New Jersey Science League
Chemistry II Exam January 2012

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

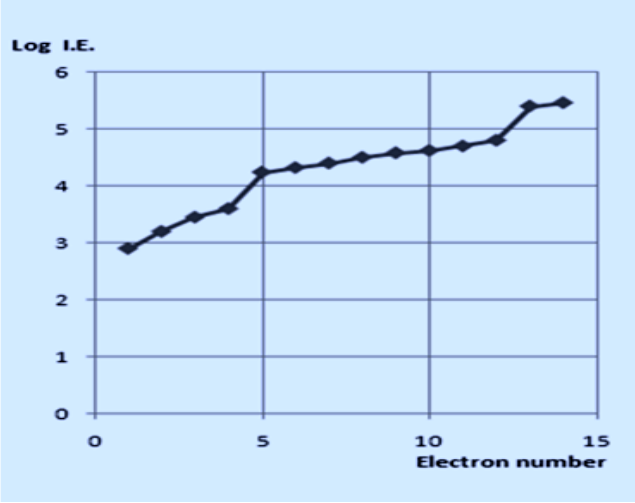
1. Which of the following statements is correct?

A. The oxidation state of Mn in MnO_4^{2-} is +7.
B. The oxidation state of P in $P_2O_7^{4-}$ is +3.
C. The oxidation state of Ba in BaO_2 is +1.
D. The oxidation state of Cr in CrO_4^{2-} is +5.
E. The oxidation state of O in OF_2 is +2.

2. 10.0 g of Zn powder is added into a solution of silver nitrate, $AgNO_3$. The total mass of the metallic solid recovered at the end of the reaction is 12.32 g. Assuming that the reaction did not go to completion, how many grams of Zn did react?

A. 9.0 B. 8.00 C. 5.00 D. 2.00 E. 1.00

3. The following graph shows the logarithm of successive ionization energies (in kJ/mol) as electrons are removed from the atoms of a particular element.



This particular element belongs to which group of the periodic table?

A. 2 B. 3 C. 14 D. 16 E. 18

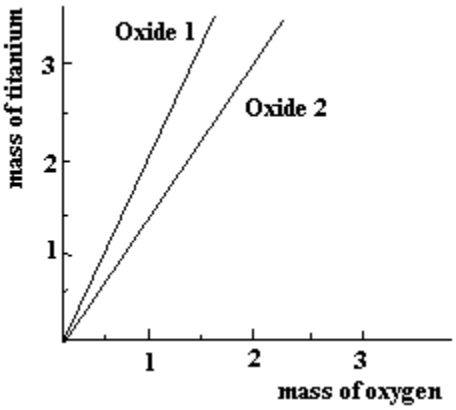
4. Which of the following atoms has the smallest radius?

A. Br B. Cl C. P D. S E. Se

5. How many electrons are described by the following quantum set, $n = 4$; $l = 2$; $m_s = +½$?

A. 5 B. 8 C. 10 D. 16 E. 32

6. A group of researchers did an experiment to determine the mass ratio of titanium to oxygen in two different oxides. Their results are shown below:



From these results it can be deduced the formulae of the two metal oxides are:

	A.	B.	C.	D.	E.
Oxide 1	TiO	Ti_2O	Ti_3O	TiO_2	Ti_2O_3
Oxide 2	Ti_2O_3	Ti_3O	Ti_2O	TiO_3	TiO_2

7. A compound consists only of C, H and N. The combustion of 20.4 mg of this compound releases 44.0 mg of CO_2 and 25.2 mg of H_2O. What is the empirical formula of this compound?

A. C_3H_7N B. $C_3H_7N_2$ C. $C_5H_{10}N$ D. $C_5H_{10}N_2$ E. $C_5H_{14}N_2$

8. When the following redox reaction is balanced what is the coefficient of H_2O?

$$VO^{2+} + MnO_4^- + H_2O \rightarrow V(OH)_4^+ + Mn^{2+} + H^+$$

A. 20 B. 11 C. 8 D. 5 E. 2

9. Convert 1.2 g/cm^3 into kg/m^3.

A. 1.2 B. 0.12 C. 1200 D. 0.012 E. 0.0012

10. Mendeleev's early periodic table was published in 1872. Dmitri Mendeleev named which element "*ekasilicon*"?

A. Al B. Si C. P D. Ge E. Ga

11. Which of the following compounds is NOT correctly named according to IUPAC naming rules?

A. $KAl(SO_4)_2 \bullet 12H_2O$	Potassium aluminum sulfate dodecahydrate
B. $(NH_4)_2Cr_2O_7$	Ammonium dichromate
C. KSCN	Potassium thiocyanate
D. P_4O_{10}	Tetraphosphorus decoxide
E. K_2MnO_4	Potassium permanganate

12. A beaker contains 100.0 mL 0.20 *M* $AgNO_3$ solution (colorless). A second beaker contains 200.0 mL 0.15 *M* K_2CrO_4 solution (yellow). These two solutions are mixed in a third beaker and a precipitate is formed. Which of the following set of statements are CORRECT? (Note: solid potassium nitrate is white and solid silver chromate is red-brown).

The color of the supernatant solution	The color of the precipitate
A. Colorless	Red-Brown
B. Yellow	White
C. Yellow	Red-Brown
D. Colorless	Yellow
E. Yellow	Black

13. Which of the following solutions has the highest concentration of the bromide ion?

A. 400 mL 0.3 *M* NaBr
B. 600 mL 0.2 *M* NaBr
C. 400 mL 0.3 *M* NaBrO
D. 600 mL 0.3 *M* $NaBrO_2$
E. 400 mL 0.2 *M* $NaBrO_3$

14. The chloride impurity in a 2.00 g sample is determined by precipitating the chloride as silver chloride. If 4.80 mL of 0.250 M $AgNO_3$ solution is required, what is the mass percent of chloride in the sample?

A. 6.25 % B. 5.13 % C. 4.52 % D. 3.17 % E. 2.13 %

15. Which of the following transitions is visible to the human eye?

A. n = 6 → n = 4
B. n = 6 → n = 1
C. n = 5 → n = 3
D. n = 4 → n = 2
E. n = 3 → n = 1

16. The organic substitution reactions require the formation of the halogen radical. This is illustrated with the reaction between methane and bromine.

$$Br_2 \rightarrow Br + Br.$$
$$CH_4 + Br \rightarrow CH_3Br + H.$$
$$H. + Br \rightarrow HBr$$

What is the frequency of the visible light that would break the bond between two bromine atoms? Bond energy of Br_2 is 193 kJ/mol.

A. $7.8\times10^{-10}\ s^{-1}$ B. $3.6\times10^{-15}\ s^{-1}$ C. $2.4\times10^{-14}\ s^{-1}$ D. $4.8\times10^{14}\ s^{-1}$ E. $2.9\times10^{38}\ s^{-1}$

17. Which of the following set of solutions will produce the largest mass of precipitate?

A. 10 mL 0.1 *M* $AgNO_3$ + 10 mL 0.2 *M* NaCl
B. 10 mL 0.1 *M* $Pb(NO_3)_2$ + 20 mL 0.1 *M* KI
C. 10 mL 0.1 *M* $AgNO_3$ + 20 mL 0.2 *M* NaCl
D. 10 mL 0.1 *M* $AgNO_3$ + 20 mL 0.1 *M* NaCl
E. 10 mL 0.1 *M* $Pb(NO_3)_2$ + 10 mL 0.1 *M* KI

18. 1.7 g of NH_3 reacts with 3.2 g of O_2 according to the following reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

Assuming that the reaction results in 90% yield, what mass of NO will be produced?

A. 2.2 g B. 2.4 g C. 2.7 g D. 3.0 g E. 3.3 g

19. You want to determine the density of an irregular solid object. Which of the following is NOT needed in determining the density of the object in a high school lab?

A. Eye goggles
B. Balance
C. Graduated cylinder
D. A liquid denser than the object
E. A liquid less dense than the object

20. Mg^{2+} ions can be precipitated with aqueous $(NH_4)_2HPO_4$ and positively identified by a magnesium indicator. What is the formula of the precipitate?

A. $MgHPO_4$
B. Mg_2HPO_4
C. $Mg(HPO_4)_2$
D. $Mg(HPO_3)_3$
E. $Mg_3(PO_4)_2$

21. The equation $Al^+ (g) \rightarrow Al^{2+} (g) + e^-$ represents the _____ energy of aluminum which _____ 1815 kJ/mol.

	First blank	Second blank
A.	First ionization	requires
B.	Second ionization	requires
C.	First electron affinity	requires
D.	Second electron affinity	releases
E.	Second ionization	releases

22. Which of the following compounds is the *least* soluble in water at 20 °C?

A. $Ca(NO_3)_2$ B. KI C. KIO_3 D. $MgCO_3$ E. LiCl

23. 0.250 g of a sample that contains only NaCl (58.5 g/mol) and $CaCl_2$ (111 g/mol) yielded 0.633 g of dried AgCl (143.5 g/mol) when reacted with excess silver nitrate solution. Calculate the percent of NaCl in the mixture.

A. 10.0 % B. 25.0 % C. 40.0 % D. 50.0 % E. 60.0 %

24. Which of the following equations is NOT an oxidation-reduction reaction?

A. $3Cu (s) + 8H^+ (aq) + 8NO_3^- (aq) \rightarrow 3Cu^{2+} (aq) + 2NO (g) + 4H_2O (l)$
B. $Cu (s) + 2Ag^+ (aq) \rightarrow Cu^{2+} (aq) + 2Ag (s)$
C. $Zn (s) + 2H^+ (aq) \rightarrow Zn^{2+} (aq) + H_2 (g)$
D. $SiCl_4 (l) + 2H_2O (l) \rightarrow 4HCl (aq) + SiO_2 (s)$
E. $PbO (s) + NH_3 (g) \rightarrow N_2 (g) + H_2O (l) + Pb (s)$

25. The sides of the Al foil are 10.00 cm and 20.00 cm. The thickness of the foil has 4.00×10^4 Al atoms. The diameter of each Al atom is about 2.50×10^2 pm. What is the mass of the Al foil? The density of the Al is 2.73 g/cm^3. Molar mass of Al is 27.0 g/mol.

A.0.273 g B. 0.546 g C. 2.73 g D. 5.46 g E. 0.0546

CHEMISTRY FORMULAS

ATOMIC STRUCTURE

$\Delta E = h\nu$ or $\Delta E = h f$

$c = \nu\lambda$ or $c = f\lambda$

$\lambda = \frac{h}{m v}$

$p = m v$

$E_n = \frac{-2.178 \times 10^{-18} \text{ joule}}{n^2}$

E = energy
ν = frequency or f = frequency
λ = wavelength
p = momentum
v = velocity
n = principal quantum number
c = speed of light 3.00×10^8 m/s
h = Planck's constant = 6.63×10^{-34} joule s
k = Boltzmann' constant = 1.38×10^{-23} joule/K
Avogardor's number = 6.02×10^{23} molecules/mole
e = electron charge = -1.602×10^{-19} coulomb
1 electron volt/atom = 96.5×10^{23} kj/mole

OXIDATION-REDUCTION ELECTROCHEMISTRY

$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

where $a\,B + b\,B \Leftrightarrow c\,C + d\,D$

$I = q/t$ I = amperes, q = charge in coulombs, t = time in seconds.

$E_{cell} = E^o_{cell} - \frac{RT \ln Q}{n\Im} = E^o_{cell} - \frac{0.0592 \log Q}{n}$ @ 25°C

$\log K = \frac{nE^o}{0.0592}$

1 Faraday $\Im$ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH = pK_a + \log \frac{[A^-]}{[HA]}$

$pOH = pK_b + \log \frac{[HB^+]}{[B]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

$K_p = K_c (RT)^{\Delta n}$
Δn = moles product gas - moles reactant gas

EQUILIBRIUM TERMS

K_a = weak acid
K_b = weak base
K_w = water
K_p = gas pressure
K_c = molar concentration

KINETICS EQUATIONS

$A_o - A = kt$ where A_0 is initial concentration or amount.

$$\ln \frac{A_o}{A} = kt$$

$$\frac{1}{A} - \frac{1}{A_o} = kt$$

$$\frac{\ln k_2}{\ln k_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THERMOCHEMISTRY

$\Delta S^o = \Sigma \Delta S^o$ products- $\Sigma \Delta S^o$ reactants

$\Delta H^o = \Sigma \Delta H^o$ products - $\Sigma \Delta H^o$ reactants

$\Delta G^o = \Sigma \Delta G^o$ products - $\Sigma \Delta G^o$ reactants

$\Delta G^o = \Delta H^o - T\Delta S^o$
$\Delta G^o = -RT \ln K = -2.303\ RT \log K$

$\Delta G^o = -n\Im E^o$
$\Delta G = \Delta G^o + RT \ln Q = \Delta G^o + 2.303\ RT \log Q$

$q = m C \Delta T$

$C_p = \frac{\Delta H}{\Delta T}$
$q = mH_f$
$q = mH_v$.

S^o = standard entropy
H^o = standard enthalpy
G^o = standard free energy
E^o = standard reduction potential
T = temperature
q = heat
c = specific heat capacity

C_p = molar heat capacity at constant pressure
1 faraday $\Im$ = 96,500 coulombs/mole

$C_{water} = \frac{4.18 \text{ joule}}{\text{g K}}$
$H_f = \frac{330 \text{ joules}}{\text{gram}}$ for water
$H_v = \frac{2260 \text{ joules}}{\text{gram}}$ for water

CHEMISTRY FORMULAS

GASES, LIQUIDS, SOLUTIONS

$PV = nRT$

$(P + \frac{n^2a}{V^2})(V-nb) = nRT$

$P_A = P_{total}\ X_A$

$P_{total} = P_A + P_B + P_C + \ldots$

$n = \frac{m}{M}$

$Kelvin = {}^{o}C + 273$

$P_1V_1 = P_2V_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$d = \frac{m}{V}$

$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$

$KE_{per\ molecule} = \frac{mv^2}{2}$

$KE_{per\ mole} = \frac{3RTn}{2}$

$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

M, molarity = $\frac{\text{moles solute}}{\text{liter of solution}}$

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f$ molality

$\Delta T_b = iK_b$ molality

$\pi = \frac{nRTi}{V}$

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where X_A = $\frac{\text{moles A}}{\text{total moles}}$

u_{rms} = root-mean-square-root
KE = Kinetic energy
r = rate of effusion
M = Molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing point constant
K_b = molal boiling point constant
Q = reaction quotient
I =current in amperes
q = charge in coulombs
t = time
E^o = standard reduction potential
K = equilibrium constant

R, Gas constant = $\frac{8.31\ \text{joules}}{\text{mole kelvin}}$
= 0.0821 $\frac{\text{liter atm}}{\text{mole kelvin}}$
= 8.31 $\frac{\text{volts coulombs}}{\text{mole kelvin}}$

Boltzmann's constant, $k = 1.38 \times 10^{-23}\ \frac{\text{joule}}{\text{K}}$

$K_{f\ water} = 1.86$ Kelvin /molal
$K_{b\ water} = 0.512$ Kelvin /molal

STP = 0.00 °C and 1.00 atm (101.3 kpa)

1 faraday ℑ = 96,500 coulombs/ mole of electrons

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (???)				

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Chemistry II January 2012 Answer Key

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

CHEMISTRY II

JANUARY: matter and measurement, atomic theory(sub-atomic particles, atomic masses), chemical formulas, chemical equations(mole relationships, mass-mass problems), stoichiometry of redox solutions, stoichiometry of molar solutions, electronic structure and periodic table.
FEBRUARY: chemical bonding, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization, liquids, solids, vapor pressure, intermolecular forces, phase changes, gases, plus January topics.
MARCH: thermochemistry(enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), molecular orbitals, non-metals, metals, solutions, colligative properties, descriptive chemistry of the elements, plus Jan and Feb topics.
APRIL: chemical equilibrium, rates of reactions, reaction mechanisms, acids, bases, and salts, Ka, Kb, Ksp, buffers, coordination compounds, redox, voltaic cells, Nernst equations, ΔS, ΔH, ΔG, nuclear chemistry, organic chemistry, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

TESTING DAYS FOR THE NEW JERSEY SCIENCE LEAGUE 2011 – 2012

JANUARY TEST: Thursday January 12, 2012
FEBRUARY TEST: Thursday February 9, 2012
MARCH TEST: Thursday March 8, 2012
APRIL TEST: Thursday April 12, 2012

The April 2012 Exam date may change according to the schools in an area spring break.

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New Jersey Science League

Chemistry II Exam February 2012

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters in parentheses for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. **Please PRINT your name, school area , and which test you are taking onto the scan-tron.**

1. Acids which are stronger than pure sulfuric acid are called superacids. Superacids are very strong proton donors capable of protonating even weak Lewis acids such as CO_2. Cations, such as CO_2H^+, which never exist in other media, have been observed in superacid solutions. What is the H-O-C bond angle in this cation?

A. 90 B. 109 C. 120 D. 137 E. 180

2. What is the hybridization of the central atom in $POCl_3$?

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

3. What is the bond order in NO^+ ion?

A. 1.0 B. 1.5 C. 2.0 D. 2.5 E. 3.0

4. Which of the following compounds has hydrogen bonds as the most abundant intermolecular forces?

A. HBr B. PH_3 C. C_6H_5N D. H_2S E. CH_3OH

5. Which of the following species is trigonal planar?

A. H_3O^+ B. PCl_3 C. I_3^- D. CO_3^{2-} E. NH_4^+

6. Which of the following species has the most lone pairs on their central atoms?

A. BF_3
B. CO_3^{2-}
C. I_3^-
D. NH_3
E. H_2O

7. Suppose you have a balloon of given volume, V_1, containing a gas at temperature, T_1. When you place the balloon in a colder room at temperature, T_2, the balloon's temperature starts to drop at constant pressure. What are the signs of the system's *q*, *w* and ΔE for this process?

A. -q, +w, -ΔE
B. +q, -w, -ΔE
C. -q, -w, +ΔE
D. -q, -w, -ΔE
E. +q, +w, +ΔE

8. Which of the responses includes all of the following that can form hydrogen bonds with water molecules?

I. C_6H_6 II. C_2H_5OH III. CH_4 IV. CH_3COOH

A. I, II B. I, III C. II, III D. II, IV E. III, IV

9. A 2.00-g sample of a mixture of naphthalene ($C_{10}H_8$) and phenanthrene ($C_{14}H_{10}$) is dissolved in 25.00 g of benzene (C_6H_6). The freezing point of the solution is 2.95 °C. What is the mass percent composition of naphthalene in the sample mixture? The freezing point of pure benzene is 5.51 °C and K_f of benzene is 5.12 °C/molal.

A. 11.9% B. 19.8% C. 28.8% D. 33.2% E. 57.6%

10. A gas sample is known to be a mixture of ethane (C_2H_6) and butane (C_4H_{10}). A bulb having a 215.0-mL capacity is filled with the gas to a pressure of 108.5×10^3 Pa at 19.2°C. If the weight of the gas in the bulb is 0.3554 g, what is the mole percent of butane in the mixture?

A. 82.64% B. 74.18% C. 50.00% D. 33.33% E. 24.82%

11. Heavy water, deuterium oxide, D_2O, is used in nuclear reactors to store the radioactive rods when they are not in use. D is an isotope of hydrogen and is found in very small quantities in the natural hydrogen. D_2O (MW = 20) can be separated from H_2O (MW = 18) by employing one of the following techniques

A. Graham's diffusion
B. Fractional distillation
C. Filtration
D. Evaporation
E. Extraction

12. $$2A\ (g) + B\ (g) \rightarrow C\ (g) + D\ (g)$$

Gases A and B react in a closed, rigid vessel to form gases C and D according to the equation above. The initial pressure of A is 2.0 atm and that of B is 2.0 atm. No C and D are initially present. The experiment is carried out at constant T. No gas A is left at the end of the reaction. What is the total pressure in the vessel at the end of the reaction?

A. 5.0 atm B. 2.0 atm C. 3.0 atm D. 4.0 atm E. 6.0 atm

13. Which one of the following statements is NOT correct?

A. SO_3 exhibits three resonance structures.
B. The molecule of BrF_5 has a square pyramidal shape.
C. The electron arrangement of XeF_4 is octahedral.
D. C_2H_5OH has stronger H-bonds than CH_3OCH_3.
E. NH_3 and BH_3 have same geometries.

14. A rigid, constant-temperature vessel, contains some O_2. When a small amount of an unknown gas is introduced into the container, the total mass of the gas mixture is doubled and the number of moles of the gases is tripled. What would be the molecular weight of this unknown gas? Assume no chemical reaction between the gases.

A. 16 B. 18 C. 26 D. 28 E. 44

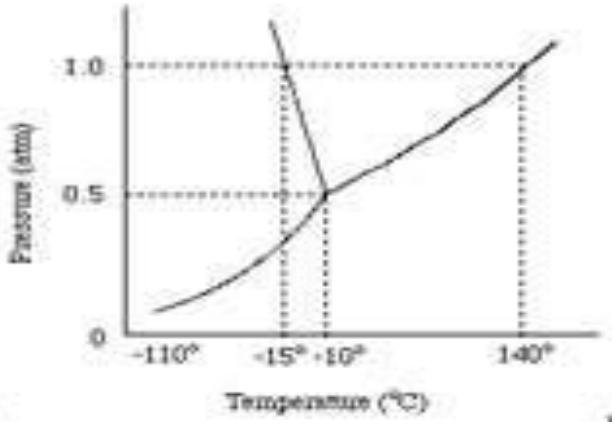
15. The number of lone pairs of electrons on the central atom in the Lewis structures of CO_2, ClO_3^-, SO_3, O_3 and NH_4^+ are, in order

A. 0, l, 1, 1, 0
B. 0, 1, 0, 1, 0
C. 0, 1, 2, 2, 1
D. 2, 1, 1, 1, 0
E. 2, 1, 1, 1, 1

16. 10.0 g of argon, 10.0 of neon and 10.0 g of hydrogen gases are introduced in a 20-L closed container at 127 °C. What is the total pressure, in atmospheres, in the container?

A. 12.9 B. 9.43 C. 6.12 D. 1.76 E. 0.943

17. The following phase diagram is given. The substance is originally at -50 °C and 0.6 atm. The temperature is raised to 90 °C at constant pressure. What is the final state of the substance?



A. solid B. liquid C. gas D. supercritical fluid E. amorphous

18. Which of the following substances would exhibit dipole-dipole intermolecular forces?

A. CH_4 B. CO_2 C. C_2H_2 D. SO_2 E. N_2

19. Which of the following melting point comparisons is incorrect?

A. mp of Ar (s) > mp of Xe (s)
B. mp of MgO (s) > mp of NaCl (s)
C. mp of SiO_2 (S) > mp of SO_2 (s)
D. mp of C (s) > mp of Hg (s)
E. mp of H_2O (s) > mp of N_2 (s)

20. Which of the following has an electron configuration of [Ar]3d^5 ?

A. Mn B. V C. Zn^{2+} D. V^{5+} E. Fe^{3+}

21. Consider the following unbalanced redox reaction that occurs in acidic solution

$$As_2O_3\,(s) + NO_3^-\,(aq) \rightarrow H_3AsO_4\,(aq) + NO\,(g)$$

100.0 mL of 0.400 *M* nitric acid is completely reacted with excess As_2O_3. What is the volume of NO collected at 997 mm Hg and 87 °C?

A. 10.0 mL B. 31.8 mL C. 76.0 mL D. 100. mL E. 900. mL

22. Which of the following compound has the lowest vapor pressure at room temperature?

A. H_2O
B. CH_3OH
C. CH_2OHCH_2OH
D. CH_3COOH
E. $CH_2OHCHOHCH_2OH$

23. 100.0 mL 0.10 *M* NaCl solution and 200.0 mL 0.20 *M* $CaCl_2$ are mixed. What is the concentration of the all chloride ions in the final solution?

A. 0.27 B. 0.30 C. 0.33 D. 0.40 E. 0.50

24. A 50.0 L cylinder at temperature of 32 ^oC and a pressure of 50.0 atm contains how many molecules of H_2 gas?

A. 6.02×10^{23} B. 1.204×10^{24} C. 6.02×10^{25} D. 3.01×10^{26} E. 6.02×10^{21}

25. Which of the following responses correctly identifies the structure of all the substances shown in the table? All the substances are pure and in their solid state.

	LiCl	**HCl**	**CH_3OCH_3**	**C (diamond)**	**K**
A.	Ionic	Ionic	Molecular	Network covalent	Atomic
B.	Ionic	Metallic	Molecular	Network covalent	Atomic
C.	Ionic	Molecular	Molecular	Network covalent	Metallic
D.	Ionic	Molecular	Metallic	Atomic	Metallic
E.	Molecular	Ionic	Ionic	Atomic	Metallic

Chemistry II February 2012 Answer Key

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

CHEMISTRY 11 For all second year and AP level students. 25 multiple choice questions per exam.

JANUARY: matter and measurement, atomic theory(sub-atomic particles, atomic masses), chemical formulas, chemical equations(precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, activity series, mole relationships, mass-mass problems), stoichiometry of redox solutions, stoichiometry of molar solutions, electronic structure and periodic table.

FEBRUARY: chemical bonding, molecular orbital theory and molecular orbitals, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization, liquids, solids, vapor pressure, intermolecular forces, phase changes, gases, plus January topics.

MARCH: thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), non-metals, metals, solutions, colligative properties, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, rates of reactions, reaction mechanisms, acids, bases, and salts, Ka, Kb, Ksp, buffers, coordination compounds, redox, voltaic cells, Nernst equations, ΔS, ΔH, ΔG, nuclear chemistry, organic chemistry, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

TESTING DAYS FOR THE NEW JERSEY SCIENCE LEAGUE 2011 – 2012

JANUARY TEST: Thursday January 12, 2012
FEBRUARY TEST: Thursday February 9, 2012
MARCH TEST: Thursday March 8, 2012
APRIL TEST: Thursday April 12, 2012

The April 2012 Exam date may change according to the spring break for schools in an area.

New Jersey Science League www.enter.net/~njscil
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New Jersey Science League

Chemistry II Exam March 2012

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Choose the letter that best completes or answers the item and fill in the corresponding oval on the scan-tron. Be certain that erasures are complete. Please PRINT your name, school name, area , and which test you are taking onto the scan-tron.

1. The electronic configuration of an atom M is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$. Which of the following is the formula of the **most common oxide** of M?

A. M_2O_3 B. M_2O C. MO_2 D. MO E. MO_3

2. The increasing bond order in the species O_2^+ , O_2^- and O_2^{2-} is

A. $O_2^{2-} < O_2^+ < O_2^-$
B. $O_2^- < O_2^{2-} < O_2^+$
C. $O_2^{2-} < O_2^- < O_2^+$
D. $O_2^+ < O_2^- < O_2^{2-}$
E. $O_2^- < O_2^+ < O_2^{2-}$

3. An ice cube at 0°C weighing 10.0 grams is dropped into an insulated vessel containing 75.0 grams of water at 60.0°C. What is the final temperature of the water after the ice has melted? The latent heat of fusion is 6.01 kJ/mol and the specific heat of water is 4.18 J/g·°C.

A. 34.7°C B. 41.1°C C. 43.5°C D. 23.2°C E. 28.9°C

4. The triad is a group of three elements. If the elements of a triad are arranged in order of increasing atomic mass, e.g. chlorine (35), bromine (80), and iodine (127), the atomic mass of the middle element is the average of the atomic masses of the other two elements. Which scientist noticed this property first?

A. Mendeleev B. Newlands C. Dalton D. Dobereiner E. Prout

5. Which of the following solutions has the lowest vapor pressure?

A. 0.1 *m* KNO_3
B. 0.2 *m* $Mg(NO_3)_2$
C. 0.1 *m* $Al(NO_3)_3$
D. 0.2 *m* NH_4NO_3
E. 0.3 *m* $C_7H_5(NO_2)_3$

6. Which of the following exhibits colligative properties?

I. Density II. Osmotic Pressure III. Boiling point elevation IV. Freezing point depression

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

7. Which of the following substances are soluble in nonpolar solvents?

I. Iodine II. Sulfur III. Sodium chloride IV. Graphite

A. Only I
B. Only II
C. Only I and II
D. Only I, II and IV
E. None of the is correct

8. Which element commonly exhibits both +1 and +3 charges?

A. Al B. Sc C. Sn D. Tl E. Bi

9. You are given the following reactions along with their reaction enthalpies:

A + 3B	→	2C + 3D	–300 kJ
E + C	→	B	100 kJ
F + ½B	→	D	40 kJ

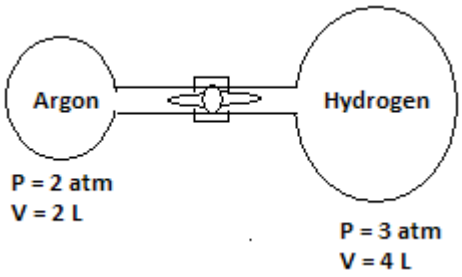
Using the above data, calculate the enthalpy of A + 2E → 2F + D.

A. –180 B. –40 C. –20 D. 120 E. 180

10. To determine the molecular weight of a protein, 3.3 mg of protein sample is dissolved in enough water to make 2.5 mL of solution. The osmotic pressure of this solution is 2.0 mm Hg at 20°C. What is the molecular weight of the protein in g/mol? 1 atm = 760. mm Hg

A. 1200 B. 7700 C. 9600 D. 11000 E. 12000

11. Two spherical containers are connected as shown in the figure on the right. The initial pressure of Argon, contained in the 2.0-L balloon is 2.0 atm and that of hydrogen is 3.0 atm which is confined in the 4.0-L balloon. Initially both gases are at the same temperature. The valve connecting these two balloons is opened and the two gases diffuse into each other. The experiment is carried out at constant T. What is the total pressure in the vessel?



A. 5.0 atm B. 2.0 atm C. 2.7 atm
D. 4.0 atm E. 6.0 atm

12. Which of the following choices is correct when the ionic solids are arranged in order of their increasing lattice energies?

A. NaF < NaCl < CaO < Al_2O_3
B. NaCl < NaF < CaO < MgO
C. NaCl < $CaCl_2$ < Al_2O_3 < $AlCl_3$
D. KBr < KI < KF < KCl
E. CaO < MgO < Al_2O_3 < Na_2O

13. What is the vapor pressure at 25°C of an aqueous solution that is 10.0% by mass NaCl? The vapor pressure of water is 23.8 mm Hg at 25°C.

A. 2.38 B. 18.8 C. 21.4 D. 23.0 E. 24.6

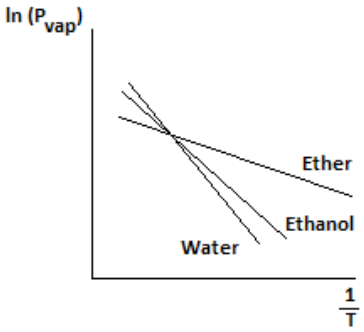
14. A solution is prepared by mixing 10.0 g of acetone (CH_3COCH_3) and 10.0 g of methanol (CH_3OH) at 25°C. Calculate the vapor pressure of the mixture? The vapor pressure of acetone at 25°C is 222 mm Hg and the vapor pressure of methanol at 25°C is 123 mm Hg.

A. 98 B. 115 C. 158 D. 173 E. 235

15. What is the molarity of an aqueous solution of concentrated nitric acid which is 63% by mass nitric acid? The density of the solution is 1.64 g/cm^3?

A. 1.64 B. 16.4 C. 0.164 D. 6.3 E. 0.63

16. Classius-Clapeyron equation estimates the enthalpy of vaporization of a pure liquid substance. The vapor pressure of a liquid increases exponentionally with increasing temperature. A straight line can be obtained by plotting *ln* (P_{vap}) versus the inverse of Kelvin temperature:



$$ln(P) = \frac{-\Delta H_{vap}}{R\left(\frac{1}{T}\right)} + constant$$

and ΔH_{vap} can be estimated by using: $-\Delta H_{vap} = slope \times R$.

Based on the graph given in the text, which compound has the highest enthalpy of vaporization?

A. water
B. ethanol
C. ether
D. they are all same
E. it cannot be determined

17. A compound is made of 39.13% of C, 8.69% of H and 52.18% of O. A solution prepared by dissolving 2.052 g of this compound in 12.0 g of water freezes at -3.45°C. What is the molecular formula of the compound? K_f = –1.86°C/molal and K_b = +0.52°C/molal.

A. $C_2H_4O_2$ B. $C_3H_8O_3$ C. $C_6H_{12}O_6$ D. $C_{12}H_{22}O_{11}$ E. $C_4H_{10}O$

18. A piston-cylinder system receives 1.00 kJ of heat energy and expands from an initial volume of 5.0 liters to 7.0 liters against an external pressure of 10.0 atmospheres. What is the change of the internal energy of the system? (*Do not observe significant figures)*

A. –1026 J B. –797.4 J C. 797.4 J D. 1026 J E. –202.6 J

19. 0.050 g of an unknown metal (M) is transferred into a 50-mL eudiometer filled with 3 *M* HCl at 22 °C. After the reaction, represented by the equation below, is terminated

$$M + 2HCl \rightarrow MCl_2 + H_2$$

the gas displaced 19.3 mL of water from the eudiometer. The atmospheric pressure was 758 mm Hg. The vapor pressure of water vapor is 28 mm Hg. What is the identity of the metal?

A. Zn B. Cu C. Fe D. Sn E. Mg

20. 10.00 g of iron piece is heated over a Bunsen burner flame and immediately dropped into an insulated container that contains 100.0 g of water at 20 °C. The final temperature of the system is 28.5 °C. What is the temperature of the flame in degree Celsius? c_{Iron} = 0.45 J/g·°C

A. 794 B. 818 C. 923 D. 1018 E. 1094

21. Calculate the heat of the reaction between propene, C_3H_6, and bromine, Br_2, to give 1,2-dibromopropane, $CH_3CHBrCH_2Br$, from the values of the bond energies provided below:

$$CH_3CHCH_2 + Br_2 \rightarrow CH_3CHBrCH_2Br$$

E_{C-C} = 347 kJ/mol; E_{C-Br} = 276 kJ/mol;
$E_{C=C}$ = 614 kJ/mol; E_{Br-Br} = 193 kJ/mol;
E_{C-H} = 413 kJ/mol;

A. –1320 B. –225 C. –92 D. 225 E. 1320

22. An endothermic process absorbs heat and cools the surroundings. An exothermic process releases heat and causes the temperature of the immediate surroundings to rise. Which of the following processes is NOT identified correctly?

A. Making ice cubes	Exothermic
B. Rusting iron	Exothermic
C. Making an anhydrous salt from its hydrate	Endothermic
D. Producing sugar by photosynthesis	Endothermic
E. Reaction of Barium hydroxide with dry ammonium nitrate	Exothermic

23. Let the energy of the 2*s* level in a hydrogen atom be –*E*. What is the energy level of the 3*s* level?

A. (-2/3) *E* B. (-3/2) *E* C. (-4/9) *E* D. (-2/3) *E* E. -3 *E*

24. Which pair of ions have the same shape?

A. CO_3^{2-} and NO_3^-
B. CO_3^{2-} and SO_3^{2-}
C. NO_3^- and ClO_3^-
D. CO_3^{2-} and ClO_3^-
E. ClO_3^- and SO_4^{2-}

25. The table contains data of the molar enthalpies of fusion and vaporization of some selected substances.

Substance	Formula	ΔH^o_f (kJ/mol)	Melting Point (°C)	ΔH^o_v (kJ/mol)	Boiling Point (°C)
Neon	Ne	0.33	–249	1.80	–246
Oxygen	O_2	0.44	–219	6.82	–183
Methane	CH_4	0.94	–182	8.18	–161
Ethane	C_2H_6	2.85	–183	14.72	–89
Chlorine	Cl_2	6.40	–101	20.41	–34
Dichloromethane	CH_2Cl_2	6.16	–97	28.6	40
Carbon tetrachloride	CCl_4	2.67	–23	30.00	77
Water	H_2O	6.08	0	40.66	100

Based on the above tabulated data, which of the following choices is NOT correct?

A. The heat of fusion of H_2 is 29 kJ/mol.

B. The standard heat of vaporization of Br_2 is 30 kJ/mol.

C. The melting point of Xe is –116 °C.

D. Melting point of $CHCl_3$ is –64 °C.

E. The boiling point of propane, C_3H_8, is –42 °C

CHEMISTRY FORMULAS

ATOMIC STRUCTURE

$\Delta E = h\nu$ or $\Delta E = h f$

$c = \nu\lambda$ or $c = f\lambda$

$\lambda = \frac{h}{m v}$

$p = m v$

$E_n = \frac{-2.178 \times 10^{-18} \text{ joule}}{n^2}$

E = energy
ν = frequency or f = frequency
λ = wavelength
p = momentum
v = velocity
n = principal quantum number
c = speed of light 3.00×10^8 m/s
h = Planck's constant = 6.63×10^{-34} joule s
k = Boltzmann' constant = 1.38×10^{-23} joule/K
Avogardor's number = 6.02×10^{23} molecules/mole
e = electron charge = -1.602×10^{-19} coulomb
1 electron volt/atom = 96.5×10^{23} kj/mole

OXIDATION-REDUCTION ELECTROCHEMISTRY

$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

where $a B + b B \Leftrightarrow c C + d D$

$I = q/t$ I = amperes, q = charge in coulombs, t = time in seconds.

$E_{cell} = E^o_{cell} - \frac{RT \ln Q}{n\mathfrak{F}} = E^o_{cell} - \frac{0.0592 \log Q}{n}$ @ 25°C

$\log K = \frac{nE^o}{0.0592}$

1 Faraday $\mathfrak{F}$ = 96,500 coulombs/mole

EQUILIBRIUM

$K_w = 1 \times 10^{-14}$ at 25°C

$pH = -\log[H^+]$; $pOH = -\log[OH^-]$

$pH + pOH = 14$

$pH = pK_a + \log \frac{[A^-]}{[HA]}$

$pOH = pK_b + \log \frac{[HB^+]}{[B]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

$K_p = K_c (RT)^{\Delta n}$
Δn = moles product gas - moles reactant gas

EQUILIBRIUM TERMS

K_a = weak acid
K_b = weak base
K_w = water
K_p = gas pressure
K_c = molar concentration

KINETICS EQUATIONS

$A_o - A = kt$ where A_0 is initial concentration or amount.

$$\ln \frac{A_o}{A} = kt$$

$$\frac{1}{A} - \frac{1}{A_o} = kt$$

$$\frac{\ln k_2}{\ln k_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THERMOCHEMISTRY

$\Delta S^o = \Sigma \Delta S^o$ products- $\Sigma \Delta S^o$ reactants

$\Delta H^o = \Sigma \Delta H^o$ products - $\Sigma \Delta H^o$ reactants

$\Delta G^o = \Sigma \Delta G^o$ products - $\Sigma \Delta G^o$ reactants

$\Delta G^o = \Delta H^o - T\Delta S^o$
$\Delta G^o = -RT \ln K = -2.303\ RT \log K$

$\Delta G^o = -n\mathfrak{F}E^o$
$\Delta G = \Delta G^o + RT \ln Q = \Delta G^o + 2.303\ RT \log Q$

$q = m C \Delta T$

$C_p = \frac{\Delta H}{\Delta T}$
$q = mH_f$
$q = mH_v$.

S^o = standard entropy
H^o = standard enthalpy
G^o = standard free energy
E^o = standard reduction potential
T = temperature
q = heat
c = specific heat capacity

C_p = molar heat capacity at constant pressure
1 faraday $\mathfrak{F}$ = 96,500 coulombs/mole

$C_{water} = \frac{4.18 \text{ joule}}{g\ K}$
$H_f = \frac{330 \text{ joules}}{\text{gram}}$ for water
$H_v = \frac{2260 \text{ joules}}{\text{gram}}$ for water

CHEMISTRY FORMULAS

GASES, LIQUIDS, SOLUTIONS

$PV = nRT$

$(P + \frac{n^2a}{V^2})(V-nb) = nRT$

$P_A = P_{total}\ X_A$

$P_{total} = P_A + P_B + P_C + \ldots$

$n = \frac{m}{M}$

Kelvin = °C + 273

$P_1V_1 = P_2V_2$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$d = \frac{m}{V}$

$u_{rms} = \sqrt{\frac{3kt}{m}} = \sqrt{\frac{3RT}{M}}$

$KE_{per\ molecule} = \frac{mv^2}{2}$

$KE_{per\ mole} = \frac{3RTn}{2}$

$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

M, molarity = $\frac{\text{moles solute}}{\text{liter of solution}}$

molality = $\frac{\text{moles of solute}}{\text{kg of solvent}}$

$\Delta T_f = iK_f \cdot \text{molality}$

$\Delta T_b = iK_b \cdot \text{molality}$

$\pi = \frac{nRTi}{V}$

P = pressure
V = volume
T = Temperature
n = number of moles
d = density
m = mass
v = velocity
where X_A = $\frac{\text{moles A}}{\text{total moles}}$

u_{rms} = root-mean-square-root
KE = Kinetic energy
r = rate of effusion
M = Molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing point constant
K_b = molal boiling point constant
Q = reaction quotient
I =current in amperes
q = charge in coulombs
t = time
E° = standard reduction potential
K = equilibrium constant

R, Gas constant = $\frac{8.31\ \text{joules}}{\text{mole kelvin}}$
= $\frac{0.0821\ \text{liter atm}}{\text{mole kelvin}}$
= $\frac{8.31\ \text{volts coulombs}}{\text{mole kelvin}}$

Boltzmann's constant, $k = 1.38 \times 10^{-23}\ \frac{\text{joule}}{\text{K}}$

$K_{f\ water} = 1.86$ Kelvin /molal
$K_{b\ water} = 0.512$ Kelvin /molal

STP = 0.00 °C and 1.00 atm (101.3 kpa)

1 faraday ℑ = 96,500 coulombs/ mole of electrons

PERIODIC TABLE OF THE ELEMENTS

1 1A																	18 8A
1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289)				

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Chemistry II March 2012 Answer Key

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

CHEMISTRY 11 For all second year and AP level students. 25 multiple choice questions per exam.

JANUARY: matter and measurement, atomic theory(sub-atomic particles, atomic masses), chemical formulas, chemical equations(precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, activity series, mole relationships, mass-mass problems), stoichiometry of redox solutions, stoichiometry of molar solutions, electronic structure and periodic table.

FEBRUARY: chemical bonding, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization, liquids, solids, vapor pressure, intermolecular forces, phase changes, gases, plus January topics.

MARCH: thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), non-metals, metals, solutions, colligative properties, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, rates of reactions, reaction mechanisms, acids, bases, and salts, Ka, Kb, Ksp, buffers, coordination compounds, redox, voltaic cells, Nernst equations, ΔS, ΔH, ΔG, nuclear chemistry, organic chemistry, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Testing Dates for 2012

Thursday March 8, 2012; *Thursday April 12, 2012

***The April 2012 exam can be changed based upon the School's spring break.**

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Testing Dates 2013

Thursday January 10, 2013, Thursday Feb 14, 2013; Thursday March 14, 2013; *Thursday April 11, 2013

***The April 2013 exam can be changed based upon the School's spring break.**

New Jersey Science League
Chemistry II Exam April 2012

Answer the following questions on the answer sheet provided. Each correct response is worth 4 points. Use the letters for your answers. Choose the letter that best completes or answers the item. Be certain that erasures are complete. Please **PRINT** your name, school area code, and which test you are taking on the scan-tron.

1. Which of the following reagents will NOT be used during the qualitative analysis of Cl^-, Br^-, CO_3^{2-} and SO_4^{2-} ions simultaneously present in an aqueous solution?

A. $BaCl_{2\,(aq)}$ B. $HNO_{3\,(aq)}$ C. $AgNO_{3\,(aq)}$ D. $NH_{3\,(aq)}$ E. $KNO_{3\,(aq)}$

2. Manganese(II) ions can be oxidized by sodium bismutate in acidic medium according to the following equation:

$$\_\_Mn^{2+}\,(aq) + \_\_BiO_3^-\,(aq) + \_\_H^+\,(aq) \rightarrow \_\_Bi^{3+}\,(aq) + \_\_MnO_4^-\,(aq) + \_\_H_2O\,(l)$$

What volume of 0.050 *M* $NaBiO_3$ is required to oxidize a sample of 2.0 mL 0.10 *M* $MnCl_2$ solution?

A. 10. mL B. 20. mL C. 25 mL D. 40. mL E. 50. mL

3. Which of the following choices describes best the change in enthalpy, the change in entropy and the spontaneity of the given reaction?

$$2C\,(s) + O_2\,(g) \rightarrow 2CO\,(g)$$

	ΔH^o	ΔS^o	ΔG^o
A.	-	-	*spontaneous* at low T
B.	-	+	*spontaneous* at any T
C.	+	+	*spontaneous* at high T
D.	+	-	*spontaneous* at low T
E.	-	-	*spontaneous* at high T

4. Acetic acid, HAc, is a weak acid and has a $K_a = 1.80\times10^{-5}$. 0.820 g of solid sodium acetate, $NaCH_3COO$, is added to 100.0 mL 0.100 *M* acetic acid solution. What is the pH of the solution obtained assuming that there is no increase in volume of the solution?

A. 4.74 B. 5.74 C. 3.74 D. 9.26 E. 8.26

5. The K_w value of water increases with increasing temperature.

$$2H_2O\,(l) \leftrightarrows H_3O^+\,(aq) + OH^-\,(aq)$$

At 60°C, the value of K_w is 1.0×10^{-13} compared to 1.0×10^{-14} at 25°C. Which of the following choices is CORRECT for water at 60°C?

A. The reaction is exothermic and the pH is higher than 7.
B. The reaction is exothermic and the pH is lower than 7.
C. The reaction is endothermic and the pH is higher than 7.
D. The reaction is endothermic and the pH is lower than 7.
E. None of the above statements is correct.

6. Consider the voltaic cell based on these half cells.

$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$ $E^o = +1.50$ V

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $E^o = +0.34$ V

Identify the anode, calculate the E^o_{cell} under the standard conditions and ΔG when $[Au^{3+}] = 0.100$ *M* and $[Cu^{2+}] = 0.100$ *M* and temperature is 25°C.

A. Cu, 1.84 V and −677 kJ
B. Au, 1.16 V and −718 kJ
C. Cu^{2+}, 1.84 V and 718 kJ
D. Cu, 1.16 V and −677 kJ
E. Au^{3+}, 1.84 V and −677 kJ

7. Enzymes are very specific biological catalysts. The substrate, S, binds to the enzyme's active site and an enzyme-substrate complex, ES, is formed. Then, the ES breaks down to give product, P, and the enzyme (E) starts the cycle all over again as shown in the following mechanism: (*k_1 is rate constant of the forward reaction and k_2 is the rate constant for the reverse reaction)*

$$E + S \underset{k_2}{\overset{k_1}{\leftrightarrow}} ES \qquad \textit{fast equilibrium}$$

$$ES \xrightarrow{k_3} E + P \qquad \textit{slow}$$

The rate of the enzyme catalyzed reaction is given by

A. $k_1[E][S]$ B. $k_2[E][S]$ C. $k_3[P][E]$ D. $\frac{k_2}{k_1}[E][S]$ E. $\frac{k_1 k_3}{k_2}[E][S]$

8. Alcohols and ethers correspond to the same general formula $C_nH_{2n+2}O$, but are identified with different functional groups, e.g. –OH for alcohols and C-O-C for ethers. Which of the following alcohols or ethers does not have a molecular formula corresponding to $C_5H_{12}O$?

A. 2-methyl-2-butanol B. n-propyl ethyl ether C. diethyl ether D. 1-pentanol E. 2-pentano

9. How long will it take to deposit all the copper ions from 100 mL 0.010 *M* copper(II) sulfate solution using a current of 1.93 A? F = 96500 C.

A. 1200 s B. 1000 s C. 120 s D. 100 s E. 19.3 s

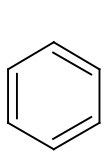
10. Which of the following compounds does NOT exhibit *cis-trans* isomerism?

A. 1,2-dimethylcyclohexane
B. 1,4-dimethylcyclohexane
C. 1-butene
D. 2-butene
E. all of the above compounds exhibit *cis-trans* isomerism

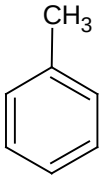
11. A radioactive isotope has a half-life of 6 minutes. What fraction will remain after 1 hour?

A. 1/6 B. 1/16 C. 1/32 D. 1/256 E. 1/1024

12. Benzene is an aromatic compound with the following cyclic structure. Toluene is obtained when a single methyl group substitution is made on the benzene ring.



Benzene



Toluene

Finally, when a second methyl group is introduced a mixture of dimethylbenzenes or xylenes are produced. How many isomers of xylenes are possible?

A. 2 B. 3 C. 4 D. 5 E. 6

13. Consider the following system at equilibrium.

$$4A\ (g) + O_2\ (g) \leftrightarrows 2C\ (g) + 2D\ (g) + 285\ kcal$$

Which of the following changes will shift the equilibrium to the left?

A. Adding a catalyst
B. Adding an inert gas
C. Removing some C
D. Increasing the temperature
E. Increasing the pressure by reducing the volume

14. Which of the following complex compounds is named correctly?

A. $K_2[HgI_4]$	potassium tetraiodomercurate
B. $Na[Al(OH)_4]$	sodium aluminate
C. $Li_4[PtCl_6]$	lithium hexachloroplatinate(IV)
D. $[Fe(en)_2(NO_2)_2]SO_4$	ethylenediaminedinitroiron(III) sulfate
E. $[Co(NH_3)_5Cl]Cl_2$	pentaamminechlorocobalt(III) chloride

15. A saturated solution of which compounds has the lowest $[Ba^{2+}]$?

A. $BaCO_3$ $K_{sp} = 1.6\times10^{-9}$
B. $BaCrO_4$ $K_{sp} = 8.5\times10^{-11}$
C. BaF_2 $K_{sp} = 2.4\times10^{-5}$
D. $Ba(OH)_2$ $K_{sp} = 5.0\times10^{-3}$
E. $BaSO_4$ $K_{sp} = 1.5\times10^{-9}$

16. 100.0 mL 0.10 *M* HCl solution and 200.0 mL 0.10 *M* $Ba(OH)_2$ solutions are mixed. What is the pH of the final solution?

A. 1.0 B. 1.3 C. 7.0 D. 12.7 E. 13.0

17. How many α and ß decays are needed for the $^{238}_{92}U \rightarrow {}^{206}_{82}Pb$ radioactive decay?

A. 8α, 6ß B. 8ß, 4α C. 6α, 4ß D. 8α, 4ß E. 6α, 6ß

18. 10.0 mL HCl solution pH = 2.0 and 10.0 mL HCl solution pH = 6.0 are mixed. What is the pH of the final solution?

A. 2.0 B. 2.3 C. 4.0 D. 4.7 E. 8.0

19. Which of the following solutions will form a buffer upon mixing?

A. 10 mL 0.1 *M* HCl + 10 mL 0.1 *M* NH_3
B. 10 mL 0.1 *M* HCl + 10 mL 0.1 *M* NaOH
C. 5 mL 0.1 *M* HCl + 10 ml 0.1 *M* NH_3
D. 10 mL 0.1 *M* CH_3COOH + 10 mL 0.1 *M* NaOH
E. 5 mL of 0.1 *M* HCl + 10 mL 0.1 *M* CH_3COOH

20. The rate law for a certain reaction is determined to be $rate = k\,[A][B]^2[C]^{-1}$. How does the rate of this reaction compare if the concentrations of A, B and C are doubled at constant temperature?

A. remains the same
B. becomes twice faster than its original rate
C. becomes twice slower than its original rate
D. becomes four times faster than its original rate
E. becomes four times slower than its original rate

21. What is the pH of the 0.0100 *M* H_2SO_4 solution? pK_{a1} = very large; $pK_{a2} = 1.20\times10^{-2}$

A. 1.84 B. 1.92 C. 2.00 D. 2.12 E. 2.92

22. Lactic acid ($HC_3H_5O_3$) is a waste product that accumulates in muscle tissue during exertion. The K_a of lactic acid is 1.4×10^{-4}. What is the percent dissociation of the lactic acid in 0.10 M aqueous solution?

A. 1.4% B. 2.6% C. 3.7% D. 4.2% E. 5.1%

23. The value of the equilibrium constant for A + B ⇆ 4C is 50. at 100°C. What is the value of the equilibrium constant for the reaction 2C ⇆ ½A + ½B at 100°C?

A. 25 B. 0.14 C. 20. D. 1.0×10^2 E. 0.50

24. For the homogeneous gas phase reaction A (g) + B (g) ⇆ C (g) + D (g), the equilibrium constant is 100 at 400 K. To a 1-L rigid container at room temperature, 1.0 mol of each of all the gases is introduced and the temperature is raised to 400 K. What is the concentration of B at equilibrium?

A. 0.18 B. 0.25 C. 0.33 D. 0.67 E. 0.75

25. What can be said about the solubility of Ag_2CrO_4 in pure water, in a 0.1 *M* $AgNO_3$ solution and in a 0.1 *M* K_2CrO_4 solution? K_{sp} of Ag_2CrO_4 at 25°C is 9.0×10^{-12}.

A. The solubility of Ag_2CrO_4 is the lowest in pure water.
B. The solubility of Ag_2CrO_4 is higher in $AgNO_3$ solution than in K_2CrO_4 solution
C. The solubility of Ag_2CrO_4 is the same in $AgNO_3$ and K_2CrO_4 solutions
D. The solubility of Ag_2CrO_4 is lower in $AgNO_3$ solution than in K_2CrO_4 solution
E. All of the above choices are wrong.

Chemistry II April 2012 Answer Key

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

CHEMISTRY 11 For all second year and AP level students. 25 multiple choice questions per exam.

JANUARY: matter and measurement, atomic theory(sub-atomic particles, atomic masses), chemical formulas, chemical equations(precipitation reactions, ionic equations, solubility, acid-base reactions, gas forming reactions, oxidation reduction reactions, activity series, mole relationships, mass-mass problems), stoichiometry of redox solutions, stoichiometry of molar solutions, electronic structure and periodic table.

FEBRUARY: chemical bonding, electronegativity, Lewis structures, molecular geometry, polarity of molecules, hybridization, liquids, solids, vapor pressure, intermolecular forces, phase changes, gases, plus January topics.

MARCH: thermo chemistry (enthalpy, Hess's Law, heats of formation, bond energies, calorimetry), non-metals, metals, solutions, colligative properties, descriptive chemistry of the elements, plus Jan and Feb topics.

APRIL: chemical equilibrium, rates of reactions, reaction mechanisms, acids, bases, and salts, Ka, Kb, Ksp, buffers, coordination compounds, redox, voltaic cells, Nernst equations, ΔS, ΔH, ΔG, nuclear chemistry, organic chemistry, descriptive chemistry of the elements, plus Jan, Feb., and Mar topics.

Testing Dates 2013

Thursday January 10, 2013, Thursday Feb 14, 2013; Thursday March 14, 2013; *Thursday April 11, 2013

***The April 2013 exam can be changed based upon the School's spring break.**

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