

60 MCQ from APClassroom n1

Name *Raymond*

1. A solution is prepared by adding 16 g of CH₃OH (molar mass 32 g) to 90. g of H₂O (molar mass 18 g). The mole fraction of CH₃OH in this solution is closest to which of the following?

 A 0.1

$$\frac{\frac{1}{2} \text{ mol}}{5 + \frac{1}{2}}$$

 B 0.2 C 0.3 D 0.4 E 0.6

2. In which of the following compounds is the mass ratio of chromium to oxygen closest to 1.62 to 1.00?

 A CrO₃

$$52 \text{ to } 16$$

 B CrO₂ C CrO D Cr₂O E Cr₂O₃

3. A sample of CaCO₃ (molar mass 100. g) was reported as being 30. percent Ca. Assuming no calcium was present in any impurities, the percent of CaCO₃ in the sample is



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(A) 30%

(B) 40% 

(C) 70%

(D) 75% 

(E) 100%

4. Consider atoms of the following elements. Assume that the atoms are in the ground state.
The atom that contains exactly two unpaired electrons

(A) S

(B) Ca

(C) Ga

(D) Sb

(E) Br



60 MCQ from APClassroom n1 A N—H B H—F C O—F D I—F E O—H

9. The melting point of MgO is higher than that of NaF. Explanations for this observation include which of the following?

- I. Mg^{2+} is more positively charged than Na^+ .
- II. O^{2-} is more negatively charged than F^- .
- III. The O^{2-} ion is smaller than the F^- ion.

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

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$\text{PCl}_5(g)$ decomposes into $\text{PCl}_3(g)$ and $\text{Cl}_2(g)$ according to the equation above. A pure sample of $\text{PCl}_5(g)$ is placed in a rigid, evacuated 1.00L container. The initial pressure of the $\text{PCl}_5(g)$ is 1.00 atm. The temperature is held constant until the $\text{PCl}_5(g)$ reaches equilibrium with its decomposition products. The figures below show the initial and equilibrium conditions of the system.

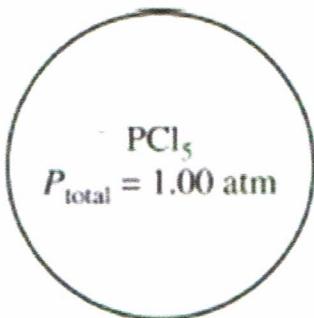


Figure 1: Initial



Figure 2: Equilibrium

16. Which of the following is the most likely cause for the increase in pressure observed in the container as the reaction reaches equilibrium?

- (A) A decrease in the strength of intermolecular attractions among molecules in the flask
- (B) An increase in the strength of intermolecular attractions among molecules in the flask
- (C) An increase in the number of molecules, which increases the frequency of collisions with the walls of the container
- (D) An increase in the speed of the molecules that then collide with the walls of the container with greater force

17. As the reaction progresses toward equilibrium, the rate of the forward reaction



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- (A) increases until it becomes the same as the reverse reaction rate at equilibrium
 - (B) stays constant before and after equilibrium is reached
 - (C) decreases to become a constant nonzero rate at equilibrium
 - (D) decreases to become zero at equilibrium
-

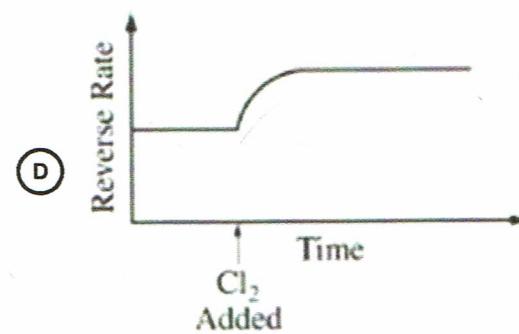
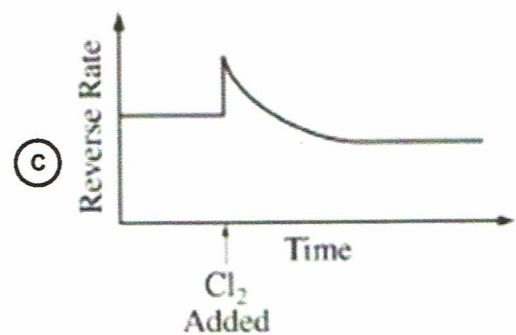
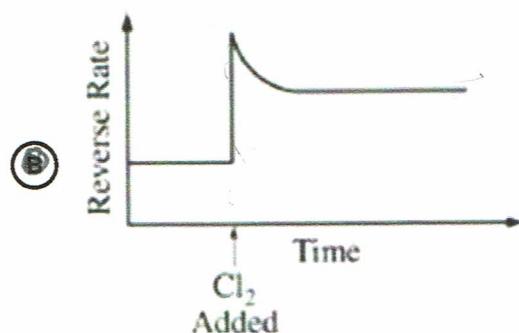
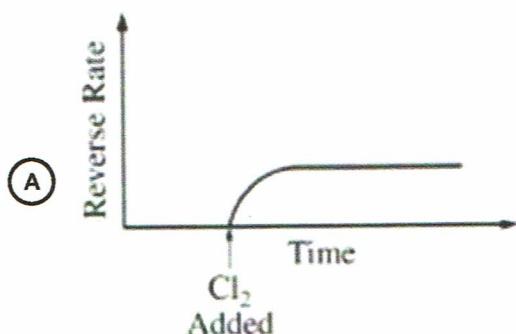
18. Which of the following statements about K_p , the equilibrium constant for the reaction, is correct?

- (A) $K_p > 1$
 - (B) $K_p < 1$
 - (C) $K_p = 1$
 - (D) It cannot be determined whether $K_p > 1$, $K_p < 1$, or $K_p = 1$ without additional information.
-

19. Additional $\text{Cl}_2(g)$ is injected into the system at equilibrium. Which of the following graphs best shows the rate of the reverse reaction as a function of time? (Assume that the time for injection and mixing of the additional $\text{Cl}_2(g)$ is negligible.)



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20. A 2 L container will hold about 4 g of which of the following gases at 0°C and 1 atm?

(A) SO₂

$$PV = NRT$$

(B) N₂

$$2 = n(0.0821)(273)$$

(C) CO₂ $\frac{4}{44}$

$\approx 8\%$ of 273

(D) C₄H₈

273 must
0.08 be around
27.34 to fit in

(E) NH₃

21. When the actual gas volume is greater than the volume predicted by the ideal gas law, the explanation lies in the fact that the ideal gas law does NOT include a factor for molecular.

(A) volume

(B) mass

(C) velocity

(D) attractions

(E) shape

22. If 200. mL of 0.60 M MgCl₂(aq) is added to 400. mL of distilled water, what is the concentration of

Mg²⁺(aq) in the resulting solution? (Assume volumes are additive).

$$\frac{0.6 \text{ mol}}{0.6 \text{ L}} = 0.12 \text{ M}$$



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(A) 0.20 M

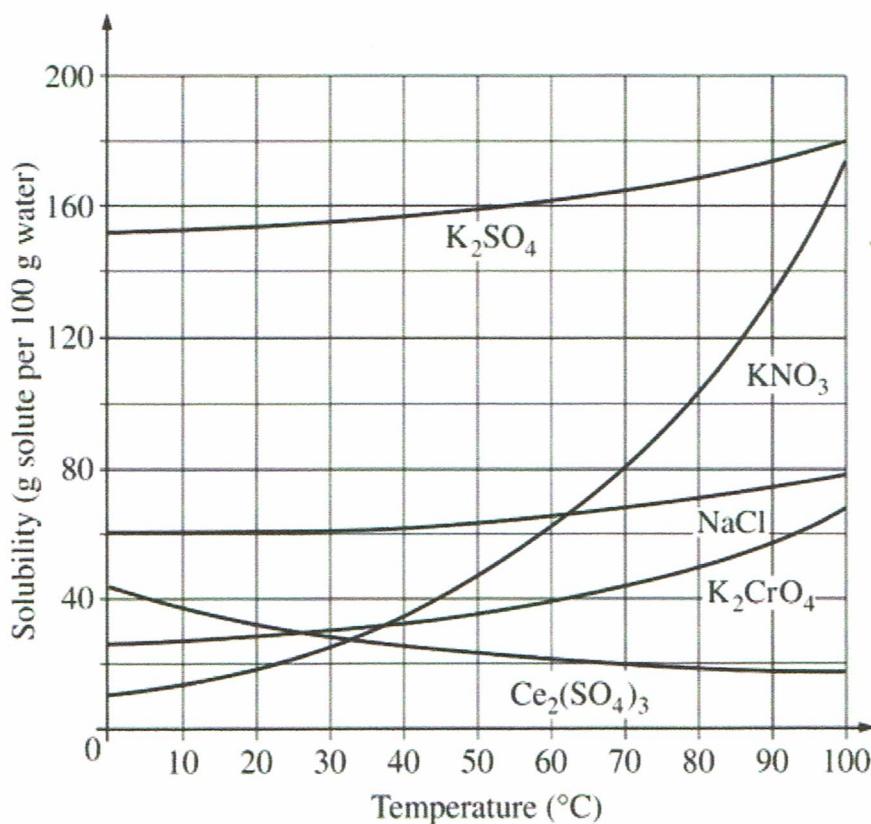
(B) 0.30 M

(C) 0.40 M

(D) 0.60 M

(E) 1.2 M

23.



On the basis of the solubility curves shown above, the greatest percentage of which compound can be recovered by cooling a saturated solution of that compound from 90°C to 30°C ?



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- A NaCl

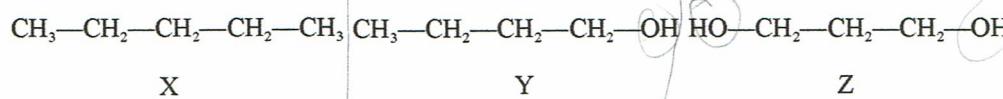
- B** KNO₃  correct

- c) K_2CrO_4

- D K_2SO_4

- ### E Ce₂(SO₄)₃

24.



Based on concepts of polarity and hydrogen bonding, which of the following sequences correctly lists the compounds above in the order of their increasing solubility in water?

- (A) $Z < Y < X$

- B** $Y < Z < X$

- c) $Y < X < Z$

- D $X < Z < Y$

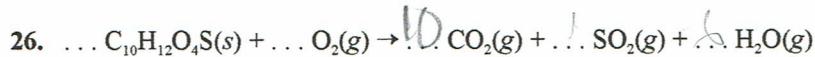
- $X < Y < Z$

25. N₂ molecules absorb ultraviolet light but not visible light. I₂ molecules absorb both visible and ultraviolet light. Which of the following statements explains the observations?



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- (A) More energy is required to make N₂ molecules vibrate than is required to make I₂ molecules vibrate.
- (B) More energy is required to remove an electron from an I₂ molecule than is required to remove an electron from a N₂ molecule.
- (C) Visible light does not produce transitions between electronic energy levels in the N₂ molecule but does produce transitions in the I₂ molecule.
- (D) The molecular mass of I₂ is greater than the molecular mass of N₂.



When the equation above is balanced and all coefficients are reduced to their lowest whole-number terms, the coefficient for O₂(g) is

28

- (A) 6

74

- (B) 7

- (C) 12

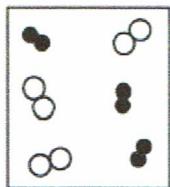
- (D) 14

- (E) 28

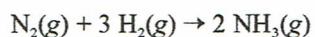


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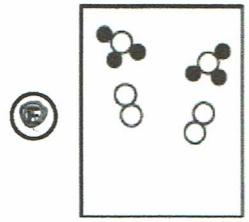
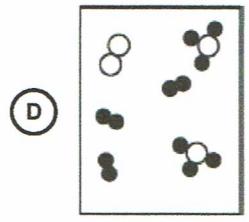
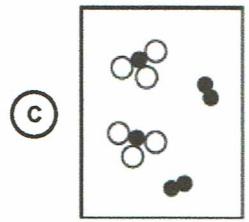
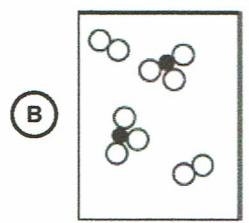
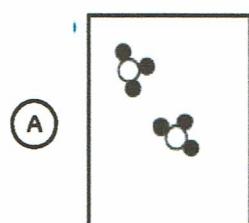
27.

 $\bullet\bullet \text{H}_2(g)$
 $\circ\circ \text{N}_2(g)$ 3N_2

The diagram above represents $\text{H}_2(g)$ and $\text{N}_2(g)$ in a closed container. Which of the following diagrams would represent the results if the reaction shown below were to proceed as far as possible?



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28. Which of the following describes the changes in forces of attraction that occur as H₂O changes phase from a liquid to a vapor?



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- (A) H – O bonds break as H – H and O – O bonds form.
- (B) Hydrogen bonds between H_2O molecules are broken.
- (C) Covalent bonds between H_2O molecules are broken.
- (D) Ionic bonds between H^+ ions and OH^- ions are broken.
- (E) Covalent bonds between H^+ ions and H_2O molecules become more effective.

29. A 20.0-milliliter sample of 0.200-molar K_2CO_3 solution is added to 30.0 milliliters of 0.400-molar $\text{Ba}(\text{NO}_3)_2$ solution. Barium carbonate precipitates. The concentration of barium ion, Ba^{2+} , in solution after reaction is

(A) 0.150 M



(B) 0.160 M

$$0.004 \text{ mol} \quad 0.012$$

(C) 0.200 M

$$\underline{0.012 - 0.004 \text{ mol}} =$$

(D) 0.240 M

$$0.05$$

(E) 0.267 M



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30. A student pipetted five 25.00-milliliter samples of hydrochloric acid and transferred each sample to an Erlenmeyer flask, diluted it with distilled water, and added a few drops of phenolphthalein to each. Each sample was then titrated with a sodium hydroxide solution to the appearance of the first permanent faint pink color. The following results were obtained.

Volumes of NaOH Solution

First Sample.....35.22 mL

X

Second Sample.....36.14 mL

Third Sample.....36.13 mL

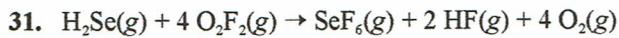
Fourth Sample36.15 mL

Fifth Sample.....36.12 mL

Which of the following is the most probable explanation for the variation in the student's results?

- (A) The burette was not rinsed with NaOH solution.
- (B) The student misread a 5 for a 6 on the burette when the first sample was titrated.
- (C) A different amount of water was added to the first sample.
- (D) The pipette was not rinsed with the HCl solution.
- (E) The student added too little indicator to the first sample.

↙ correct



Which of the following is true regarding the reaction represented above?



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- (A) The oxidation number of O does not change.
- (B) The oxidation number of H changes from -1 to +1.
- (C) The oxidation number of F changes from +1 to -1.
- (D) The oxidation number of Se changes from -2 to +6.
- (E) It is a disproportionation reaction for F.

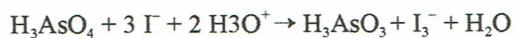
32. Which of the following is the conjugate acid of NH_2^- ?

- (A) NH^{2-}
- (B) NH_3
- (C) H^+
- (D) NH_4^+
- (E) H_2O



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33.



The oxidation of iodide ions by arsenic acid in acidic aqueous solution occurs according to the stoichiometry shown above. The experimental rate law of the reaction is:

$$\text{Rate} = k[\text{H}_3\text{AsO}_4][\text{I}^-][\text{H}_3\text{O}^+]$$

According to the rate law for the reaction, an increase in the concentration of hydronium ion has what effect on this reaction?

- A The rate of reaction increases.
- B The rate of reaction decreases.
- C The value of the equilibrium constant increases.
- D The value of the equilibrium constant decreases.
- E Neither the rate nor the value of the equilibrium constant is changed.

34.

Experiment	[X] ₀	[Y] ₀	Initial Rate of Formation of Z (mol L ⁻¹ sec ⁻¹)
1	0.40	0.10	R
2	0.20	0.20	?

The table above shows the results from a rate study of the reaction X + Y → Z. Starting with known concentrations of X and Y in experiment 1, the rate of formation of Z was measured. If the reaction was first order with respect to X and second order with respect to Y, the initial rate of formation of Z in experiment 2 would be

\cancel{Y} X X^2



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(A) $\frac{R}{4}$

(B) $\frac{R}{2}$

(C) R

(D) $2R$

(E) $4R$

35.

Time (days)	0	1	2	3	4	5	6	7	...	10	...	20
% Reactant remaining	100	79	63	50	40	31	25	20		10		1

A reaction was observed for 20 days and the percentage of the reactant remaining after each day was recorded in the table above. Which of the following best describes the order and the half-life of the reaction?

(A)

Reaction Order

First

Half-life (days)

3

(B)

Reaction Order

First

Half-life (days)

10

(C)

Reaction Order

Second

Half-life (days)

3

(D)

Reaction Order

Second

Half-life (days)

3

(E)

Reaction Order

Second

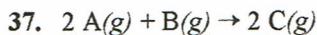
Half-life (days)

10

36. Which of the following best describes the role of the spark from the spark plug in an automobile engine?

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- (A) The spark decreases the energy of activation for the slow step.
- (B) The spark increases the concentration of the volatile reactant.
- (C) The spark supplies some of the energy of activation for the combustion reaction.
- (D) The spark provides a more favorable activated complex for the combustion reaction.
- (E) The spark provides the heat of vaporization for the volatile hydrocarbon.



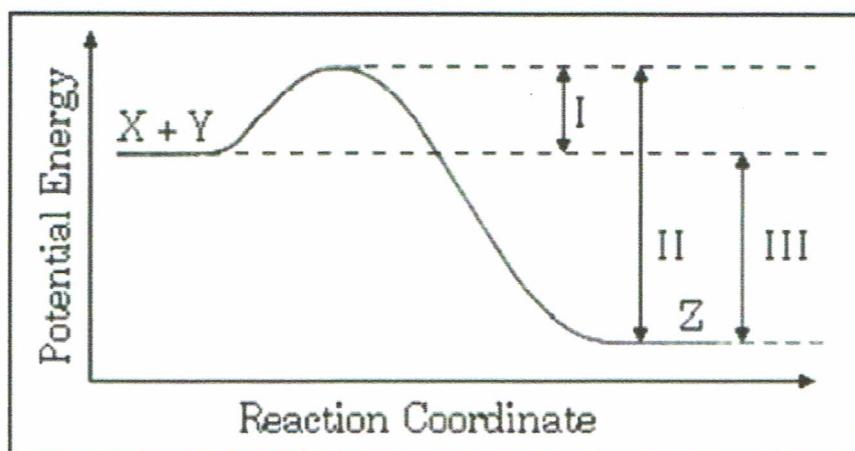
When the concentration of substance B in the reaction above is doubled, all other factors being held constant, it is found that the rate of the reaction remains unchanged. The most probable explanation for this observation is that

- (A) the order of the reaction with respect to substance B is 1
- (B) substance B is not involved in any of the steps in the mechanism of the reaction
- (C) substance B is not involved in the rate-determined step of the mechanism, but is involved in subsequent steps
- (D) substance B is probably a catalyst, and as such, its effect on the rate of the reaction does not depend on its concentration
- (E) the reactant with the smallest coefficient in the balanced equation generally has little or no effect on the rate of the reaction



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38.



The energy diagram for the reaction $X + Y \rightarrow Z$ is shown above. 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
- E I, II, and III



The elements K and Cl react directly to form the compound KCl according to the equation above. Refer to the information above and the table below to answer the questions that follow.



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Process	ΔH° (kJ/mol _{rxn})
$K(s) \rightarrow K(g)$	v
$K(g) \rightarrow K^+(g) + e^-$	w
$Cl_2(g) \rightarrow 2 Cl(g)$	x
$Cl(g) + e^- \rightarrow Cl^-(g)$	y
$K^+(g) + Cl^-(g) \rightarrow KCl(s)$	z

39. Which of the values of ΔH° for a process in the table is (are) less than zero (i.e., indicate(s) an exothermic process)?

 $\sim \Delta H$ A z only B y and z only C x, y, and z only D w, x, y, and z

40. How much heat is released or absorbed when 0.050 mol of $Cl_2(g)$ is formed from $KCl(s)$?

 A 87.4 kJ is released B 43.7 kJ is released C 43.7 kJ is absorbed D 87.4 kJ is absorbed

$$\frac{83.7 \text{ kJ}}{0.05 \text{ mol}} \rightarrow \text{endo}$$



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41. It is observed that the reaction producing KCl from its elements goes essentially to completion. Which of the following is a true statement about the thermodynamic favorability of the reaction?

- A The reaction is favorable and driven by an enthalpy change only.
- B The reaction is unfavorable and driven by an entropy change only.
- C The reaction is favorable and driven by both enthalpy and entropy changes.
- D The reaction is unfavorable due to both enthalpy and entropy changes.

$\Delta H^{\circ} = -705 \text{ J mol}^{-1}$ more endothermic

-6H

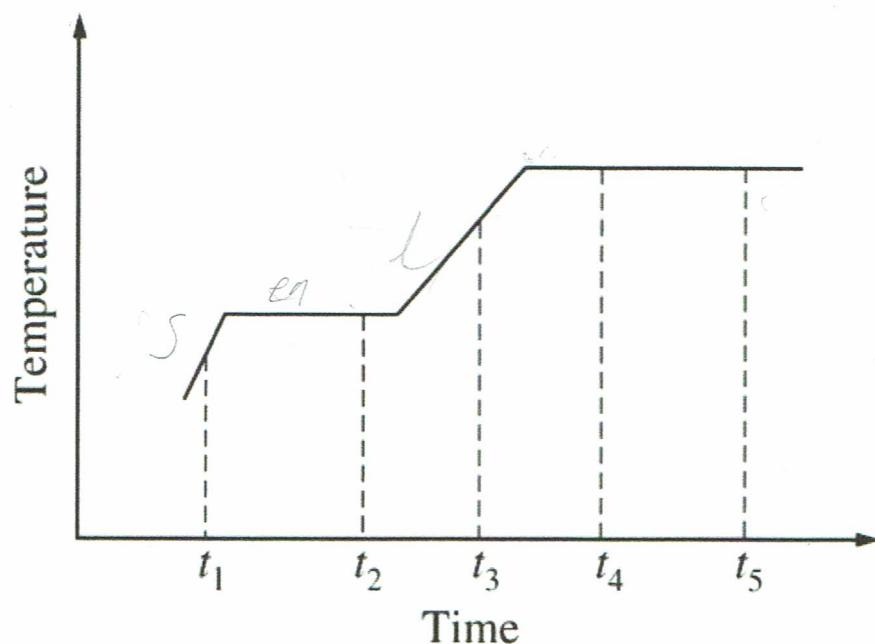
42. A 100g sample of a metal was heated to 100°C and then quickly transferred to an insulated container holding 100g of water at 22°C. The temperature of the water rose to reach a final temperature of 35°C. Which of the following can be concluded?

- A The metal temperature changed more than the water temperature did; therefore the metal lost more thermal energy than the water gained.
- B The metal temperature changed more than the water temperature did, but the metal lost the same amount of thermal energy as the water gained.
- C The metal temperature changed more than the water temperature did; therefore the heat capacity of the metal must be greater than the heat capacity of the water.
- D The final temperature is less than the average starting temperature of the metal and the water; therefore the total energy of the metal and water decreased.

The following questions relate to the graph below. The graph shows the temperature of a pure substance as it is heated at a constant rate in an open vessel at 1.0 atm pressure. The substance changes from the solid to the liquid to the gas phase.



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43. The substance is at its normal freezing point at time

(A) t_1

(B) t_2

(C) t_3

(D) t_4

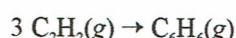
(E) t_5

44. Which of the following best describes what happens to the substance between t_4 and t_5 ?



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- A The molecules are leaving the liquid phase.
- B The solid and liquid phases coexist in equilibrium.
- C The vapor pressure of the substance is decreasing.
- D The average intermolecular distance is decreasing.
- E The temperature of the substance is increasing.

45.What is the standard enthalpy change ΔH° , for the reaction represented above? $(\Delta H_f^\circ \text{ of } \text{C}_2\text{H}_2(g) \text{ is } 230 \text{ kJ mol}^{-1};$ $(\Delta H_f^\circ \text{ of } \text{C}_6\text{H}_6(g) \text{ is } 83 \text{ kJ mol}^{-1};)$

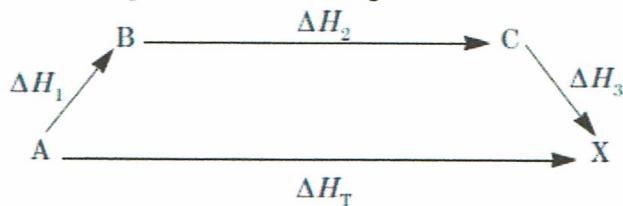
- A -607 kJ
- B -147 kJ
- C -19 kJ
- D +19 kJ
- E +773 kJ

$$83 - (3(230))$$



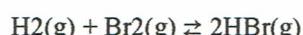
60 MCQ from APClassroom n1**46.** $A \rightarrow X$

The enthalpy change for the reaction represented above is ΔH_T . This reaction can be broken down into a series of steps as shown in the diagram:



A relationship that must exist among the various enthalpy changes is

- (A) $\Delta H_T - \Delta H_1 - \Delta H_2 - \Delta H_3 = 0$
- (B) $\Delta H_T + \Delta H_1 + \Delta H_2 + \Delta H_3 = 0$
- (C) $\Delta H_3 - (\Delta H_1 + \Delta H_2) = \Delta H_T$
- (D) $\Delta H_2 - (\Delta H_3 + \Delta H_1) = \Delta H_T$
- (E) $\Delta H_T + \Delta H_2 = \Delta H_1 + \Delta H_3$

47.

At a certain temperature, the value of the equilibrium constant, K , for the reaction represented above is 2.0×10^5 . What is the value of K for the reverse reaction at the same temperature?



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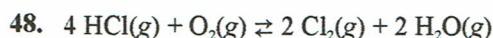
(A) -2.0×10^{-5}

(B) 5.0×10^{-6}

(C) 2.0×10^{-5}

(D) 5.0×10^{-5}

(E) 5.0×10^{-4}



Equal numbers of moles of HCl and O₂ in a closed system are allowed to reach equilibrium as represented by the equation above. Which of the following must be true at equilibrium?

- I. [HCl] must be less than [Cl₂].
- II. [O₂] must be greater than [HCl].
- III. [Cl₂] must equal [H₂O].

(A) I only

(B) II only

(C) I and III only

(D) II and III only

(E) I, II, and III



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49.

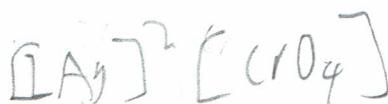


Which of the following changes to the equilibrium system represented above will increase the quantity of $\text{HI}(g)$ in the equilibrium mixture?

- I. Adding $\text{H}_2(g)$
- II. Increasing the temperature
- III. Decreasing the pressure

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

50. What is the molar solubility in water of Ag_2CrO_4 ? (The K_{sp} for Ag_2CrO_4 is 8×10^{-12} .)

 A $8 \times 10^{-12} M$  B $2 \times 10^{-12} M$ C $\sqrt{4 \times 10^{-12}} M$ D $\sqrt[3]{4 \times 10^{-12}} M$ E $\sqrt[3]{2 \times 10^{-12}} M$ 

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51. How many moles of NaF must be dissolved in 1.00 liter of a saturated solution of PbF₂ at 25°C to reduce the [Pb²⁺] to 1 x 10⁻⁶ molar?

(K_{sp} PbF₂ at 25°C = 4.0 x 10⁻⁸)

A 0.020 mole

B 0.040 mole

C 0.10 mole

D 0.20 mole

E 0.40 mole

$$\begin{aligned} K_{sp} &= [Pb][F]^2 \\ 4 \cdot 10^{-8} &= 1 \cdot 10^{-6} [F]^2 \\ 0.104 &= [F] \end{aligned}$$

$$0.2 < F$$

52. At 25°C, aqueous solutions with a pH of 8 have a hydroxide ion concentration, [OH⁻], of

A 1 x 10⁻¹⁴ M

B 1 x 10⁻⁸ M

C 1 x 10⁻⁶ M

D 1 M

E 8 M

53. Is a strong electrolyte in aqueous solution



60 MCQ from APClassroom n1 A $\text{NH}_3(\text{g})$ B $\text{BH}_3(\text{g})$ C $\text{H}_2(\text{g})$ D $\text{H}_2\text{S}(\text{g})$ E $\text{HBr}(\text{g})$

54. The pH of 0.1–molar ammonia is approximately

 A 1 B 4 C 7 D 11 E 14

55. A cube of ice is added to some hot water in a rigid, insulated container, which is then sealed. There is no heat exchange with the surroundings. What has happened to the total energy and the total entropy when the system reaches equilibrium?



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(A)	<u>Energy</u> Remains constant	<u>Entropy</u> Remains constant
(B)	<u>Energy</u> Remains constant	<u>Entropy</u> Decreases
(C)	<u>Energy</u> Remains constant	<u>Entropy</u> Increases
(D)	<u>Energy</u> Decreases	<u>Entropy</u> Increases
(E)	<u>Energy</u> Increases	<u>Entropy</u> Decreases

56. Which of the following represents the ground state electron configuration for the Mn^{3+} ion? (Atomic number Mn = 25)

- (A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$ ← correct
- (B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
- (C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ X
- (D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$
- (E) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^1$

57.



What is the hybridization of the carbon atoms in a molecule of ethyne, represented above?



60 MCQ from APClassroom n1

 A*sp* B*sp*² C*sp*³ D*d*²*sp* E*d*²*sp*

58. Which of the following pieces of laboratory glassware should be used to most accurately measure out a 25.00 mL sample of a solution?

 A

5 mL pipet

 B

25 mL pipet

 C

25 mL beaker

 D

25 mL Erlenmeyer flask

 E

50 mL graduated cylinder



A mixture of gases containing 0.20 mol of SO_2 and 0.20 mol of O_2 in a 4.0 L flask reacts to form SO_3 . If the temperature is 25°C, what is the pressure in the flask after reaction is complete?

$$\begin{aligned} PV &= NRT \\ P &= \frac{NRT}{V} \end{aligned}$$



60 MCQ from APClassroom n1

(A) $\frac{0.4(0.082)(298)}{4} \text{ atm}$

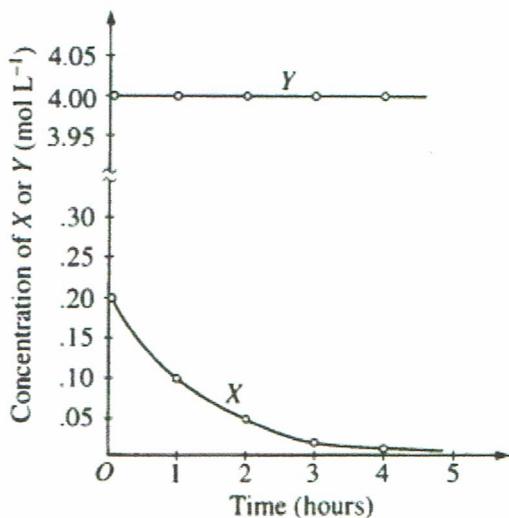
(B) $\frac{0.3(0.082)(298)}{4} \text{ atm}$ *corr/ct*

(C) $\frac{0.2(0.082)(298)}{4} \text{ atm}$ *X*

(D) $\frac{0.2(0.082)(25)}{4} \text{ atm}$

(E) $\frac{0.3(0.082)(25)}{4} \text{ atm}$

60.



The graph above shows the results of a study of the reaction of X with a large excess of Y to yield Z . The concentrations of X and Y were measured over a period of time. According to the results, which of the following can be concluded about the rate law for the reaction under the conditions studied?



60 MCQ from APClassroom n1

- A It is zero order in $[X]$.
- B It is first order in $[X]$.
- C It is second order in $[X]$.
- D It is first order in $[Y]$.
- E The overall order of the reaction is 2.