- 1. An unknown substance dissolves readily in water but not in benzene (a nonpolar solvent). Molecules of what type are present in the substance?
 - a) neither polar nor nonpolar
 - b) polar
 - c) either polar or nonpolar
 - d) nonpolar
 - e) none of these

SECTION: 4.1

LEVEL: medium

Conceptual

- 2. [Algorithmic] A 20.0-g sample of HF is dissolved in water to give 2.0×10^2 mL of solution. The concentration of the solution is:
 - a) 1.0 M
 - b) 3.0 M
 - c) 0.10 M
 - d) 5.0 M
 - e) 10.0 M

ANS: d)

SECTION: 4.3

LEVEL: medium

- 3. 1.00 mL of a 3.50×10^{-4} M solution of oleic acid is diluted with 9.00 mL of petroleum ether, forming solution A. 2.00 mL of solution A is diluted with 8.00 mL of petroleum ether, forming solution B. How many grams of oleic acid are 5.00 mL of solution B? (molar mass for oleic acid = 282 g/mol)
 - a) 4.94×10^{-4} g
 - b) 7.00×10^{-6} g
 - c) 4.94×10^{-5} g
 - d) 1.97×10^{-6} g
 - e) 9.87×10^{-6} g

ANS: e)

SECTION: 4.3

LEVEL: hard

- 4. [Algorithmic] How many grams of NaCl are contained in 350. mL of a 0.250 M solution of sodium chloride?
 - a) 41.7 g
 - b) 5.11 g
 - c) 14.6 g
 - d) 87.5 g
 - e) none of these

ANS: b)

SECTION: 4.3

- 5. Which of the following aqueous solutions contains the greatest number of ions?
 - a) 400.0 mL of 0.10 M NaCl
 - b) 300.0 mL of 0.10 M CaCl₂
 - c) 200.0 mL of 0.10 M FeCl₃
 - d) 200.0 mL of 0.10 M KBr
 - e) 800.0 mL of 0.10 M sucrose

SECTION: 4.3

LEVEL: medium

- 6. **[Algorithmic]** What mass of calcium chloride, CaCl₂, is needed to prepare 2.850 L of a 1.56 M solution?
 - a) 25.9 g
 - b) 60.8 g
 - c) 111 g
 - d) 203 g
 - e) 493 g

ANS: e)

SECTION: 4.3

LEVEL: medium

- 7. **[Algorithmic]** A 54.8 g sample of SrCl₂ is dissolved in 112.5 mL of solution. Calculate the molarity of this solution.
 - a) 0.346 M
 - b) 3.07 M
 - c) 3.96 M
 - d) 8.89 M
 - e) none of these

ANS: b)

SECTION: 4.3

LEVEL: medium

- 8. [Algorithmic] What mass of solute is contained in 256 mL of a 0.895 M ammonium chloride solution?
 - a) 12.3 g
 - b) 13.7 g
 - c) 47.9 g
 - d) 53.5 g
 - e) none of these

ANS: a)

SECTION: 4.3

- 9. [Algorithmic] A 51.24-g sample of Ba(OH)₂ is dissolved in enough water to make 1.20 liters of solution. How many mL of this solution must be diluted with water in order to make 1.00 liter of 0.100 molar Ba(OH)₂?
 - a) 400. mL
 - b) 333 mL
 - c) 278 mL
 - d) $1.20 \times 10^3 \, mL$
 - e) 285 mL

ANS: a)

SECTION: 4.3

LEVEL: medium

- 10. **[Algorithmic]** What volume of 18.0 M sulfuric acid must be used to prepare 15.5 L of 0.195 M H₂SO₄?
 - a) 168 mL
 - b) 0.336 L
 - c) 92.3 mL
 - d) 226 mL
 - e) none of these

ANS: a)

SECTION: 4.3

LEVEL: medium

- 11. [Algorithmic] How many grams of NaOH are contained in 5.0×10^2 mL of a 0.80 M sodium hydroxide solution?
 - a) 16 g
 - b) 80. g
 - c) 20. g
 - d) 64 g
 - e) 410 g

ANS: a)

SECTION: 4.3

LEVEL: medium

- 12. [Algorithmic] A 230.0-mL sample of a 0.275 M solution is left on a hot plate overnight; the following morning the solution is 1.10 M. What volume of solvent has evaporated from the 0.275 M solution?
 - a) 58.0 mL
 - b) 63.3 mL
 - c) 172 mL
 - d) 230. mL
 - e) 288 mL

ANS: c)

SECTION: 4.3

13. The net ionic equation for the reaction of aluminum sulfate and sodium hydroxide contains which of the following species?

	 a) 3Al³⁺(aq) b) OH⁻(aq) c) 3OH⁻(aq) d) 2Al³⁺(aq) e) 2Al(OH)₃(s) 		
	ANS: c)	SECTION: 4.6,8	LEVEL: medium
14.	The net ionic equation contains which of the feature $Ca^{2+}(aq)$	for the reaction of calcium bromide a ollowing species?	and sodium phosphate
	c) $2Ca_3(PO_4)2(s)$ d) $6NaBr(aq)$ e) $3Ca^{2+}(aq)$		
	ANS: e)	SECTION: 4.6,8	LEVEL: medium
15.	Which of the following a) HF b) KOH c) HClO ₄ d) HClO e) HBrO ANS: c)	is a strong acid?	I FVFI · easy
16.	All of the following are a) HCNO b) HBr c) HF d) HNO ₂ e) HCN ANS: b)	weak acids <i>except</i>	LEVEL: easy
17.	 Which of the following a) Ca(OH)₂ b) KOH c) NH₃ d) LiOH 	is <i>not</i> a strong base?	
	e) $Sr(OH)_2$ ANS: c)	SECTION: 4.2	LEVEL: easy

- 18. Which of the following is paired incorrectly?
 - a) HI strong acid
 - b) HNO_3 weak acid
 - c) $Ba(OH)_2$ strong base
 - d) HBr strong acid
 - e) NH_3 weak acid

SECTION: 4.2

LEVEL: easy

- 19. The interaction between solute particles and water molecules, which tends to cause a salt to fall apart in water, is called
 - a) hydration.
 - b) polarization.
 - c) dispersion.
 - d) coagulation.
 - e) conductivity.

ANS: a)

SECTION: 4.1

LEVEL: easy

- 20. Consider two organic molecules, ethanol and benzene. One dissolves in water and the other does not. Why?
 - a) They have different molar masses.
 - b) One is ionic, the other is not.
 - c) One is an electrolyte, the other is not.
 - d) Ethanol contains a polar O H bond, and benzene does not.
 - e) Two of these.

ANS: d) SECTION: 4.1,2 LEVEL: easy

Conceptual

- 21. When sodium chloride and lead(II) nitrate react in an aqueous solution, which of the following terms will be present in the balanced molecular equation?
 - a) PbCl(s)
 - b) Pb₂Cl(s)
 - c) NaNO₃(aq)
 - d) 2NaNO₃(aq)
 - e) 2PbCl₂(s)

ANS: d)

SECTION: 4.5,6

- 22. When solutions of phosphoric acid and iron(III) nitrate react, which of the following terms will be present in the balanced molecular equation?
 - a) HNO₃(aq)
 - b) 3HNO₃(aq)
 - c) 2FePO₄(s)
 - d) 3FePO₄(s)
 - e) 2HNO₃(aq)

SECTION: 4.5,6

LEVEL: medium

- 23. When solutions of cobalt(II) chloride and carbonic acid react, which of the following terms will be present in the net ionic equation?
 - a) $CoCO_3(s)$
 - b) $H^+(aq)$
 - c) $2C_0CO_3(s)$
 - d) 2Cl-(aq)
 - e) two of these

ANS: a)

SECTION: 4.5,6

LEVEL: medium

- 24. You have exposed electrodes of a light bulb in a solution of H_2SO_4 such that the light bulb is on. You add a dilute solution and the bulb grows dim. Which of the following could be in the solution?
 - a) Ba(OH)₂
 - b) NaNO₃
 - c) K₂SO₄
 - d) $Ca(NO_3)_2$
 - e) none of these

ANS: a)

SECTION: 4.2,5,8

LEVEL: medium

Conceptual

- 25. You mix 260. mL of 1.20 M lead(II) nitrate with 300. mL of 1.90 M potassium iodide. The lead(II) iodide is insoluble. Which of the following is false?
 - a) The final concentration of Pb^{2+} ions is 0.0482 M.
 - b) You form 131 g of lead(II) iodide.
 - c) The final concentration of K⁺ is 1.02 M.
 - d) The final concentration of NO_3^- is 1.02 M.
 - e) All are true.

ANS: d) SECTION: 4.5-7 LEVEL: hard

26. The concentration of a salt water solution which sits in an open beaker decreases over time.

ANS: False	SECTION: 4.3	LEVEL: medium
Conceptual		

- 27. You have 2 solutions of chemical *A*. To determine which has the highest concentration of *A* in molarity, what is the minimum number of the following you must know?
 - I. the mass in grams of *A* in each solution
 - II. the molar mass of *A*
 - III. the volume of water added to each solution
 - IV. the total volume of the solution
 - a) 0
 - b) 1
 - c) 2
 - d) 3
 - e) You must know all of them.

```
ANS: c)
```

Conceptual

SECTION: 4.3

LEVEL: medium

28. The following reactions:

$$\begin{split} \mathrm{Pb}^{2+} &+ 2\mathrm{I}^{-} \rightarrow \mathrm{PbI}_{2} \\ & 2\mathrm{Ce}^{4+} + 2\mathrm{I}^{-} \rightarrow \mathrm{I}_{2} + 2\mathrm{Ce}^{3+} \end{split}$$

$$HOAc + NH_3 \rightarrow NH_4^+ + OAc^-$$

are examples of

- a) acid-base reactions.
- b) unbalanced reactions.
- c) precipitation, acid-base, and redox reactions, respectively.
- d) redox, acid-base, and precipitation reactions, respectively.
- e) precipitation, redox, and acid-base reactions, respectively.

ANS: e)

SECTION: 4.4-9

LEVEL: medium

Conceptual

- 29. In writing the total ionic equation for the reaction (if any) that occurs when aqueous solutions of KOH and Mg(NO₃)₂ are mixed, which of the following would *not* be written as ionic species?
 - a) KOH
 - b) $Mg(NO_3)_2$
 - c) $Mg(OH)_2$
 - d) KNO₃
 - e) All of the above would be written as ionic species.

ANS: c)

SECTION: 4.4,6

- 30-32. Aqueous solutions of barium chloride and silver nitrate are mixed to form solid silver chloride and aqueous barium nitrate.
 - 30. The balanced molecular equation contains which one of the following terms?

a)	$A \sigma Cl(s)$	
a)	Ager(s)	

- b) 2AgCl(s)
- c) $2Ba(NO_3)_2$
- d) $BaNO_3$
- e) 3AgCl(s)

SECTION: 4.5,6

LEVEL: medium

- 31. The balanced complete ionic equation contains which of the following terms?
- a) $2Ba^{2+}(aq)$ b) Cl⁻(aq) c) $2Ag^{+}(aq)$ d) $NO_3^-(aq)$ e) $3NO_3^-(aq)$ ANS: c) **SECTION:** 4.5,6 **LEVEL:** medium 32. The net ionic equation contains which of the following terms? a) $Ag^{+}(aq)$
 - b) $Ba^{2+}(aq)$
 - c) $NO_3^-(aq)$
 - d) $2NO_3^{-}(aq)$
 - e) none of these

ANS: a)

SECTION: 4.5,6

LEVEL: medium

- 33. The man who discovered the essential nature of acids through solution conductivity studies is
 - a) Priestly.
 - b) Boyle.
 - c) Einstein.
 - d) Mendeleev.
 - e) Arrhenius.

ANS: e)

SECTION: 4.2

LEVEL: easy

34. The following reactions

 $2K(s) + Br_2(l) \rightarrow 2KBr(s)$ $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$ $HCl(aq) + KOH(aq) \rightarrow H_2O(l) + KCl(aq)$

are examples of

- a) precipitation reactions.
- b) redox, precipitation, and acid-base, respectively.
- c) precipitation (two) and acid-base reactions, respectively.
- d) redox reactions.
- e) none of these

ANS: b) SECTION: 4.4–9 LEVEL: medium

Conceptual

- 35. Aqueous solutions of sodium sulfide and copper(II) chloride are mixed together. Which statement is correct?
 - a) Both NaCl and CuS precipitate from solution.
 - b) No precipitate forms.
 - c) CuS will precipitate from solution.
 - d) NaCl will precipitate from solution.
 - e) No reaction will occur.

ANS: c)

SECTION: 4.5

LEVEL: easy

36. Which of the following salts is insoluble in water?

- a) Na₂S
- b) K₃PO₄
- c) $Pb(NO_3)_2$
- d) CaCl₂
- e) All of these are soluble in water.

ANS: e) SECTION: 4.5 LEVEL: easy

37. How many of the following salts are expected to be insoluble in water?

	sodium sulfide ammonium sulfate	barium nitrate potassium phosphate	
a)	none		
b)	1		
c)	2		
d)	3		
e)	4		
ANS	: a)	SECTION: 4.5	LEVEL: easy

38. When $NH_3(aq)$ is added to $Cu^{2+}(aq)$, a precipitate initially forms. Its formula is:

a)	$Cu(NH_3)_4^{2+}$		
b)	$Cu(NO_3)_2$		
c)	Cu(OH) ₂		
d)	$Cu(NH_3)_2^{2+}$		
e)	CuO		
AN	S: c)	SECTION: 4.5	LEVEL: medium
39. Wh	ich of the following ions is m	nost likely to form an insoluble sulf	ate?
a)	K+		
b)	T ;+		

- b) $L1^+$ c) Ca^{2+} d) S^{2-} e) Cl^- ANS: c) SECTION: 4.5 LEVEL: easy
- 40. Which of the following compounds is soluble in water?
 - a) Ni(OH)₂
 - b) K_3PO_4
 - c) BaSO₄
 - d) CoCO₃e) PbCl₂

ANS: b)

SECTION: 4.5

LEVEL: easy

- 41. A solution contains the ions Ag⁺, Pb²⁺, and Ni²⁺. Dilute solutions of NaCl, Na₂SO₄, and Na₂S are available to separate the positive ions from each other. In order to effect separation, the solutions should be added in which order?
 - a) Na₂SO₄, NaCl, Na₂S
 b) Na₂SO₄, Na₂S, NaCl
 c) Na₂S, NaCl, Na₂SO₄
 d) NaCl, Na₂S, Na₂SO₄
 e) NaCl, Na₂SO₄, Na₂S

 ANS: a) SECTION: 4.5 LEVEL: hard

- 42. Which pair of ions would *not* be expected to form a precipitate when dilute solutions of each are mixed?
 - a) Al^{3+} , S^{2-} b) Pb^{2+} , Cl^{-} c) Ba^{2+} , PO_4^{3-} d) Pb^{2+} , OH^{-} e) Mg^{2+} , SO_4^{2-} ANS: e) SECTION: 4.5 LEVEL: easy
- 43. In the balanced molecular equation for the neutralization of sodium hydroxide with sulfuric acid, the products are:
 - a) $NaSO_4 + H_2O$ b) $NaSO_3 + 2H_2O$ c) $2NaSO_4 + H_2O$ d) $Na_2S + 2H_2O$ e) $Na_2SO_4 + 2H_2O$ ANS: e) SECTION: 4.6,8 LEVEL: medium
- 44. [Algorithmic] If all of the chloride in a 5.000-g sample of an unknown metal chloride is precipitated as AgCl with 70.90 mL of 0.2010 M AgNO₃, what is the percentage of chloride in the sample?
 - a) 50.55%
 - b) 10.10%
 - c) 1.425%
 - d) 20.22%
 - e) none of the above

SECTION: 4.7

LEVEL: hard

- 45. Which of the following do you need to know to be able to calculate the molarity of a salt solution?
 - I. the mass of salt added
 - II. the molar mass of the salt
 - III. the volume of water added
 - IV. the total volume of the solution
 - a) I, III
 - b) I, II, III
 - c) II, III
 - d) I, II, IV
 - e) You need all of the information.

ANS: d)

SECTION: 4.3

LEVEL: easy

Conceptual

- 46. [Algorithmic] You mix 60.0 mL of 1.0 M silver nitrate with 25.0 mL of 0.80 M sodium chloride. What mass of silver chloride should you form?
 - a) 2.9 g
 - b) 5.8 g
 - c) 8.7 g
 - d) 9.6 g
 - e) none of these

ANS: a)

SECTION: 4.7

LEVEL: medium

- 47. You have separate solutions of HCl and H₂SO₄ with the same concentrations in terms of molarity. You wish to neutralize a solution of NaOH. Which acid solution would require more volume (in mL) to neutralize the base?
 - a) the HCl solution
 - b) the H_2SO_4 solution
 - c) You need to know the acid concentrations to answer this question.
 - d) You need to know the volume and concentration of the NaOH solution answer this question.
 - e) c and d

ANS: a)

SECTION: 4.8

Conceptual

- 48. [Algorithmic] What mass of NaOH is required to react exactly with 25.0 mL of 1.2 M H_2SO_4 ?
 - a) 1.2 g
 - b) 1.8 g
 - c) 2.4 g
 - d) 3.5 g
 - e) none of these

ANS: c)

SECTION: 4.8

LEVEL: medium

LEVEL: hard

- 49. [Algorithmic] A 3.00-g sample of an alloy (containing only Pb and Sn) was dissolved in nitric acid (HNO₃). Sulfuric acid was added to this solution, which precipitated 2.93 g of PbSO₄. Assuming that all of the lead was precipitated, what is the percentage of Sn in the sample? (molar mass of PbSO₄ = 303.3 g/mol)
 - a) 33.3% Sn
 - b) 17.7% Sn
 - c) 50.0% Sn
 - d) 66.7% Sn
 - e) 2.00% Sn

ANS: a)

SECTION: 4.7

LEVEL: hard

- 50. [Algorithmic] A mixture contained no fluorine compound except methyl fluoroacetate, FCH_2COOCH_3 (molar mass = 92.1 g/mol. When chemically treated, all the fluorine was converted to CaF_2 (molar mass = 78.1 g/mol). The mass of CaF_2 obtained was 12.1 g. Find the mass of methyl fluoroacetate in the original mixture.
 - a) 92.0 g
 - b) 28.5 g
 - c) 24.2 g
 - d) 14.3 g
 - e) 12.1 g

SECTION: 4.7

LEVEL: hard

- 51. [Algorithmic] A 1.000-g sample of a metal chloride, MCl₂, is dissolved in water and treated with excess aqueous silver nitrate. The silver chloride that formed weighed 1.286 g. Calculate the atomic mass of M.
 - a) 222.8 g/mol
 - b) 76.00 g/mol
 - c) 152.0 g/mol
 - d) 304.0 g/mol
 - e) none of these

ANS: c)

SECTION: 4.7

LEVEL: hard

52-55. You have 75.0 mL of a 2.50 M solution of $Na_2CrO_4(aq)$. You also have 125 mL of a 2.50 M solution of AgNO₃(aq). Calculate the concentrations of the following ions when the two solutions are added together.

52. [Algorithmic] Na⁺

- a) 0 M
- b) 0.938 M
- c) 1.88 M
- d) 2.50 M
- e) 5.00 M
- **ANS:** c)

SECTION: 4.7

LEVEL: medium

- 53. [Algorithmic] CrO_4^{2-}
 - a) 0 M
 - b) 0.156 M
 - c) 0.188 M
 - d) 0.938 M
 - e) 2.50 M
 - **ANS:** b)

SECTION: 4.7

54.	1. [Algorithmic] Ag ⁺			
	a) 0	M		
	b) 0	0.800 M		
	c) 1	.00 M		
	d) 1	.50 M		
	e) 1	.80 M		
	ANS:	a)	SECTION: 4.7	LEVEL: medium
55.	[Algori	thmic] NO3 ⁻		
	a) 0	ИМ		
	b) 0	0.313 M		
	c) 1	56 M		
	d) 3	o.13 M		
	e) 2	50 M		
	ANS:	c)	SECTION: 4.7	LEVEL: medium
56.	A 0.307 using 3	'-g sample of an unknown 5.2 mL of 0.106 M NaOH.	n triprotic acid is titrated to the third Calculate the molar mass of the ac	d equivalence point id.
	a) 2	.47 g/mol		
	b) 1	71 g/mol		

- b) 1/1 g/mol
- c) 165 g/mol
- d) 151 g/mol
- e) 82.7 g/mol

ANS: a)

SECTION: 4.8

LEVEL: medium

57. [Algorithmic] Sulfamic acid, HSO_3NH_2 (molar mass = 97.1 g/mol), is a strong monoprotic acid that can be used to standardize a strong base:

 $HSO_3NH_2(aq) + KOH(aq) \rightarrow KSO_2NH_2(aq) + H_2O(l)$

A 0.179-g sample of HSO₃NH₂ required 19.4 mL of an aqueous solution of KOH for a complete reaction. What is the molarity of the KOH solution?

- a) 9.25 M
- b) 9.50×10^{-5} M
- c) 0.0950 M
- d) 0.194 M
- e) none of these

ANS: c)

SECTION: 4.8

- 58. [Algorithmic] A student weighs out 0.568 g of KHP (molar mass = 204 g/mol) and titrates to the equivalence point with 36.78 mL of a stock NaOH solution. What is the concentration of the stock NaOH solution? KHP is an acid with one acidic proton.
 - a) 0.100 M
 - b) 3.15 M
 - c) 0.943 M
 - d) 0.0757 M
 - e) none of these

ANS: d)

SECTION: 4.8

LEVEL: medium

- 59. In which of the following does nitrogen have an oxidation state of +4?
 - a) HNO₃
 - b) NO_2
 - c) N_2O
 - d) NH₄Cl
 - e) NaNO₂

ANS: b)

SECTION: 4.9

LEVEL: easy

- 60. Which of the following statements is *not* true?
 - a) When a metal reacts with a nonmetal, an ionic compound is formed.
 - b) A metal-nonmetal reaction can always be assumed to be an oxidation-reduction reaction.
 - c) Two nonmetals can undergo an oxidation-reduction reaction.
 - d) When two nonmetals react, the compound formed is ionic.
 - e) A metal-nonmetal reaction involves electron transfer.
 - ANS: d) SECTION: 4.9 LEVEL: easy

Conceptual

61. The following reactions

$$ZnBr_2(aq) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2AgBr(s)$$

$$KBr(aq) + AgNO_3(aq) \rightarrow AgBr(s) + KNO_3(aq)$$

are examples of

- a) oxidation-reduction reactions.
- b) acid-base reactions.
- c) precipitation reactions.
- d) a and c
- e) none of these

ANS: c)

SECTION: 4.4-9

LEVEL: easy

Conceptual

62. All of the following reactions

$$2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$$

$$2Ag_2O(s) \rightarrow 4Ag(s) + O_2(g)$$

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

can be classified as

- a) oxidation-reduction reactions.
- b) combustion reactions.
- c) precipitation reactions.
- d) a and b
- e) a and c

SECTION: 4.4-9

LEVEL: easy

63. In the reaction $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$, which species is oxidized?

a) O₂

ANS: a)

Conceptual

- b) O²⁻
- c) Ca
- d) Ca²⁺
- e) none of these

ANS: c)

SECTION: 4.9

LEVEL: medium

64. In the reaction $2Cs(s) + Cl_2(g) \rightarrow 2CsCl(s)$, Cl_2 is

- a) the reducing agent.
- b) the oxidizing agent.
- c) oxidized.
- d) the electron donor.
- e) two of these

ANS: b)

SECTION: 4.9

- 65. In the reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, N_2 is
 - a) oxidized.
 - b) reduced.
 - c) the electron donor.
 - d) the reducing agent.
 - e) two of these

```
ANS: b)SECTION: 4.9LEVEL: medium
```

66. In the reaction $P_4(s) + 10Cl_2(g) \rightarrow 4PCl_5(s)$, the reducing agent is

- a) chlorine.
- b) PCl₅.
- c) phosphorus.
- d) Cl-.
- e) none of these

```
ANS: c)
```

SECTION: 4.9

LEVEL: medium

67. In the reaction $C(s) + O_2(g) \rightarrow CO_2(g)$ carbon is _____.

- a) the reducing agent
- b) the electron acceptor
- c) reduced
- d) the oxidizing agent
- e) more than one of these

ANS: a)

SECTION: 4.9

- 68. [Algorithmic] Diabetics often need injections of insulin to help maintain the proper blood glucose levels in their bodies. How many moles of insulin are needed to make up 45 mL of 0.0052 M insulin solution?
 - a) $4.6 \times 10^{-4} \text{ mol}$ b) $5.0 \times 10^{-3} \text{ mol}$ c) $1.7 \times 10^{-4} \text{ mol}$ d) $6.0 \times 10^{2} \text{ mol}$ e) $2.3 \times 10^{-4} \text{ mol}$ ANS: e) SECTION: 4.3 LEVEL: easy
- 69. For the reaction of sodium bromide with chlorine gas to form sodium chloride and bromine, the appropriate half-reactions are (ox = oxidation and re = reduction):

ANS	: b)		SEC	TION: 4.10	LEVEL: medium
e)	ox:	$2Na^+ + 2e^- \rightarrow 2Na;$	re:	$2Cl^- \rightarrow Cl_2 + 2e^-$	
d)	ox:	$Br + 2e^- \rightarrow Br^{2-};$	re:	$2Cl^- \rightarrow Cl_2 + 2e^-$	
c)	ox:	$Cl + e^- \rightarrow Cl^-;$	re:	$Br \rightarrow Br^- + e^-$	
b)	ox:	$2Br^- \rightarrow Br_2 + 2e^-;$	re:	$Cl_2 + 2e^- \rightarrow 2Cl^-$	
a)	ox:	$Cl_2 + 2e^- \rightarrow 2Cl^-;$	re:	$2Br^- \rightarrow Br_2 + 2e^-$	

- 70. Which of the following reactions does *not* involve oxidation-reduction?
 - a) $CH_4 + 3O_2 \rightarrow 2H_2O + CO_2$ b) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ c) $2Na + 2H_2O \rightarrow 2NaOH + H_2$ d) $MnO_2 + 4HCl \rightarrow Cl_2 + 2H_2O + MnCl_2$ e) All are oxidation-reduction reactions. **ANS:** e) **SECTION:** 4.9 **LEVEL:** medium **Conceptual**

- 71. Which of the following are oxidation-reduction reactions?
 - I. $PCl_3 + Cl_2 \rightarrow PCl_5$
 - II. $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$
 - III. $CO_2 + 2LiOH \rightarrow Li_2CO_3 + H_2O$
 - IV. $FeCl_2 + 2NaOH \rightarrow Fe(OH)_2 + 2NaCl$
 - a) III
 - b) IV
 - c) I and II
 - d) I, II, and III
 - e) I, II, III, and IV

ANS: c)

SECTION: 4.9

LEVEL: medium

Conceptual

72. Which of the following statements is(are) *true*? Oxidation and reduction

- a) cannot occur independently of each other.
- b) accompany all chemical changes.
- c) describe the loss and gain of electron(s), respectively.
- d) result in a change in the oxidation states of the species involved.
- e) a, c, and d are true

ANS: e)SECTION: 4.9LEVEL: medium

Conceptual

73. In the reaction $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$, which, if any, element is oxidized?

- a) zinc
- b) hydrogen
- c) sulfur
- d) oxygen
- e) none of these

ANS: a)

SECTION: 4.9

LEVEL: medium

74. In the following reaction, which species is oxidized?

 $8NaI + 5H_2SO_4 \rightarrow 4I_2 + H_2S + 4Na_2SO_4 + 4H_2O$

- a) sodium
- b) iodine
- c) sulfur
- d) hydrogen
- e) oxygen

```
ANS: b)SECTION: 4.9LEVEL: medium
```

75. How many of the following are oxidation-reduction reactions?

```
NaOH + HCl \rightarrow NaCl + H_2O
             Cu + 2AgNO_3 \rightarrow 2Ag + Cu(NO_3)_2
             Mg(OH)_2 \rightarrow MgO + H_2O
             N_2 + 3H_2 \rightarrow 2NH_3
       a) 0
       b) 1
       c) 2
      d) 3
       e) 4
     ANS: c)
                                          SECTION: 4.9
                                                                                LEVEL: medium
     Conceptual
76. In the reaction shown below, what species is oxidized?
             2NaI + Br_2 \rightarrow 2NaBr + I_2
       a) Na<sup>+</sup>
```

```
b) I<sup>-</sup>
c) Br<sub>2</sub>
d) Br<sup>-</sup>
e) I<sub>2</sub>
ANS: b) SECTION: 4.9 LEVEL: medium
77. Given the following reaction in acidic media:
```

 $Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$

answer the following question: The coefficient for water in the balanced reaction is

a) 1. b) 3. c) 5. d) 7. e) none of these ANS: d) SECTION: 4.10 LEVEL: medium 78. Balance the following oxidation-reduction reaction using the half-reaction method:

 $Fe^{3+} + I^- \rightarrow Fe^{2+} + I_2$

In the balanced equation, the coefficient of Fe^{2+} is

ANS	: b)	SECTION: 4.10	LEVEL: medium
e)	none of these		
d)	4.		
c)	3.		
b)	2.		
a)	1.		

79. The following unbalanced equation represents a reaction that occurs in basic solution:

 $\mathrm{MnO_4^{2-}}+\mathrm{C_2O_4^{2-}} \rightarrow \mathrm{MnO_2}+\mathrm{CO_3^{2-}}$

How many moles of MnO_4^{2-} are required to produce 1 mole of CO_3^{2-} ?

ANS	: e)	SECTION: 4.10	LEVEL: hard
e)	none of these		
d)	1		
c)	2		
b)	3		
a)	4		

80-82. The following reaction occurs in aqueous acid solution:

 $NO_3^- + I^- \rightarrow IO_{3-} + NO_2$

80. The oxidation state of iodine in IO_3^- is:

81.

a) 0		
b) +3		
c) -3		
d) +5		
e) –5		
ANS: d)	SECTION: 4.9	LEVEL: easy
In the balanced equat	ion the coefficient of NO ₃ ⁻ is:	
a b		

aj	2		
b)	3		
c)	4		
d)	5		
e)	6		
ANS	: e)	SECTION: 4.10	LEVEL: medium

82. In the balanced equation the coefficient of water is:

ANS	: c)	SECTION: 4 .10	LEVEL: medium
e)	5		
d)	4		
c)	3		
b)	2		
a)	1		

83. When the equation $Cl_2 \rightarrow Cl^- + ClO_3^-$ (basic solution) is balanced using the smallest whole-number coefficients, the coefficient of OH⁻ is:

ANS: e)	SECTION: 4.10	LEVEL: medium
e) 6		
d) 4		
c) 3		
b) 2		
a) 1		

- 84. When the following reaction is balanced in acidic solution, what is the coefficient of I₂?
 - $IO_{3}^{-} + I^{-} \rightarrow I_{2}$ a) 1 b) 2 c) 3 d) 4 e) none of these **ANS:** c) **SECTION:** 4.10 **LEVEL:** medium
- 85. The MnO₄⁻ is often used to analyze for the Fe²⁺ content of an aqueous solution via the reaction MnO₄⁻ + Fe²⁺ \rightarrow Fe³⁺ + Mn²⁺ in acidic solution. What is the ratio of MnO₄⁻ : Fe²⁺ in the balanced equation?

ANS: e)	SECTION: 4.10	LEVEL: medium
e) 5:1		
d) 4:1		
c) 3:1		
b) 2:1		
a) 1:1		

86. Balance the following oxidation-reduction reaction using the half-reaction method.

 $Cr_2O_7^{2-} + I_2 \rightarrow Cr^{3+} + IO_3^{-}$

In the balanced equation, the coefficient of water is:

- a) 4
- b) 17
- c) 11
- d) 7
- e) 6

ANS: b)

SECTION: 4.10

LEVEL: medium

- 87. [Algorithmic] With what volume of 5.0 M HF will 7.4 g of calcium hydroxide react completely, according to the reaction $2HF + Ca(OH)_2 \rightarrow CaF_2 + 2H_2O$?
 - a) 20. mL
 - b) 50. mL
 - c) 30. mL
 - d) 40. mL
 - e) $1.0 \times 10^2 \, \text{mL}$

ANS: d)

SECTION: 4.8

LEVEL: hard

- 88. For the redox reaction $2Fe^{2+} + Cl_2 \rightarrow 2Fe^{3+} + 6Cl^-$ which of the following are the correct half-reactions?
 - I. $Cl_2 + 2e^- \rightarrow 2Cl^-$
 - II. $Cl \rightarrow Cl^- + e^-$
 - III. $Cl_2 \rightarrow 2Cl^- + 2e^-$
 - IV. $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$
 - V. $Fe^{2+} + e^- \rightarrow Fe^{3+}$
 - a) I and IV
 - b) I and V
 - c) II and IV
 - d) II and V
 - e) III and IV

ANS: a)

SECTION: 4.10

89. [Algorithmic] The following equation describes the oxidation of ethanol to acetic acid by potassium permanganate:

 $3C_2H_5OH + 4KMnO_4 \rightarrow 3HC_2H_3O_2 + 4MnO_2 + 4KOH + H_2O$

5.0 g of ethanol and an excess of aqueous $KMnO_4$ are reacted, and 5.9 g $HC_2H_3O_2$ result. What is the percent yield?

- a) 100%
- b) 91%
- c) 67%
- d) 30.%
- e) 5.9 g $HC_2H_3O_2$ is impossible since it represents more than a 100% yield.

ANS: b) SECTION: 3.9,4.10 LEVEL: medium

90. Given the reaction

$$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

determine the number of electrons involved in this reaction.

ANS	: a)	SECTION: 4.10	LEVEL: medium
e)	2		
d)	4		
c)	6		
b)	8		
a)	10		

Selecting from the following reagents, indicate which reagents would be mixed to give the compounds in Questions 91 and 92.

$CuSO_4(aq)$	$Fe_2(CO_3)_3(s)$	NH ₃ (aq)
CuCO ₃ (s)	FeCl ₃ (aq)	Na ₂ SO ₄ (aq)
Cr(OH) ₃ (s)	$H_2SO_4(aq)$	

91. $Cu(OH)_2$ ANS: $CuSO_4(aq)$ and $NH_3(aq)$ SECTION: 4.5,6 LEVEL: medium

LEVEL: medium

92. $\operatorname{FeCl}_3(\operatorname{aq}) + \operatorname{Na}_2\operatorname{SO}_4(\operatorname{aq})$

ANS: $FeCl_3(aq) + Na_2SO_4(aq)$ **SECTION:** 4.5,6

Write balanced equations for each of the processes in Questions 93 through 97, choosing from the following substances as reactants:

	BaCl ₂	O ₂	H_2SO_4	HNO ₃
	C ₂ H ₅ OH	H ₂ O	Ca(OH) ₂	К
	Na ₂ CrO ₄	КОН	$Pb(NO_3)_2$	
93.	Precipitation of BaSO ₄	from solution		
	ANS: $H_2SO_4 + BaCl_2$	\rightarrow BaSO ₄ + 2HO	1	
	Conceptual	SEC	ГІОN: 4.5,9	LEVEL: medium
94.	Formation of hydrogen ANS: $2K + H O \rightarrow 2K$	n gas		
	Conceptual	SEC	FION: 4.5,9	LEVEL: medium
95	Neutralization of sulfu	uric acid	,	
95.	ANS: $H_{2}SO_{4} + 2KOH$	$I \rightarrow K_s SO_t + 2H_t$.0	
	Conceptual	SEC	<u>20</u> ΓΙΟΝ: 4.5,9	LEVEL: medium
96	Combustion reaction			
<i>y</i> 0.	ANS: $C_2H_2OH + 3O_2$	$\rightarrow 2CO_2 + 3H_2O_2$)	
	Conceptual	SEC.	ГІО N: 4.5,9	LEVEL: medium
97.	Dissolution of calcium	hvdroxide with	another reagent	
	ANS: $Ca(OH)_2 + 2HO$	$Cl \rightarrow CaCl_{2} + 2H$	[₂ O	
	Conceptual	SEC	ГІОN: 4.5,9	LEVEL: medium
00 100		11 ·		
98-103	3. Balance each of the fo	ollowing equation	ons.	
98.	$C_3H_5(NO_3)_3 \rightarrow N_2 + C_3$	$O_2 + H_2O + O_2$		
	ANS: $4C_3H_5(NO_3)_3 -$	$\rightarrow 6N_2 + 12CO_2 + 6N_2 +$	$-10H_2O + O_2$	
		SEC	TION: 4.10	LEVEL: easy
99.	$\text{KI} + \text{HNO}_3 \rightarrow \text{KNO}_3 +$	$NO + I_2 + H_2O$		
	ANS: 6KI + 8HNO ₃ -	$\rightarrow 6 \text{KNO}_3 + 2 \text{NO}_3$	$0 + 3I_2 + 4H_2O$	
		SEC	FION: 4.10	LEVEL: easy
100.	$\operatorname{Cr}_2\operatorname{O}_7^{2-} + \operatorname{I}^- \to \operatorname{Cr}^{3+} + \operatorname{I}^-$	O_3^- (acid)		
	ANS: $8H^+ + Cr_2O_7^{2-1}$	$+ I^{-} \rightarrow 2Cr^{3+} + I0$	$D_3^- + 4H_2O$	
		SEC".	FION: 4.10	LEVEL: medium
101.	$Zn + As_2O_3 \rightarrow AsH_3 +$	Zn ²⁺ (acid)		
	ANS: 12H ⁺ + 6Zn + A	$As_2O_3 \rightarrow 2AsH_3$	$+ 6Zn^{2+} + 3H_2O$	
		SEC	FION: 4.10	LEVEL: medium

102. $MnO_4^- + Br^- \rightarrow MnO_2 + BrO_3^-$ (base)				
	ANS: H ₂ O + 2N	$MnO_4^- + Br^- \rightarrow 2$	2MnO ₂ + BrO ₃ ⁻ + 2OH ⁻	
			SECTION: 4.10	LEVEL: medium
103.	$Bi(OH)_3 + SnO_2^2$	$- \rightarrow \text{Bi} + \text{SnO}_3^2 -$	(base)	
	ANS: 2Bi(OH)	$+ 3 \text{SnO}_2^2 \rightarrow 2$	Bi + 3SnO ₃ ²⁻ + 3H ₂ O	
		~ _	SECTION: 4.10	LEVEL: medium
104.	Polar molecules	have an unequa	al distribution of charge w	vithin the molecule.
	ANS: True		SECTION: 4.1	LEVEL: easy
105.	An acid is a subs	stance that prod	uces OH- ions in water.	
	ANS: False		SECTION: 4.2	LEVEL: easy
106.	The filtrate is the	e solid formed v	vhen two solutions are m	ixed.
	ANS: False		SECTION: 4.5	LEVEL: easy
107.	A chemical that	changes color a	t the endpoint of a reactio	n is called a colorimeter.
	ANS: False		SECTION: 4.8	LEVEL: easy
108.	Oxidation is the	gain of electron	IS.	
	ANS: False		SECTION: 4.9	LEVEL: easy
109.	A reducing ager	it is an electron	donor.	
	ANS: True		SECTION: 4.9	LEVEL: easy
110.	A molecule with	an unequal cha	arge distribution is said to	be a molecule.
	ANS: polar		SECTION: 4.1	LEVEL: easy
111.	Soluble ionic con	npounds contai	ning the hydroxide ion a	re called strong
	ANS: bases		SECTION: 4.1	LEVEL: easy
112.	Ais	a substance dise	solved in a liquid to make	e a solution.
	ANS: solute		SECTION: 4.2	LEVEL: easy
113.	A ele	ectrolyte dissoci	iates to a great extent in a	n aqueous solution.
	ANS: strong		SECTION: 4.2	LEVEL: easy
114.	Molarity is defir	ned as	of solute per volume of	f solution in
	ANS: moles, lit	ters	SECTION: 4.6	LEVEL: easy

115. Consider the reaction between 15.0 mL of a 1.00 *M* aqueous solution of AgNO₃ and 10.0 mL of a 1.00 *M* aqueous solution of K_2 CrO₄. When these react, a precipitate is observed.

What is present in solution **after** the reaction is complete? Note: the solid is not considered to be in solution.

- a) Ag⁺, NO₃⁻, K⁺, CrO₄²⁻, water
- b) Ag+, NO₃-, K+, water
- c) K^+ , CrO_4^2 -, water
- d) NO₃-, K⁺, CrO₄²⁻, water
- e) water

ANS: d) SECTION: 4.3-5,7 LEVEL: hard

Questions 116 and 117 deal with an aqueous solution of calcium nitrate added to an aqueous solution of sodium phosphate. Write and balance the equation for this reaction to answer questions 116 and 117.

116. What is the sum of the coefficients when the molecular equation is balanced in standard form?

111101	0)		
ANS:	e)	SECTION: 4.5.6	LEVEL: medium
e) (12		
d) 1	11		
c) 7	7		
b) 5	5		
a) 4	4		

117. What is the formula of the solid formed in the reaction?

- a) $Ca(PO_4)_2$
- b) CaPO₄
- c) $Ca_3(PO_4)_2$
- d) $Ca_3(PO_3)_2$
- e) None of these
- ANS: c)
 SECTION: 4.5
 LEVEL: easy

 118. You have 2 solutions of sodium chloride. One is a 2.00 M solution, the other is a 4.00 M
- solution. You have much more of the 4.00 *M* solution and you add the solutions together. Which of the following could be the concentration of the final solution?

Cond	ceptual		
ANS	: c)	SECTION: 4.3	LEVEL: medium
e)	7.20 M		
d)	6.00 M		
c)	3.80 M		
b)	3.00 M		
a)	2.60 M		

- 119. You have equal masses of different solutes dissolved in equal volumes of solution. Which of the solutes would make the solution having the highest molar concentration?
 - a) NaOH
 - b) KCl
 - c) KOH
 - d) LiOH
 - e) All the same

ANS: d)

SECTION: 4.3

LEVEL: medium

Conceptual

120. A solid acid HX is mixed with water. 2 possible solutions can be obtained. Which of the following is true?



- a) In case I, HX is acting like a weak acid, and in case II, HX is acting like a strong acid.
- b) In case I, HX is acting like a strong acid, and in case II, HX is acting like a weak acid.
- c) In both cases, HX is acting like a strong acid.
- d) In both cases, HX is acting like a weak acid.
- e) HX is not soluble in water.

ANS: b)

SECTION: 4.8

LEVEL: medium

Conceptual