

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

Name of the Student: _____

Max. Marks : 26 Marks

Time : 26 Minutes

Q1.

A hundred years ago, a method to determine the age of certain rocks was developed. An unstable isotope of rubidium is present in some rocks when they form. Over time the rubidium decays to a stable isotope of strontium.

Give a reason why the half-life of the rubidium isotope is hard to determine.

(1)

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(Total for question = 1 mark)

Q2.

A hundred years ago, a method to determine the age of certain rocks was developed. An unstable isotope of rubidium is present in some rocks when they form. Over time the rubidium decays to a stable isotope of strontium.

Recent investigations suggest that the half-life of the rubidium isotope may be larger than the traditionally accepted value.

Explain how this would affect the ages obtained by this dating method.

(2)

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(Total for question = 2 marks)

Q3.

Nuclear decay is described as being spontaneous and random.

Americium-241 is used in schools as a source of alpha radiation.

A pure americium-241 source was bought 34 years ago by a school.

- (i) Determine the percentage of the initial activity that would be expected today for the americium-241 source.
half-life of americium-241 = 432 years

(3)

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Expected percentage of initial activity =

- (ii) The decay products of americium are unstable and undergo a series of further decays.

The table shows the first three decays in this sequence.

Isotope	Decay product	Emission	Half-life
americium-241	neptunium-237	alpha	432 years
neptunium-237	protactinium-233	alpha	2 100 000 years
protactinium-233	uranium-233	beta	27 days

A student states, "Protactinium-233 emits beta particles when it decays, so by now the americium-241 source bought 34 years ago will be emitting a significant amount of beta radiation."

Discuss the student's statement.

(3)

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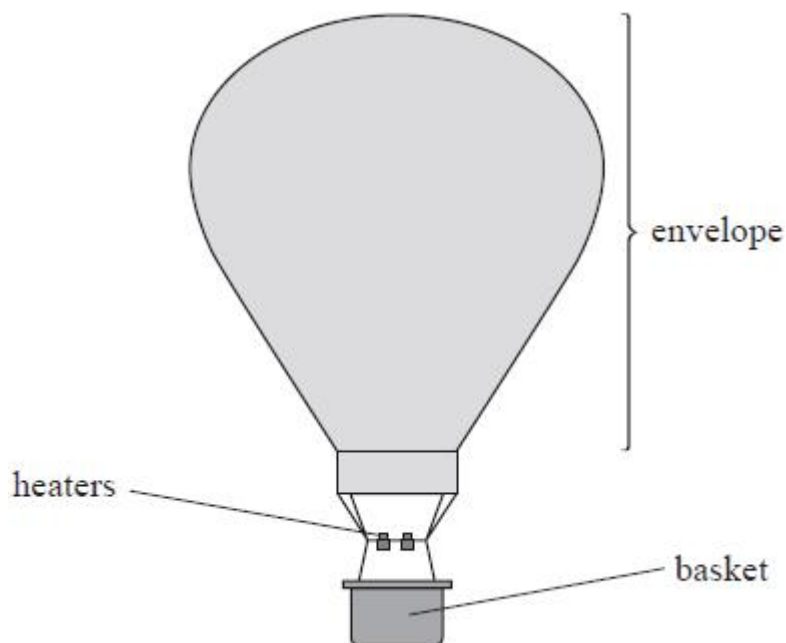
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(Total for question = 6 marks)

Q4.

A hot air balloon consists of a fabric envelope, heaters and a basket, as shown.



When the balloon is set up, the envelope is partly filled with air at 20°C. The air is then heated to 120°C and expands to fill the envelope and becomes less dense.

The air pressure inside the envelope is always equal to the air pressure outside the envelope because the envelope is open at the bottom.

The balloon takes off when the upthrust is more than the total weight of the balloon, the air in the envelope and the passengers.

Deduce whether the balloon can take off.

volume of air at 120°C in inflated envelope = 2800 m³

density of air at 20°C = 1.2 kg m⁻³

mass of balloon = 380 kg

mass of passengers = 340 kg

upthrust when the envelope is full = 33 000 N

(i) State one assumption of the kinetic theory of gases.

(1)

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(ii) Derive an equation to show that, for a gas at temperature T ,

the mean kinetic energy of the molecules $= \frac{3}{2} kT$

(2)

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(iii) Calculate the root-mean-square speed of nitrogen molecules at a temperature of 120°C.

mass of nitrogen molecule = 28 u

(3)

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Root-mean-square speed =

(Total for question = 6 marks)

Q5.

Radon is a radioactive gas. One isotope of radon, $^{220}_{86}\text{Rn}$, decays to polonium, Po, by emitting an alpha particle. Complete the nuclear equation for the decay of radon.

(2)



(Total for question = 2 marks)

Q6.

In March 2011, a nuclear meltdown occurred at the Fukushima Nuclear Power Plant and radioactive materials were released into the environment.

A month later, seaweed off the coast near Long Beach, California was found to be contaminated with iodine-131, a radioisotope that decays by emitting β particles. In one sample the activity was found to be 2.5 Bq per gram of dry seaweed.

(a) State what is meant by the activity of a radioactive source.

(1)

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(b) A Geiger counter is used to measure the count from a sample of seaweed over a period of 10 minutes. The corrected readings obtained are shown in the table below.

Corrected count 1	Corrected count 2	Corrected count 3	Corrected count rate / Bq
3820	3830	3825	6.38

(i) State why the readings obtained from the Geiger counter have to be corrected.

(1)

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(ii) Explain why the radioactive count is repeated.

(2)

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(iii) The measurements were repeated with the same sample of seaweed 30 days later.
Calculate the new corrected count rate of the sample.
half-life of iodine-131 = 8.0 days

(3)

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New corrected count rate =

(iv) There is a moderate risk to the public from the accumulation of iodine-131 in the seaweed. Explain why.
(2)

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(Total for question = 9 marks)