Year 10

Name _____

USES OF RADIOACTIVITY QUESTIONS

1 Peter is finding the age of a rock sample.

He knows that uranium-238 decays, through other isotopes, to form stable lead-206.

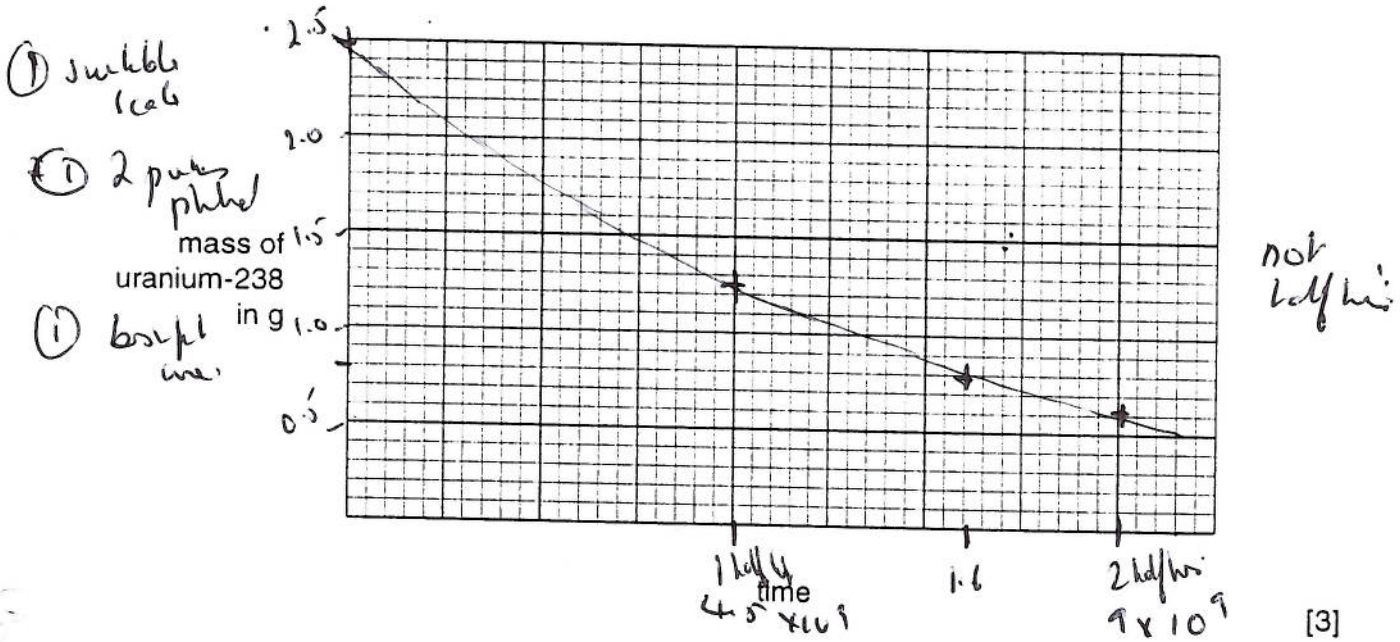
The half-life of uranium-238 is 4.5×10^9 years. The half lives of the other isotopes are all very short in comparison.

When Peter analyses the rock sample, he finds that it contains 0.8 g of uranium-238.

Peter finds out the mass of lead-206 in the sample.

He is then able to work out that the rock originally contained 2.5 g of uranium-238.

(a) Plot and draw a suitable graph to show how 2.5 g of uranium-238 decays over a period of two half-lives.



[3]

(b) Use your graph to estimate the age of the rock sample.

You must show clearly on your graph how you work out your answer.

(1) line on point 1.6 half lives

age of rock sample = 7.2 x 10^9 (7.4) years [3]

(c) Suggest how Peter uses the measurement of the mass of lead-206 in the sample to work out the original mass of uranium-238 in the sample.

State any assumption he may need to make.

(1) take mass Pb^{206} now + add 0.8 g

(2) take mass now x 238/236

(3) take mass now x 238/206 + add 0.8 g

(1)

[2]

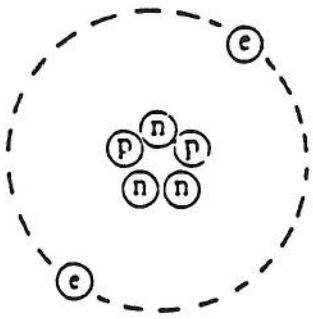
no Pb in rock at start / no Pb lost

all of U^{238} changed to Pb^{206}

[Total: 8]

Leave margin blank

2. (a) Here is a diagram representing a particular atom. The key for the particles shown is next to the diagram.



Key
- (p) Proton
- (n) Neutron
- (e) Electron

(i) Write down the proton (atomic) number of this atom.

2

(1 mark)

(ii) Write down the nucleon (mass) number of this atom.

5

(1 mark)

(iii) Write down the net charge on the whole atom and explain your answer.

Net charge: 0

(1 mark)

Explanation: Equal number of positive protons and negative electron

(1 mark)

(b) The nucleus of an isotope of the atom in part (a) is identical to one of the radioactive emissions from a radioactive element.

(i) What are *isotopes*?

Atoms will the same no. of protons + different no. of neutron

(1 mark)

(ii) Which radioactive emission is being referred to?

alpha

(1 mark)

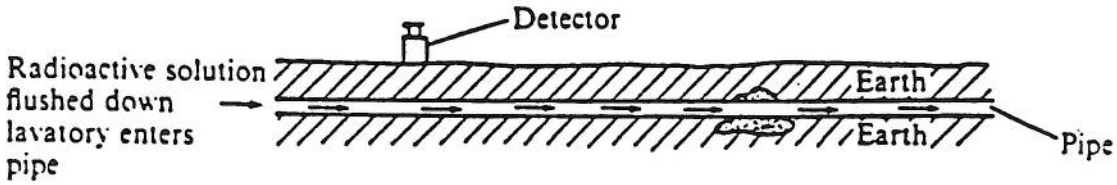
(iii) What charge would this nucleus have?

+2

(1 mark)

Leave margin blank

(c) Radioactive isotopes can be used to search for leaks in underground sewage pipes.



You can choose an α, β or γ-emitting source for this.

(i) Which one would you choose and why?

.....γ.....only γ could penetrate to the detector.....

(2 marks)

(ii) Suggest a suitable half-life for the source.

.....few hours.....

(1 mark)

(iii) How would the search for the leak be carried out?

.....run detector over the γ pipe - where there was a

.....leak, high γ rays.....

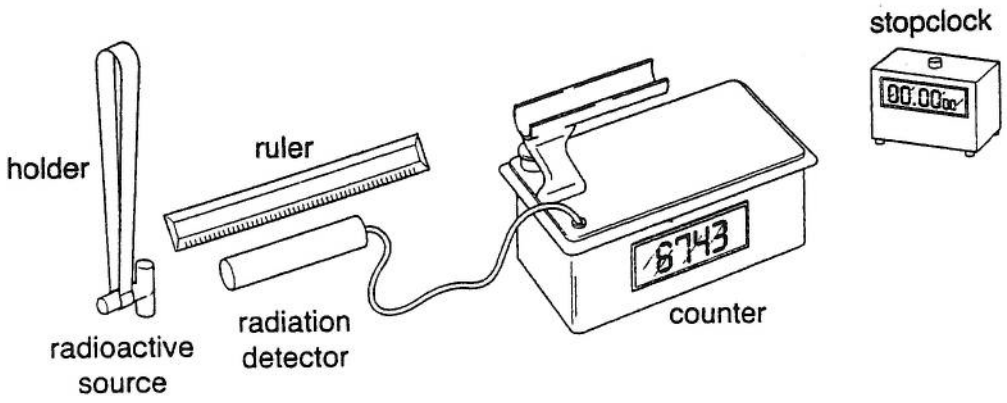
(2 marks)

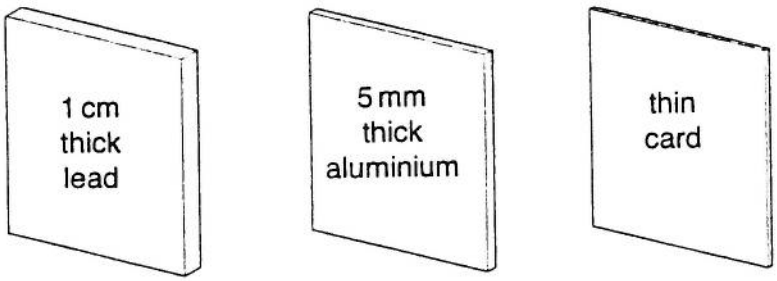
TURN OVER FOR NEXT QUESTION

For Examiner's Use

3 This question is about radioactivity.

(a) Matthew's teacher does an experiment to show the penetrating powers of the different types of radiation.
He uses this apparatus.

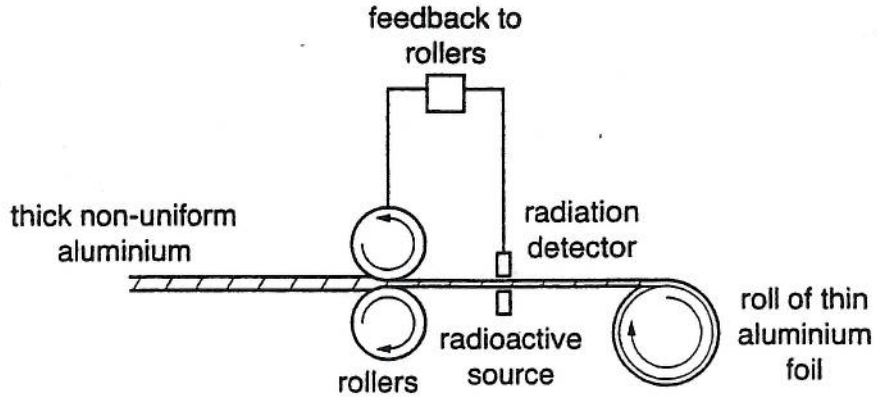




(i) Suggest **two** safety precautions Matthew's teacher must take when doing the experiment.

a	i	**Any two from:** keep at a distance / use tongs; do not handle / wear gloves / use tongs; do not point at anyone/direction of use; source strength; time of usage; keep in lead box when not in use / shielding / lead apron; don't allow pupils to help with experiment;	2		
	ii	background count / radiation;	1		
	iii	**Any three from:** clamp source; keep source and detector a fixed distance apart; count without sheet; for fixed time; place sheet in between source and detector; note new count (rate); repeat for three sheets;	3	**any two for 1 mark** alpha stopped by cardboard beta stopped by aluminium gamma stopped / reduced by lead	
		QWC one mark is for correct spelling	1		

(b) The diagram represents a system that produces thin aluminium foil of uniform thickness.
The radioactive source and detector are used to monitor the thickness of the aluminium.



(i) State which type of radiation the source emits.

both .....[1]

(ii) Explain why you would use this type of radiation.

ii	**Any two from:** alpha would be stopped by (aluminium); gamma would go straight through / little absorption; beta varies with thickness;	2	....[2]

(iii) Describe how the system monitors and controls the thickness of the foil.

iii	when count (rate) goes up; aluminium too thin; (feedback) increases distance between rollers; (or opposite)	1 1 1

.....

3]

(c) France has recently closed its last coal mine.
It now produces nearly all of its electricity from nuclear power.
The United Kingdom produces nearly a third of its electricity from nuclear power.
Many scientists argue that using nuclear power is a better way of generating electricity than burning fossil fuels.
Others say nuclear power is too dangerous.

(i) Suggest **three** ways that scientists discuss these different views with each other.

i	print/journals / publications; electronically / internet / email / fax / TV; personally / meetings / conventions;	1 1 1	telephone = personally or electronically	....[3]

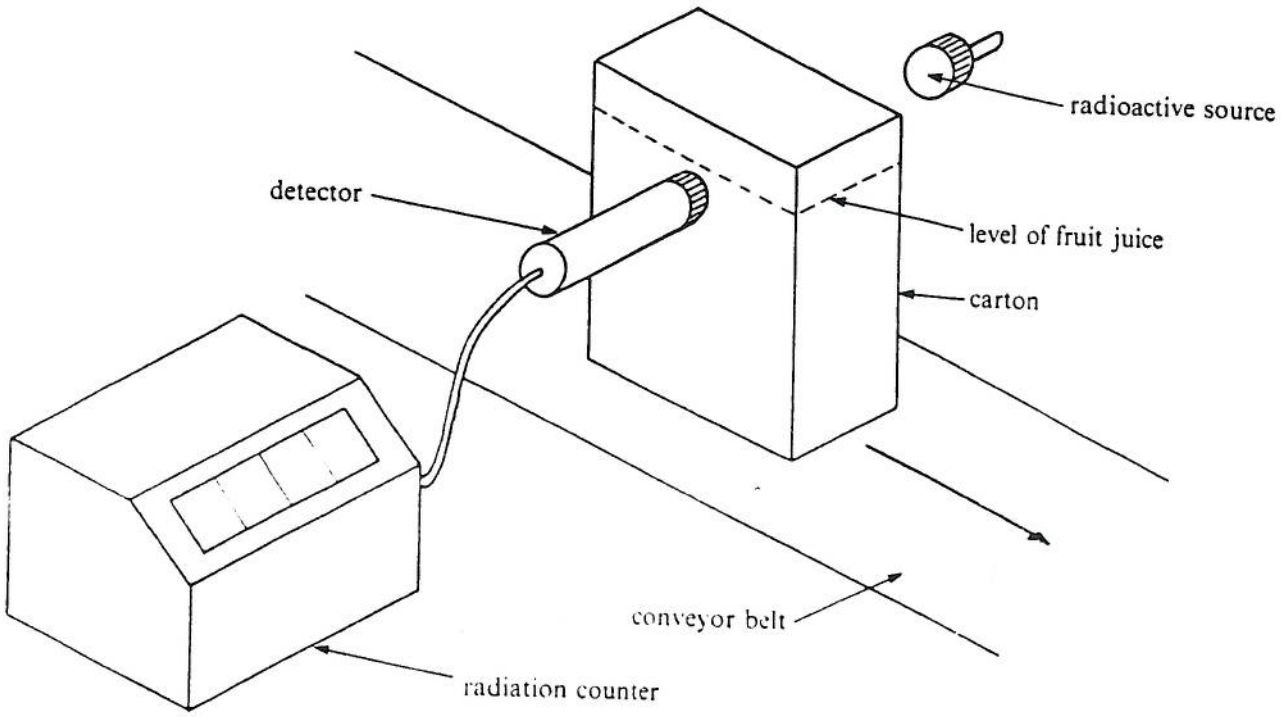
3. .....

(ii) Suggest why different groups of scientists can have such different views.

ii	**Any two from:** evidence interpreted in different ways; incomplete evidence / do different experiments and get different results / different knowledge; bias; demands of society / peers;	2	own opinions	.... [2]

18]

4 A radioactive source and a detector are used to check the level of fruit juice in a carton. Cartons of fruit juice on a conveyor belt pass between the radioactive source and the detector.



The table shows information about some radioactive sources which are available.

radioactive isotope	radiation emitted	half-life
americium – 241	alpha	460 years
barium – 139	beta	85 minutes
cobalt – 60	gamma	5.3 years
radium – 224	alpha	3.6 days
strontium – 90	beta	28 years
technetium – 99 m	gamma	6 hours

The radioactive source in the diagram emits beta radiation.

(a) (i) Why is alpha radiation not suitable?

stopped by air / cadboard / will not need gloves or clothes. [1]

(ii) Why is gamma radiation not suitable?

Not affected by presence or absence of gloves [1]

(b) Two isotopes emit beta radiation.

Which should be used here? strontium - 90

Explain.

long half so will produce almost constant radiation for

for a

half not need replacing [3]

(c) What happens when a half-full carton goes past the detector?

count rate goes up

[1]

(d) The people working near to the conveyor belt need to be protected from the radiation emitted by the source.

How can this be done?

Shielding the source / detector (by perspex etc.)

[1]

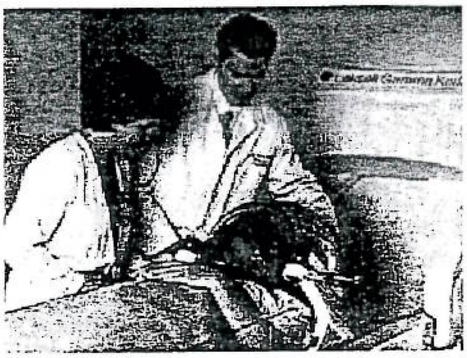
For Examiner's Use

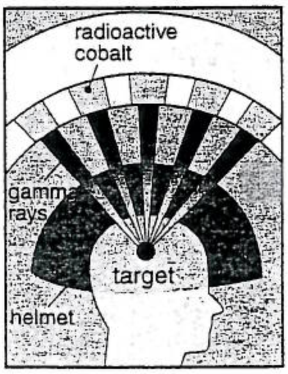
5 Jane is being treated for brain cancer.

The equipment being used is called a gamma knife.

Cobalt-60 is used as a source of gamma radiation.

Jane's head is being treated by over two hundred gamma ray beams, directed on the cancer in her brain.





(a) (i) What are gamma rays?

high frequency / high energy / short wavelength / emitted from nucleus

electromagnetic waves [2]

(ii) Alpha radiation and beta radiation are not suitable to use when treating brain cancers.

Why are gamma rays suitable?

penetrate skull to reach cancer [1]

(iii) Suggest why low intensity beams from all directions around the head are used instead of one intense beam of gamma radiation.

gives very high dose to cancer + low dose to

healthy surrounding tissue [1+1]

(b) Strontium-90 emits beta particles.

(i) Strontium-90 is used to treat cancer in the eye.

Suggest why strontium-90 is used instead of cobalt-60.

betas would be absorbed by cancer in eye / gamma

would not [1]

For Examiner's Use

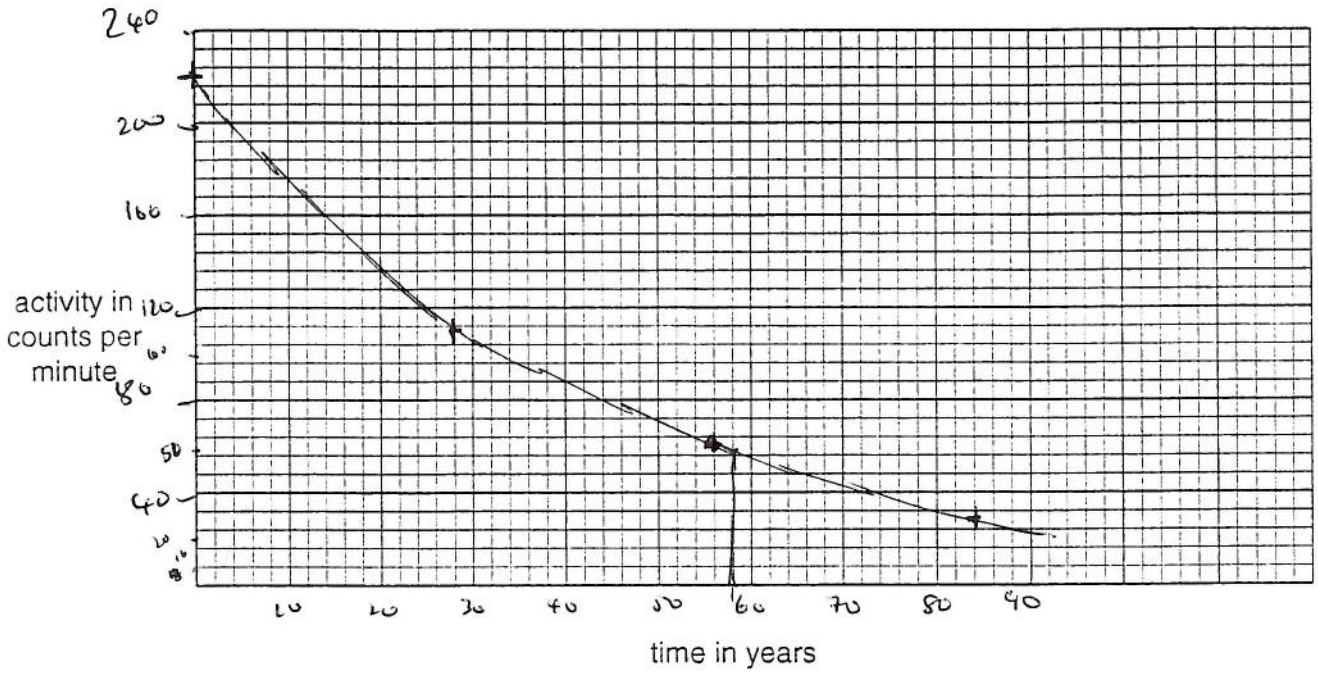
(ii) The half-life of strontium-90 is 28 years.

Explain what is meant by the term **half-life**.

time taken for the activity to halve / for ½ the unstable nucleus to decay [2]

(iii) The activity of a sample of strontium-90 is measured as 220 counts per minute.

Plot a graph to show how the activity will change over a period of 90 years. [4]



220 0
110 28
55 56
27 84

(iv) After how many years will the activity be 50 counts per minute?

You **must** show clearly on the graph how you work out your answer.

time = 58 years [2]

[Total: 14]

[Turn over

6 Radioactive substances can be used in medicine to find out what is wrong with diseased parts of the human body.

One suitable substance is known as technetium-99m.

The patient is given a drink of a solution which contains technetium-99m. After 20 minutes the radioactive element has passed through the digestive system to the patient's liver, where it then remains. A radiation dectector is then passed over the outside of the body near the liver. Doctors compare the activity found with that expected from a healthy liver.

(i) The radiation has to be detected outside the person's body. Would you expect technetium-99m to emit alpha, beta or gamma rays? Explain your answer.

gamma

only gam would penetrate + detect outside the body

[2]

(ii) Technetium-99m has a half life of 6 hours. Use the information given to explain why this is a more suitable radioactive substance for this purpose than one with a half-life of 6 minutes.

if 6 mins, decayed to [illegible] 1/8 th before it can be measured so is too short to do job

6 hours half life means radiation emitted approximately constant during procedure

[3]

(iii) Exposure of the body to radiation is dangerous. Why, then, do doctors examine diseased parts of the body with radioactive substances?

– Only way to find out if ~~diseased~~ parts are functioning

– avoids invasive surgery

[2]