AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.4.3 HAZARDS AND USES OF RADIOACTIVE EMISSIONS AND OF BACKGROUND RADIATION (PACK 2)

SCORE	PERCENTAGE
/119	%

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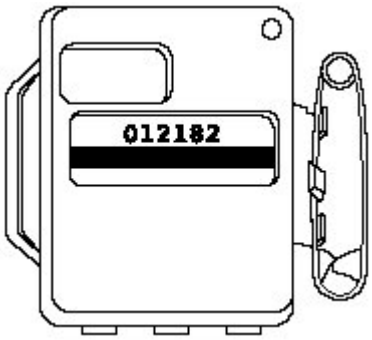
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Q1.

The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

_____

(1)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

_____

_____

(1)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

_____

_____

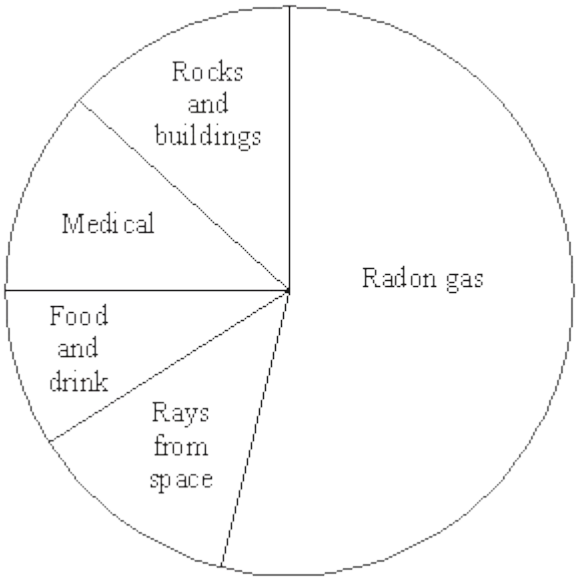
(1)

(Total 3 marks)

Q2.

Radiation is around us all of the time. The pie chart shows the sources of this radiation.

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(i) What is the main source of this radiation?

_____

(1)

(ii) What name is given to the radiation that is around us all of the time?

_____

(1)

(Total 2 marks)

Q3.

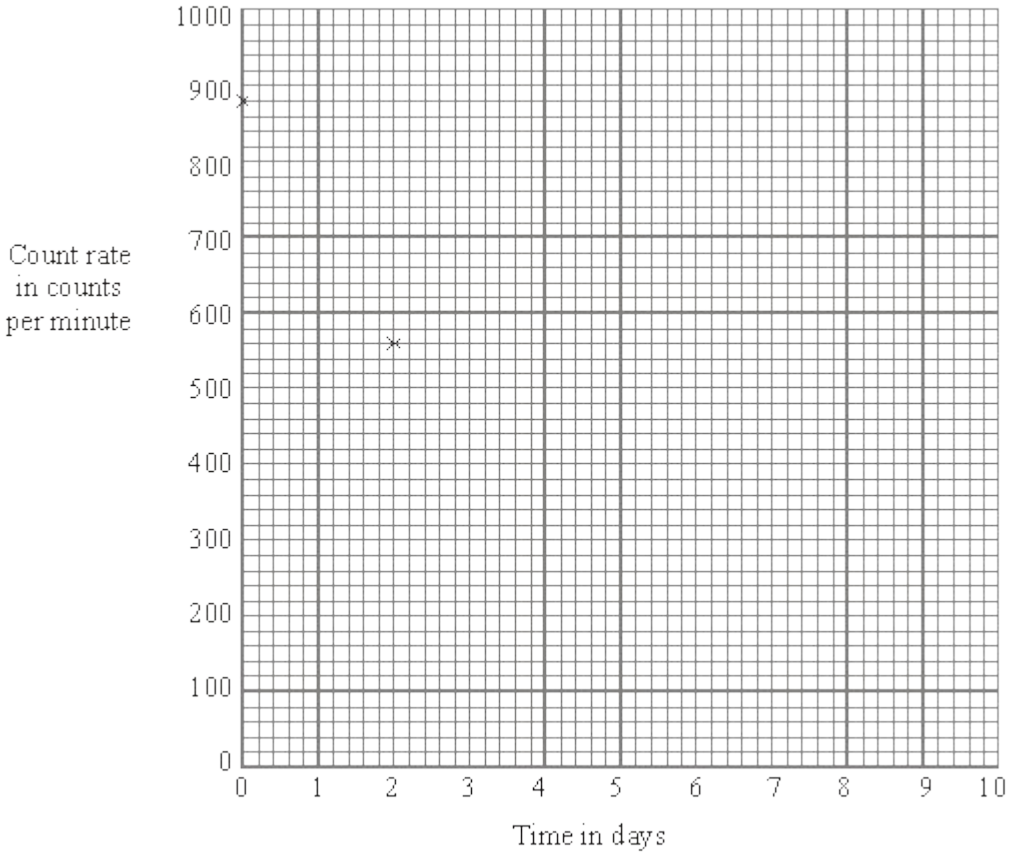
The table shows how the count rate from a radioactive substance changes in 10 days.

Time in days	0	2	4	6	8	10
Count rate in countsper minute	880	555	350	220	140	90

(a) Draw a graph of count rate against time.

The first two points have been plotted for you.

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(3)

(b) (i) Use your graph to find out how long it takes for the count rate to fall from 880 counts per minute to 440 counts per minute.

Time = _____ days

(1)

(ii) What is the half-life of this substance?

Half-life = _____ days

(1)

(c) The table gives the half-life and type of radiation given out by four different radioactive isotopes.

Radioactive isotope	Half-life in days	Radiation given out
bismuth-210	5.0	beta
polonium-210	138.0	alpha and gamma
radon-222	3.8	alpha
thorium-234	24.1	beta and gamma

Some samples of each isotope have the same count rate today. Which sample will have the lowest count rate one month from today?

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_____

Give a reason for your answer.

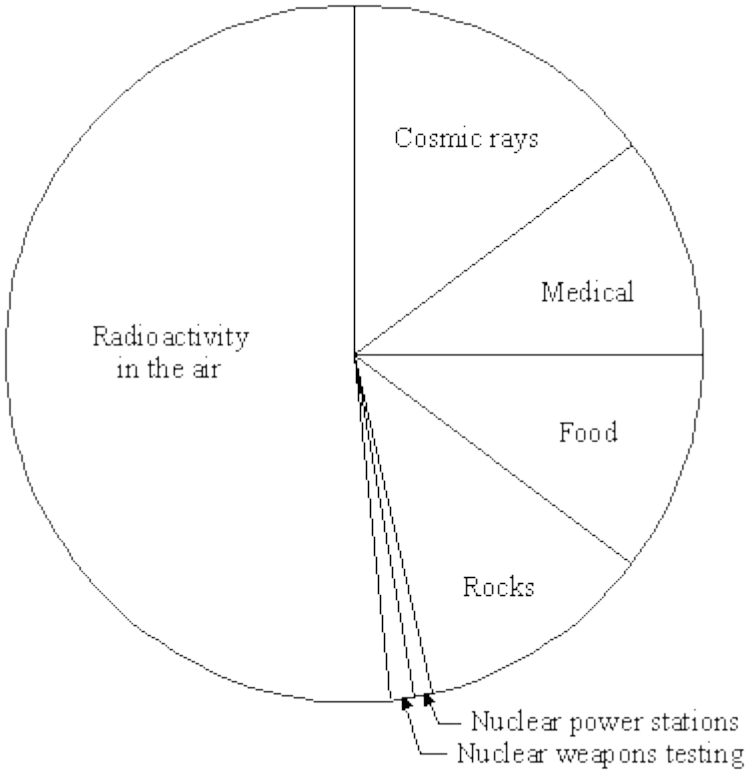
_____

(2)

(Total 7 marks)

Q4.

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)

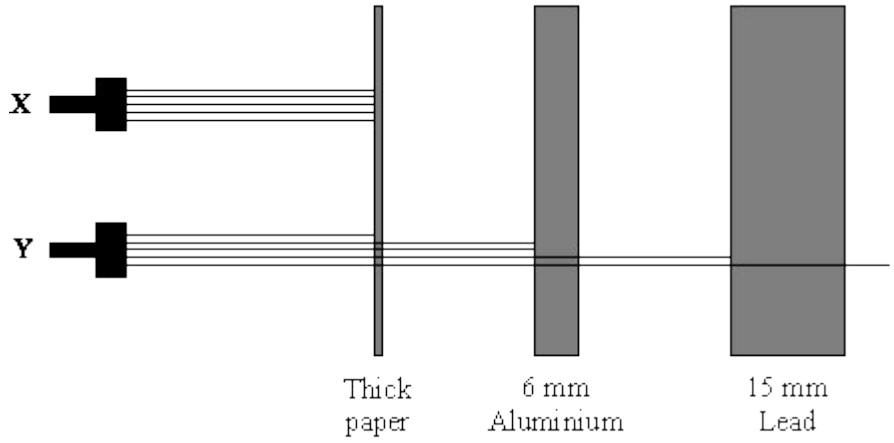
Q5.

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

alpha particles
beta particles
gamma radiation.

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



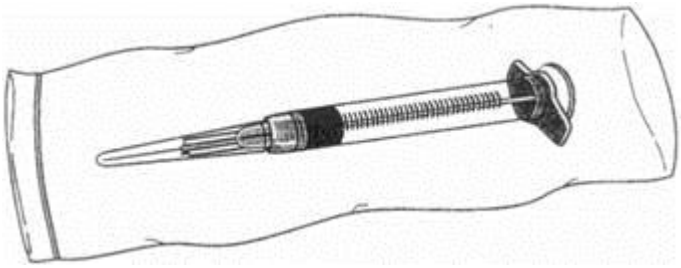
What types of radiation are emitted by each of the sources?

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.

_____

_____

_____

_____

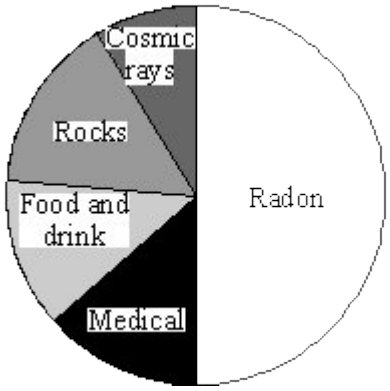
(3)

(Total 5 marks)

Q6.

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

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(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.

_____

_____

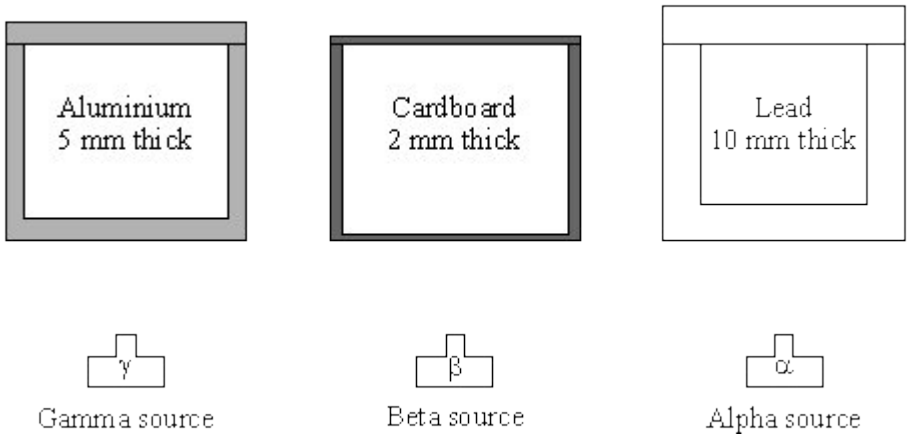
_____

(2)

(Total 3 marks)

Q7.

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

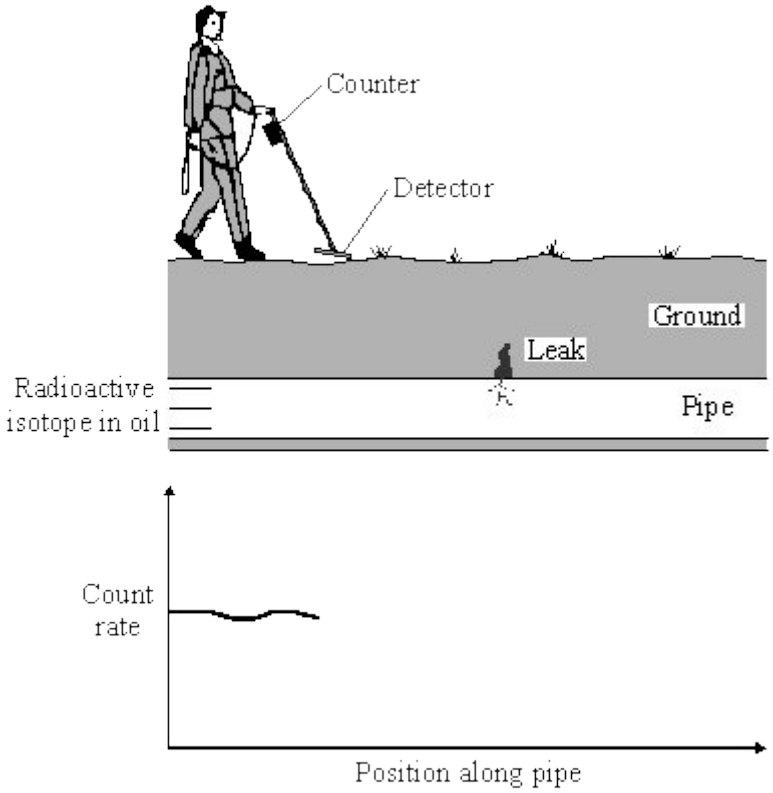


Draw lines to show which source should be stored in each box so that the risk of radiation leakage is a minimum.

(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.

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(i) State the type of detector used.

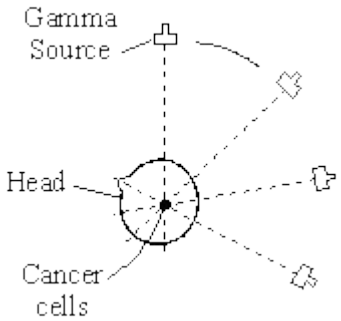
_____

(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.

_____

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_____

_____

_____

(2)

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

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

Q8.

(a) The table shows the half-life of some *radioactive* isotopes.

Radioactive isotope	Half-life
magnesium-27	10 minutes
sodium-24	15 hours
sulphur-35	87 days
cobalt-60	5 years

(i) What is meant by the term *radioactive?*

_____

_____

(1)

(ii) Which **one** of the isotopes in the table could form part of a compound to be used as a tracer in medicine? Explain the reason for your choice.

_____

_____

_____

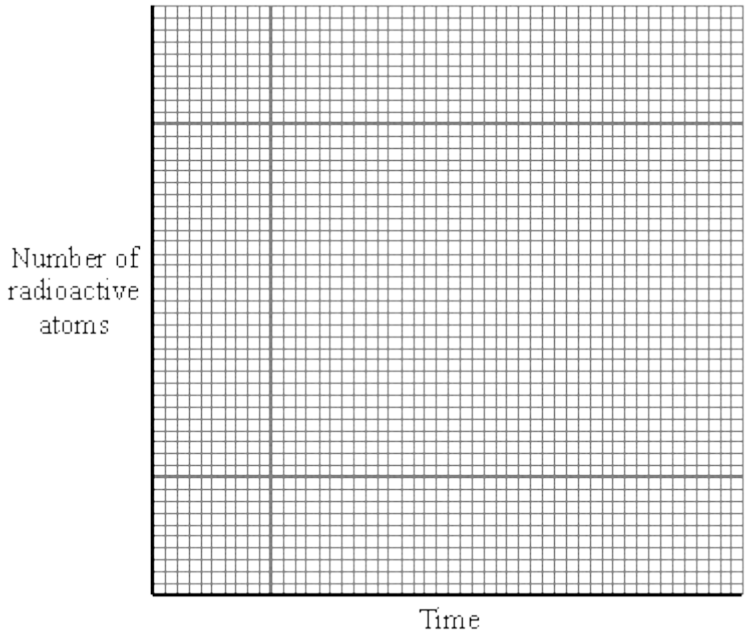
_____

_____

(3)

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(iii) Draw a graph to show how the number of radioactive atoms present in the isotope cobalt-60 will change with time.



(3)

(b) Nuclear power stations provide about 17% of the world's electricity. They add less than 1% to the total background levels of radiation. Some people are opposed to the use of nuclear fuels for the generation of electricity. Explain why.

_____

_____

_____

_____

_____

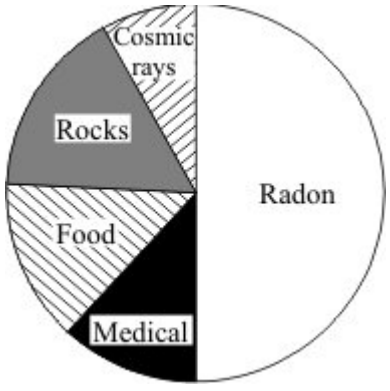
_____

(3)

(Total 10 marks)

Q9.

(a) The pie-chart shows the main sources of background radiation.



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(i) Which source in the pie-chart adds the smallest amount of radiation to background levels?

_____

(1)

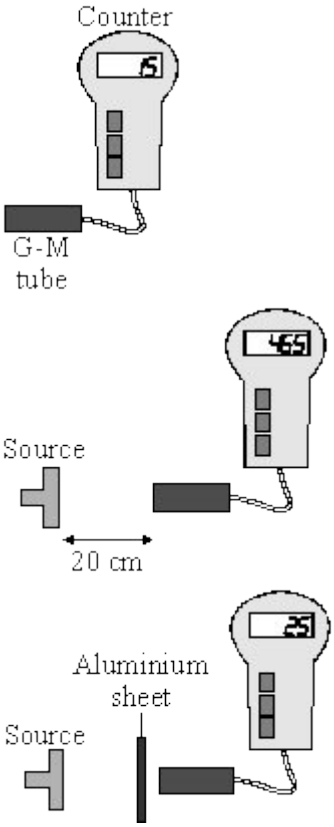
(ii) Name **two** natural sources of background radiation in the pie-chart.

1. _____

2. _____

(2)

(b) The diagrams show how a radiation detector and counter can be used to measure radiation levels. In each case the numbers show the count one minute after the counter is switched on.



(i) How many counts are just from background radiation?

_____

(ii) How many counts are just from the source?

_____

(iii) What type of radiation did the source give out?

_____

Give a reason for your answer.

_____

_____

_____

_____

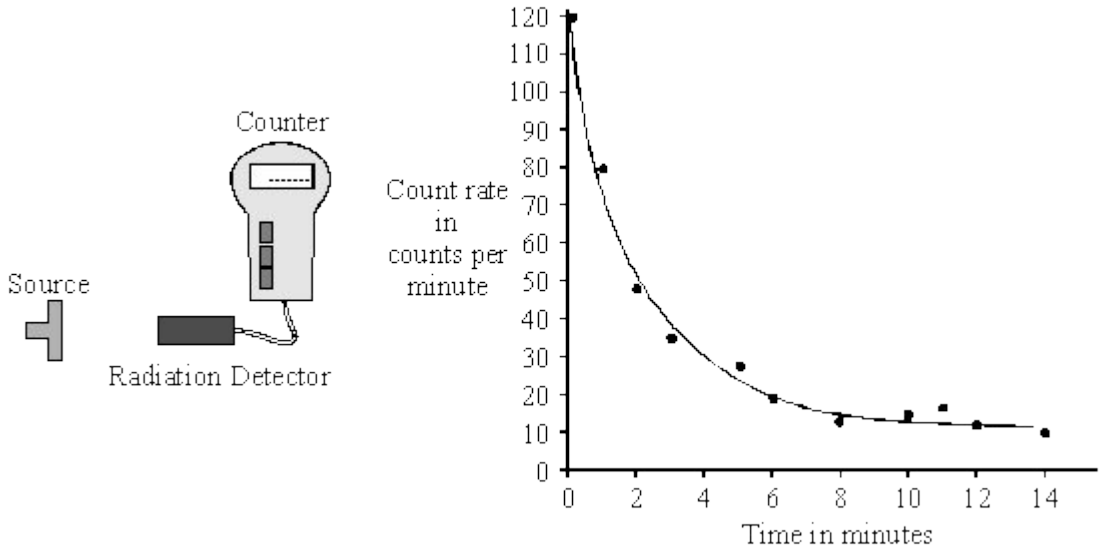
(4)

(Total 7 marks)

Q10.

(a) A radiation detector and counter were used to detect and measure the radiation emitted from a weak source. The graph shows how the number of counts recorded in one minute changed with time.

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(i) Even though the readings from the counter were accurately recorded, not all the points fit the smooth curve. What does this tell us about the process of radioactive decay?

_____

(1)

(ii) After ten minutes the number of counts recorded each minute is almost constant.
Explain why.

_____

_____

_____

(2)

(b) The radioactive isotope sodium-24 injected into the bloodstream can be used to trace blood flow to the heart. Sodium-24 emits both *beta particles* and *gamma rays*.

(i) What is a *beta particle*?

_____

(1)

(ii) What is a *gamma ray*?

_____

_____

(1)

(iii) The count rate from a solution containing sodium-24 decreases from 584 counts per minute to 73 counts per minute in 45 hours. Calculate the half-life of sodium-2.2. Show clearly how you work out your answer.

_____

_____

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_____

Half-life = _____ hours

(3)

(iv) Give **one** advantage of using sodium-24 to trace blood flow compared to using an isotope with a half-life of:

[A] ten years; _____

_____

(1)

[B] ten seconds. _____

_____

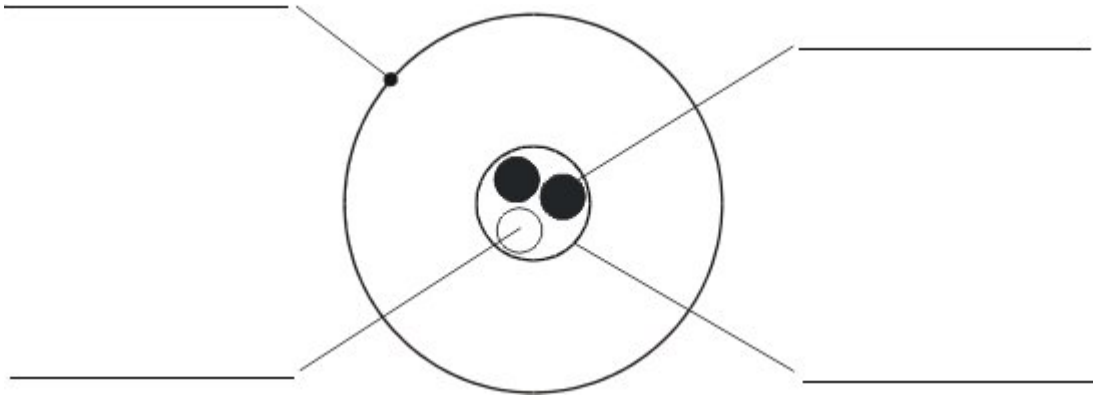
(1)

(Total 10 marks)

Q11.

(a) Tritium ($^{3}_{1}H$) is an isotope of hydrogen. Tritium has a proton number of 1 and a mass number of 3.

(i) The diagram below shows a simple model of a tritium atom. Complete the diagram by adding the names of the particles indicated by the labels.



(4)

(ii) Explain how the nucleus of an ordinary hydrogen atom is different from the nucleus of a tritium atom. Ordinary hydrogen atoms ($^{1}_{1}H$) have a mass number of 1.

_____

_____

_____

(2)

(iii) Tritium is a radioactive substance which emits beta (β) radiation.
Why do the atoms of some substances give out radiation?

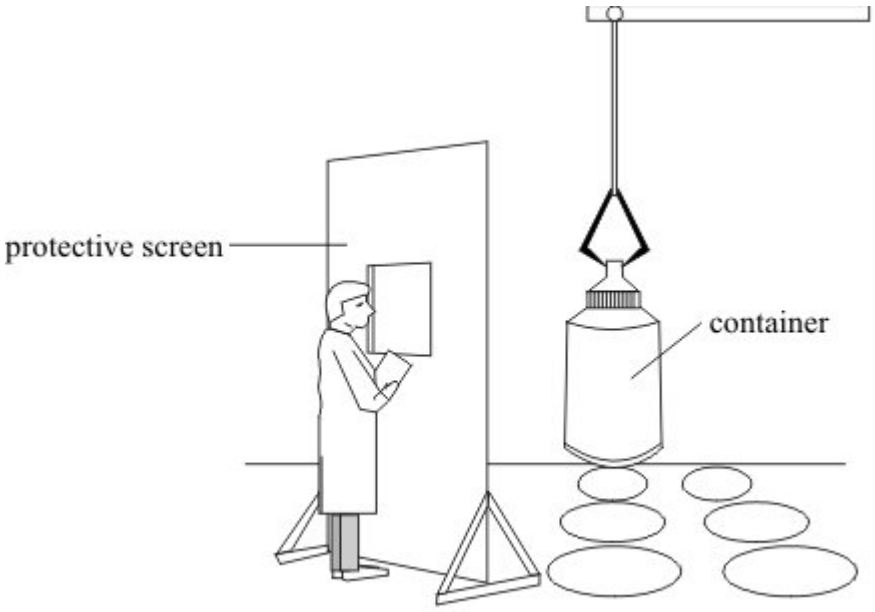
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_____

_____

(2)

(b) Tritium is one of the elements found in the waste material of the nuclear power industry. The diagram below shows a worker behind a protective screen. The container holds a mixture of different waste materials which emit alpha (α), beta (β) and gamma (γ) radiation.



Suggest a suitable material for the protective screen. The material should prevent radiation from the container reaching the worker. Explain your answer.

_____

_____

_____

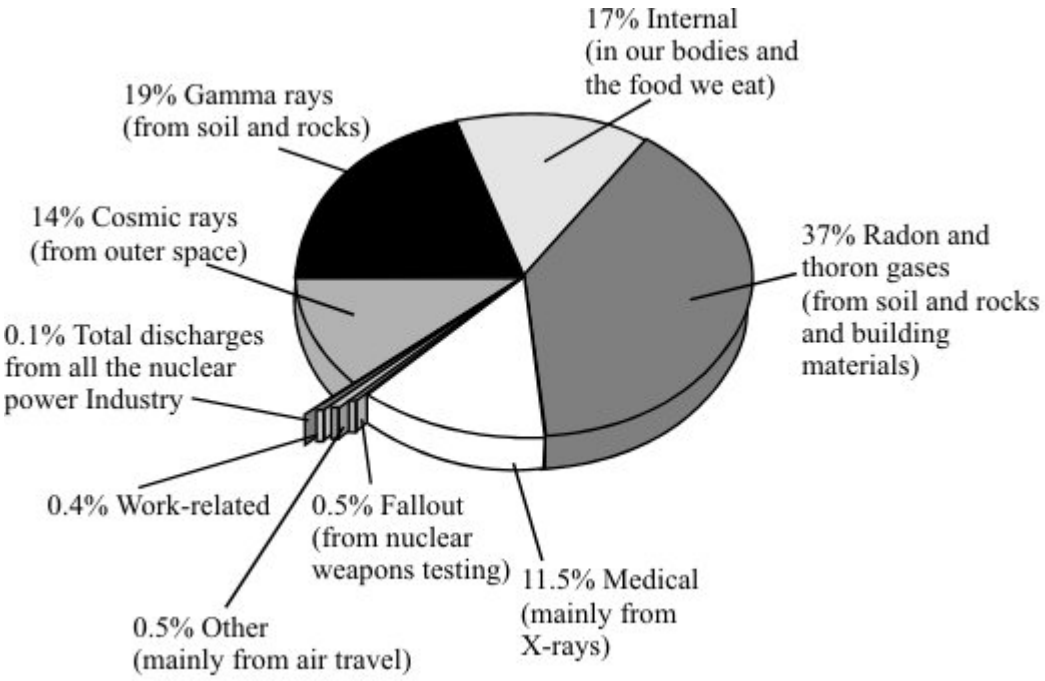
(2)

(Total 10 marks)

Q12.

The chart below shows the sources of radiation in Britain.

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

_____

(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.

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	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)

Q13.

In some areas of the U.K. people are worried because their houses are built on rocks that release radon.

Read the information about radon.

- It is a gas.

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- It is formed by the breakdown of radium.
- It emits alpha radiation.
- Each radon atom has 86 protons.
- Each radon atom has 136 neutrons.

Explain why it may be dangerous to live near rocks that release radon.

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.

_____

_____

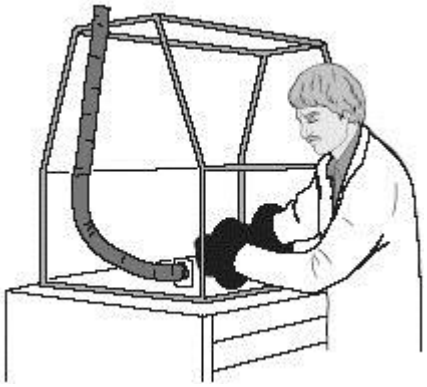
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_____

(Total 3 marks)

Q14.

The picture shows a man at work in a factory that uses radioactive materials.



The radioactive material is kept behind glass shields. The man wears gloves so that he cannot touch the radioactive material directly.

Explain, as fully as you can, why these precautions are taken.

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.

_____

_____

_____

_____

_____

_____

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(Total 4 marks)

Q15.

The table gives the properties of some radionuclides (radioactive isotopes).

Radionuclide	Half life	Main type of radiation emitted
Radon-220	54.5 seconds	Alpha
Americium-241	433 years	Alpha
Phosphorus-32	14 days	Beta
Strontium-90	28 years	Beta
Technetium-99	6 hours	Gamma
Cobalt-60	5 years	Gamma

(i) Which radionuclide would be best for monitoring the thickness of aluminium foil?

_____

Explain the reason for your answer.

_____

_____

_____

(2)

(ii) Which radionuclide would be best for acting as a tracer inside the human body?

_____

Explain the reason for your answer.

_____

_____

_____

(2)

(Total 4 marks)

Q16.

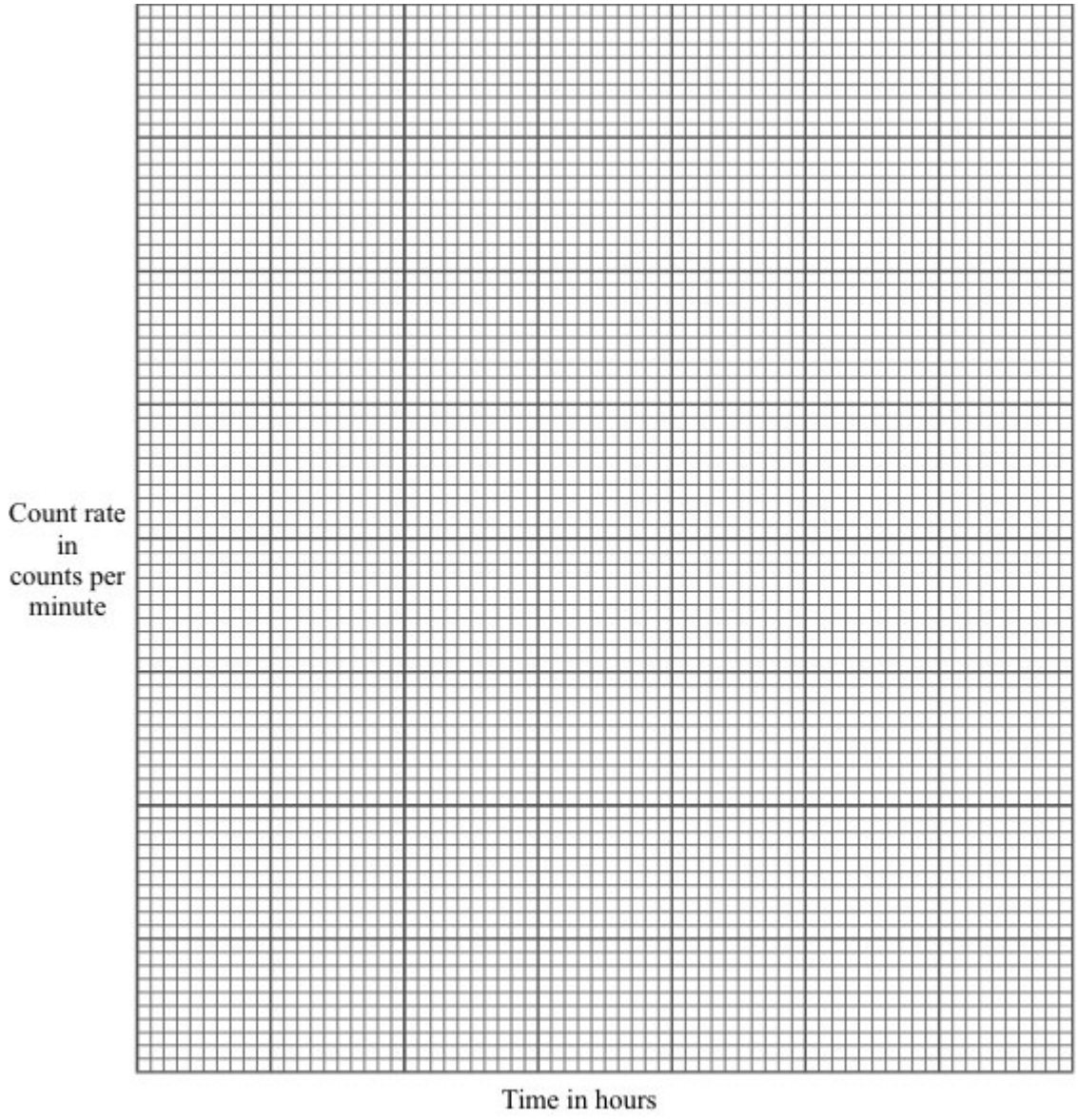
The isotope of sodium with a mass number of 24 is radioactive. The following data were obtained in an experiment to find the half-life of sodium-24.

Time in hours	Count rate in counts per minute

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0	1600
10	1000
20	600
30	400
40	300
50	150
60	100

(a) Draw a graph of the results and find the half-life for the isotope. On the graph show how you obtain the half-life.

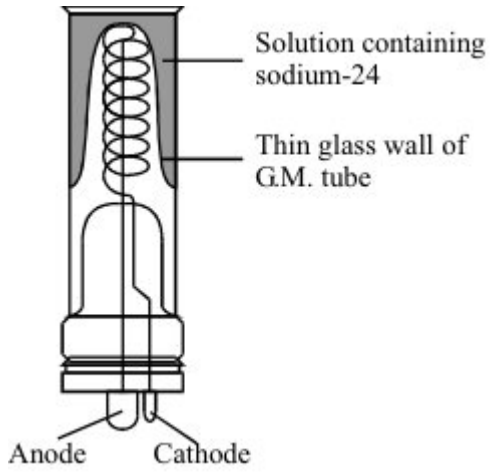


Half-life = _____ hours

(4)

(b) Sodium-24 decays by beta emission. The G.M. tube used in the experiment is shown in the diagram. Each beta particle which gets through the glass causes a tiny electric current to pass in the circuit connected to the counter.

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(i) Why must the glass wall of the G.M. tube be very thin?

_____

_____

(1)

(ii) Why is this type of arrangement of no use if the radioactive decay is by alpha emission?

_____

_____

(1)

(c) Sodium chloride solution is known as saline. It is the liquid used in 'drips' for seriously-ill patients. Radioactive sodium chloride, containing the isotope sodium-24, can be used as a tracer to follow the movement of sodium ions through living organisms.

Give **one** advantage of using a sodium isotope with a half-life of a few hours compared to using an isotope with a half-life of:

(i) five years; _____

_____

(1)

(ii) five seconds. _____

_____

(1)

(Total 8 marks)

Q17.

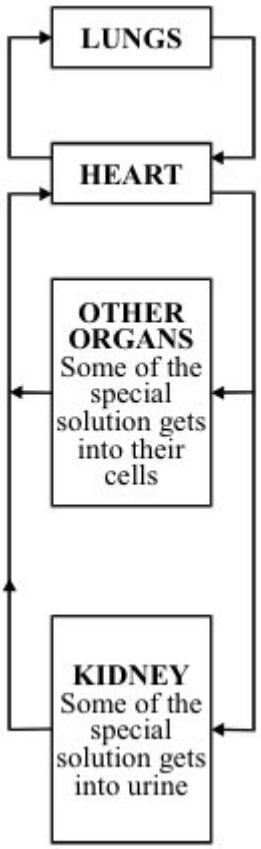
Doctors sometimes need to know how much blood a patient has.

They can find out by using a radioactive solution.

After measuring how radioactive a small syringe-full of the solution is they inject it into the patient's blood.

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They then wait for 30 minutes so that the solution has time to become completely mixed into the blood.

Finally, they take a syringe-full of blood and measure how radioactive it is.

Example:

If the doctor injects 10 cm^3 of the radioactive solution and this is diluted 500 times by the blood there must be 10 × 500 = 5000 cm^3 of blood.

(a) After allowing for background radiation:

- 10 cm^3 of the radioactive solution gives a reading of 7350 counts per minute;
- a 10 cm^3 sample of blood gives a reading of 15 counts per minute.

Calculate the volume of the patient's blood.
(Show your working.)

_____

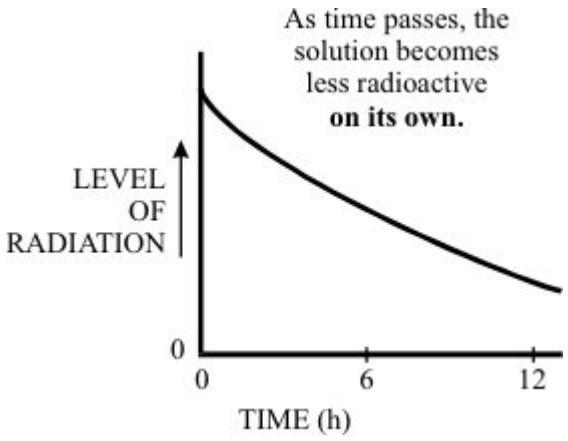
_____

_____

_____

(4)

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Radiation from radioactive substances can harm your body cells.

(b) The doctor's method of estimating blood volume will not be completely accurate. Write down **three** reasons for this.

1. _____

2. _____

3. _____

(3)

(c) The doctors use a radioactive substance which loses half of its radioactivity every six hours. Explain why this is a suitable radioactive substance to use.

_____

_____

(2)

(Total 9 marks)

Q18.

(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)

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(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.)

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

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