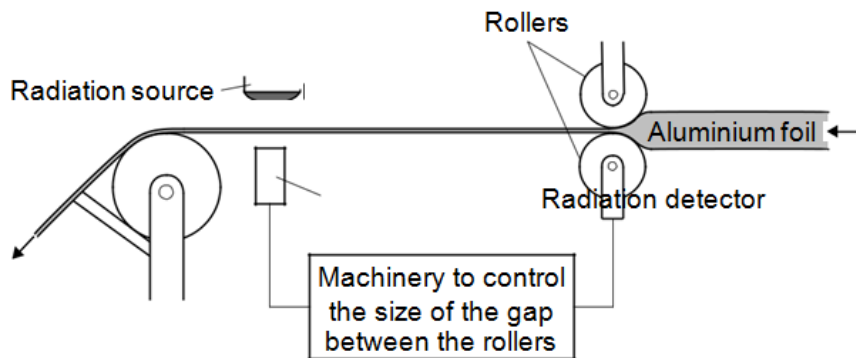


Nuclear Radiations and Isotopes 3 QP

Q:1 The diagram shows a system used to control the thickness of aluminium foil as it is being rolled. A radiation source and detector are used to monitor the thickness of the foil.

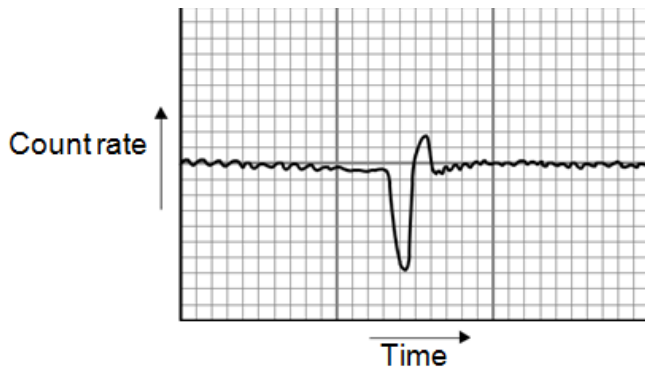


(a) Which type of source, alpha, beta or gamma, should be used in this control system?

Explain why each of the other two types of source would not be suitable.

(3 marks)

(b) The chart shows how the count rate recorded by the detector varies over a short period of time.

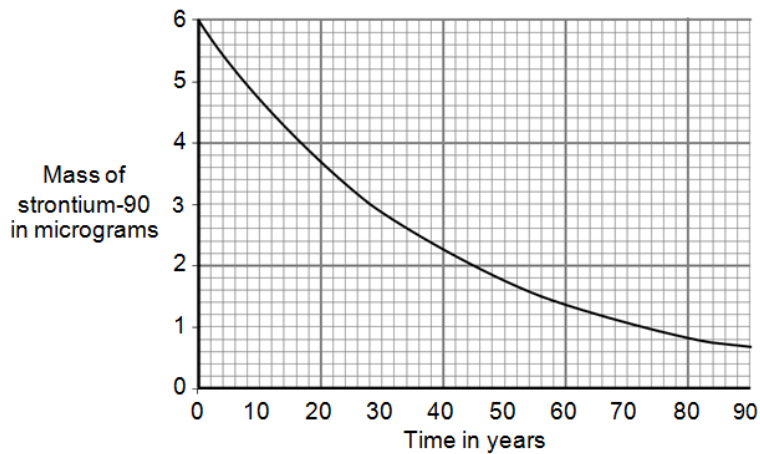


Use the graph to explain how the thickness of the foil changes, and how the control system responds to this change.

(2 marks)

(c) When first used, the radiation source contains 6 micrograms of strontium-90.

The graph shows how the mass of the strontium-90 will decrease as the nuclei decay.



The control system will continue to work with the same source until 75 % of the original strontium-90 nuclei have decayed.

After how many years will the source need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

Number of years = _____

(2 marks)

Q:2 Certain types of atom emit alpha, beta or gamma radiation. The radiation is emitted from the centre of the atom.

(a) What name is given to the centre of an atom?

(1 mark)

(b) The sign below is used to warn people that a radiation source is being used in a laboratory.



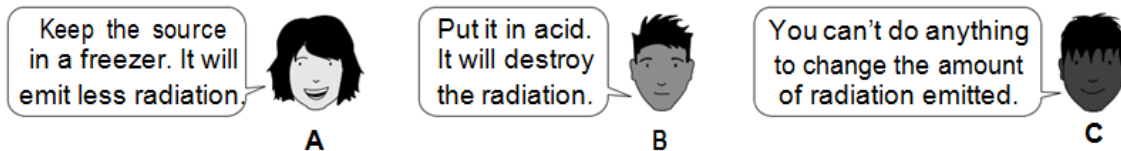
Why is it important to warn people that a radiation source is being used?

(1 mark)

(c) Before using a radiation source, a teacher asked her class whether there was any way that she could reduce the amount of radiation that the source emitted. Three students each gave an answer to the teacher.

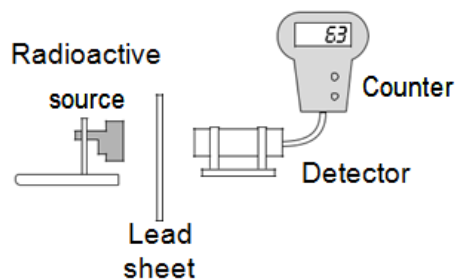
Which one of the students, A, B or C, is correct?

Write your answer in the box.



(1 mark)

(d) The diagram shows the apparatus used by the teacher to demonstrate how one type of radiation is able to pass through lead.



One lead sheet, 2 mm thick, was placed between the source and the detector and a count rate was taken. Extra lead sheets were added. For each extra lead sheet, a new count rate was taken and recorded in the table.

| Number of lead sheets | Count rate in counts per minute |
|-----------------------|---------------------------------|
| 1 | 226 |
| 2 | 220 |
| 3 | 210 |
| 4 | 190 |

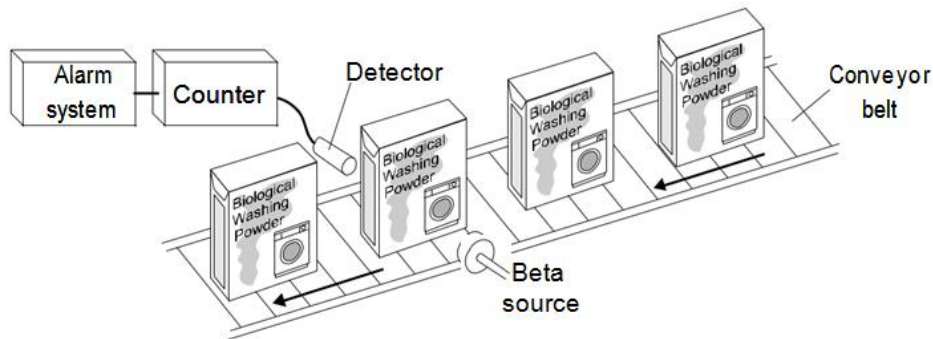
Which type of radiation was the source emitting: alpha, beta or gamma?

Give the reason for your answer.

(2 marks)

(e) The diagram shows how a company detects any boxes left empty by an automatic filler.

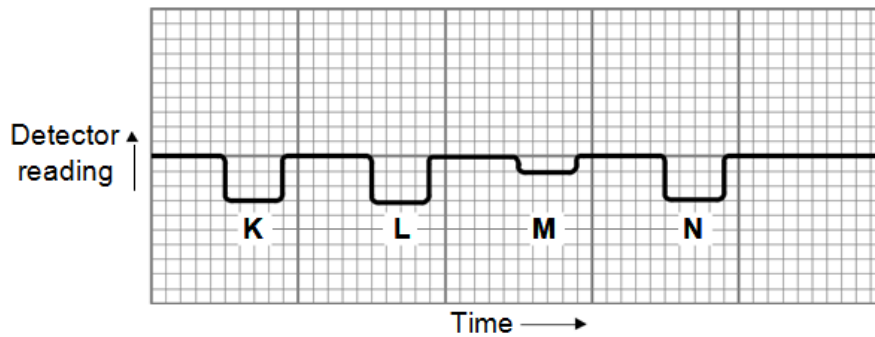
When an empty box passes between the beta source and the detector, a buzzer sounds. A worker then removes the box from the conveyor belt.



(e) (i) Why would this system not work if an alpha source were used instead of the beta source?

(1 mark)

(e) (ii) The chart shows how the detector reading changes as boxes pass along the conveyor belt.

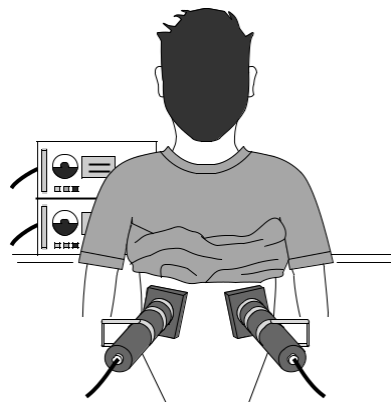


Which part of the chart, K, L, M or N, shows that an empty box is passing between the beta source and the detector?

Give a reason for your answer.

(2 marks)

Q:3 A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.



Detectors

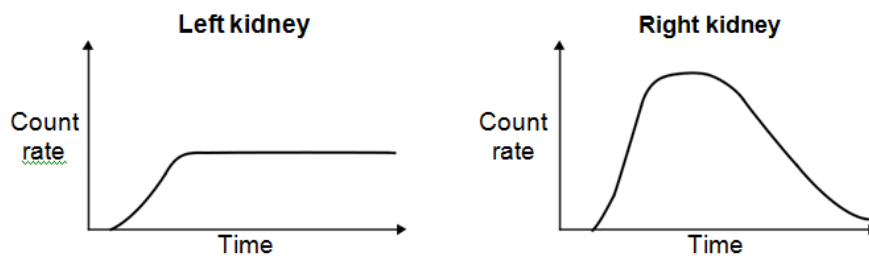
The doctor injects a small amount of technetium-99 into the patient's bloodstream.

Technetium-99 emits gamma radiation.

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.



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

(1 mark)

- (b) 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 marks)

Q:4 There are many different isotopes of gold. The isotope, gold-198, is radioactive. An atom of gold-198 decays by emitting a beta particle.

(a) Complete the following sentences.

All atoms of gold have the same number of _____

and the same number of _____

The atoms from different isotopes of gold have different numbers of _____

A beta particle is an _____ emitted

from the _____ of an atom.

(3 marks)

Q:5 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 mark)

(ii) Food packed in crates or boxes can be treated using this method. Why must a source that emits gamma radiation be used?

(1 mark)

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

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

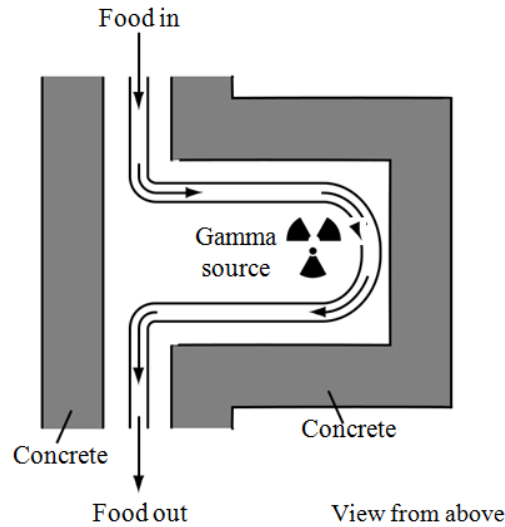
Electrons neutrons protons

An atom of caesium 137 has two more _____ than an atom

of caesium 135.

(1 mark)

- (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 mark)

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

(1 mark)

- (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 marks)

Q:6 (a) The names of three types of nuclear radiation are given in List A. Some properties of these three types of radiation are given in List B.

Draw a straight line to link each type of radiation in List A to its correct property in List B. Draw only three lines.

| List A Type of nuclear radiation | List B Property of radiation |
|--|--|
| alpha | not deflected by an electric field |
| beta | stopped by thin metal but not paper |
| gamma | the most strongly ionising |
| | will not harm living cells |

(3 marks)

(b) One of the substances in the table is used as a radioactive tracer. A hospital patient breathes in air containing the tracer. The radiation given out is measured by a doctor using a detector outside the patient's body.

| Substance | Radiation given out | Solid, liquid or gas |
|------------------|----------------------------|-----------------------------|
| X | alpha | gas |
| Y | gamma | gas |
| Z | gamma | solid |

Which one of the substances, X, Y or Z, should be used as the tracer?

Give two reasons for your answer.

1 _____

2 _____

(3 marks)

(c) Radiation can also be used to kill the bacteria on fresh food.

Give one reason why farmers, shop owners or consumers may want food to be treated with radiation.

(1 mark)

TOTAL MARKS=36