Put the first three letters of your LAST NAME in the boxes

CH302 UNIT 7 EXAM FREE RESPONSE
Spring 2014
(***You must keep your answers in the space provided.***

NAME:_____KEY_____

EID:_____

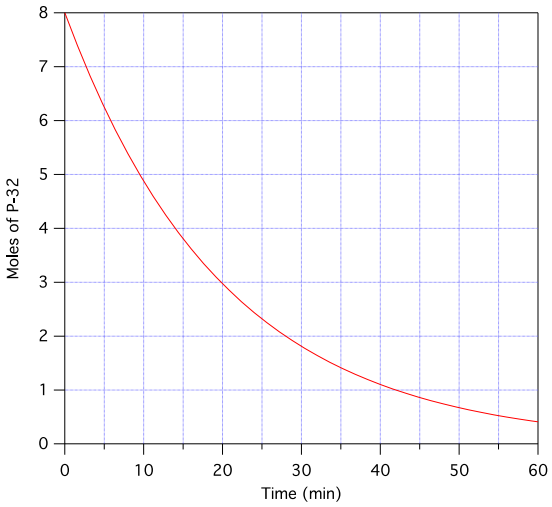
Version #: _____

1. Phosphorus-32 is a radioactive isotope of P that decays via beta(-) decay. Write a balanced equation for this nuclear reaction including the mass and charge numbers of all the species involved. (3 points)

$^{32}_{15}P \rightarrow \ ^{0}_{-1}\beta + {}^{32}_{16}S$

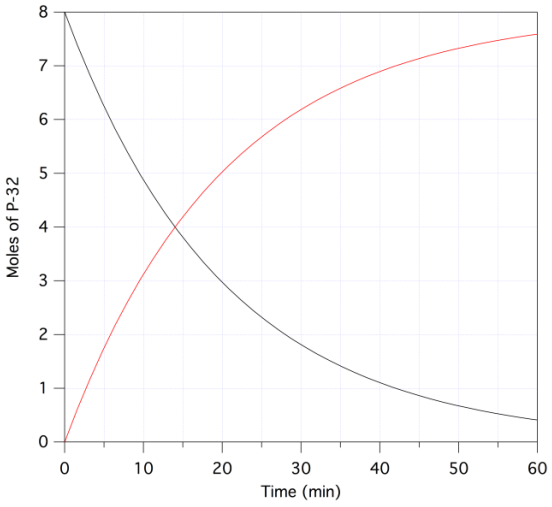
Total of three points:
1 point for each correct species

2. Below is a plot the number of moles of P-32 nuclei as a function of time. Based on the graph, what is the half-life of P-32? (2 points)



Acceptable answers within a range 13-15 minutes.
Total of 2 points (No partial credit given)

3. On the same graph, sketch a plot of the nuclide formed from the beta(-) decay. (2 points)



The curve should be similarly shaped as P-32 decays, but will be flipped because the nuclude formed increase (starting at 0moles and increase to 8moles as time increases).

Total of 2 points: 1 point for positive slope, 1 point for correct shape.

4. For the reaction $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$

	[NO] (M)	[Cl_2] (M)	rate (M/min)
1	0.1	0.1	0.18
2	0.1	0.3	0.54
3	0.2	0.3	2.16

Based on the data in the table, what is the empirical rate law for this reaction? (4 points)
Rate = $k[NO]^2[Cl_2]^1$
Total of 4 points: 2 points for correct set-up, 1 point for each exponent

What is the reaction order with respect to Cl_2? (1 point)
1st order
Total of 1 point for correct answer based on their answer for the first question. (No partial credit given.)

What is the overall reaction order for this reaction? (1 point)
3rd order
Total of 1 point for correct answer based on their answer for the first question. (No partial credit given.)

What are the value and the units of the rate constant? (2 points)
k = 180 $M^{-2}min^{-1}$
Total of 2 points: Based on their answer for the first question: 1 point for correct value, 1 point for correct units. Other acceptable answer: 3 $M^{2}\text{-}s^{-1}$

5. Below are three mechanisms for this reaction. Circle the one(s) (there may be more than one) that are consistent with the empirical rate law. (3 points)

Mechanism #1

$$NO(g) + Cl_2(g) \rightleftharpoons NOCl_2(g) \quad (fast)$$
$$NO(g) + NOCl_2(g) \rightarrow 2NOCl(g) \quad (slow)$$

Mechanism #2

$$NO(g) + Cl_2(g) \rightleftharpoons NOCl_2(g) \quad (slow)$$
$$NO(g) + NOCl_2(g) \rightarrow 2NOCl(g) \quad (fast)$$

Mechanism #3

$$NO(g) + NO(g) \rightleftharpoons N_2O_4 \quad (slow)$$
$$N_2O_4(g) + Cl_2(g) \rightarrow 2NOCl(g) \quad (fast)$$

Total of 3 points: 1 point for correctly circling Mechanism #1, 1 point each for not circling Mechanisms #2 and #3

If the rate law determined in #4 is Rate = $k[NO][Cl_2]$, then only Mechanism #2 can be circled not #1 and #3.
If the rate law determined in #4 is Rate = $k[NO]^2$, then only Mechanism #3 can be circled not #1 and #2.

No points given for not circling anything unless a valid explanation given for the rate written in #4

6. List two ways you could speed up this reaction other than changing concentrations. (2 points)
1. Add a catalyst
2. Increase temperature
Total of 2 points: 1 point for each valid response

Medium is not an acceptable answer since the species are in gas form. Condensing to a liquid would actually change the concentration which is not acceptable based on the question.