MMM, Delicious MC Practice for the AP Chem Fall Final!

1. Dark purple $KMnO_4$ solution is added from a buret to a colorless, acidified solution of $H_2O_2(aq)$ in an Erlenmeyer flask. (Note: At the end point of the titration, the solution is a pale pink color.)

$$5\ H_2O_2(aq) + 2\ MnO_4^{2-}(aq) + 6\ H^+(aq) \rightarrow 2\ Mn^{2+}(aq) + 8\ H_2O(l) + 5\ O_2(g)$$

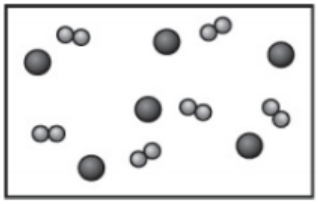
Which element is being oxidized, and what is the element's change in oxidation number?

A Oxygen, which changes from -1 to 0
B Oxygen, which changes from 0 to -2
C Manganese, which changes from -1 to +2
D Manganese, which changes from +7 to +2

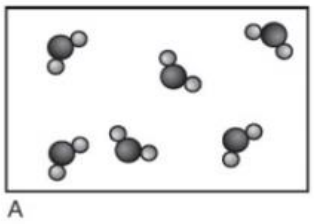
2. The equation for the reaction is:

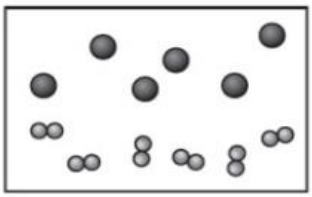
$$2\ S(g) + 3\ O_2(s) \rightarrow 2\ SO_3(g)$$

Consider a mixture of sulfur atoms and dioxygen molecules in a closed container below:



Which of the following best represents what's in the container after the reaction goes to completion?


A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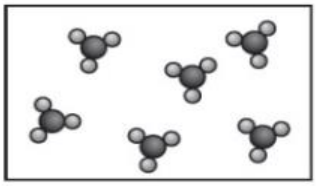
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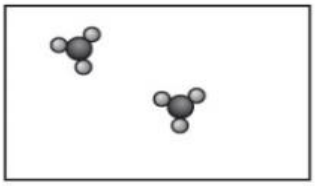
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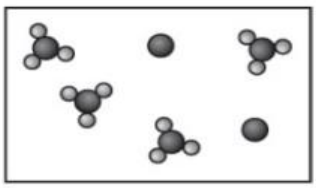
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3. What is the net ionic equation for the acid-base reaction that occurs when nitric acid is added to solid copper (II) hydroxide?

a. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

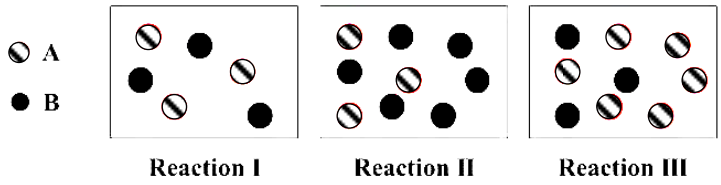
b. $2\ H^+(aq) + Cu(OH)_2(s) \rightarrow Cu^{2+}(aq) + 2\ H_2O(l)$

c. $2\ H^+(aq) + 2\ NO_3^-(aq) + Cu^{2+}(aq) + 2\ OH^-(aq) \rightarrow Cu(NO_3)_2(aq) + 2\ H_2O(l)$

d. $2\ H^+(aq) + 2\ NO_3^-(aq) + Cu^{2+}(aq) + 2\ OH^-(aq) \rightarrow Cu^{2+}(aq) + 2\ NO_3^-(aq) + 2\ H_2O(l)$

4. When 2.00 g of H_2 reacts with 32.0 g of O_2 in an explosion, the final gas mixture will contain:

   a. H_2, H_2O, and O_2 b. H_2 and H_2O only c. O_2 and H_2O only d. H_2O only



5. The following boxes represent reactions of A ⇋ B at equilibrium.

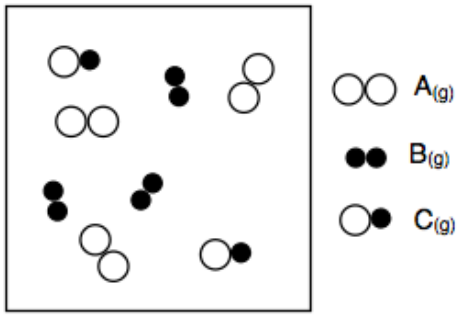
   For which reaction shown above is K smallest?

   a. Reaction I
   b. Reaction II
   c. Reaction III
   d. Cannot be determined.

6. Under equilibrium conditions, 0.60 moles of A, 0.60 moles of B and 0.60 moles of C are present in a 3.1 L solution for the reaction shown below. Determine the value of the equilibrium constant, *K*.

$$2\,A + B \leftrightarrow 2\,C$$

   a. $K = 17$ b. $K = 5.2$ c. $K = 1.7$ d. $K = 0.52$



7. The picture above shows the species initially present in a 1.0 L container. The chemical reaction shown below takes place.

$$A + B \leftrightarrow C \qquad K_c = 2.3 \times 10^{-3}$$

   Which of the following statements is true?

   a. The reaction shifts towards the products to reach equilibrium.
   b. The reaction shifts towards the reactants to reach equilibrium.
   c. The reaction mixture is at equilibrium.
   d. The direction of shift cannot be determined from the information given.

8. If the temperature at which a reaction takes place is increased, the rate of the reaction will

A increase if the reaction is endothermic and decrease if the reaction is exothermic.
B decrease if the reaction is endothermic and increase if the reaction is exothermic.
C increase if the reaction is endothermic and increase if the reaction is exothermic.
D decrease if the reaction is endothermic and decrease if the reaction is exothermic.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

9. Based on the information given in the table below, what is the $\Delta H°$ for the above reaction?

Bond	Average Bond Energy (kJ/mol)
H—H	500
O=O	500
O—H	500

A +1000kJ **B** −500kJ **C** +1000kJ **D** −1500kJ

10. The equation for the combustion of the flammable gas ethene, C_2H_4, is shown below.

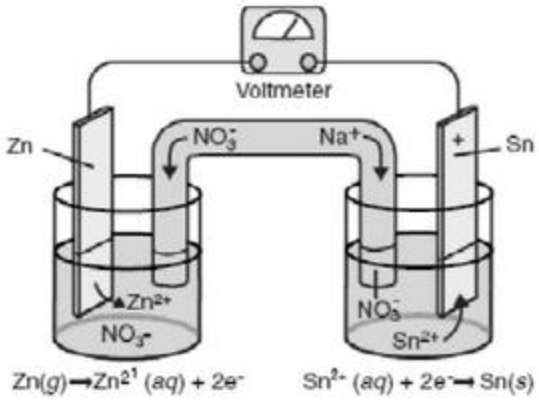
$$C_2H_4(g) + 3\,O_2 \rightarrow 2\,CO_2(g) + 2\,H_2O(l)$$

Given the table of bond energies below, what is the enthalpy change for this reaction?

Bond	Average Bond Energy (kJ/mol)	Bond	Average Bond Energy (kJ/mol)
C - H	413	C = O	799
C - C	347	H - O	467
C = C	614	H - H	432
C - O	358	O = O	495

A –1,313 kJ/mol **B** +1,313 kJ/mol **C** –952 kJ/mol_{rxn} **D** +952 kJ/mol_{rxn}

11.



$Zn^{2+} + 2e^- \rightarrow Zn°$ $E°= -0.76$ V
$Sn^{2+} + 2e^- \rightarrow Sn°$ $E°= -0.14$ V

If the half-cell containing 1.00 *M* $Zn^{2+}(aq)$ to the left is replaced with a half-cell containing 2.00*M* $Zn^{2+}(aq)$, what will be the effect on the cell potential and voltage of the galvanic cell?

A The voltage will decrease and the cell potential will increase.
B The voltage will increase and the cell potential will decrease.
C The voltage will decrease and the cell potential will decrease.
D The voltage will increase and the cell potential will increase.

12. How many electrons are transferred in the following reaction? (The reaction is unbalanced.)

$$Ca(s) + Cr^{3+}(aq) \rightarrow Cr(s) + Ca^{2+}(aq)$$

A 2 **B** 4 **C** 3 **D** 6

13. What element is undergoing oxidation (if any) in the following reaction?

$$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(g)$$

A O **B** H **C** C **D** both C and H

14.

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

A sample of N_2O_5 was placed in an evacuated container, and the reaction represented above occurred. The value of $P_{N_2O_5}$, the partial pressure of $N_2O_5(g)$, was measured during the reaction and recorded in the table below.

Time (min)	$P_{N_2O_5}$ (atm)	$\ln(P_{N_2O_5})$	$\frac{1}{P_{N_2O_5}}$ (atm^{-1})
0	150	5.0	0.0067
100	75	4.3	0.013
200	38	3.6	0.027
300	19	2.9	0.053

Which of the following correctly describes the reaction?

A The decomposition of N_2O_5 is a zero-order reaction.
B The decomposition of N_2O_5 is a first-order reaction.
C The decomposition of N_2O_5 is a second-order reaction.
D The overall reaction order is 3.

15.

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Based on the reaction represented above, an electrolytic cell was constructed from zinc and copper half-cells. The observed voltage was found to be 1.30 volt. However, the standard cell potential, E^o, is 1.05 volts. Which of the following could correctly account for this observation?

A The copper electrode was larger than the zinc electrode.
B The Cu^{2+} solution was more concentrated than the Zn^{2+} solution.
C The Zn^{2+} solution was more concentrated than the Cu^{2+} solution.
D The solutions in the half-cells had different volumes.

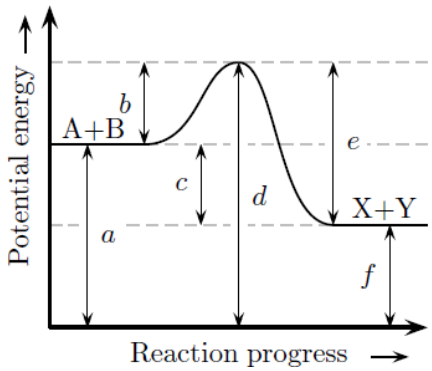
16. Which of the following sets of conditions must be true for a reaction that is thermodynamically favorable at low temperatures?

A $\Delta H > 0, \Delta S > 0$ **C** $\Delta H < 0, \Delta S > 0$

B $\Delta H > 0, \Delta S < 0$ **D** $\Delta H < 0, \Delta S < 0$

Consider the following potential energy diagram and the statements that follow for the general reaction

$$A + B \rightarrow X + Y$$

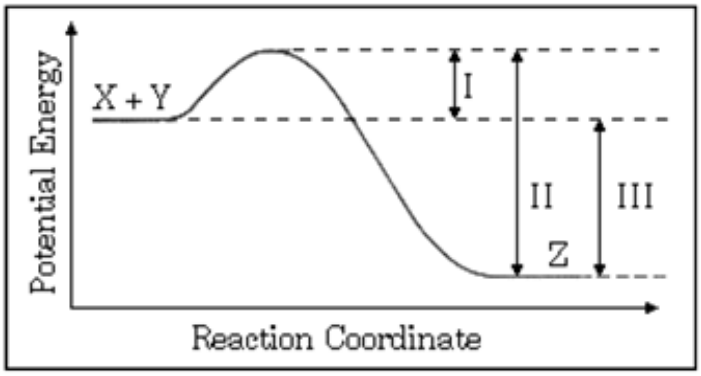


17. Which of the following statements are true?

I. The reaction represents an endothermic reaction.
II. Arrow *d* represents the enthalpy change for the reaction.
III. The reaction releases heat energy to the surroundings.

A II and III only **B** III only **C** I only **D** I and II only

18. The energy diagram for the reaction X + Y → Z is shown below. The addition of a catalyst to this reaction would cause a change in which of the indicated energy differences?



A I only **B** II only **C** III only **D** I and II only

19. Consider the following equilibrium: $H_2(g) + I_2(s) \rightleftharpoons 2HI(g)$
The proper K_{eq} expression is:

A $\frac{\sqrt{([H_2][I_2])}}{[HI]^2}$ **B** $\frac{[H_2][I_2]}{[HI]}$ **C** $\frac{[HI]^2}{[H_2][I_2]}$ **D** $\frac{[HI]^2}{[H_2]}$

Refer to the following equation for the following two questions.

$Mn(s) + Cu^{2+}(aq) \rightarrow Mn^{2+}(aq) + Cu(s)$ $\quad E^{o} = 1.52$ volts

20. Which expression shows the calculations of ΔG^{o} in **kJ/mol** for this reaction?

A $-2 \times 8.31 \times 1.52 \times 1000$

B $\dfrac{-2 \times 96500 \times 1.52}{1000}$

C $\dfrac{-2 \times 96500 \times 1.52}{8.31}$

D $\dfrac{-2 \times 96500}{8.31 \times 1.52}$

21. Which of the following statements about the above reaction are correct?

I. Mn(*s*) is oxidized.
II. The Cu(*s*) acts as the anode.
III. The equilibrium constant, K_{eq}, is less than 1.

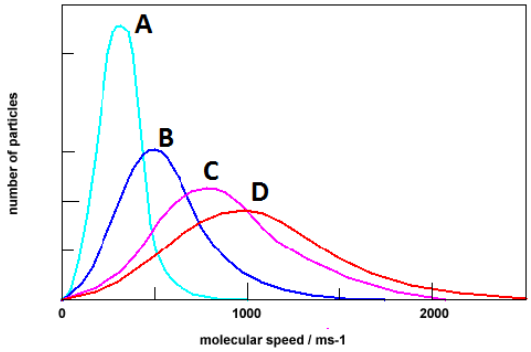
A I only
B II only
C I and II only
D I, II, and III

22. A galvanic cell consists of one half-cell that contains Ag(*s*) and $Ag^{+}(aq)$, and one half-cell that contains Cu(*s*) and $Cu^{2+}(aq)$. What species are produced at the electrodes under standard conditions?

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ $\quad E^{\circ} = +0.80$ V
$Cu^{2+}(aq) + 2\ e^{-} \rightarrow Cu(s)$ $\quad E^{\circ} = +0.34$ V

A Cu(*s*) is formed at the cathode, and $Ag^{+}(aq)$ is formed at the anode.
B $Cu^{2+}(aq)$ is formed at the cathode, and Cu(*s*) is formed at the anode.
C Ag(*aq*) is formed at the cathode and, Cu(*s*) is formed at the anode.
D Ag(*s*) is formed at the cathode, and $Cu^{2+}(aq)$ is formed at the anode.

23.



The Maxwell-Boltzmann distribution above represents four different temperature samples of the same gas collected under constant pressure conditions. Which plot in the graph represents the sample at the highest temperature?

A A **B** B **C** C **D** D

24. How many Na^+ ions are in 500. mL of 0.20 M NaF solution?

A 3.01×10^{22} ions
B 3.01×10^{20} ions
C 6.02×10^{20} ions
D 6.02×10^{22} ions

25.

$$HCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + HNO_3(aq)$$

One-half liter of a 0.20 molar HCl solution is mixed with one-half-liter of a 0.40-molar solution of $AgNO_3$. A reaction occurs forming a precipitate as shown above. If the reaction goes to completion, what is the mass of AgCl produced?

A 14 grams **B** 70 grams **C** 84 grams **D** 28 grams

26.

Experiment	Initial [NO] ($mol\ L^{-1}$)	Initial [O_2] ($mol\ L^{-1}$)	Initial Rate of Formation of NO_2 ($mol\ L^{-1}\ s^{-1}$)
1	0.10	0.10	2.5×10^{-4}
2	0.20	0.10	5.0×10^{-4}
3	0.20	0.40	8.0×10^{-3}

The initial-rate data in the table above were obtained for the reaction represented below. What is the experimental rate law for the reaction?

$$2\ NO + O_2 \rightarrow 2\ NO_2$$

A rate = $k[NO][O_2]$
B rate = $k[NO][O_2]^2$
C rate = $k[NO]^2[O_2]$
D rate = $k[NO]^2[O_2]^2$

27. The equilibrium constant, K, for the reaction below is greater than $1x10^{10}$. Which of the following correctly descrives the standard voltage, E^o, and the standard free energy change, ΔG^o, for this reaction?

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

A E^o is positive and and ΔG^o is negative.
B E^o is negative and and ΔG^o is positive.
C E^o and and ΔG^o are both positive.
D E^o and and ΔG^o are both negative.

28. For a galvanic cell that uses the following two half-reactions,

$$Cr_2O_7^{2-}(aq) + 14\ H^+(aq) + 6\ e^- \rightarrow 2\ Cr^{3+}(aq) + 7\ H_2O(l)$$
$$Pb(s) \rightarrow Pb^{2+}(aq) + 2\ e^-$$

how many moles of Pb(s) are oxidized by three moles of $Cr_2O_7^{2-}$?

A 3 **B** 6 **C** 18 **D** 9

29. Carbon monoxide reacts with oxygen to form carbon dioxide by the following reaction:

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g) \qquad \Delta H = -32.4 \text{ kJ}$$

How much heat would be released if 336 g of carbon monoxide reacted with sufficient oxygen to produce carbon dioxide?

A 389 kJ **B** 672 kJ **C** 777 kJ **D** 194 kJ

30.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

If 16 grams of CH_4 reacts with 16 grams of O_2 in the reaction shown above, which of the following will be true?

A Equal number of moles of CO_2 and H_2O will be formed.
B The limiting reagent will be CH_4.
C The limiting reagent will be O_2.
D Equal masses of CO_2 and H_2O will be formed.

31. Using the following standard reduction potentials,

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $\quad E° = +0.77$ V
$Ni^{2+}(aq) + 2\ e^- \rightarrow Ni(s)$ $\quad E° = -0.23$ V

Calculate the standard cell potential for the galvanic cell reaction given below, and determine whether or not this reaction is spontaneous under standard conditions.

$$Ni^{2+}(aq) + 2\ Fe^{2+}(aq) \rightarrow 2\ Fe^{3+}(aq) + Ni(s)$$

A $E°$ = +1.00 V, spontaneous
B $E°$ = -1.00 V, spontaneous
C $E°$ = +1.00 V, nonspontaneous
D $E°$ = -1.00 V, nonspontaneous

32. How long must a constant current of 50.0 A be passed through an electrolytic cell containing aqueous Cu^{2+} ions to produce 5.00 moles of copper metal?

A 5.4 hours **B** 0.37 hours **C** 1.7 hours **D** 0.19 hours

33. The electrolysis of molten $AlCl_3$ for 3.25 hr with an electrical current of 15.0 A produces _____ g of aluminum metal.

A 147 **B** 16.4 **C** 4.55×10^{-3} **D** 0.606

Multiple Choice Key

1. A
2. E
3. B
4. C
5. C
6. B
7. B
8. C
9. B
10. A
11. C
12. D
13. C
14. B
15. B
16. D
17. B
18. D
19. D
20. B
21. A
22. D
23. D
24. D
25. A
26. B
27. A
28. D
29. D
30. C
31. D
32. A
33. B