1) For which of the following reactions does Kc = Kp at 25°C?

I: 3 A(s) + 5 B(g) ⇌ 3 AB(g) + B2 (g), ΔH = 30 J

II: 2 C(g) + 2 D(g) ⇌ 4 CD(g), ΔH = −15 J

III: 2 Y(s) + E_2Y(g) ⇌ YE(g) + Y_2(g) + E(g), ΔH = 0 J

A) I only
B) II only
C) III only
D) I and II only
E) II and III only

2) The decomposition of acetaldehyde is shown by the reaction below. After twelve minutes, the partial pressures are the following: P_{CH3CHO} = 3.4 atm, P_{CH4} = 0.1 atm, P_{CO} = 0.2 atm, what must be true for the reaction to reach equilibrium? CH3CHO(g) ⇌ CH4(g) + CO(g), Kp = $2x10^{-2}$

A) Q < K and shifts forwards
B) Q < K and shifts backwards
C) Q > K and shifts forwards
D) Q > K and shifts backwards

3) When are the following reactions spontaneous? Answer in order.
Reaction I: 2 N_2O(g) + O_2(g) ⇌ 4NO(g), ΔH = 197.1 kJ
Reaction II: N_2(g) + 3H_2(g) ⇌ 2NH_3(g), ΔH = −91.8 kJ

A) At high temperatures; At high temperatures
B) At low temperatures; At low temperatures
C) At high temperatures; At low temperatures
D) At low temperatures; At high temperatures
E) At high temperatures; At all temperatures

4) Which of the following reactions produce energy and how much energy is produced?
Reaction I: $^{2}H + ^{3}H \rightarrow ^{4}He + ^{1}n$
Reaction II: $^{35}P + ^{197}Os \rightarrow ^{231}Pa + ^{1}n$
Masses (amu): ^{1}n (1.0087); ^{2}H (2.0141); ^{3}H (3.0160); ^{4}He (4.0026); ^{35}P (34.9733); ^{90}Sr (89.9077); ^{142}Xe (141.9297); ^{197}Os (196.9684); ^{231}Pa (231.0358); ^{235}U (235.0439)

A) Reaction I: $1.7x10^{12}$ J
B) Reaction II: $9.3x10^{12}$ J
C) Reaction I: $1.7x10^{15}$ J
D) Reaction II: $9.3x10^{15}$ J
E) Neither reaction produces energy

5) What is the percent yield of AB for the following reaction at equilibrium if 1.00 mole of each reactant was placed in a 2L flask and heated to 500°C?
$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$ Kc=1.778 at 500°C?
A) 86%
B) 39%
C) 60%
D) 27%
E) 40%

Use the following information to answer question 6:

H_2B, $K_a=1.0 \times 10^{-5}$; HB^-, $k_a=1.0 \times 10^{-7}$; HBO_3, $k_a=1.0 \times 10^{-9}$; HBO_2, $k_a=1.0 \times 10^{-11}$

H_2A, $K_a=1.0 \times 10^{-2}$; HA^-, $k_a=1.0 \times 10^{-4}$; HAO_3, $k_a=1.0 \times 10^{-6}$; HAO_2, $k_a=1.0 \times 10^{-8}$

6) Select the **false** statement below.
A) The H-A bond length in H_2A is likely longer than the H-B bond length in H_2B
B) The H-A bond length in HAO_2 is likely longer than the H-B bond length in HBO_2
C) The electronegativity of A is likely greater than the electronegativity of B
D) The k_a of HAO_3 is greater than the k_a of HAO_2, and this is likely related to the greater oxidation state of A in HAO_3
E) HA^- can act as a Bronsted-Lowry acid or a Bronsted-Lowry base, but it is stronger as an acid

7) Predict whether the following solutions will be acidic, basic, or neutral.
The ka of ammonium is 5.6×10^{-10} and the ka of nitrous acid is 7.2×10^{-4}
KNO_2 KNO_3 NH_4NO_3 NH_4NO_2
A) Acidic, basic, neutral, basic
B) Basic, acidic, neutral, acidic
C) Basic, neutral, acidic, acidic
D) Acidic, neutral, basic, neutral
E) Neutral, acidic, acidic, acidic

8) Predict the pH of a saturated solution of $Ca(OH)_2$ at 25°C. ksp = 7.9×10^{-6}
A) 7.22
B) 12.40
C) 1.59
D) 6.78
E) 10.30

9) You wish to make a formate/formic acid ($HCOO^-$/HCOOH) buffer solution with a pH of 3.50 by dissolving 20.0g of solid sodium formate into 2.00L of a formic acid solution. Which of the following is closest to the concentration of formic acid required to make this happen? Assume no significant volume change during dissolution. Ka of formic acid is 1.80×10^{-4}

A) 0.039 M
B) 0.085 M
C) 0.13 M
D) 0.26 M
E) 0.51 M

10) A current of 11.3 A is applied to 1.25 L of a solution of 0.552 M HBr converting some of the H+ to $H_2(g)$, which bubbles out of solution. What is the pH of the solution after 73 minutes?

A) 0.161
B) 0.258
C) 0.387
D) 0.669
E) 0.849

11) Which of the following statements is true about an electrolytic cell?

A) electrons flow toward the anode
B) a nonspontaneous reaction is forced to occur
C) an electric current is produced by a chemical reaction
D) oxidation occurs at the cathode
E) none of the above

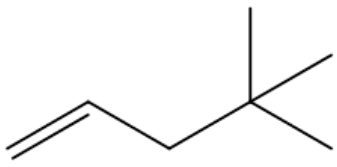
12) Which of the following nuclides would be predicted to go through positron emission/e− capture?

I: ^{67}Zn II: ^{115}Sn III: ^{184}W IV: ^{229}Th

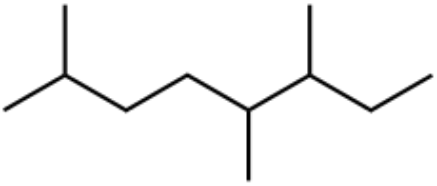
A) Only I B) Only II C) I and III D) II and IV E) I, II, and III

13) What is the name of the molecule on the right?

A) 1,1,1-trimethyl-3-propene
B) 1,1,1-trimethyl-3-butene
C) 2,2-dimethyl-4-butane
D) 3,3-dimethyl-1-butene
E) 2,2-dimethyl-4-pentane
F) 4,4-dimethyl-1-pentene



14) How many of the following is/are named correctly?



1-methyl-2-bromocyclohexane 1,1,2-trimethylpentane 3,4,7-trimethyloctane

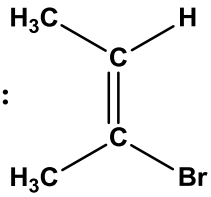
(1) Zero (2) One (3) Two (4) Three

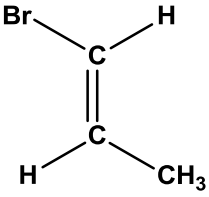
15) Given the following reaction, which of the following is *true*:

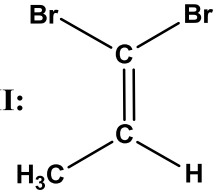
$HSO_3^- + H_2O \leftrightarrow H_3O^+ + SO_3^{2-}$

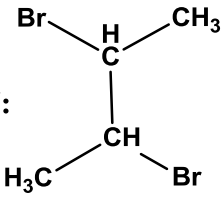
A) The desired buffer pH should be ± 1 pH unit from the pH of H_2SO_3
B) Incoming strong acid like HCl will be consumed by reacting with SO_3^{2-}
C) One possible way to prepare this buffer would be a calculated mixture of SO_3^{2-} and NaOH
D) One possible way to prepare this buffer would be a calculated mixture of HSO_3^- and HCl
E) The optimal buffer will exhibit a ratio of $[A^{2-}/HA^-]$ either greater than 10 or less than 0.10

16) Which of the following can exhibit cis-trans isomerism?

I:


II:


III:


IV:


A) Only I
B) Only IV
C) I and II
D) III and IV
E) II and III