Signature: | Name: | Marks:

Radioactivity
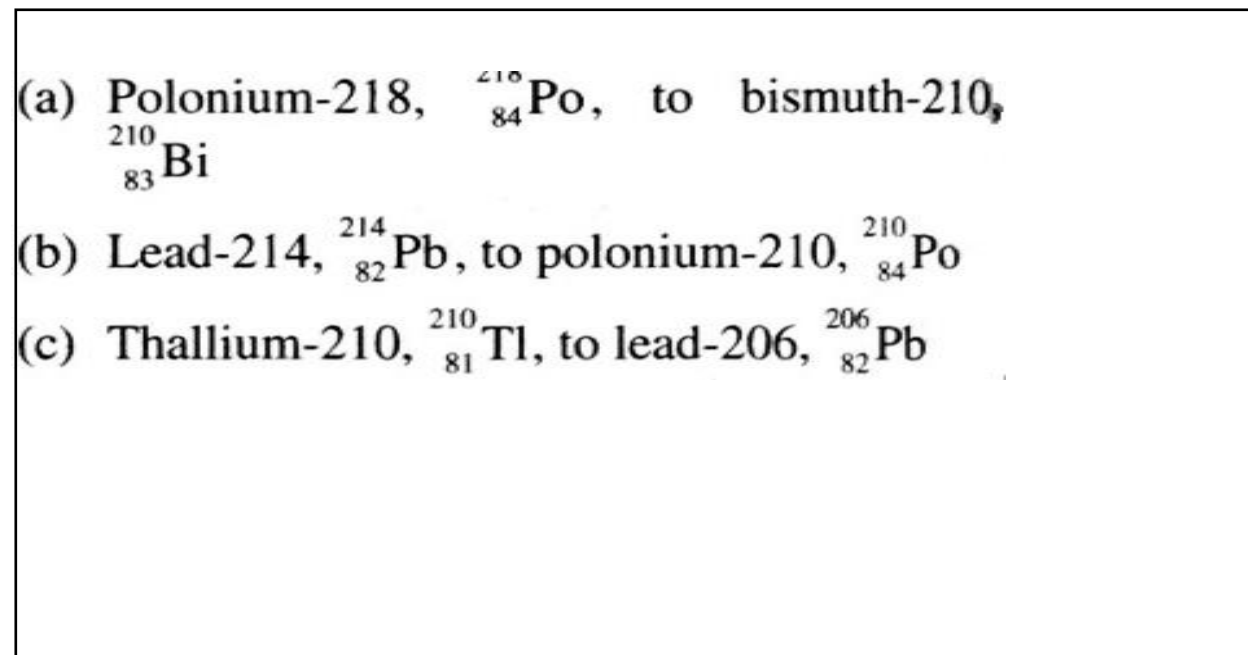
Q1.

Fill in the blanks in the following equations:

(a) $^{222}_{\square}\text{Rn} \rightarrow ^{\square}_{84}\text{Po} + \alpha$

(b) $^{\square}_{83}\text{Bi} \rightarrow ^{210}_{\square}\text{Th} + \alpha$

(c) $^{\square}_{82}\text{Pb} \rightarrow ^{214}_{\square}\text{Bi} + \beta$

(d) $^{234}_{\square}\text{Th} \rightarrow ^{\square}_{91}\text{Pa} + \beta$

(e) $^{218}_{\square}\text{Po} \rightarrow ^{\square}_{82}\text{Pb} + 2\alpha + 2\beta$

(f) $^{\square}_{92}\text{U} \rightarrow ^{226}_{\square}\text{Ra} + 3\alpha + 2\beta$
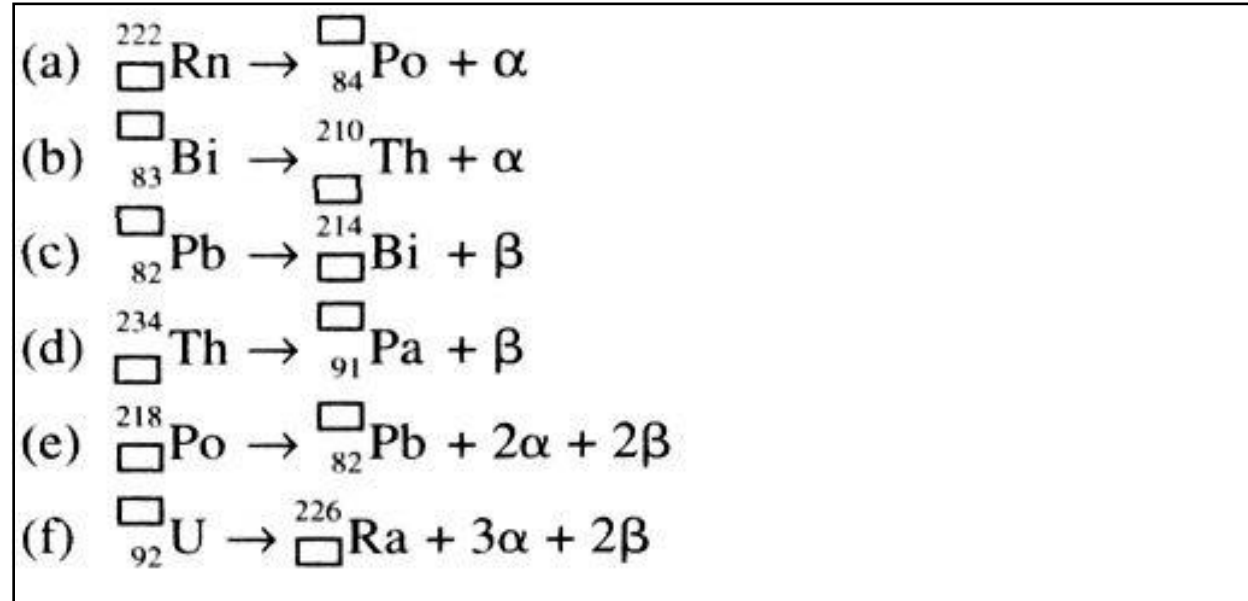
Q2.

Calculate the number of alpha particles and/ or beta particles emitted during each radioactive decay series below.

(a) Polonium-218, $^{218}_{84}\text{Po}$, to bismuth-210, $^{210}_{83}\text{Bi}$

(b) Lead-214, $^{214}_{82}\text{Pb}$, to polonium-210, $^{210}_{84}\text{Po}$

(c) Thallium-210, $^{210}_{81}\text{Tl}$, to lead-206, $^{206}_{82}\text{Pb}$

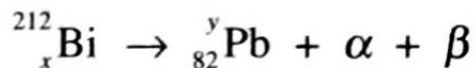## Q3.

A radioactive nucleus contains 84 protons and 132 neutrons. After undergoing radioactive decay, the nucleus contains 83 protons and 129 neutrons. What is emitted during the decay?

Q4.

Bismuth-212 undergoes radioactive decay as shown by the equation below. Find the values of x and y.

$$^{212}_{x}\text{Bi} \rightarrow\ ^{y}_{82}\text{Pb} + \alpha + \beta$$

## Q5.

Carbon-14 is an example of artificial radioisotope that can be synthesized when the nucleus of carbon-13 is bombarded by a neutron. Write an equation to show how carbon-14 can be synthesized from carbon-13.

Q6.

Radioisotope are usually used in medical field to detect disorders in internal organs. Radioisotopes are also used in industry for purposes such as detecting underground water pipe leakage.

a) A doctor conducts an investigation by injecting a suitable radioisotope into the blood circulation of a patient with lung disorder. The radioisotope has a half-life of 5 days. A healthy lung expels the radioisotope in 30 minutes. The presence of the radioisotope in the left and right lungs is shown in the graphs below:
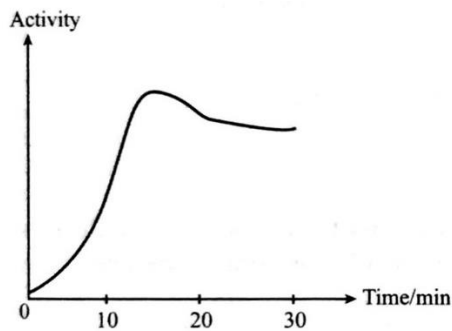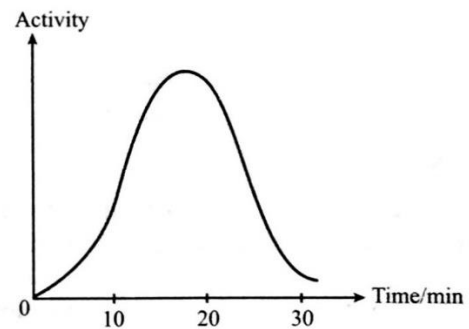
Left lung   Right lung

   I. What is a radioisotope?

  II. Based on the graphs in the diagram above, which lung is not functioning properly? Give one reason to your answer.

III. The initial activity of the radioisotope injected into the blood circulation of the patient is 2400 counts per second. What is the time needed for the activity of the radioisotope to decrease to 150 counts per second?

b) The underground water pipe surrounding a factory experienced a leakage. You are assigned to investigate the characteristic of some radioisotopes that are suitable to be used to detect the location of the leakage of the underground water pipes. The table shows the characteristics of five different radioisotopes.

Radioisotope	Characteristics of isotope			
	Physical state	Type of radiation	Half-life	Solubility in water
P	Solid	Gamma	3 months	Moderate
Q	Liquid	Beta	2 years	Low
R	Solid	Beta	16 hours	High
S	Gas	Alpha	20 minutes	Moderate
T	Liquid	Alpha	5 hours	Low

I. Explain the suitability of the characteristics of the radioisotopes to be used in detecting the location of the leakage in the underground water pipes.

II. Determine the most suitable radioisotope for this purpose and give your reasons.

c) A scientist suggests the use of gamma rays to sterilize food before they are canned. Explain whether gamma ray is suitable to be used to sterilize food in food industry.

d) When the nucleus of polonium-210 undergoes radioactive decay, it emits two types of radiation. The isotope is placed in front of an electrical field and the radioactive radiation path is shown in the diagram below.
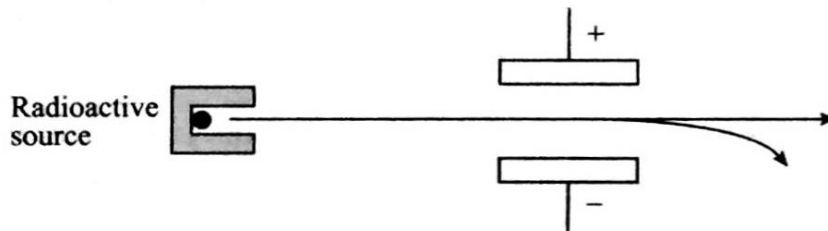
I.   Name the radiation emitted by the isotope.
II. Explain why the rays travel according to the path shown.