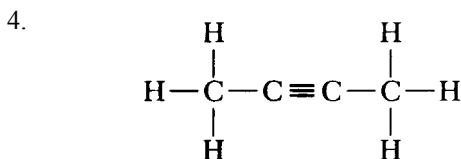


1. A x-ray hits an oxygen atom and excites a valence electron from the 2p level to the 3s level. After the electron drops back down to ground state, it gives off a certain amount of energy in the form of light. Calculate this energy.
- (A) -3.025×10^{-19} (D) 2.178×10^{-18}
(B) -2.178×10^{-18} (E) 3.025×10^{-19}
(C) -1.089×10^{-18}

2. Which of the following elements will present a paramagnetic electron configuration?
- (A) Zinc (D) Cobalt
(B) Cadmium (E) Magnesium
(C) Calcium

3. Which molecule has precisely two lone pairs according to its Lewis diagrams?
- (A) CO_2 (D) NH_4^+
(B) H_2Se (E) I_2
(C) BF_3



What type(s) of *sp* hybridization are found on the C atoms in the above compound?

- I. *sp*
II. *sp*²
III. *sp*³
IV. *dsp*³
- (A) I only (D) II and III only
(B) II and IV only (E) III and IV only
(C) I and III only
5. Molecules exhibiting a planar configuration include which of the following?
- I. AlCl_3
II. NH_3
III. CH_3Cl
- (A) I only (D) I and II
(B) II only (E) I and III
(C) III only
6. The half life of ^{133}Cs is 6.5 days. If you begin with a pure sample of ^{133}Cs , what percent is left after 26 days?
- (A) 3.13 % (D) 12.5 %
(B) 5.00 % (E) 25.0 %
(C) 6.25 %

7. Radioactive plutonium, $^{214}_{84}\text{Pu}$, emits an alpha particle and changes to a new element, "X". This new element emits a beta particle and is converted to newer element, "Y". Which are representations of elements X and Y?
- (A) $^{210}_{81}\text{X}$ and $^{212}_{83}\text{Y}$ (D) $^{210}_{80}\text{X}$ and $^{210}_{81}\text{Y}$
(B) $^{212}_{82}\text{X}$ and $^{210}_{81}\text{Y}$ (E) $^{210}_{82}\text{X}$ and $^{210}_{83}\text{Y}$
(C) $^{212}_{80}\text{X}$ and $^{211}_{81}\text{Y}$

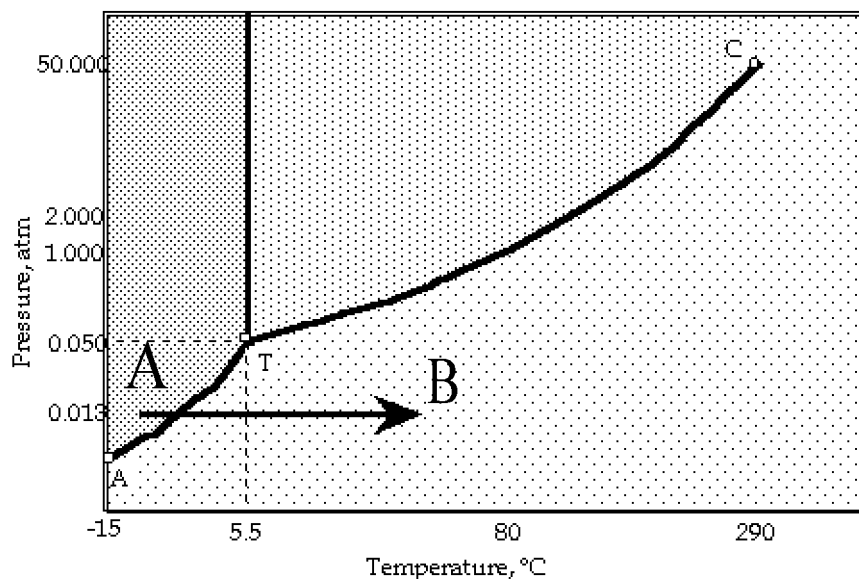
8. At 25°C He gas (molar mass 4.00 grams) effuses at a rate of 0.100 mole per minute. What is the rate of effusion of O_2 (molar mass 32.0 grams)?
- (A) 0.025 mole per minute (D) 0.20 mole per minute
(B) 0.035 mole per minute (E) 0.40 mole per minute
(C) 0.10 mole per minute

9. A gas gives off 1500. J of heat at the same time that it expands from 3.000 liters to 6.000 liters against a pressure of 1.500 atm. (1 L•atm = 101.0 J). What is the internal energy change of the gas?
- (A) -1955. J (D) +1045. J
(B) -1803. J (E) +1955. J
(C) -1045. J

10. Pressure cookers are used at high altitudes to cook food faster, which of the following statements pertaining to this fact is true?
- (A) The cooker holds water at a constant pressure at a higher atmosphere, resulting in hotter water.
(B) The cooker lowers the pressure on water causes it to boil at a higher temperature, allowing for hotter water.
(C) The cooker raises the pressure on water causing it to boil at a higher temperature, allowing for hotter water.
(D) The cooker forces the water to contain a higher concentration of dissolved gases, allowing for hotter water.
(E) The cooker forces the water to maintain constant density, allowing for hotter water.
11. A 50.0 mL aliquot of a sulfuric acid solution was treated with barium chloride and the resulting BaSO_4 was isolated and weighed. If 0.667 g of BaSO_4 was obtained, what was the molarity of the H_2SO_4 ?
- (A) 0.00700 M (D) 0.114 M
(B) 0.0286 M (E) 1.43 M
(C) 0.0572 M

12. A clear, colorless liquid in a beaker in a hood is heated at a constant rate. The liquid begins to boil at 110°C. The boiling temperature gradually increases to 115°C, at which time the heating is discontinued. The material in the beaker is probably a
- (A) pure element (D) heterogeneous solution
(B) pure compound (E) homogeneous solution
(C) a colloid

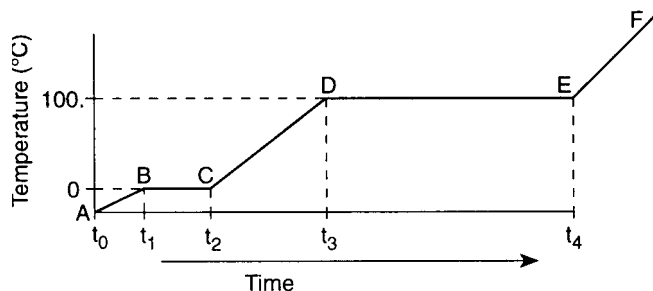
13.



What phase change is occurring from point A to point B?

- (A) Solidification (B) Condensation (C) Sublimation (D) Vaporization (E) Melting

14.



Look at the heating curve for a pure substance above. Which of the following is true about the substance from point D to E?

- (A) Kinetic energy is increasing; potential energy is decreasing
 (B) Kinetic energy is decreasing; potential energy is increasing
 (C) Kinetic energy is constant; potential energy is decreasing
 (D) Kinetic energy is constant; potential energy is increasing
 (E) Kinetic energy is increasing; potential energy is constant

15. The weight of HNO_3 (molecular weight 63.0) in 40.0 milliliters of 5.00-molar solution is

- (A) 5.6 g (D) 12.6 g
 (B) 8.7 g (E) 13.1 g
 (C) 10.4 g

16. Which of the following is the **weakest** acid?

- (A) HClO_3 (D) HClO_2
 (B) HClO_4 (E) HClO
 (C) HCl

17.

Which represents an acid-base reaction according to the Lewis definition but not the Bronsted-Lowry definition?

- (A) $\text{MgCl}_2(s) \leftrightarrow \text{Mg}^{2+}(aq) + 2\text{Cl}^-(aq)$
 (B) $\text{CN}^-(aq) + \text{H}_2\text{O}(l) \leftrightarrow \text{HCN}(aq) + \text{OH}^-(aq)$
 (C) $\text{NH}_3(g) + \text{HBr}(g) \leftrightarrow \text{NH}_4\text{Br}(s)$
 (D) $\text{Fe}(\text{H}_2\text{O})_6^{3+}(aq) + \text{H}_2\text{O}(l) \leftrightarrow [\text{Fe}(\text{H}_2\text{O})_5\text{OH}]^{2+}(aq) + \text{H}_3\text{O}^+(aq)$
 (E) $\text{HF}(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O}(l) + \text{F}^-(aq)$

18.

Acid	Base	K_a
$\text{H}_2\text{SO}_4 \leftrightarrow \text{H}^+ +$	HSO_4^-	Very Large
$\text{HSO}_4^- \leftrightarrow \text{H}^+ +$	SO_4^{2-}	1.2×10^{-2}
$\text{Fe}(\text{H}_2\text{O})_6^{3+} \leftrightarrow \text{H}^+ +$	$\text{Fe}(\text{H}_2\text{O})_5(\text{OH})^{2+}$	8.9×10^{-4}
$\text{H}_2\text{CO}_3 \leftrightarrow \text{H}^+ +$	HCO_3^-	4.3×10^{-7}
$\text{NH}_4^+ \leftrightarrow \text{H}^+ +$	NH_3	5.7×10^{-10}
$\text{HCO}_3^- \leftrightarrow \text{H}^+ +$	CO_3^{2-}	5.6×10^{-11}

A water solution of ions is prepared. Based on the K_a values above, which ions will react with the water to produce an acid solution at room temperature?

- I. Na^+
 II. Fe^{3+}
 III. NH_4^+
 IV. HCO_3^-
 V. HSO_4^-
- (A) I and II only (D) II, III, and V only
 (B) II and III only (E) III, IV, and V only
 (C) I, II, and III only

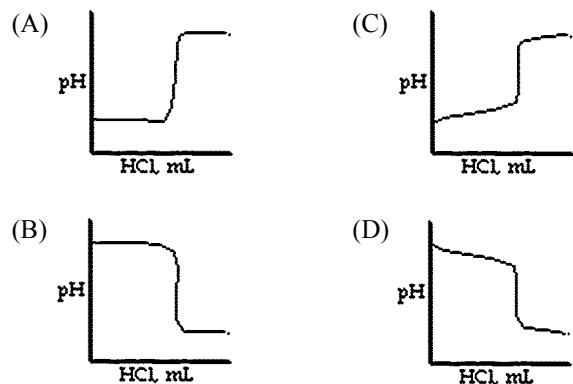
19. Consider the following:

- I. PO_4^{3-}
- II. HPO_4^{2-}
- III. H_2PO_4^-
- IV. H_3PO_4

The term amphiprotic can be used to describe

- (A) I only
- (B) I and II only
- (C) I, II and III only
- (D) II, III and IV only
- (E) II and III only

20. Which curve best represents the titration of NaOH with HCl?



21. A container is filled with 10.0 L of 0.050 M NaI. What is the maximum mass of solid $\text{Pb}(\text{NO}_3)_2$ that can be dissolved without forming a precipitate?

- (A) 1.1×10^{-2} g
- (B) 2.2×10^{-3} g
- (C) 3.2×10^{-4} g
- (D) 5.6×10^{-5} g
- (E) 5.6×10^{-7} g

22. $K_{sp} = 7.00 \times 10^{-9}$ for BaCO_3
 $K_{sp} = 9.90 \times 10^{-9}$ for CaCO_3

A 100. mL solution is 0.10 M with respect to $\text{Ca}(\text{NO}_3)_2$ and 0.10 M with respect to $\text{Ba}(\text{NO}_3)_2$. If 0.10 M K_2CO_3 is added to the solution in drops until a precipitation occurs, which of the following will occur?

- (A) Barium carbonate will be the only precipitate.
- (B) Calcium carbonate will be the only precipitate.
- (C) Both calcium and barium carbonate will precipitate.
- (D) Potassium nitrate and barium carbonate will precipitate.
- (E) Potassium nitrate and calcium carbonate will precipitate.

23. $\text{Mn}^{2+} + \text{IO}_3^- + \text{H}_2\text{O} \rightarrow \text{MnO}_4^- + \frac{1}{2}\text{I}_2 + 2\text{H}^+$

What is the reducing agent in the reaction above?

- (A) IO_3^-
- (B) H_2O
- (C) Mn^{2+}
- (D) H^+
- (E) I_2

24. A student mixes 100. mL of 1.00 M calcium hydroxide (aq) with 100. mL of 1.00 M aluminum nitrate (aq).

Assuming the hydroxide ion concentration becomes relatively small, which of the following is true about the increasing concentration of the remaining ions?

- (A) $[\text{Ca}^{2+}] < [\text{NO}_3^-] < [\text{Al}^{3+}]$
- (B) $[\text{Al}^{3+}] < [\text{NO}_3^-] < [\text{Ca}^{2+}]$
- (C) $[\text{NO}_3^-] < [\text{Al}^{3+}] < [\text{Ca}^{2+}]$
- (D) $[\text{Ca}^{2+}] < [\text{Al}^{3+}] < [\text{NO}_3^-]$
- (E) $[\text{Al}^{3+}] < [\text{Ca}^{2+}] < [\text{NO}_3^-]$

25. $__ \text{CuOH} + __ \text{O}_2 + __ \text{H}_2\text{O} \rightarrow __ \text{Cu}(\text{OH})_2$

If 2 moles of O_2 oxidizes CuOH according to the unbalanced equation above, how many moles of $\text{Cu}(\text{OH})_2$ can be formed?

- (A) 2
- (B) 4
- (C) 5
- (D) 6
- (E) 8

26. $\text{As}_2\text{O}_3 + 2\text{NO}_3^- + 2\text{H}_2\text{O} + 2\text{H}^+ \rightarrow 2\text{H}_3\text{AsO}_4 + \text{N}_2\text{O}_3$

In this reaction, nitrogen

- (A) loses electrons and increases in oxidation number
- (B) gains electrons and increases in oxidation number
- (C) loses electrons and decreases in oxidation number
- (D) gains electrons and decreases in oxidation number
- (E) maintains the number of electrons and the oxidation number

27. During the electrolysis of a solution of KCl, what substance is produced at the anode?

- (A) $\text{H}_2\text{O}(l)$
- (B) $\text{Cl}_2(g)$
- (C) $\text{O}_2(g)$
- (D) $\text{H}_2(g)$
- (E) $\text{K}(s)$

28. How long would it take, running a current of 9.65 amperes, to deposit 130. g of zinc from a solution of ZnF_2 ?

- (A) 4.00×10^4 s
- (B) 2.00×10^4 s
- (C) 1.00×10^4 s
- (D) 4.00×10^3 s
- (E) 2.00×10^3 s

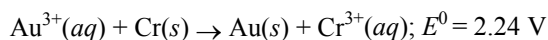
29. **STANDARD ELECTRODE POTENTIALS**
Ion Concentrations 1.0 M H_2O at 298 K, 1 atm

Half-Reaction	E° , volts
$\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}(s)$	-0.45
$\text{Zn}^{2+} + 2e^- \rightarrow \text{Zn}(s)$	-0.76

Which species is most readily oxidized?

- (A) e^-
- (B) Fe^{2+}
- (C) Fe^{3+}
- (D) $\text{Zn}(s)$
- (E) Zn^{2+}

30. Base your answer to the following question on the equation below.



Which of the following is true?

- (A) ΔG is positive and $K > 1$. (D) ΔG is negative and $K < 1$.
 (B) ΔG is positive and $K < 1$. (E) Both ΔG and K are zero.
 (C) ΔG is negative and $K > 1$.

31. **STANDARD ELECTRODE POTENTIALS**
Ion Concentrations 1.0 M H₂O at 298 K, 1 atm

Half-Reaction	E^0 , volts
$\text{Cl}_2(g) + 2e^- \rightarrow 2\text{Cl}^-$	+1.36
$\text{Hg}^{2+} + 2e^- \rightarrow \text{Hg}(l)$	+0.85
$2\text{H}^+ + 2e^- \rightarrow \text{H}_2(g)$	0.00
$\text{Co}^{2+} + 2e^- \rightarrow \text{Co}(s)$	-0.28
$\text{Cr}^{3+} + 3e^- \rightarrow \text{Cr}(s)$	-0.74
$2\text{H}_2\text{O} + 2e^- \rightarrow 2\text{OH}^- + \text{H}_2(g)$	-0.83
$\text{Al}^{3+} + 3e^- \rightarrow \text{Al}(s)$	-1.66
$\text{Ca}^{2+} + 2e^- \rightarrow \text{Ca}(s)$	-2.87

Based on the table above, which is true?

- I. Calcium is oxidized by water.
 II. Al metal reacts with water, Cr does not.
 III. Cobalt metal will react with $\text{HCl}(aq)$, liberating H_2 .
 IV. Mercury metal will react with $\text{HCl}(aq)$, liberating H_2 .
 (A) I and II only (D) I, III, and IV only
 (B) I and IV only (E) II and III only
 (C) I, II, and III only

32. What is the net ionic equation for the reaction between 1.0 M HNO_2 and 1.0 M NaOH ?

- (A) $\text{Na}^+ + \text{NO}_2^- \rightarrow \text{NaNO}_2$
 (B) $\text{H}^+ + \text{NaOH} \rightarrow \text{Na}^+ + \text{H}_2\text{O}$
 (C) $\text{HNO}_2 + \text{OH}^- \rightarrow \text{NO}_2^- + \text{H}_2\text{O}$
 (D) $\text{HNO}_2 + \text{NaOH} \rightarrow \text{NaNO}_2 + \text{H}_2\text{O}$
 (E) $\text{HNO}_2 + \text{OH}^- \rightarrow \text{NaNO}_2 + \text{H}_2\text{O}$

33. $_ \text{Fe}^{2+} + _ \text{MnO}_4^- + _ \text{H}^+ \rightarrow _ \text{Mn}^{2+} + _ \text{Fe}^{3+} + _ \text{H}_2\text{O}$

What is the coefficient for H_2O after the above equation is balanced and all the coefficients are in lowest terms?

- (A) 1 (D) 4
 (B) 2 (E) 5
 (C) 3

34. How much methane (CH_4) must be burned completely in air to produce 55 g of carbon dioxide?

- (A) 16. g (D) 64. g
 (B) 20. g (E) 80. g
 (C) 32. g

35. Which is the correct name for VO ?

- (A) vanadium(I) oxide (D) vanadium(IV) oxide
 (B) vanadium(II) oxide (E) vanadium(V) oxide
 (C) vanadium(III) oxide

36. The name corresponding to the formula Na_2SO_3 is

- (A) sodium sulfide (D) sodium sulfur trioxide
 (B) sodium sulfite (E) disodium sulfite
 (C) sodium sulfate

37. $\text{IO}_3^- + 5\text{I}^- + 2\text{H}^+ \leftrightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$

50.0 mL of 0.200 M IO_3^- is mixed with 20.0 mL of 0.250 M I^- in a solution that contains excess H^+ . What amount of I_2 will be formed according to the equation above?

- (A) 0.003 M (D) 0.150 M
 (B) 0.005 M (E) 0.008 M
 (C) 0.010 M

38. $2\text{MnO}_4^- + 5\text{H}_2\text{C}_2\text{O}_4 + 3\text{H}_2\text{SO}_4 \rightarrow 2\text{MnSO}_4 + 10\text{CO}_2 + 8\text{H}_2\text{O} + \text{K}_2\text{SO}_4$

According to the equation above, how many moles MnO_4^- of would be necessary to produce 20.0 moles of CO_2 , starting with 25.0 moles of $\text{H}_2\text{C}_2\text{O}_4$?

- (A) 4.00 moles (D) 2.00 moles
 (B) 25.0 moles (E) 8.00 moles
 (C) 20.0 moles

39. $2\text{HBr}(g) \leftrightarrow \text{H}_2(g) + \text{Br}_2(g)$

Initially, 0.100 mol HBr is placed into a 2.0 L container. At equilibrium, there are 0.040 mol HBr present. What is the equilibrium concentration of H_2 ?

- (A) 0.45 M (D) 0.030 M
 (B) 0.0050 M (E) 0.015 M
 (C) 0.010 M

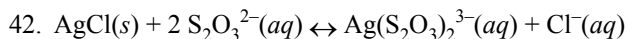
40. In which of the following reactions will an increase in pressure result in a shift to the RIGHT at equilibrium?

- (A) $2\text{NH}_3(g) \leftrightarrow 3\text{H}_2(g) + \text{N}_2(g)$
 (B) $\text{H}_2(g) + \text{Cl}_2(g) \leftrightarrow 2\text{HCl}(g)$
 (C) $\text{Cl}_2(g) \leftrightarrow 2\text{Cl}(g)$
 (D) $2\text{H}_2(g) + \text{O}_2(g) \leftrightarrow 2\text{H}_2\text{O}(g)$
 (E) $\text{Cl}_2\text{O}(g) \leftrightarrow \frac{1}{2}\text{O}_2(g) + \text{Cl}_2(g)$

41. $\text{N}_2\text{O}_4(g) + 58\text{kJ} \leftrightarrow 2\text{NO}_2(g)$

The reaction shifts to the right when

- (A) NO_2 is added
 (B) N_2O_4 is removed
 (C) the temperature is decreased
 (D) the pressure of the system is increased
 (E) the volume of the system is increased

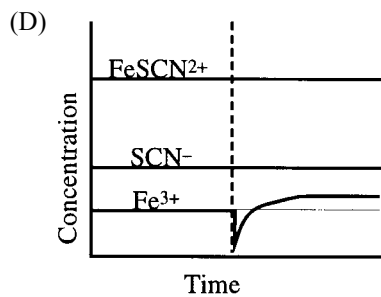
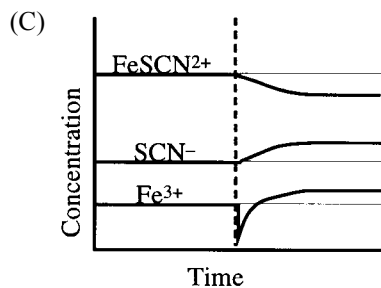
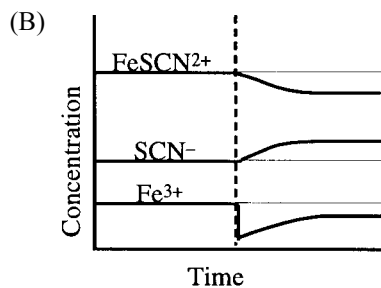
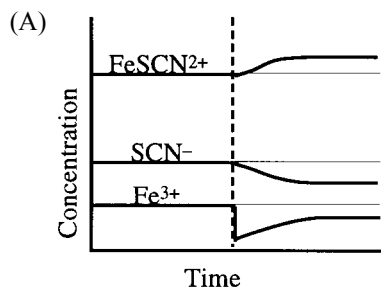


If more $\text{S}_2\text{O}_3^{2-}$ is added to the above system at equilibrium, the

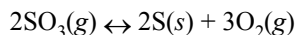
- (A) amount of $\text{AgCl}(s)$ increases
- (B) rate of forward reaction decreases
- (C) concentration of $\text{Cl}^-(aq)$ increases
- (D) concentration of $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}(aq)$ decreases
- (E) equilibrium cannot be reestablished



What happens to the concentrations of the three ions when some Fe^{3+} ion is removed by precipitation from the above aqueous solution, with the temperature remaining constant?



44. The following endothermic reaction occurs in a rigid container.



Which of the following causes more oxygen to be produced?

- I. Increase in pressure.
 - II. Increase in temperature.
 - III. Introduction of a catalyst.
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and II only
 - (E) I, II, and III

45. Which of the following reactions does NOT proceed significantly to the right?

- (A) $\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2 \text{H}_2\text{O}$
- (B) $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$
- (C) $\text{NH}_3 + \text{H}_3\text{O}^+ \rightarrow \text{NH}_4^+ + \text{H}_2\text{O}$
- (D) $\text{NH}_3 + \text{OH}^- \rightarrow \text{NH}_2^- + \text{H}_2\text{O}$
- (E) $\text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{HSO}_4^-$

46. A solution of 0.100 M HOCN has a pH of 2.24. What is the K_a value for this acid?

- (A) 3.3×10^{-4}
- (B) 4.2×10^{-3}
- (C) 1.5×10^{-2}
- (D) 1.2×10^{-2}
- (E) 2.0×10^{-1}

47. In a 100.0 mL sample of 0.0800 M NaOH the $[\text{H}_3\text{O}^+]$ is

- (A) $1.25 \times 10^{-13} \text{ M}$
- (B) $1.25 \times 10^{-12} \text{ M}$
- (C) $8.00 \times 10^{-1} \text{ M}$
- (D) $8.00 \times 10^{-2} \text{ M}$
- (E) $8.00 \times 10^{-3} \text{ M}$

48. The 0.10 M solution with the greatest electrical conductivity is

- (A) H_2S
- (B) H_2SO_4
- (C) H_2SO_3
- (D) HCOOH
- (E) H_2CO_3

49. The $[\text{H}_3\text{O}^+]$ in a solution of pH 0.60 is

- (A) $4.0 \times 10^{-14} \text{ M}$
- (B) $2.2 \times 10^{-1} \text{ M}$
- (C) $2.5 \times 10^{-1} \text{ M}$
- (D) $6.0 \times 10^{-1} \text{ M}$
- (E) $1.5 \times 10^{-1} \text{ M}$

50. What is the pOH of 3.50 M NaOH?

- (A) -14.54
- (B) 0.54
- (C) 13.46
- (D) 13.92
- (E) -0.54

51. What volume of water must be added to 50.0 mL of 0.100 M HCl to raise the pH to 2.00?

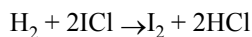
- (A) 450. mL
- (B) 500. mL
- (C) 550. mL
- (D) 50.0 mL
- (E) 45.0 mL

52. Which will form a buffer solution?
 (A) HBr and NaOH (D) H_2CO_3 and NaHCO_3
 (B) HCl and NH_4Cl (E) H_3PO_4 and Na_3PO_4
 (C) HNO_3 and NaNO_3

53.

Experimental $[\text{H}_2]$ (mol/L)	Initial $[\text{ICl}]$ (mol/L)	Initial Rate of Reaction (mol/s·L)
1	.30	.20
2	.30	9.0×10^{-3}
3	.10	1.0×10^{-3}

The above chart contains experimental data obtained from the following reaction:



What is the experimental rate law for this reaction?

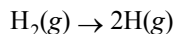
- (A) $\text{Rate} = k[\text{H}_2]/[\text{ICl}]$ (D) $\text{Rate} = k[\text{H}_2]^2[\text{ICl}]^2$
 (B) $\text{Rate} = k[\text{H}_2][\text{ICl}]$ (E) $\text{Rate} = k[\text{H}_2]^2[\text{ICl}]$
 (C) $\text{Rate} = k[\text{H}_2][\text{ICl}]^2$
54. The heat of combustion for $\text{CH}_6\text{O}_2\text{N}_2(\text{g})$ is -98 kcal.
 $\text{CH}_6\text{O}_2\text{N}_2(\text{g}) + 5/2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{NO}_2(\text{g}) + 3 \text{H}_2\text{O}(\text{g})$

Substance	ΔH_f° , kcal
$\text{CO}_2(\text{g})$	-94
$\text{H}_2\text{O}(\text{g})$	-48
$\text{NO}_2(\text{g})$	$+8.0$

What is the heat of formation for $\text{CH}_6\text{O}_2\text{N}_2(\text{g})$?

- (A) -216 kcal (D) $+124$ kcal
 (B) -182 kcal (E) -124 kcal
 (C) 182 kcal
55. $12\text{O}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) + 243$ kJ
 $12\text{O}_2(\text{g}) + 2\text{H}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) + 661$ kJ

Given the above two equations, how much energy is needed to dissociate 1.00 mole of H_2 according to the equation below?



- (A) 243 kJ (D) 904. kJ
 (B) 418 kJ (E) 1320 kJ
 (C) 661. kJ

56. Which reaction has the largest decrease in entropy?

- (A) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$
 (B) $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$
 (C) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2 \text{HI}(\text{g})$
 (D) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$
 (E) $\text{C}_{\text{charcoal}} \rightarrow \text{C}_{\text{graphite}}$

57. $4 \text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{Cl}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$

The above reaction is not spontaneous at 700 K but is at lower temperatures. Which of the following describes the reaction at 700 K?

- (A) ΔG , ΔH , and ΔS are positive
 (B) ΔG , ΔH , and ΔS are negative
 (C) ΔG and ΔS are negative; ΔH is positive
 (D) ΔG and ΔH are negative; ΔS is positive
 (E) ΔG and ΔS are positive; ΔH is negative
58. Which compound dissolves in water to form a clear solution?
 (A) CrCl_2 (D) CoCl_2
 (B) LiCl (E) NiCl_2
 (C) FeCl_3
59. Which of the following is true about the halogens?
 (A) Fluorine is the least electronegative element.
 (B) Bromine liberates free chlorine from a solution of chloride ions.
 (C) Ionization energy increases with increasing atomic number.
 (D) Fluorine has the smallest atomic radius.
 (E) They combine with Group I metals to form compounds of the form XY_2 .

60. Base your answer to the following question on the atomic numbers given below

- (A) 9
 (B) 10
 (C) 46
 (D) 51
 (E) 84

Which element does not form compounds?

- (A) A (D) D
 (B) B (E) E
 (C) C

61. Which of the following substances has the smallest dipole moment?

- (A) HF (D) HCN
 (B) NaCl (E) H_2O
 (C) SF_6

62. The solution with the highest pH is

- (A) 1.0 M NaCl (D) 1.0 M Na_2SO_3
 (B) 1.0 M NaCN (E) 1.0 M NaF
 (C) 1.0 M NaIO_3

63. The pressure on a sample of gas is increased from 100 kPa to 130 kPa at constant temperature. Which of the following increases?

- I. The density of the gas
 - II. The average distance between molecules
 - III. The average speed of the molecules.
- (A) I only (D) I and II only
 (B) III only (E) I, II, and III
 (C) I and III only

64. The temperature of a sample of xenon atoms is raised from 50°C to 90°C. Which of the following statements is true about the average kinetic energy of the atoms?

- (A) The average kinetic energy does not change.
 (B) The average kinetic energy of the sample increased by a factor of 363/323.
 (C) The average kinetic energy of the sample increased by a factor of 9/5.
 (D) The average kinetic energy increased by a factor of 81/25.
 (E) More information is needed to know whether the average kinetic energy changed.

65. Of the following organic compounds, which is LEAST soluble in water at 298 K?

- (A) C₆H₆, benzene
 (B) CH₃Cl, chloromethane
 (C) C₂H₅OH, ethanol
 (D) C₂H₅COOH, propanoic acid
 (E) C₅H₁₀O₅, fructose

66. $\text{Cr}_2\text{O}_7^{2-} + 6\text{Br}^- + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{Br}_2 + 7\text{H}_2\text{O}$

In a redox titration, 15.58 mL of 0.125 M Cr₂O₇²⁻ was needed to completely oxidize the Br⁻ in a 25.00 mL sample of NaBr. What is the [Br⁻] in the original solution?

- (A) 1.95 × 10⁻³ M (D) 6.21 × 10⁻⁵ M
 (B) 4.67 × 10⁻¹ M (E) 7.18 × 10⁻⁶ M
 (C) 5.22 × 10⁻⁴ M

67. Why does an abrupt color change take place when phenolphthalein is used as an indicator in the titration of a strong acid and a strong base?

- (A) When enough base is added to the solution, phenolphthalein acts as a catalyst for the color change.
 (B) Phenolphthalein changes the rate of reaction, causing a color change.
 (C) As the solution being titrated approaches its end point, a large change in pH takes place.
 (D) The phenolphthalein is consumed by the strong base and is removed from the titration.
 (E) Since phenolphthalein is strong base, it changes color when it reacts with another strong base.

68. Two cells, one containing MnCl₃ and the other containing CuNO₃ are connected in series. How much copper is deposited in the time that 82.5 g of manganese is deposited.

- (A) 54.0 g (D) 324.0 g
 (B) 108.0 g (E) 648.0 g
 (C) 162.0 g

69. $\text{NH}_4^+(aq) + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+(aq) + \text{NH}_3(aq)$

When a few drops of HCl are added,

- (A) both the [NH₃] and the [NH₄⁺] increase
 (B) both the [NH₃] and the [NH₄⁺] decrease
 (C) the [NH₃] decreases and the [NH₄⁺] increases
 (D) the [NH₃] increases and the [NH₄⁺] decreases
 (E) the [NH₃] increases and the [NH₄⁺] remains constant

70. When added to water, the hydrogen carbonate ion produces a solution which is

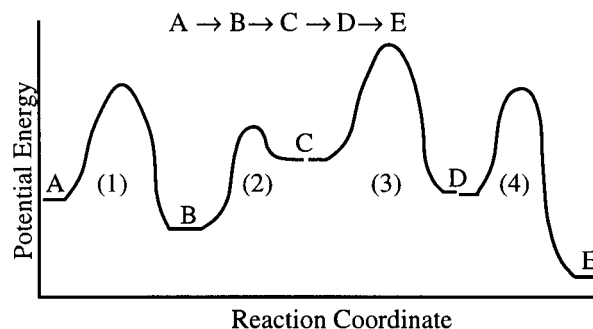
- (A) basic because K_b is greater than K_a
 (B) basic because K_a is greater than K_b
 (C) acidic because K_b is greater than K_a
 (D) basic because K_a is greater than K_b
 (E) acidic because K_a is equal to K_b

71. $\text{HMo} + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{Mo}^-$

Which relationship is true at the transition point for methyl orange indicator (HMo)?

- (A) [HMo] > [Mo⁻] (D) [HMo] ↔ [H₃O⁺]
 (B) [HMo] = [Mo⁻] (E) [HMo] > [H₃O⁺]
 (C) [HMo] < [Mo⁻]

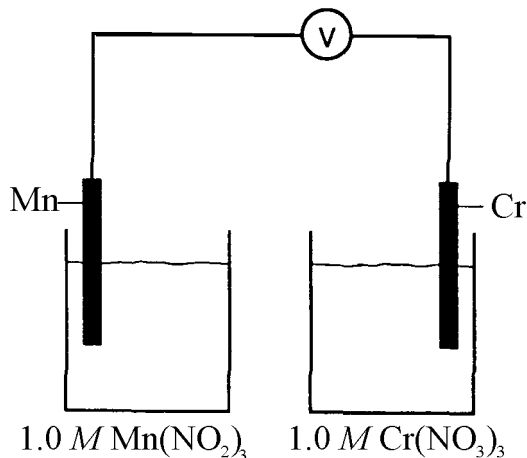
72.



Which is the “rate determining step” for the above hypothetical reaction mechanism of the overall reaction A → E?

- (A) step 1
 (B) step 2
 (C) step 3
 (D) step 4
 (E) the rate determining step cannot be determined

73. A galvanic cell is constructed using a manganese electrode in a 1.00-molar solution of $\text{Mn}(\text{NO}_3)_2$ and a chromium electrode in a 1.00-molar solution of $\text{Cr}(\text{NO}_3)_3$. Both solutions are at 25°C and a partial diagram of the cell is shown below.



- (a) Write a balanced equation for the spontaneous overall reaction that occurs in this cell and identify the oxidizing and reducing agents.
- (b)
- Which metal is the anode?
 - Which additional component is necessary to make the cell operate?
 - What is the function of this component?
- (c) How will the potential of this cell change if the concentration of $\text{Mn}(\text{NO}_3)_2$ is increased to 2.00 molar?
74. Triple beam balance Graduated cylinder
 Thermometer Stirring rod
 Empty Beaker Bunsen Burner
 Flask with distilled H_2O Ringstand Container of unknown substance

An experiment is set up to determine the molecular mass of a water-soluble, nonvolatile, non-electrolyte. The equipment listed above is available to use. No other equipment is available.

- Briefly list the steps needed to carry out this experiment.
 - What experimental data needs to be collected to calculate the molecular mass of the unknown substance?
 - List the calculations necessary to determine the molecular mass of the unknown substance.
 - What changes would have to be made if the substance was an electrolyte?
75. Explain each of the following observations using principles of atomic structure and/or bonding.
- Calcium has a lower first ionization energy than beryllium.
 - The ionic radius of a Br^- ion is smaller than that of a Se^{2-} ion.
 - Magnesium has a higher first ionization energy than aluminum.
 - A strontium atom is larger than a cadmium ion.

Answer Key

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

31. C
32. C
33. D
34. B
35. B
36. B
37. A
38. A
39. E
40. D
41. E
42. C
43. A
44. B
45. D
46. A
47. A
48. B
49. C
50. E
51. A
52. D
53. E
54. E
55. B
56. B
57. B
58. B
59. D
60. B

Answer Key

61. C 62. B 63. A 64. B 65. A 66. B 67. C 68. D 69. C 70. A 71. B 72. C 73. (a) $3 \text{Mn} + 2 \text{Cr}^{3+} \rightarrow 3 \text{Mn}^{2+} + 2 \text{Cr}$

(b) (i) Mn

(ii) a salt bridge

(iii) allows the migration of ions (not electrons)

(c) It would decrease.

74. (a) • mass empty beaker.

• pour some water into beaker.

• mass beaker with water.

• mass container of unknown substance.

• add some of substance to beaker.

• mass container of unknown substance.

• stir beaker to dissolve substance.

• place beaker on ring stand.

• place thermometer in beaker.

• heat beaker with bunsen burner until it boils.

(b) • mass of empty beaker.

• mass of beaker with water.

• initial mass of container of unknown substance.

• final mass of container of unknown substance.

• boiling point of solution.

(c) (mass of beaker with water) – (mass of empty beaker) = (mass of water)

(final mass of container of unknown substance) – (initial mass of container of unknown substance) = (mass of unknown substance)

(boiling point of solution) – 100°C = (temperature change)

(temperature change) × 1.86 = molality

(molality) × (mass of water) = (moles of substance)

(mass of substance) ÷ (moles of substance) = molecular mass of substance.

(d) One would have to divide the molarity of the solution by the number of particles the substance ionizes into.

75. (a) A valence electron in calcium is much further from the nucleus than in beryllium, and thus requires less energy to remove.

(b) Though the species are isoelectronic, bromine has a greater nuclear charge, thus causing the electron shells to contract.

(c) The 3p electron in aluminum is shielded by the completed 3s orbital and is thus easier to remove.

(d) Though cadmium has 10 more electrons, they fill an inner d-sublevel, and thus do not contribute to size. The greater nuclear charge in cadmium causes it to be smaller than a strontium atom.

Eduware Genealogy by Question

Displaying UNIT CHAPTER TOPIC SUBTOPIC QUESTION ID

1. I. STRUCTURE OF MATTER / A. Atomic Theory and Atomic Structure / 2. Electron Energy Levels / c. Atomic orbitals : 0002037
2. I. STRUCTURE OF MATTER / A. Atomic Theory and Atomic Structure / 2. Electron Energy Levels / c. Atomic orbitals : 0001192
3. I. STRUCTURE OF MATTER / B. Chemical Bonding / 2. Molecular Models / a. Lewis structures : 0001962
4. I. STRUCTURE OF MATTER / B. Chemical Bonding / 2. Molecular Models / b. Orbital hybridization and molecular orbitals : 0001325
5. I. STRUCTURE OF MATTER / B. Chemical Bonding / 3. Geometry of Molecules and Ions / a. Basic geometry : 0000280
6. I. STRUCTURE OF MATTER / C. Nuclear Chemistry / 1. Nuclear Equations / a. Half life : 0001357
7. I. STRUCTURE OF MATTER / C. Nuclear Chemistry / 1. Nuclear Equations / b. Predicting products : 0001751
8. II. STATES OF MATTER / A. Gases / 1. Laws of Ideal Gases / a. Equation of state for an ideal gas : 0000296
9. II. STATES OF MATTER / A. Gases / 1. Laws of Ideal Gases / a. Equation of state for an ideal gas : 0000481
10. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 1. Phase Diagrams and Changes of State / a. Normal boiling point : 0002029
11. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 2. Solutions / b. Concentrations : 0001164
12. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 2. Solutions / a. General properties : 0001820
13. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 1. Phase Diagrams and Changes of State / b. Triple point : 0001420
14. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 1. Phase Diagrams and Changes of State / c. Changes of state : 0001418
15. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 2. Solutions / b. Concentrations : 0001186
16. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / a. Definitions and nature of acids and bases : 0000871
17. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / a. Definitions and nature of acids and bases : 0001137
18. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / b. Strengths of acids and bases : 0001571
19. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / c. Amphoterism : 0000969
20. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / d. Titration : 0001851
21. III. REACTIONS / A. Reaction Types / 2. Precipitation Reactions / a. What is the precipitate : 0001090
22. III. REACTIONS / A. Reaction Types / 2. Precipitation Reactions / a. What is the precipitate : 0001481
23. III. REACTIONS / A. Reaction Types / 3. Oxidation-Reduction Reactions / b. The Role of the electron in oxidation-reduction : 0001048
24. III. REACTIONS / A. Reaction Types / 2. Precipitation Reactions / b. Equilibrium : 0001387
25. III. REACTIONS / A. Reaction Types / 3. Oxidation-Reduction Reactions / c. Balancing : 0000302
26. III. REACTIONS / A. Reaction Types / 3. Oxidation-Reduction Reactions / b. The Role of the electron in oxidation-reduction : 0000855
27. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / a. Electrolytic and galvanic cells : 0000375
28. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / b. Faraday's laws : 0000295
29. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / c. Standard half-cell potentials : 0001546
30. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / c. Standard half-cell potentials : 0000115
31. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / c. Standard half-cell potentials : 0001559
32. III. REACTIONS / B. Stoichiometry / 1. Ionic & Molecular Species in Chemical Systems / a. Net ionic equations : 0001046
33. III. REACTIONS / B. Stoichiometry / 2. Balancing of Equations / a. Balancing of equations : 0002058
34. III. REACTIONS / B. Stoichiometry / 3. Mass and Volume Relations / a. Mole concept : 0000319
35. III. REACTIONS / B. Stoichiometry / 3. Mass and Volume Relations / b. Empirical formulas : 0001702
36. III. REACTIONS / B. Stoichiometry / 3. Mass and Volume Relations / b. Empirical formulas : 0001782
37. III. REACTIONS / B. Stoichiometry / 3. Mass and Volume Relations / c. Limiting reactants : 0001259
38. III. REACTIONS / B. Stoichiometry / 3. Mass and Volume Relations / c. Limiting reactants : 0001367
39. III. REACTIONS / C. Equilibrium / 1. Concept of Dynamic Equilibrium / b. Chemical : 0000911
40. III. REACTIONS / C. Equilibrium / 2. Le Chatelier's Principle / a. Pressure : 0001209
41. III. REACTIONS / C. Equilibrium / 2. Le Chatelier's Principle / a. Pressure : 0001032
42. III. REACTIONS / C. Equilibrium / 2. Le Chatelier's Principle / b. Concentration : 0001605
43. III. REACTIONS / C. Equilibrium / 2. Le Chatelier's Principle / b. Concentration : 0001635
44. III. REACTIONS / C. Equilibrium / 2. Le Chatelier's Principle / c. Temperature : 0001939
45. III. REACTIONS / C. Equilibrium / 4. Solution Equilibria / a. Solubility product constants : 0000162
46. III. REACTIONS / C. Equilibrium / 4. Solution Equilibria / a. Solubility product constants : 0000838
47. III. REACTIONS / C. Equilibrium / 4. Solution Equilibria / b. Dissolution of slightly soluble compounds : 0000827
48. III. REACTIONS / C. Equilibrium / 4. Solution Equilibria / b. Dissolution of slightly soluble compounds : 0001105
49. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / a. pK/pH : 0000805
50. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / a. pK/pH : 0000893
51. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / a. pK/pH : 0001486
52. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / b. Buffers : 0001863
53. III. REACTIONS / D. Kinetics / 1. Reaction Rates / b. Rate laws : 0002004
54. III. REACTIONS / E. Thermodynamics / 1. First Law / a. Change in enthalpy : 0000496
55. III. REACTIONS / E. Thermodynamics / 1. First Law / b. Heat of formation : 0001640
56. III. REACTIONS / E. Thermodynamics / 2. Second Law / a. Entropy : 0000499
57. III. REACTIONS / E. Thermodynamics / 2. Second Law / c. Spontaneity : 0000284

Eduware Genealogy by Question

58. IV. DESCRIPTIVE CHEMISTRY / A. Specific Chemicals and Elements / 1. Specific Chemicals and Elements / a. Alkali metals : 0001936
59. IV. DESCRIPTIVE CHEMISTRY / A. Specific Chemicals and Elements / 1. Specific Chemicals and Elements / c. Halogens : 0000277
60. IV. DESCRIPTIVE CHEMISTRY / A. Specific Chemicals and Elements / 1. Specific Chemicals and Elements / e. Noble gases : 0000342
61. I. STRUCTURE OF MATTER / B. Chemical Bonding / 3. Geometry of Molecules and Ions / b. Dipole moments of molecules : 0001338
62. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / a. pK/pH : 0001085
63. II. STATES OF MATTER / A. Gases / 1. Laws of Ideal Gases / a. Equation of state for an ideal gas : 0000266
64. II. STATES OF MATTER / A. Gases / 2. Kinetic-Molecular Theory / b. Dependence on absolute temperature : 0001249
65. II. STATES OF MATTER / B. Solids, Liquids and Solutions / 2. Solutions / a. General properties : 0000056
66. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / d. Titration : 0001029
67. III. REACTIONS / A. Reaction Types / 1. Acid-Base Reactions / d. Titration : 0001219
68. III. REACTIONS / A. Reaction Types / 4. Electrochemistry / b. Faraday's laws : 0000385
69. III. REACTIONS / C. Equilibrium / 4. Solution Equilibria / c. Common ion effect : 0000831
70. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / a. pK/pH : 0000989
71. III. REACTIONS / C. Equilibrium / 5. Acid Base Equilibria / c. Hydrolysis : 0001836
72. III. REACTIONS / D. Kinetics / 3. Reaction Mechanisms / a. Rate determining step : 0001580
73. III. REACTIONS / F. Part 2 Questions (Unit III) / 1. Part 2 Questions (Unit III) / a. Part 2 Questions : 0000567
74. V. LABORATORY / C. Part 2 Questions (Unit V) / 1. Part 2 Questions (Unit V) / a. Part 2 Questions (Unit V) : 0000548
75. I. STRUCTURE OF MATTER / D. Part 2 Questions (Unit I) / 1. Part 2 Questions (Unit I) / a. Part 2 Questions : 0000545

Eduware Genealogy by Category

- 2: I. STRUCTURE OF MATTER\A. Atomic Theory and Atomic Structure\2. Electron Energy Levels\c. Atomic orbitals - (1, 2)
- 1: I. STRUCTURE OF MATTER\B. Chemical Bonding\2. Molecular Models\a. Lewis structures - (3)
- 1: I. STRUCTURE OF MATTER\B. Chemical Bonding\2. Molecular Models\b. Orbital hybridization and molecular orb - (4)
- 1: I. STRUCTURE OF MATTER\B. Chemical Bonding\3. Geometry of Molecules and Ions\a. Basic geometry - (5)
- 1: I. STRUCTURE OF MATTER\B. Chemical Bonding\3. Geometry of Molecules and Ions\b. Dipole moments of molecules - (61)
- 1: I. STRUCTURE OF MATTER\C. Nuclear Chemistry\1. Nuclear Equations\a. Half life - (6)
- 1: I. STRUCTURE OF MATTER\C. Nuclear Chemistry\1. Nuclear Equations\b. Predicting products - (7)
- 1 I. STRUCTURE OF MATTER\D. Part 2 Questions (Unit I)\1. Part 2 Questions (Unit I)\a. Part 2 Questions - (75)
- 2: II. STATES OF MATTER\B. Solids, Liquids and Solutions\2. Solutions\a. General properties - (12, 65)
- 1: II. STATES OF MATTER\B. Solids, Liquids and Solutions\1. Phase Diagrams and Changes of State\b. Triple point - (13)
- 1: II. STATES OF MATTER\B. Solids, Liquids and Solutions\1. Phase Diagrams and Changes of State\c. Changes of state - (14)
- 3: II. STATES OF MATTER\A. Gases\1. Laws of Ideal Gases\a. Equation of state for an ideal gas - (8, 9, 63)
- 2: II. STATES OF MATTER\B. Solids, Liquids and Solutions\2. Solutions\b. Concentrations - (11, 15)
- 1: II. STATES OF MATTER\A. Gases\2. Kinetic-Molecular Theory\b. Dependence on absolute temperature - (64)
- 1: II. STATES OF MATTER\B. Solids, Liquids and Solutions\1. Phase Diagrams and Changes of State\c. Normal boiling point - (10)
- 2: III. REACTIONS\A. Reaction Types\1. Acid-Base Reactions\c. Definitions and nature of acids and bas - (16, 17)
- 3: III. REACTIONS\A. Reaction Types\1. Acid-Base Reactions\c. Titration - (20, 66, 67)
- 1: III. REACTIONS\A. Reaction Types\2. Precipitation Reactions\b. Equilibrium - (24)
- 2: III. REACTIONS\A. Reaction Types\2. Precipitation Reactions\c. What is the precipate - (21, 22)
- 2: III. REACTIONS\A. Reaction Types\3. Oxidation-Reduction Reactions\b. The Role of the electron in oxidation-r - (23, 26)
- 1: III. REACTIONS\A. Reaction Types\3. Oxidation-Reduction Reactions\c. Balancing - (25)
- 1: III. REACTIONS\A. Reaction Types\4. Electrochemistry\c. Electrolytic and galvanic cells - (27)
- 3: III. REACTIONS\A. Reaction Types\4. Electrochemistry\b. Faraday's laws - (28, 68)
- 2: III. REACTIONS\A. Reaction Types\4. Electrochemistry\c. Standard half-cell potentials - (29, 30, 31)
- 1: III. REACTIONS\B. Stoichiometry\1. Ionic & Molecular Species in Chemical S\c. Net ionic equations - (32)
- 1: III. REACTIONS\B. Stoichiometry\2. Balancing of Equations\c. Balancing of equations - (33)
- 1: III. REACTIONS\B. Stoichiometry\3. Mass and Volume Relations\c. Mole concept - (34)
- 2: III. REACTIONS\B. Stoichiometry\3. Mass and Volume Relations\b. Empirical formulas - (35, 36)
- 2: III. REACTIONS\B. Stoichiometry\3. Mass and Volume Relations\c. Limiting reactants - (37, 38)
- 1: III. REACTIONS\C. Equilibrium\1. Concept of Dynamic Equilibrium\b. Chemical - (39)
- 2: III. REACTIONS\C. Equilibrium\2. Le Chatelier's Principle\c. Pressure - (40, 41)
- 2: III. REACTIONS\C. Equilibrium\2. Le Chatelier's Principle\b. Concentration - (42, 43)
- 1: III. REACTIONS\C. Equilibrium\2. Le Chatelier's Principle\c. Temperature - (44)
- 2: III. REACTIONS\C. Equilibrium\4. Solution Equilbria\c. Solubility product constants - (45, 46)
- 2: III. REACTIONS\C. Equilibrium\4. Solution Equilbria\b. Dissolution of slightly soluble compoun - (47, 48)
- 5: III. REACTIONS\C. Equilibrium\5. Acid Base Equilibria\c. pK/pH - (49, 50, 51, 62, 70)
- 1: III. REACTIONS\C. Equilibrium\5. Acid Base Equilibria\b. Buffers - (52)
- 1: III. REACTIONS\D. Kinetics\1. Reaction Rates\b. Rate laws - (53)
- 1: III. REACTIONS\E. Thermodynamics\1. First Law\c. Change in enthalpy - (54)
- 1: III. REACTIONS\E. Thermodynamics\1. First Law\b. Heat of formation - (55)
- 1: III. REACTIONS\E. Thermodynamics\2. Second Law\c. Entropy - (56)
- 1: III. REACTIONS\E. Thermodynamics\2. Second Law\c. Spontaneity - (57)
- 1: III. REACTIONS\A. Reaction Types\1. Acid-Base Reactions\b. Strengths of acids and bases - (18)
- 1: III. REACTIONS\C. Equilibrium\4. Solution Equilbria\c. Common ion effect - (69)
- 1: III. REACTIONS\C. Equilibrium\5. Acid Base Equilibria\c. Hydrolysis - (71)
- 1: III. REACTIONS\D. Kinetics\3. Reaction Mechanisms\c. Rate determining step - (72)
- 1: III. REACTIONS\F. Part 2 Questions (Unit III)\1. Part 2 Questions (Unit III)\a. Part 2 Questions - (73)
- 1: III. REACTIONS\A. Reaction Types\1. Acid-Base Reactions\c. Amphoterism - (19)
- 1: IV. DESCRIPTIVE CHEMISTRY\A. Specific Chemicals and Elements\1. Specific Chemicals and Elements\c. Alkali metals - (58)
- 1: IV. DESCRIPTIVE CHEMISTRY\A. Specific Chemicals and Elements\1. Specific Chemicals and Elements\c. Halogens - (59)
- 1: IV. DESCRIPTIVE CHEMISTRY\A. Specific Chemicals and Elements\1. Specific Chemicals and Elements\c. Noble gasses - (60)
- 1: V. LABORATORY\C. Part 2 Questions (Unit V)\1. Part 2 Questions (Unit V)\a. Part 2 Questions (Unit V) - (74)

AP Chemistry Sample Exam

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AP Chemistry Sample Exam

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