OXFORD

INTERNATIONAL AQA EXAMINATIONS

Topic Test: OxfordAQA International AS level Physics Particles

Radiation and Radioactivity

Name: ____________________

Class: ____________________

Date: ____________________

Time: **45 minutes**

Marks: **37 marks**

Comments:

1 Complete the equation below to show the decay of a neutron.
Show the proton numbers, nucleon numbers and symbols of all three particles produced.

$$^{1}_{0}n \longrightarrow \,^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + \,^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + \,^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots$$

(Total 3 marks)

2 (a) State the name of the antiparticle of a positron.

___

(1)

(b) Describe what happens when a positron and its antiparticle meet.

___

___

(2)

(Total 3 marks)

3 A single nucleus of $^{11}_{6}C$ decays into a nucleus of $^{11}_{5}B$.

During this decay two additional particles are emitted.

(a) Identify this decay.

___

(1)

(b) Identify the neutral particle emitted in this decay.

___

(1)

(c) Identify the antiparticle of the neutral particle in question (b).

___

(1)

(Total 3 marks)

4 (a) (i) Determine the charge, in C, of a $^{239}_{92}U$ nucleus.

___

___

(ii) A positive ion with a $^{239}_{92}U$ nucleus has a charge of 4.80×10^{-19} C.
Determine how many electrons are in this ion.

____

____

____

(4)

(b) A $^{239}_{92}U$ nucleus may decay by emitting **two** β^- particles to form a plutonium nucleus $^{X}_{Y}Pu$.
State what X and Y represent and give the numerical value of each.

X ____

____

Y ____

____

(4)

(Total 8 marks)

5 (a) Name the constituent of an atom which

(i) has zero charge,

____

(ii) has the largest charge to mass ratio,

____

(iii) when removed leaves a different isotope of the element.

____

(3)

(b) An α particle is the same as a nucleus of helium, ${}^{4}_{2}He$.

The equation

$${}^{229}_{90}Th \longrightarrow {}^{X}_{Y}>Ra + \alpha$$

represents the decay of thorium by the emission of an α particle.

Determine

(i) the values of X and Y, shown in the equation,

X = ______________________

Y = ______________________

(ii) the ratio $\dfrac{\text{mass of } {}^{X}_{Y}\text{Ra nucleus}}{\text{mass of } \alpha \text{ particle}}$

____

____

____

(3)

(Total 6 marks)

6 (a) Explain what is meant by an isotope.

____

____

____

____

(2)

(b) The incomplete table shows information for two isotopes of uranium.

	number of protons	**number of neutrons**	**specific charge of nucleus/**
first isotope	92	143	
second isotope			3.7×10^{7}

(i) Write the unit for the specific charge in the heading of the last column of the table.

(1)

(ii) In the above table write down the number of protons in the second isotope in the table.

(1)

(iii) Calculate the specific charge of the first isotope and write this in the table.

___

___

___

___

(3)

(iv) Calculate the number of neutrons in the second isotope and put this number in the table

___

___

___

___

___

(3)

(Total 10 marks)

7 What is the specific charge of a $^{9}_{4}Be^{2+}$ ion?

A 2.1×10^{7} C kg^{-1} ⬭

B 4.3×10^{7} C kg^{-1} ⬭

C 9.6×10^{7} C kg^{-1} ⬭

D 2.2×10^{-1} C kg^{-1} ⬭

(Total 1 mark)

8 In a nuclear reaction $^{14}_{7}\text{N}$ is bombarded by neutrons. This results in the capture of one neutron and the emission of one proton by one nucleus of $^{14}_{7}\text{N}$. The resulting nucleus is

A $^{13}_{7}\text{N}$

B $^{14}_{6}\text{C}$

C $^{12}_{6}\text{C}$

D $^{14}_{8}\text{O}$

(Total 1 mark)

9 A Geiger counter is used to measure the corrected count rate C from a gamma source in a vacuum.

What is the relationship between C and the distance x between the Geiger counter and the source?

A C is directly proportional to x^2 ⬭

B C is directly proportional to x ⬭

C C is inversely proportional to x ⬭

D C is inversely proportional to x^2 ⬭

(Total 1 mark)

10 ^{207}Pb can be formed from a series of decays beginning with ^{211}Pb. Only alpha particles and beta particles are emitted in the series.

How many alpha and beta particles are emitted in the series?

A 1 alpha particle and 1 beta particle ⬭

B 1 alpha particle and 2 beta particles ⬭

C 2 alpha particles and 1 beta particle ⬭

D 2 alpha particles and 2 beta particles ⬭

(Total 1 marks)

Mark schemes

1 proton correct (1,1) accept p or p^+ ✓

electron correct (0,−1) accept e or e^- or β or β^- ✓

(electron-)antineutrino correct (0, 0) ✓

Must be an <u>anti</u>neutrino

[3]

2 (a) electron

B1

1

(b) they annihilate (condone disappear/destroy or eliminate each other)

B1

forming (two) gamma ray(s)/radiation or photon(s)
(i.e. condone singular)
NOT just energy

B1

2

[3]

3 (a) Beta-<u>plus</u> **or** positron (emission) ✓

Accept $^{0}_{+1}\beta$

Accept correct decay equation in which beta plus is seen

Just beta decay is insufficient

1

(b) (electron) neutrino ✓

Accept correct symbols

Reject anti-neutrino.

1

(c) the correct antiparticle to student's (b). ✓

Accept correct symbols

*Expect (electron) antineutrino but **not** if **(b)** is incorrect*

ecf from (b)

1

[3]

4 (a) (i) (charge) = $92 \times 1.60 \times 10^{-19}$
$= 1.47 \times 10^{-17}$ (C) **(1)**

(ii) (magnitude of ion charge) = 3(*e*) **(1)**
number of electrons (= 92 – 3) = 89 **(1)**

4

(b) X: number of nucleons [or number of neutrons plus protons or mass number] **(1)**
239 **(1)**
Y: number of protons [or atomic number] **(1)**
94 **(1)**

4

[8]

5 (a) (i) neutron **(1)**

(ii) electron **(1)**

(iii) neutron **(1)**

3

(b) (i) (X =) 225 **(1)**
(Y =) 88 **(1)**

(ii) $\left(\frac{\text{mass of } ^{225}_{88}\text{Ra}}{\text{mass of } \alpha \text{ particle}} = \frac{225}{4}\right)$ = 56(.3) **(1)**
(allow C.E. for value of X from (i))

3

[6]

6 (a) isotopes (are varieties of the same element that) have the same number of protons/atomic number/proton number **(1)**

but different numbers of neutrons/nucleons/atomic mass **(1)**

2

(b)

	number of protons	number of neutrons	specific charge of nucleus/ C kg^{-1} **(1)**
first isotope	92	143	$= 92 \times 1.6 \times 10^{-19}$ **(1)** $/(92 \times 1.67 \times 10^{-27} + 143 \times 1.67 \times 10^{-27})$ **(1)** $= 3.8 \times 10^{7}$ **(1)**
second isotope	92 **(1)**	$3.7 \times 10^{7} = 92 \times 1.6 \times 10^{-19} /(A \times 1.67 \times 10^{-27})$ **(1)** $A \times 1.67 \times 10^{-27} = 92 \times 1.6 \times 10^{-19}/3.7 \times 10^{7}$ $A = 238$ **(1)** number of neutrons $= 238 - 92 = 146$ **(1)** **or** 148 if used u **or** 147 (depends on rounding)	3.7×10^{7}

8

[10]

7 A

[1]

8 B

[1]

9 D

[1]

10 B

[1]