Test on Radioactivity

Name: _____Date:_____

1. A steel manufacturer wishes to check that the thickness of the steel he produces is uniform.

a. Describe how this could be done using a radioactive source and a counter. (2)

_____

b. Name the type of radiation you would expect the source to emit. _____(1)

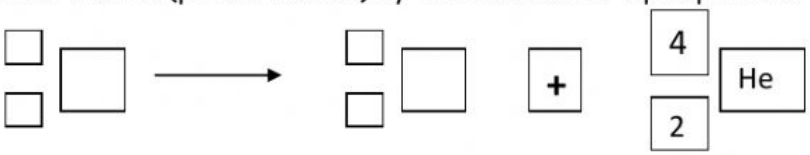
c. A radioactive source has a half-life of 12 hours. Define the term half-life.

_____(1)

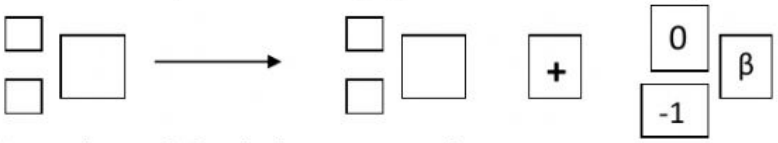
2. The following are five nuclei (nuclides)

$^{58}_{29}Cu$ $^{54}_{27}Co$ $^{59}_{29}Cu$ $^{58}_{30}Zn$ $^{59}_{30}Zn$

a. Write a nuclear equation to show a nuclide (daughter nuclide) which could be produced from another nuclide (parent nuclide) by the emission of alpha particle. (2)



b. Write a nuclear equation to show a nuclide (daughter nuclide) which could be produced from another nuclide (parent nuclide) by the emission of beta particle. (2)



c. Name the nuclide which possesses the most neutrons. _____ (1)

3. A particular atom of Thorium (Th) has an atomic number of 90 and a mass number of 232.

a. Explain what those numbers indicate about the nucleus of the atom. (2)

_____

b. Thorium decays by alpha particle. State two properties of the alpha particle. (2)

_____

c. Some Thorium -232 nuclei decay by beta emission to an isotope of Protactinium (Pa). Describe how beta decays occurs.

_____(2)

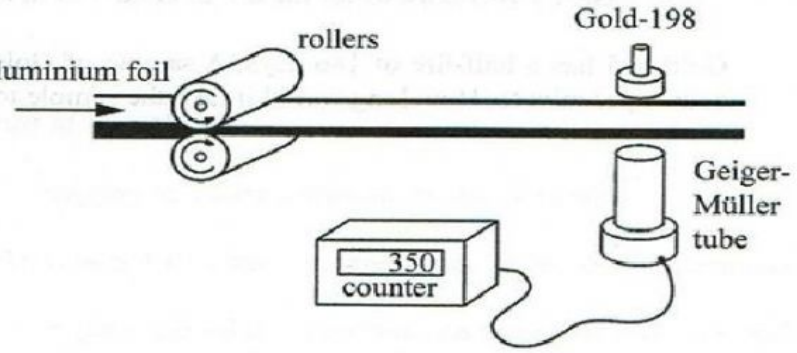
d. State two properties of beta particle._____

_____(2)

e. A sample of another isotope of thorium has a mass of 120g. After 102 hours, only 3.75g of the original isotope remains. Find the value of the half-life of this isotope of thorium.

_____(2)

4. Fig. 7.1 shows a rolling mill which produces thin sheets of aluminium. The thickness of the aluminium is monitored using beta emitter, Gold-198, a Geiger Müller tube and a counter as shown below.



a. What happens to the count rate when the thickness of the foil decreases?

_____(1)

b. Why would Gold-172, an alpha emitter not be suitable for monitoring the thickness of the aluminum sheets?

_____(1)

c. Gold-198 is used in the treatment of some cancers and other diseases. Give two reasons for the use of Gold-198 in the nuclear medicine.

_____(2)

d. Gold-195 has a half life of 186 days. A sample of God-195 has a count rate of 8000 counts per minute. How long would it take the sample to fall to 125 counts per minute?

(3)

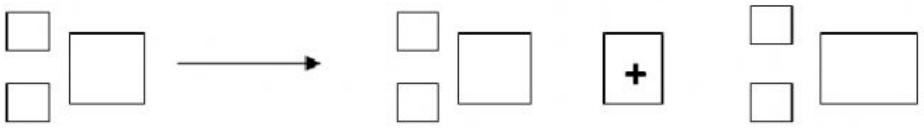
5. This question is about radioactivity.

Americium-241 $\left({}^{241}_{95}\mathrm{Am}\right)$ is a radioactive isotope. A nucleus, of americium-241, decays by emitting an alpha-particle to form a nucleus of neptunium (Np) as shown in the incomplete equation.

${}^{241}_{95}\mathrm{Am} \rightarrow \ldots\ldots\ldots \mathrm{Np} + \frac{4}{2}\alpha$

(a) (i) Calculate the number of neutrons in a nucleus of americium-241. [1]

(ii) Complete the decay equation that represents alpha decay of americium-241. (2)



(b) Very small quantities of a radioactive isotope are used to check the circulation of blood by injecting the isotope into the bloodstream.

(i) Describe how the results are obtained. [2]

(ii) Explain why a γ-emitting isotope is used for this purpose rather than one that emits either α-particles or β-particles. [2]

(c) A researcher wants to determine the type of radiation emitted by a radioactive source. Using the radioactive source, a Geiger-Müller tube, a rate meter and various absorbers of ionising radiation, the researcher obtained the following values for the average count rate from a number of readings taken for each situation. Only the average count rate is shown in the table.

situation	average count rate/minute
radioactive source not present	60
radioactive source alone	1350
radioactive source + 1 sheet of paper	1350
radioactive source + 5 mm thick aluminium	120
radioactive source + 3 cm thick lead	60

(i) State the average count rate for the background radiation. [1]

(ii) Determine the nature of the radiation(s) emitted by the source. Justify your answer. [2]

COMPLETE THIS PART IN A GRAPH PAPER AND TAKE A PICTURE OF THE GRAPH WORK AND SUBMIT IT THROUGH WHATSAPP (443-0228).

(d) In a further experiment, the researcher investigates the range of the radiation in air. He progressively altered the distance of the radioactive source from the Geiger-Müller tube and records the count rate at each distance. At the time of the experiment, background radiation was determined to be 50 counts per minute. The results are shown in the table.

distance/m (air)	0	1	2	3	4	5	6	7	8
average count rate	1400	1000	700	550	300	200	150	50	50
corrected average count rate									

(i) Complete the row in the table to show the corrected average count rate/minute at each measured distance. [1]

(ii) Plot a graph of corrected average count rate/minute (y-axis) against distance/m (x-axis). [6]

(iii) From the graph determine the
– average count rate when the source is 3.5 m away from the Geiger-Müller tube,
– distance, when the average count rate is 850 counts/minute. [2]

(iv) Suggest the range of the radiation in air. [1]

TOTAL MARKS [20]