.....

(1)

(iii) An atom of radon-222 decays by emitting an alpha particle.
The equation representing the decay is shown below.

$$^{222}_{86}Rn \longrightarrow {}^{218}_{84}X + \text{alpha particle}$$

How can you tell from the equation that 'X' is not an atom of radon?

.....

.....

(1)

(b) Having an X-ray taken increases your exposure to radiation.

The table gives:

- the radiation doses received for 6 different medical X-rays;
- the number of days' of exposure to natural background radiation each dose is equivalent to.

Medical X-ray	Radiation dose received (in arbitrary units)	Equivalent number of days of exposure to natural background radiation
Chest	2	2.4
Skull	7	8.4
Pelvis	22	26.4
Hip	44	52.8
Spine	140	
CT head scan	200	240

A hospital patient has an X-ray of the spine taken.
Calculate the number of days of exposure to natural background radiation that an X-ray of the spine is equivalent to.

Show how you work out your answer.

.....

.....

.....

Equivalent number of days = ...

(2)

(c) Scientists have shown that X-rays increase the risk of developing cancer.
The scientists came to this conclusion by studying the medical history of people placed in one of two groups, **A** or **B**.
The group into which people were put depended on their X-ray record.

(i) Person **J** has been placed into group **A**.
Place each of the people, **K**, **L**, **M**, **N** and **O**, into the appropriate group, **A** or **B**.

Person	**J** 	**K** 	**L** 	**M** 	**N** 	**O** 
Medical X-ray record	3 arm	None	None	2 skull	None	4 leg

Group A	**Group B**
J	

(1)

(ii) To be able to make a fair comparison, what is important about the number of people in each of the two groups studied by the scientists?

.....

.....

(1)

(iii) What data would the scientists have compared in order to come to the conclusion that X-rays increase the risk of developing cancer?

.....

.....

(1)

(iv) The chance of developing cancer due to a CT head scan is about 1 in 10 000.
The chance of developing cancer naturally is about 1 in 4.

A hospital patient is advised by a doctor that she needs to have a CT head scan.
The doctor explains to the patient the risks involved.

Do you think that the patient should give her permission for the CT scan to be taken?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1)
(Total 9 marks)

Q35. (a) Background radiation is all around us all the time.

(i) Radon is a natural source of background radiation.

Name another natural source of background radiation.

.....

(1)

(ii) X-rays are an artificial source of background radiation.

Name another artificial source of background radiation.

.....

(1)

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.....

.....

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Show how you work out your answer.

.....

.....

.....

Equivalent number of days = ...

(2)

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Place each of the people, **K**, **L**, **M**, **N** and **O**, into the appropriate group, **A** or **B**.

Person	**J** 	**K** 	**L** 	**M** 	**N** 	**O** 
Medical X-ray record	3 arm	None	None	2 skull	None	4 leg

Group A	**Group B**
J	

(1)

(ii) To be able to make a fair comparison, what is important about the number of people in each of the two groups studied by the scientists?

.....

.....

(1)

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.....

.....

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The doctor explains to the patient the risks involved.

Do you think that the patient should give her permission for the CT scan to be taken?

Draw a ring around your answer.

Yes **No**

Give a reason for your answer.

.....

.....

(1)
(Total 9 marks)