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McCord CH302

unique: 49175 and 49190

Exam 3

Apr 17, 2019

Wednesday 7:30 - 9:00 PM

A-L in UTC 2.112A

M-Z In BUR 106

Remember to refer to the Periodic Table handout that is separate from this exam copy.

NOTE: Please keep this exam copy intact (all pages still stapled - including this cover page). You must turn in ALL the materials that were distributed. This means that you turn in your exam copy (name and signature included), bubble sheet, periodic table handout, and all scratch paper. Please also have your UT ID card ready to show as well.

This print-out should have 20 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 5.0 points

Carbon-14 ($t_{1/2}$ = 5730 years) is useful for radioactive dating methods because we can estimate stable isotope ratios in organic samples. A fossil from the early Holocene Epoch originally contained 14.8 g ^{14}C. Today, the fossil contains 3.7 g. What is the approximate age of the fossil?

1. 5730 years

2. 22920 years

3. 24194 years

4. 11460 years

5. 17190 years

002 5.0 points

What is the mass of the barium chromate precipitate resulting from the addition of 300 mL 0.025 M $Ba(OH)_2$ to 200 mL 0.040 M Na_2CrO_4?

1. 3.48 g

2. 2.03 g

3. 3.80 g

4. 2.52 g

5. 1.90 g

003 (part 1 of 2) 5.0 points

You run an experiment to determine the initial rates of the following generic reaction at various starting conditions:

$$A + X_2 \rightleftharpoons AX_2$$

	[A] M	[X_2] M	initial rate $M \cdot s^{-1}$
Trial 1	0.60	1.56	2.00×10^{-3}
Trial 2	0.60	3.12	8.00×10^{-3}
Trial 3	1.20	1.56	4.00×10^{-3}
Trial 4	0.90	2.40	7.10×10^{-3}

What is the correct rate law for the reaction?

1. Rate = (1.40)[A]

2. Rate = $(1.37 \times 10^{-3})[A][X_2]^2$

3. Rate =$(1.37 \times 10^{-3})[A][X_2]$

4. Rate = $(3.84 \times 10^{-3})[A][X_2]^2$

5. Rate = $(3.84 \times 10^{-3})[A]^{-1}[X_2]^2$

004 (part 2 of 2) 5.0 points

What are the units of the rate constant in the previous question?

1. $\frac{1}{M^4 \cdot s}$

2. $\frac{1}{M \cdot s}$

3. $\frac{M}{s}$

4. $\frac{1}{M^2 \cdot s}$

5. $\frac{1}{M^3 \cdot s}$

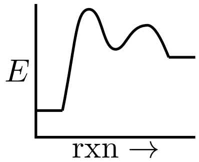
005 5.0 points

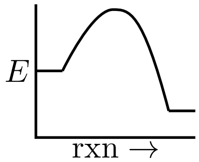
The chlorination of methane is an exothermic reaction with a two-step mechanism shown below:

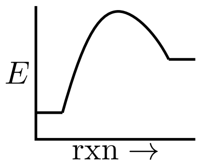
Step 1: $CH_4 + Cl_2 \longrightarrow CH_3 + HCl$ (slow)

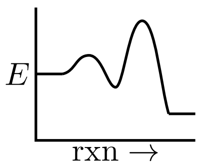
Step 2: $CH_3 + Cl_2 \longrightarrow CH_3Cl + Cl^-$ (fast)

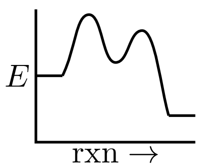
Which of the following reaction coordinate diagrams best fits this data?

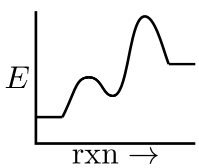
1. 

2. 

3. 

4. 

5. 

6. 

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006 5.0 points

A salt with the generic formula $M(OH)_3$ is stirred into a container of pure water at 25 °C until the solution becomes saturated. The pH is then measured and found to be 10.85. What is the value of K_{sp} for $M(OH)_3$?

1. 3.1×10^{-14}

2. 6.8×10^{-12}

3. 5.7×10^{-13}

4. 8.4×10^{-14}

5. 2.3×10^{-12}

6. 9.2×10^{-13}

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007 5.0 points

The solubility of mercury(II) thiocyanate, $Hg(SCN)_2$, is 0.0683 g per 100 mL. What is the K_{sp} for this salt?

1. 2.6×10^{-10}

2. 3.2×10^{-20}

3. 4.0×10^{-8}

4. 5.3×10^{-12}

5. 4.6×10^{-6}

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008 5.0 points

Identify the missing isotope in the nuclear reaction.

$$^{226}_{88}\text{Ra} \rightarrow \underline{\ \ ?\ \ } + ^{4}_{2}\alpha$$

1. $^{230}_{86}$Th

2. $^{226}_{86}$Rn

3. $^{222}_{90}$Rn

4. $^{222}_{86}$Rn

5. $^{230}_{90}$Th

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009 5.0 points

$^{99}_{42}$Mo undergoes radioactive decay by emitting a single beta particle. Which of the following reactions corresponds to this process?

1. $^{99}_{42}\text{Mo} \longrightarrow ^{99}_{44}\text{Ru} + ^{0}_{-1}\beta$

2. $^{99}_{42}\text{Mo} + ^{0}_{-1}\beta \longrightarrow ^{99}_{41}\text{Nb}$

3. $^{99}_{42}\text{Mo} \longrightarrow ^{98}_{42}\text{Tc} + ^{1}_{0}n$

4. $^{99}_{42}\text{Mo} \longrightarrow ^{99}_{43}\text{Tc} + ^{0}_{-1}\beta$

5. $^{99}_{42}\text{Mo} + ^{0}_{-1}\beta \longrightarrow ^{99}_{43}\text{Tc}$

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010 5.0 points

How does a catalyst affect the rate of a chemical reaction?

1. A catalyst decreases the rate constant by lowering the activation energy

2. A catalyst increases the energy of the transition state such that a larger number of particles have sufficient energy to overcome the activation energy

3. A catalyst increases the rate constant by increasing the activation energy

4. A catalyst increases the rate constant by providing an alternate mechanism with a lower activation energy

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011 5.0 points

You mix 0.02 mmol $Sr(NO_3)_2$ solution and 0.05 mmol NaF solution to form a 100 mL solution. What precipitate (if any) forms?

1. SrF_2

2. No precipitate forms

3. $NaNO_3$

4. NaF

5. $Sr(NO_3)_2$

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012 5.0 points

Consider the elementary reaction shown below at 645 K:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$
$$k = 1.44 \times 10^{-4}\, M^{-1}s^{-1}$$

If 2.00 moles of HI are placed into a 5.00 L container, how many hours will pass after two half-lives?

1. 86.8 hours

2. 14.5 hours

3. 0.965 hours

4. 1.93 hours

5. 2.95 hours

6. 0.482 hours

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013 5.0 points

Consider the following reaction:

$$2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(\ell)$$

Oxygen is being consumed at a rate equal to 1.24 M/s. What is the initial rate at which carbon dioxide is forming?

1. 0.709 M/s

2. 2.17 M/s

3. 4.96 M/s

4. 1.24 M/s

5. 8.68 M/s

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014 5.0 points

Consider the fission reaction of the plutonium-239 isotope, used for nuclear power:

$$^1_0n + {}^{239}Pu \longrightarrow {}^{134}Xe + {}^{103}Zr + 3\,^1_0n$$
$$\text{Rate} = k[^1_0n][^{239}Pu]$$

Based on the information above, which of the following statements should be a concern regarding the use of plutonium-239 as a thermal fuel?

1. Exposure to radioactive steam is common in areas surrounding nuclear power plants

2. The rate of the reaction rapidly diminishes as neutrons are consumed in the nuclear chain reaction

3. The fission of the plutonium-239 nucleus is highly endothermic, creating a violent energy output

4. The rate of the reaction can rapidly increase in the first few minutes if this process is not carefully controlled

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015 5.0 points

Which of the following salts is the most soluble in pure water?

1. CaF_2 $K_{sp} = 3.5 \times 10^{-11}$

2. $BaSO_4$ $K_{sp} = 1.1 \times 10^{-10}$

3. CuBr $K_{sp} = 6.3 \times 10^{-9}$

4. All of these salts have the same solubility

016 5.0 points

^{123}I is a radioactive isotope ($t_{1/2}$ = 13.22 hours) useful for clinical imaging. How long will it take for a dose to diminish to 18.7% of its original value?

1. 87.9 hours

2. 34.2 hours

3. 38.7 hours

4. 70.7 hours

5. 557 hours

6. 22.2 hours

7. 32.0 hours

8. 29.7 hours

017 5.0 points

Barium fluoride (BaF_2) is most soluble in which of the following solutions?

1. 0.50 M NaF

2. The molar solubility of barium fluoride is the same in each of these solutions

3. 0.005 M $Ba(OH)_2$

4. 0.18 M NaF

5. 0.15 M $Ba(OH)_2$

018 5.0 points

Consider the following reaction mechanism:

Step 1: $2NO \rightleftharpoons N_2O_2$ (k_1, fast, eq.)

Step 2: $O_2 + N_2O_2 \rightarrow 2NO_2$ (k_2, slow)

Which of the following will increase the rate of the reaction without affecting the activation energy of the overall reaction?

I. Increasing the O_2 concentration

II. Increasing the temperature

III. Introducing a catalyst

IV. Increasing the NO_2 concentration

1. I and II only

2. I only

3. I, II, and III only

4. II only

5. III and IV only

6. I and III only

019 5.0 points

A biological reaction has an activation energy of 16.7 kJ/mol and a rate constant equal to 0.012 s^{-1} at 25 °C. What is the value of the rate constant at 37 °C?

1. 0.0092 s^{-1}

2. 0.024 s^{-1}

3. 0.016 s^{-1}

4. 30.5 s^{-1}

5. 0.012 s^{-1}

020 5.0 points

Consider the following overall reaction:

$$2\,A_2 + X \rightarrow B.$$

Using the overall reaction, determine the rate law for the following mechanism:

$$A_2 + X \rightleftharpoons Z + Y \qquad (k_1, \text{fast})$$

$Z + Y \rightarrow I$ $(k_2$, slow)

$I + A_2 \rightarrow B$ $(k_3$, fast)

1. Rate $= k^{'}$ [Z][Y]

2. Rate $= k^{'}$ [A_2] [Z] [X]

3. Rate $= k^{'}$ [A_2] [X]

4. Rate $= k^{'}$ [Z] [X]

5. Rate $= k^{'}$ $[A_2]^2$

6. Rate $= k^{'}$ $[A_2]^2$ [X]