

1

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.

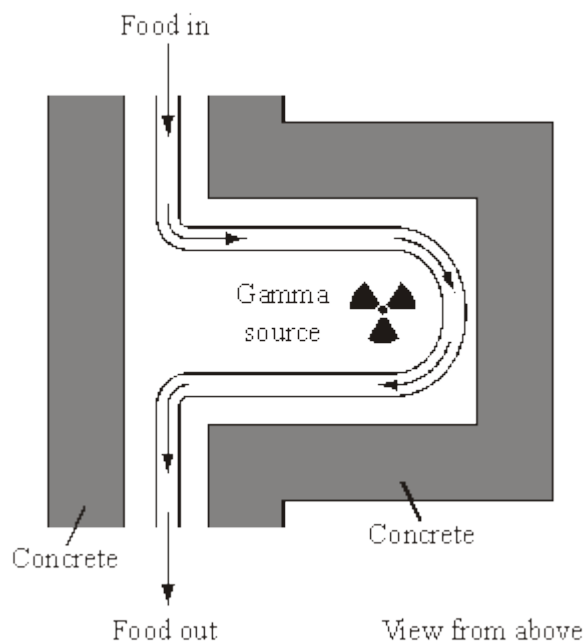
Complete the following sentence by choosing the correct word from the box.

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?

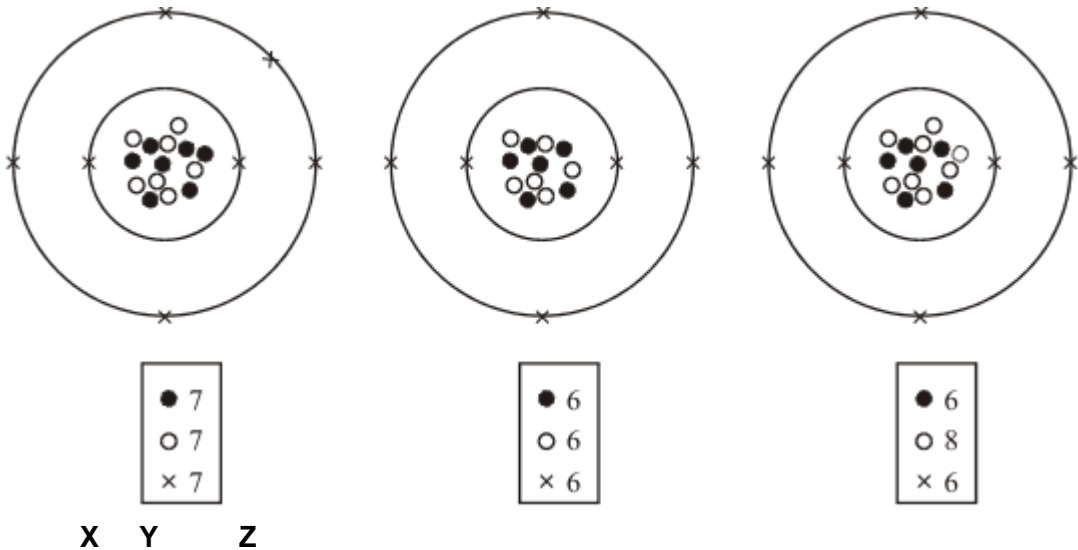
.....
.....

(1)

(Total 8 marks)

2

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



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

.....

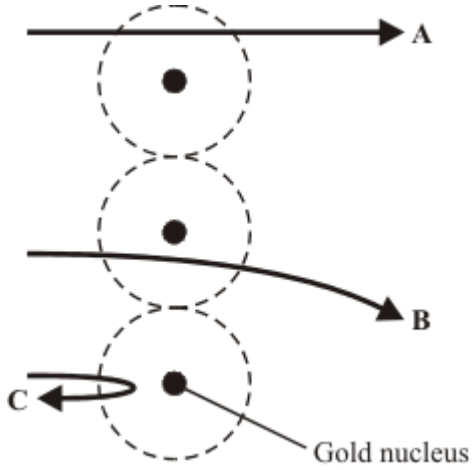
Give a reason for your answer.

.....

.....

(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)

3

(a) Alpha particles (α), beta particles (β) and gamma rays (γ) are types of nuclear radiation.

(i) Which of the three types of radiation is the most strongly ionising?

.....

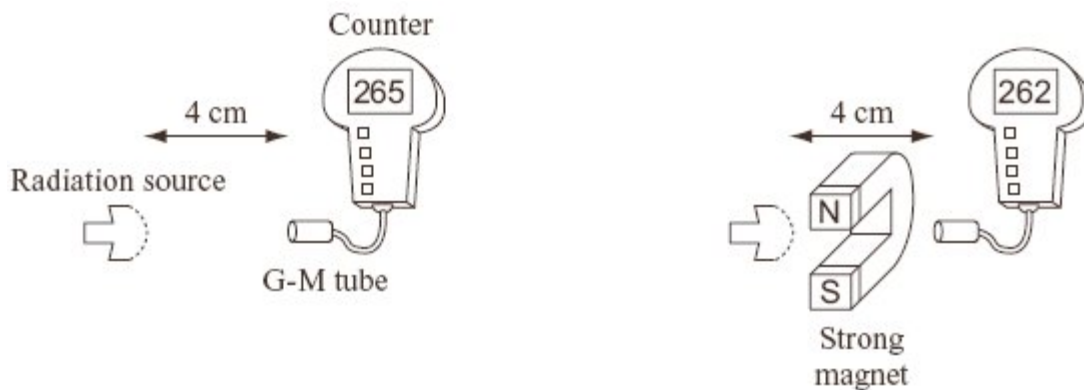
(1)

(ii) What effect does nuclear radiation have on living cells?

.....

(1)

- (b) The diagrams show a G-M tube and counter used to measure the radiation emitted from a source. Both diagrams show the reading on the counter one minute after it was switched on.



Explain why the counter readings show that the source is giving out only gamma radiation.

.....

.....

.....

.....

(2)

- (c) The box gives information about the radioactive isotope technetium-99.

<p>Type of radiation emitted: gamma</p> <p><i>Half-life:</i> 6 hours</p> <p>Used as a medical tracer</p>
--

What is meant by the term *half-life*?

.....

.....

(1)

- (d) To study the blood flow in a patient's lungs, a doctor injects a small quantity of a technetium-99 compound into the patient. The radiation emitted by the technetium-99 atoms is detected outside the patient's body.

Explain why a doctor would not use a radioactive isotope with a very short half-life, such as 2 seconds, as a medical tracer.

.....
.....
.....
.....

(2)

(Total 7 marks)

4

- (a) A radioactive source emits alpha (α), beta (β) and gamma (γ) radiation.

- (i) Which **two** types of radiation will pass through a sheet of card?

.....

(1)

- (ii) Which **two** types of radiation would be deflected by an electric field?

.....

(1)

- (iii) Which type of radiation has the greatest range in air?

.....

(1)

- (b) A student suggests that the radioactive source should be stored in a freezer at $-20\text{ }^{\circ}\text{C}$. The student thinks that this would reduce the radiation emitted from the source.

Suggest why the student is wrong.

.....
.....

(1)

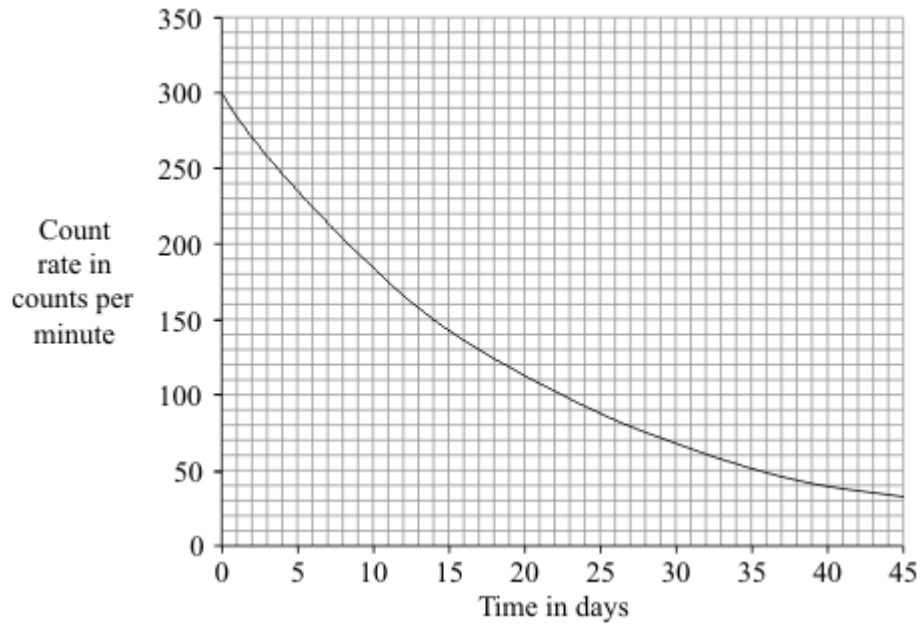
- (c) Phosphorus-32 is a radioactive isotope that emits beta radiation.

- (i) How is an atom of phosphorus-32 different from an atom of the stable isotope phosphorus-31?

.....
.....

(1)

- (ii) The graph shows how the count rate of a sample of phosphorus-32 changes with time.



Use the graph to calculate the half-life of phosphorus-32.

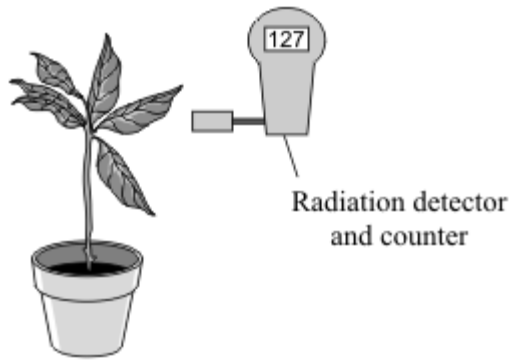
Show clearly how you used the graph to obtain your answer.

.....
.....

Half-life = days

(2)

- (iii) Plants use phosphorus compounds to grow. Watering the root system of a plant with a solution containing a phosphorus-32 compound can help scientists to understand the growth process.



Explain why phosphorus-32 is suitable for use as a tracer in this situation.

.....

.....

.....

.....

(2)
(Total 9 marks)

Mark schemes

1

- (a) (i) electromagnetic (wave / radiation)
accept em (wave / radiation)
ignore reference to frequency 1
- (ii) gamma can penetrate the crate / box / packaging
accept converse (but must relate to both alpha and beta)
ignore just gamma radiation kills bacteria
accept can get through to food 1
- (iii) neutrons 1
- (b) (i) absorb gamma / radiation
accept it stops / reduces the radiation 1
- (ii) any **one** from:
- slow down the conveyor belt
 - food does more than one circuit
 - stay on the conveyor belt longer
 - food closer to the source / radiation
ignore larger doses / use more of the source
ignore thinner packaging 1

(c) (i) idea of testing food on humans / animals

1

no (measured) ill effects **or** monitor their health

accept monitor people that have eaten the food

accept a measurement / comparison for 1 mark

eg measure the amount of radiation in treated food

comparison plus a reason for the comparison would get 2 marks

*eg idea of measuring level of radiation in treated food **with** no*

*measurable increase in level = 2 marks **or** comparing it to*

untreated food = 2 marks

1

(ii) so can make own decision about eating or not eating treated food

accept may be against their religious / moral views

accept some people prefer food that hasn't been tampered with

ignore in case they don't like the idea of eating treated food

accept don't want to eat treated food

ignore might be allergic to the food

eg think it will give them cancer = 0 marks

think it will give you cancer so I need to know so that I can choose =

1 mark

1

[8]

2

(a) Y and Z

1

they have the same number of protons **or** same atomic number

*accept they have the same number of electrons **or** same number of protons **and** electrons*

allow only different in number of neutrons N.B. independent marks

1

(b) **Quality of written communication**

for correct use of terms underlined in B or C

Q ✓ Q ✗

1

A – alpha particle passes straight through the empty space of the atom
or it is a long way from the nucleus

describes 3 tracks correctly for 2 marks

describes 2 or 1 track correctly for 1 mark

B – alpha particle deflected / repelled / repulsed by the (positive) nucleus

C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards

*do **not** accept hits the nucleus*

*do **not** accept answers referring to refraction*

*do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion*

mention of difference in charge on nucleus negates that track

max 2

[5]

3

(a) (i) alpha

1

(ii) damages them / changes DNA

accept kills them / destroys

accept causes cancer

accept causes cell mutations

*do **not** accept they ionise cells on its own*

1

(b) count is (roughly) the same

1

gamma is not affected by magnetic field

accept magnet for magnetic field

1

or

alpha and beta are deflected by a magnetic field (1)

count would go down significantly (1)

(c) time taken for number of nuclei to halve
do not accept time for radioactivity to halve

or

time taken for count rate to fall to half
(its initial value)
do not accept time for nuclei to halve

1

(d) not enough time to take measurements / make observations

before level of radiation became insignificant

1

1

[7]

4

(a) (i) beta and gamma
both answers required
accept correct symbols

1

(ii) alpha and beta
both answers required
accept correct symbols

1

(iii) gamma
accept correct symbol

1

(b) nothing (you do to a radioactive substance / source) changes the
count rate / activity / rate of decay / radiation (emitted)
accept it = radiation emitted

or (reducing) the temperature does not change the activity / count rate / rate of decay /
radiation (emitted)

1

(c) (i) has one more neutron
correct answer only

1

(ii) 14 days
no tolerance
allow 1 mark for showing a correct method on the graph

2

(iii) any **two** from:

- beta particles / radiation can be detected externally
- beta particles / radiation can pass out of / through the plant
- long half-life gives time for phosphorus to move through the plant / be detected / get results
- phosphorus-32 is chemically identical to phosphorus-31
- phosphorus-32 is used in the same way by a plant as phosphorus-31

2

[9]