Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 11_Nuclear Radiation

Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

Astronauts on the 1971 Apollo 14 mission to the Moon brought back many rock samples. It is now believed that one of these contains a piece of rock that originated on Earth about 4 billion years (4×10^9 years) ago.

The piece of rock is believed to have been launched into space when an asteroid struck the Earth.

The rock sample contains uranium. The radioactive decay of uranium allows it to be used to determine the time since the rock was formed on the Earth.

(i) The uranium isotope $^{238}_{92}U$ becomes the lead isotope $^{206}_{82}Pb$ through a series of radioactive decays.

Calculate the number of α particles and the number of β particles emitted for one nucleus of $^{238}_{92}U$ to decay to become a nucleus of $^{206}_{82}Pb$.

(2)

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Number of α particles = ...

Number of β particles = ...

(ii) The half-life of $^{238}_{92}U$ is 4.47×10^9 years.

The half-lives of the other stages in the decay to $^{206}_{82}Pb$ are relatively so short that they can be ignored.

There was no lead in the rock when it formed, so all the $^{206}_{82}Pb$ in the sample is a product of $^{238}_{92}U$ decay. In the sample, for every 103 uranium nuclei present at the start, 50 are now lead nuclei.

Show that the age of the sample is about 4×10^9 years.

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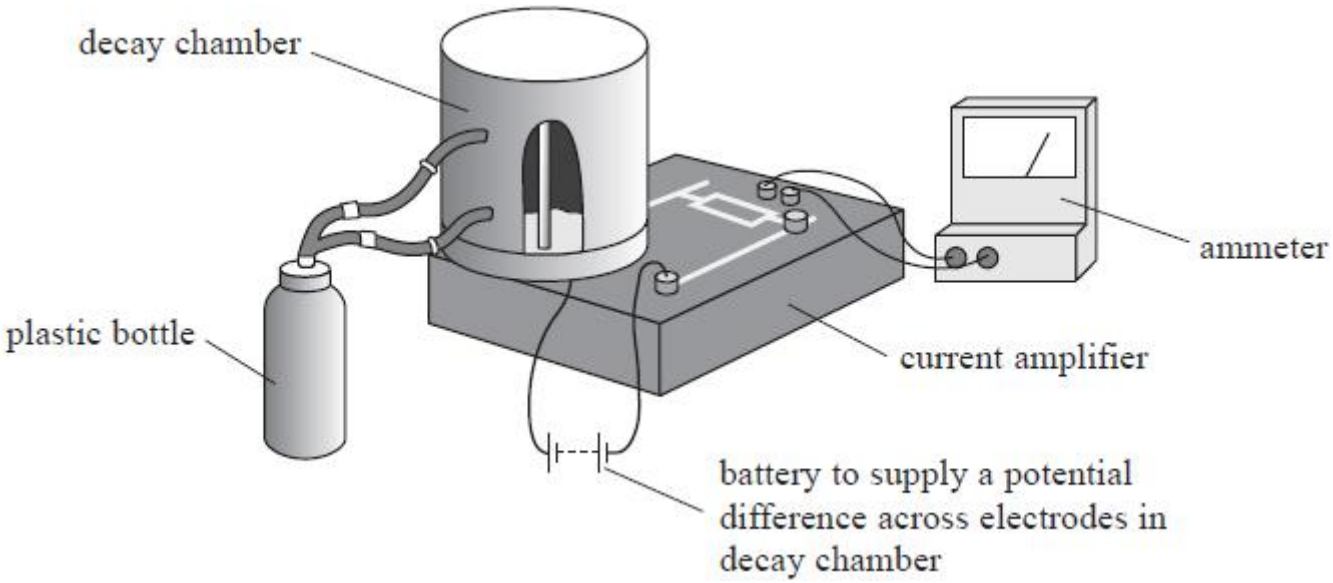
(Total for question = 5 marks)

Q2.

Radon is a radioactive gas. One isotope of radon, $^{220}_{86}Rn$, decays to polonium, Po, by emitting an alpha particle.

The diagram shows apparatus for monitoring the decay of radon in the laboratory.
Radon gas is produced in the plastic bottle from the decay of radium. A small amount of radon is then inserted into the decay chamber by squeezing the plastic bottle.
A current is produced between two electrodes inside the chamber. This current is amplified and recorded by the ammeter.



(i) Explain why a current is produced in the decay chamber.

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(ii) A teacher is demonstrating the operation of the decay chamber to her class. She squeezes the bottle to introduce radon into the chamber.

She claims that within 450 s the activity of the radon in the chamber will be less than 1% of its initial value.
Assess whether her claim is correct.
half-life of radon = 55.6 s

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(Total for question = 5 marks)

Q3.

Nuclear decay is described as being spontaneous and random.

A radioactive source used in a school laboratory emits alpha and beta radiation.

Describe how the percentage of the activity due to beta radiation may be determined using a Geiger–Müller tube and ratemeter.

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(Total for question = 4 marks)

Q4.

In 2011, a tsunami was caused by a massive earthquake centred some distance off the coast of Japan. The tsunami caused a cooling system failure at the Fukushima Nuclear Power Plant. This resulted in a nuclear meltdown and radioactive materials were released into the surroundings.

A reservoir beside one of the reactor buildings contained a large volume of water. In 2013, this water was found to have an extremely high concentration of caesium-137.

Caesium-137 is a radioactive isotope of caesium.

The most common radionuclide amongst the fission products in the fuel was iodine-131, which decays with a half-life of 8.0 days to form a stable isotope of the gas xenon.

Deduce whether enough xenon would have collected in 32 days to exert a pressure of 1.0×10^5 Pa in a volume of 450 m^3. Assume that no gas escapes.

temperature = 20 °C

initial number of iodine nuclei = 1.25×10^{28}

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(Total for question = 6 marks)