

Key

# CONSTRUCTED RESPONSE REVIEW: Nuclear Chemistry

June 2009

Base your answers to questions 68 through 70 on the information below.

Cobalt-60 is commonly used as a source of radiation for the prevention of food spoilage. Bombarding cobalt-59 nuclei with neutrons produces the nuclide cobalt-60. A food irradiation facility replaces the cobalt-60, a source of gamma rays, when the radioactivity level falls to  $\frac{1}{8}$  of its initial level. The nuclide cesium-137 is also a source of radiation for the prevention of food spoilage.

- 68 Identify *one* emission spontaneously released by a cobalt-60 nucleus. [1] *use Table N!*
- 69 Determine the total number of years that elapse before an original cobalt-60 source in an irradiation facility must be replaced. [1] *\* see work on next page!*
- 70 Complete the nuclear equation *in your answer booklet* for the decay of cesium-137. Your response must include the symbol, atomic number, and mass number of the missing particle. [1] *USE Table N!*

ANSWERS:

68. Beta or  $\beta^-$

69. 15.83 years

70.  ${}_{55}^{137}\text{Cs} \rightarrow {}_{-1}^0\text{e} + {}_{56}^{137}\text{Ba}$

January 2010

- 52 Determine the total time that must elapse until only  $\frac{1}{4}$  of an original sample of the radioisotope Rn-222 remains unchanged. [1]

*\* see work on next page!*

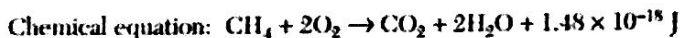
Answer to Question 52

7.646 days

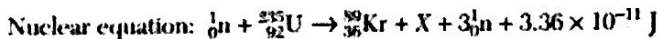
Base your answers to questions 79 through 81 on the information below.

Hydrocarbons and fissionable nuclei are among the sources used for the production of energy in the United States. A chemical reaction produces much less energy than a nuclear reaction per mole of reactant.

The balanced chemical equation below represents the reaction of one molecule of a hydrocarbon with two molecules of oxygen.



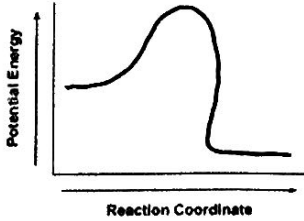
The nuclear equation below represents one of the many possible reactions for one fissionable nucleus. In this equation, X represents a missing product.



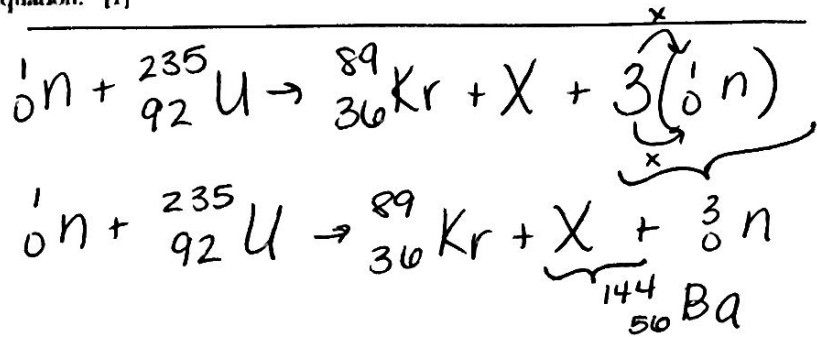
- 79 Identify the type of organic reaction represented by the chemical equation. [1]
- 80 On the labeled axes *in your answer booklet*, draw a potential energy diagram for the reaction of the hydrocarbon with oxygen. [1] *exothermic since energy is in products!*
- 81 Write an isotopic notation for the missing product represented by X in the nuclear equation. [1]

ANSWERS:

79. Combustion

80. 

81.  ${}_{56}^{144}\text{Ba}$



June 2009

#69)

Half Lives	Time	Fraction
0	0	$\frac{1}{1}$
1 $+5.271$	5.271	$\frac{1}{2}$
2 $+5.271$	10.542	$\frac{1}{4}$
3 $+5.271$	15.813	$\frac{1}{8}$

⊗ Half Life of cobalt-60 is 5.271 years (Table N)

January 2010

#52)

Half Lives	Time	Fraction
0 $+3.823$	0	$\frac{1}{1}$
1 $+3.823$	3.823 days	$\frac{1}{2}$
2 $+3.823$	7.646 days	$\frac{1}{4}$

⊗ Half Life of Rn-222 is 3.823 days (Table N)

## August 2010

Base your answers to questions 79 through 81 on the information below.

The radioisotope uranium-238 occurs naturally in Earth's crust. The disintegration of this radioisotope is the first in a series of spontaneous decays.

The sixth decay in this series produces the radioisotope radon-222. The decay of radon-222 produces the radioisotope polonium-218 that has a half life of 3.04 minutes. Eventually, the stable isotope lead-206 is produced by the alpha decay of an unstable nuclide.

79 Explain, in terms of electron configuration, why atoms of the radioisotope produced by the sixth decay in the U-238 disintegration series do not readily react to form compounds. [1]

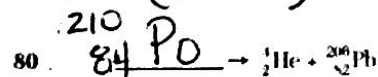
80 Complete the nuclear equation in your answer booklet for the decay of the unstable nuclide that produces Pb-206, by writing a notation for the missing nuclide. [1]

81 Determine the original mass of a sample of Po-218, if 0.50 milligram of the sample remains unchanged after 12.16 minutes. [1]

⊗ see work on next page!

ANSWERS:

79. Rn-222 is in Group 18, so has a full valence shell (8 e<sup>-</sup>)



81. 8.00g

## January 2011

Base your answers to questions 66 through 68 on the information below.

In the early 1800s, John Dalton proposed an atomic theory that was based on experimental observations made by several scientists. Three concepts of Dalton's atomic theory are stated below.

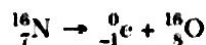
Statement A: Atoms are indivisible and cannot be destroyed or broken down into smaller parts.

Statement B: Atoms of one element cannot be changed into atoms of another element.

Statement C: All atoms of one element have the same mass.

66 Explain, in terms of particles, why statement A is no longer accepted. [1]

67 The decay of N-16 is represented by the balanced equation below.



State evidence that indicates statement B is *not* always true. [1]

68 Explain, in terms of particles in the atoms of an element, why statement C is *false*. [1]

Answers:

66. Subatomic particles such as the protons, neutrons, & electrons are now known to exist

67. In this equation, nitrogen undergoes Beta decay to become oxygen.

68. All elements exist as isotopes. This means that atoms of the same isotope can have a different # of neutrons, so a different mass number.

August 2010

#81) Half-life of Po-218 is 3.04 minutes  
(in reading)

Half Lives	Time	Amount
0	0	8.00
1 $+3.04$	3.04	4.00
2 $+3.04$	6.08	2.00
3 $+3.04$	9.12	1.00
4 $+3.04$	12.16	0.50

work backwards!