Unit 3
Nuclear Chemistry

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1 What is the result of an atom losing an alpha α particle?

2 6g of a radioactive isotope of ^{60}Co has a half-life of 5 yrs. How much of this isotope would be left after 20 yrs?

3 The process below represents ……………

4 What is produced (X) when ^{238}U is combined with a neutron.

5 To a **saturated solution** of sodium nitrate, a further sample of a radioactive sample of sodium nitrate was added.

6 $^{131}I^-$ can be used to study diseased thyroid glands. Its half-life is 8 days. A patient was given 0.0053 mol of this isotope. How many grams would be left after 16 days?

7 A sample of pottery was found to have 3.3 mg of ^{14}C. If the half-life of ^{14}C is 5000 yrs how many mol of ^{14}C did the sample of pottery have when the pottery was made?

8 There are 287 naturally occurring isotopes of which 18 are unstable or radioactive. What would the neutron:proton ratio be for the radioactive isotope ^{239}Pu?

1 What is the result of an atom losing an alpha α particle?

a. The atomic number increases and the mass number increases.

b. The atomic number decreases and the mass number increases.

c. The atomic number increases and the mass number decreases.

d. The atomic number decreases and the mass number decreases.

a hint!!!!

1st hint

What is meant by atomic number and mass number?

2nd hint

An alpha particle is a helium nucleus

What is the result of an atom losing an alpha α particle?

Correct because…………

An alpha particle is a helium nucleus. It is made up from 2 protons and 2 neutrons, i.e. it has an atomic (proton) number of 2 and a mass number of 4.
So the **atomic number decreases and the mass number decreases**.

2

6g of a radioactive isotope of ^{60}Co has a half-life of 5 yrs. how much of this isotope would be left after 20 yrs?

a. 1.2 g

b. 0.375 g

c. 0.75 g

d. 0.188 g

a hint!!!!

1st hint
How many half- lives are there over a period of 20 years?

2nd hint
Start-5 years-10 years-15 years-20 years.

6g of a radioactive isotope of ^{60}Co has a half-life of 5 yrs. How much of this isotope would be left after 20 yrs?

Correct because………

The half- life of a radioactive isotope is a measure of the time it takes for activity to be reduced by half. Over a period of 20 years, **4** half-lives would be needed.

^{60}Co 6g $\xrightarrow{1}$ ^{60}Co 3g $\xrightarrow{2}$ ^{60}Co 1.5g $\xrightarrow{3}$ ^{60}Co 0.75g $\xrightarrow{4}$ ^{60}Co 0.375g

3 Which process is represented by this nuclear equation?

$$^{236}_{92}U \longrightarrow \; ^{142}_{56}Ba + \; ^{91}_{36}Kr + 3\; ^{1}_{0}n$$

a. Nuclear fusion

b. Nuclear fission

c. Alpha emission

d. Neutron capture

a hint!!!!

Nuclear fusion takes place inside stars, where hydrogen is converted into helium.

a hint!!!!

An alpha particle has an atomic number of 2 and a mass number of 4.

a hint!!!!

Neutron capture would result in an increase in the mass number.

Which process is represented by this nuclear equation?

$$^{236}_{92}U \longrightarrow \, ^{142}_{56}Ba + \, ^{91}_{36}Kr + 3\, ^{1}_{0}$$

Correct because………….

Nuclear fission involves the splitting of a nucleus into two nuclei.

4 What is produced (X) when ^{238}U is combined with a neutron.

$$ {}^{1}_{0}n + {}^{238}U \longrightarrow X + {}^{0}_{-1}e $$

a. ${}^{239}_{92}U$

b. ${}^{240}_{93}Pu$

c. ${}^{240}_{92}U$

d. ${}^{239}_{93}Pu$

a hint!!!!

A beta particle is lost, how would this change the atomic number?

a hint!!!!

How does adding a neutron change the mass number?

What is produced (X) when ^{238}U is combined with a neutron?

$$^{1}_{0}n + ^{238}U \longrightarrow X + ^{0}_{-1}e$$

Correct because……….

Adding a neutron to ^{238}U increases the mass number increase by 1, but the atomic number (proton number) will not change. A beta particle is also emitted. This will change a neutron into a proton, so increasing the atomic number by 1.
The atomic number of uranium is always 92.

$$X = ^{239}_{93}Pu$$

5 When a 10g sample of radioactive sodium nitrate is added to 10 cm^3 of a **saturated solution** of sodium nitrate, the solution will.....

a. have the same intensity of radiation as before.

b. have a lower intensity of radiation.

c. have a higher level of intensity of radiation than before.

d. have no detectable level of radiation.

a hint!!!!

An un-dissolved salt will be in dynamic equilibrium with the dissolved salt.

When a 10g sample of radioactive sodium nitrate is added to 10 cm3 of a **saturated solution** of sodium nitrate, the solution will…..

Correct because……….

Have a higher level of intensity of radiation than before. This happens because in a saturated solution the excess solid is in a dynamic equilibrium with the dissolved solid. So over time some of the radioactive sodium nitrate will dissolve.

6 $^{131}I^{-}{}_{(aq)}$ can be used to study diseased thyroid glands. Its half-life is 8 days. A patient was given 0.0053 moles of This isotope.

How many grams would be left after 16 days?

a. 0.0013 g

b. 0.087 g

c. 0.174 g

d. 0.0027 g

a hint!!!!

1st hint

How many grams is 0.0053 mol? n = mass/gfm

2nd hint

How many half lives are involved?

$^{131}I^-$ can be used to study diseased thyroid glands. Its half-life is 8 days. A patient was given 0.0053 moles of this isotope. How many grams would be left after **16** days?

Correct because……….

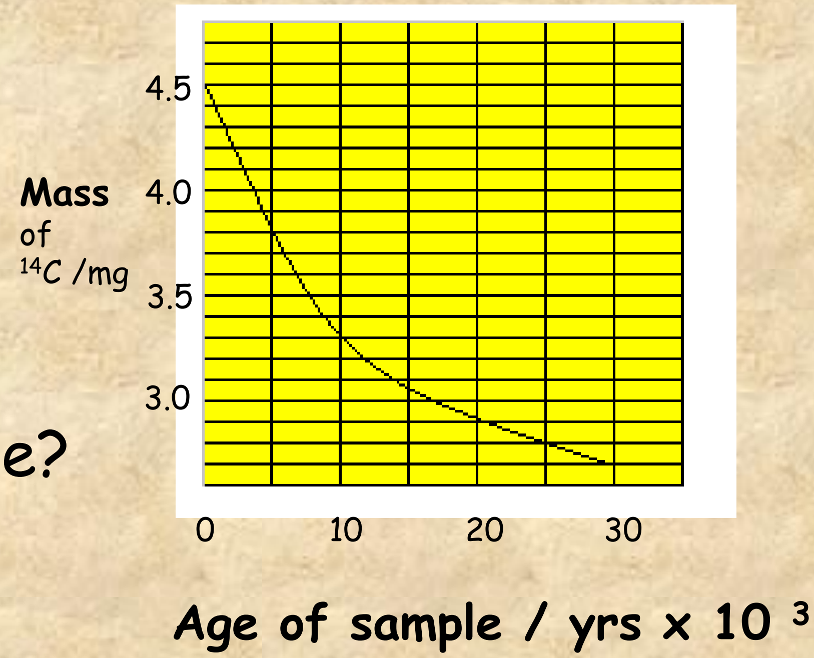
The mass of $^{131}I^-$ in 0.0053 n = n (number moles) = mass/gfm
So mass = n x gfm = 0.0053 x 131= 0.694g

	8 days 1 ½ life		16 days 2 ½ life	
$^{131}I^-$	$\longrightarrow$	$^{131}I^-$	$\longrightarrow$	$^{131}I^-$
0.694g		0.347g		0.174g

Ans: c. 0.174 g

7

A sample of pottery was found to have 3.3 mg of ^{14}C. If the half-life of ^{14}C is 5000 yrs how many moles of ^{14}C did the sample of pottery have when the pottery was made?



a. 1.1×10^{-3} mol

b. 1.32×10^{-2} mol

c. 5.5×10^{-4} mol

d. 9.43×10^{-4} mol

a hint!!!!

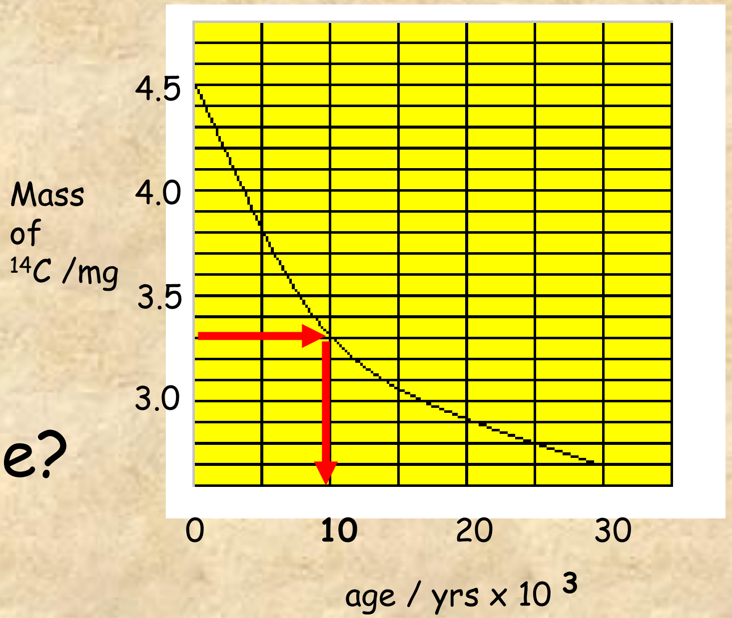
1st hint

How many mg of Carbon was in the pot when it was made?

2nd hint

n = mass/gfm

A sample of pottery was found to have 3.3 mg of ^{14}C. If the half-life of ^{14}C is 5000 yrs how many moles of ^{14}C did the sample of pottery have when the pottery was made?



Correct because........

3.3mg gives a time of 10000 years, i.e. 2 half-lives. So the pottery would have had 13.2 mg of ^{14}C when it was made. (13.2 => 6.6 => 3.3)

n (number of moles) = mass/formula mass

13.2 mg/14 = 1.32×10^{-2} / 14 =

Ans: **d. 9.43×10^{-4} mol**

8

There are 287 naturally occurring isotopes of which 18 are unstable or radioactive. What would be the proton:neutron ratio for the radioactive isotope ^{239}Pu?

a. 1:1.54

b. 1:0.39

c. 1:1.00

d. 1:2.54

a hint!!!!

1st hint

^{239} Pu has a mass number of 239 and an atomic number of 93

2nd hint

Number of neutrons = mass no. – atomic no.

There are 287 naturally occurring isotopes of which 18 are unstable or radioactive. What would the proton:neutron ratio be for the radioactive isotope ^{239} Pu?

Correct because……..

1:1.54 (indicates 1.54 x more neutrons than protons)

146/93 = 1.54

The proton:neutron ratio is an important factor in deciding whether or not a particular nuclide undergoes radioactive decay. The stable, lighter elements have a ratio of near to one. A greater number of neutrons to protons will result in a stable nuclei.