2009 Ashdown Examination

**DIRECTIONS**

- Put your name, school, and test number on the bubble sheet, as follows;

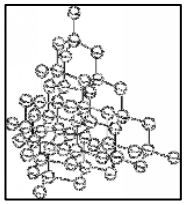
  NAME__Your_Name____

  SUBJECT__School_____

  PERIOD_____DATE_____Test Number____

- There are 90 questions, and the exam will last 100 minutes.
- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a soft, #2 pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark very carefully.
- There is only one correct answer to each question. Any questions for which more than one response has been blackened **will not be counted**.
- Your score is based solely on the number of questions you answer correctly. **It is to your advantage to answer every question.**
- When you are told to start the exam, you may tear off this sheet and the periodic table sheet below this one.
- After the test is over and the proctors have collected the bubble sheets, you may take this exam home with you.
- Answers will be posted in the registration area after the examination.
- Prize winners and qualifiers will be notified within 3 days or sooner.
- Good luck!

2009 Ashdown Examination



1. The name of the carbon allotrope shown to the right is:
   A. graphite B. diamond C. bucky ball D. nanotube

2. The element whose symbol comes from the Latin word for "liquid silver" is:
   A. tin B. copper C. silver D. mercury

3. Dimethylhydrazine, $C_2N_2H_8$, and $N_2O_4$ were used as the propellant for the Apollo lunar descent module. Balance this equation with the smallest whole number coefficients and select the answer that is the **sum of the coefficients**.

   _____ $C_2N_2H_8$ + _____ $N_2O_4$ → _____ $CO_2$ + _____ $H_2O$ + ____ $N_2$

   A. 8 B. 10 C. 12 D. 14

4. Which substance is a binary compound?
   A. sodium nitrite B. sodium nitride C. sodium hydroxide D. sodium cyanide

5. An example of a chemical property is:
   A. color B. density C. mass D. flammability

6. MSDS's should be consulted:
   A. In case of fire or explosion
   B. Before working with a chemical
   C. In the event of a spill
   D. All of the above

7. Teachers just love it when students request the proper equipment when doing a laboratory. To impress your teacher, you ask for the item to the right as a(n):
   A. crucible and lid
   B. evaporating dish and cover
   C. mortar and pestle
   D. Petri dish

Questions 8 and 9 deal with methylamine, $CH_3NH_2$. $K_b = 5.0 \times 10^{-4}$.

8. What is the pH of a 0.20 M aqueous solution of methylamine?
   A. 2.00 B. 16.00 C. 10.00 D. 12.00

9. The percent ionization of 0.20 M methylamine aqueous solution is:
   A. 1.0 % B. 2.0% C. 5.0% D. 10%

10. A compound is 29.0% Na, 40.5% S and 30.5% O by mass. What is the empirical formula for this compound? (Na=23.0, S=32.1, O=16.0)
    A. $Na_2SO_4$ B. $Na_2SO_3$ C. $NaSO_2$ D. $Na_2S_2O_3$

11. Which of the following chemical reactions is classified as **both** a double replacement reaction and an acid-base neutralization?
    A. $3\ NaOH + FeCl_3 \rightarrow 3\ NaCl + Fe(OH)_3$
    B. $NaOH + HCl \rightarrow NaCl + HOH$
    C. $2\ AgNO_3 + Na_2CrO_4 \rightarrow Ag_2CrO_4 + 2\ NaNO_3$
    D. $2\ NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2\ HCl$

For problems 12-14, use the following information:

$2\ KClO_3(s) \rightarrow 2\ KCl(s) + 3\ O_2(g)$
$2\ KHCO_3(s) \rightarrow K_2O(s) + H_2O(g) + 2\ CO_2(g)$
$K_2CO_3(s) \rightarrow K_2O(s) + CO_2(g)$

Molar masses: $H_2O = 18.0$, $CO_2 = 44.0$, $O_2 = 32.0$, $KClO_3 = 122.6$, $KHCO_3 = 100.1$, $K_2CO_3 = 138.2$, $KCl = 74.55$

12. A mixture of $KClO_3$, $K_2CO_3$, $KHCO_3$ and KCl is heated to produce $CO_2$, $O_2$, and $H_2O$ gases according to the equations above. KCl does not react. When 100.0 g of the mixture is heated, 1.80 g of $H_2O$, 13.20 g of $CO_2$, and 4.00 g of $O_2$ are produced. The number of grams of $K_2CO_3$ in the sample is:
A. 13.8 g B. 27.6 g C. 41.5 g D. 43.8 g

13. How many grams of KCl were in the original sample?
A. 44.2 g B. 47.3 g C. 52.7 g D. 55.7 g

14. A crucible with $KClO_3$ weighs 22.503 grams. After heating to drive off the oxygen, the mass of the crucible and KCl was 22.103 grams. The grams of $KClO_3$ originally in the crucible is
A. 1.02 g B. 1.53 g C. 2.04 g D. 2.30 g

15. The electronic configuration of Cr is [Ar] $4s^1\ 3d^5$ and not [Ar] $4s^2\ 3d^4$ as predicted by the standard electron configurations. The reason for this is because:
A. it violates the Pauli exclusion principle
B. the 4s orbital can hold only one electron
C. the 3d orbital is full with 5 electrons
D. the 4s and 3d orbitals are half-full

16. The area of a carpet 3.52 meters by 2.78 meters is:
A. 9.8 $m^2$ B. 9.79 $m^2$ C. 9.786 $m^2$ D. 9.7856 $m^2$

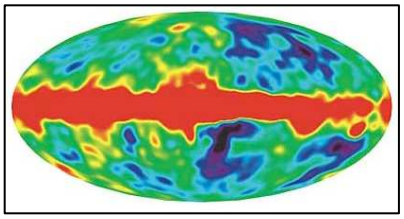
17. From the bond energies below and $\Delta H^o_f\ (NH_3(g)) = -46.$ kJ/mole, the nitrogen-nitrogen bond energy in $N_2(g)$ is:

$$3\ H_2(g) + N_2(g) \rightarrow 2\ NH_3(g)$$

A. 193 kJ
B. 965 kJ
C. 1011 kJ
D. 1057 kJ

| Bond | Bond Enthalpy |
|---|---|
| H-H | 435 kJ |
| N-H | 386 kJ |

18. The image to the right shows:
A. a picture of the infant universe
B. the cigar galaxy, M82 (NGC 3034)
C. a supernova remnant nebula
D. an orbital path of black-hole



19. The molarity of an aqueous concentrated nitric acid solution, which is 70.0% nitric acid by mass and has a density of 1.41 grams/mL is: ($HNO_3 = 63.0$ grams/mole)
A. 11.1 M B. 15.7 M C. 8.5 M D. 16.7 M

20. Liquid Q is a polar solvent and liquid R is a nonpolar solvent. Based on this information, you would expect:
    A. Both liquids to be miscible with a third liquid T.
    B. Liquid Q to be miscible with liquid R.
    C. NaCl to be soluble to both Q and R.
    D. Liquid Q and $H_2O$ to be miscible

21. Which of the following signs should be prominently displayed in a chemistry laboratory?

I.

II.

III.

IV.

    A. I, II, III only  B. I and II only  C. IV only  D. All should be prominently displayed

22. Identify the **INCORRECT** statement below:
    A. Metals have lower ionization energies than nonmetals
    B. Elements with high ionization energies tend to have large atomic radii.
    C. Atomic radii decrease as you go across a period.
    D. The second ionization energy is always larger than the first ionization energy.

23. The mass of a watch glass was measured four times. The masses were 99.997 g, 100.008 g, 100.011 g, and 100.005 g. What is the average mass of the watch glass?
    A. 100.0 g  B. 100.01g  C. 100.005 g  D. 100.00525 g

24. Identify the **INCORRECT** statement below:
    A. The mass number of an atom is the number of neutrons plus protons in the atom.
    B. Two elements differ from one another by having a differing mass number.
    C. Atomic number is the number of protons in the nucleus of an atom.
    D. The mass of the electrons is a small fraction of the total mass of any atom.

25. The preferred Lewis structure for laughing gas, $N_2O$ is:

    A. [ **:N** – **N** ≡ **O**:]  B. [ **:N** ≡ **N**– **O :** ]  C. [ **N** = **O** = **N** ]  D. A, B, and C are equally preferred.

26. Which of the following does **NOT** have the same number of moles of carbon as 63.0 g of $NaHCO_3$? (H=1.0, C = 12.0, O = 16.0, Na = 23.0)
    A. 22.5 g $HC_2H_3O_2$
    B. 12.0 g of $CH_4$
    C. 0.375 moles $H_2C_2O_4$
    D. $4.852 \times 10^{23}$ molecules of $CO_2$

27. A hypothetical element has of the following naturally occurring isotopes. What is its atomic mass?
    A. 24.85 amu
    B. 24.95 amu
    C. 25.00 amu
    D. 25.05 amu

| Isotope | Mass | Abundance |
|---|---|---|
| 1 | 24.00 amu | 40.00% |
| 2 | 25.00 amu | 25.00% |
| 3 | 26.00 amu | 35.00% |

28. A gallon of gasoline contains 2,420 grams of carbon and is 99% oxidized to $CO_2$ when combusted in a vehicle. The Boston metropolitan area has 2.432 million vehicles that average of 40.0 miles per day with an average mileage of 25.0 miles per gallon. How many tons of $CO_2$ are discharged into the metropolitan Boston atmosphere per day? (1 pound =453.6 grams, 2000 pounds = 1 ton, C=12.01, $CO_2$=44.01)
    A. 10.5 kilotons/day  B. 37.7 kilotons/day  C. 38.4 kilotons/day  D. 17080 kilotons/day

29. Examine the following information of two gas samples and determine which of the following statements is **INCORRECT.**

| **Sample A:** | **Sample B:** |
|---|---|
| 1 mole of $S_2$(g) (64 g/mole) at T = 800 K and P = 0.20 atm | 2 mole of $O_2$(g) (32 g/mole) at T = 400 K and P = 0.40 atm |

    A. The average kinetic energy of the molecules in sample A is twice the average kinetic energy of the molecules in sample B
    B. Assuming identical intermolecular forces in the two samples, sample A should be more nearly ideal than sample B.
    C. The mean square velocity of molecules in sample A will be twice as larger as the mean square velocity of molecules in sample B.
    D. The volume of sample A is twice the volume of sample B.

30. In the following reaction, which ion or molecule is the Bronsted-Lowry conjugate acid?

$$H^- + H_2O \rightarrow H_2 + OH^-$$

    A. $H^-$  B. $H_2O$  C. $H_2$  D. $OH^-$

31. In the nuclear reaction: $^{1}_{0}n + \_\_\_\_\_ \rightarrow {}^{142}_{56}Ba + {}^{95}_{38}Sr + 3{}^{1}_{0}n$, the missing particle is:

    A. $^{239}_{92}U$  B. $^{240}_{94}Pu$  C. $^{239}_{93}Np$  D. $^{239}_{94}Pu$

32. In the following equilibrium reaction:

$$CuS(s) + O_2(g) \rightleftharpoons Cu(s) + SO_2(g) \quad (K_c = 1.5)$$

    A reaction mixture initially contains 3.00 M $O_2$ with excess CuS. Determine the equilibrium concentrations of $O_2$ and $SO_2$, when $K_C$ at this temperature is 1.5.

| | **$[O_2]$** | **$[SO_2]$** |
|---|---|---|
| A. | 1.20 | 1.80 |
| B. | 1.80 | 1.20 |
| C. | 2.00 | 1.00 |
| D. | 1.00 | 2.00 |

33. Aluminum reacts violently with ammonium perchlorate. Using the standard enthalpies of formation listed, the enthalpy of this reaction is:

$$3\ Al(s) + 3\ NH_4ClO_4(s) \rightarrow Al_2O_3(s) + AlCl_3(s) + 3\ NO(g) + 6\ H_2O(g)$$

    A. -1465 kJ  B. -1645 kJ  C. –2665 kJ  D. -4435 kJ

| Reaction | $\Delta H_f^o$ (kJ/mole) |
|---|---|
| $NH_4ClO_4(s)$ | -295 |
| $Al_2O_3(s)$ | -1675 |
| $AlCl_3(s)$ | -705 |
| $NO(g)$ | 90 |
| $H_2O(g)$ | -240 |

34. The "¼ life" for a first order reaction is:

A. $\frac{0.602}{k}$ B. $\frac{0.347}{k}$ C. $\frac{4}{k}$ D. $\frac{1.386}{k}$

35. The chemistry laboratory is a place of discovery and learning. However, by the very nature of laboratory work, it can be dangerous if proper common sense precautions aren't taken. Which of the following laboratory safety rules should be strictly followed?

A. Don't eat or drink in the lab.
B. Notify the instructor immediately in case of an accident.
C. No unauthorized experiments are to be performed.
D. All of the above should be strictly followed.

36. The pH of a 0.50 M solution of sodium hydrogen sulfate, $NaHSO_4$, which has a $K_a$ for $HSO_4^-$ is $1.02 \times 10^{-2}$:

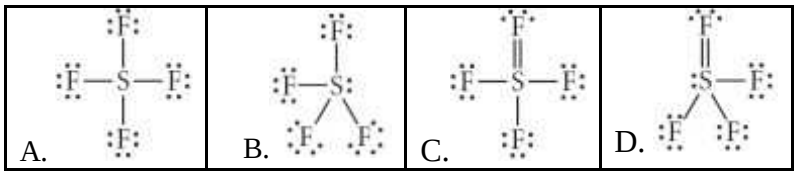
A. 1.00 B. 1.15 C. 1.18 D. 1.99

37. Write the balance reaction when the following rate relationships are true:

$$\text{Rate} = \frac{1}{2}\frac{\Delta[N_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t} = -\frac{1}{2}\frac{\Delta[N_2O]}{\Delta t}$$

A. $\frac{1}{2}\ N_2 + O_2 \rightarrow \frac{1}{2}\ N_2O$ B. $2\ N_2O \rightarrow 2\ N_2 + O_2$ C. $N_2O \rightarrow N_2 + 2\ O_2$ D. $2\ N_2 + O_2 \rightarrow 2\ N_2O$

38. The correct Lewis structure for $SF_4$ is:



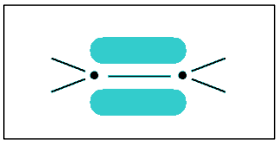

39. The VSEPR molecular shape for $SF_4$ above is:

A. tetrahedral
B. square pyramid
C. square planar
D. see-saw

40. How was the copper in the Universe produced?

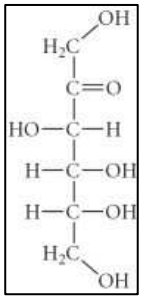
A. In the core of stars through fusion
B. In nuclear decay of radioactive elements
C. In supernovae explosions
D. In the "big bang"

41. The type of orbital illustrated to the right is a:



A. s orbital B. p orbital C. σ orbital D. π orbital

42. How many chiral carbons are in the structure to the right?

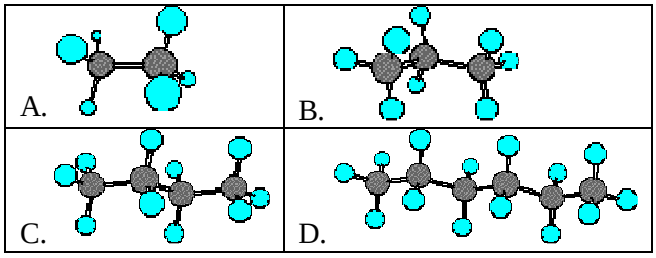


A. 0 B. 2 C. 3 D. 4 or more

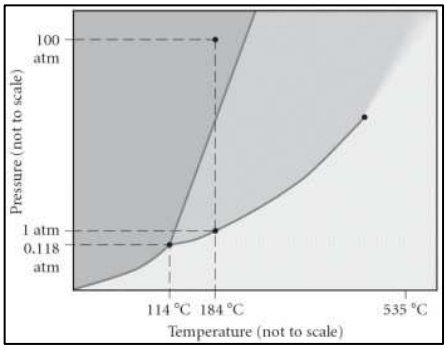
43. What is the total vapor pressure of a solution containing 1.50 moles of acetone (58.0 grams/mole) and 2.50 moles of pentane (72.2 grams/mole)? At the measured temperature the vapor pressure of pure acetone is 264 torr and pure pentane is 432 torr.
A. 264 torr B. 327 torr C. 369 torr D. 696 torr

44. The grams of copper that will dissolve if 0.300 moles of copper pellets mixed with 100.0 mL of 2.00 M HCl at 75°C is: (Cu = 63.55 grams/mole, HCl = 36.45 grams/mole)
A. none B. 6.36 grams C. 12.7 grams D. 19.1 grams

45. The butane molecule is:




46. On the phase diagram to the right, the dashed line at 1 atm of pressure is followed from 100 to 500°C, what phase changes will occur (in order of increasing temperature)?
A. condensation, followed by vaporization
B. sublimation, followed by deposition
C. vaporization, followed by deposition
D. melting, followed by vaporization




47. Dianabol is one of the anabolic steroids that have been used by some athletes to increase the size and strength of their muscles. Dianabol consists of carbon, hydrogen, and oxygen. A sample of 14.765 g of Dianabol is burned, and 43.257 g $CO_2$ and 12.395 g $H_2O$ are formed. What is the empirical formula for Dianabol? (Atomic masses: C = 12.0, O = 16.0, H = 1.01, $CO_2$ = 44.0, $H_2O$ = 18.0)
A. $C_7H_5O$ B. $C_7H_5O_2$ C. $C_{10}H_{14}O$ D. $C_{14}H_{10}O$

48. A 50.0 mL sample of 0.20 M $HC_2H_3O_2$ is titrated with 0.10 M NaOH. Determine the pH of the solution after the addition of 35.0 mL of NaOH. The $K_a$ of $HC_2H_3O_2$ is $1.75 \times 10^{-5}$.
A. 1.11 B. 4.49 C. 4.75 D. 5.01

49. Fluorine-18 undergoes positron emission with a half-life of 110 minutes. If a patient is given a 248 mg dose for a PET scan, how long will it take for the amount of fluorine-18 to drop to 83 mg? (Assume that none of the fluorine is excreted from the body).
A. 85 minutes B. 174 minutes C. 197 minutes D. 394 minutes

50. The enthalpy change for the reaction below is:

$2B(s) + 3/2\ O_2(g) \rightarrow B_2O_3(s)$ is:

A. -1009 kJ B. -1273 kJ C. -2725 kJ D. -2989 kJ

| **Reaction** | **Enthalpy (kJ)** |
|---|---|
| $B_2O_3(s) + 3H_2O(g) \rightarrow 3O_2(g) + B_2H_6(g)$ | $\Delta H = 2035$ kJ |
| $H_2O(l) \rightarrow H_2O(g)$ | $\Delta H = +44$ kJ |
| $H_2(g) + \frac{1}{2}\ O_2(g) \rightarrow H_2O(l)$ | $\Delta H = -286$ kJ |
| $2B(s) + 3H_2(g) \rightarrow B_2H_6(g)$ | $\Delta H = +36$ kJ |

51. Carbon in the Universe comes from 3 He-4 nuclei fusing to create a C-12 atom—A very slow process requiring 100 million K deep inside giant red star core where H is all consumed and He is in abundance. Unstable Be-8 is crucial in creating C-12 but for a split second, 2 He–4 particles fuse to make Be-8 which is then struck by a third α particle, creating C-12. This improbable sequence is called the ***triple-alpha process*** because the net effect is to combine 3 α particles (He nuclei) to form a C-12 nucleus. This result means that life had a chance to develop on Earth and you are a prime example of this process. The overall reaction is given below.

$$3\ {}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C} + {}^{0}_{0}\gamma + \text{energy}$$

| Particle | Rest Mass (amu) |
|---|---|
| $^{4}$He (α) | 4.00150 |
| $^{12}$C | 12.00000 |
| $^{0}_{0}\gamma$ | 0.0 |

The amount of energy in kJ resulting in fusing of 3 α particles into a mole of carbon-12 is: ($c = 3.00 \times 10^{8}$ m/s)

A. $4.05 \times 10^{8}$ B. $4.05 \times 10^{11}$ C. $1.35 \times 10^{13}$ D. $4.05 \times 10^{14}$

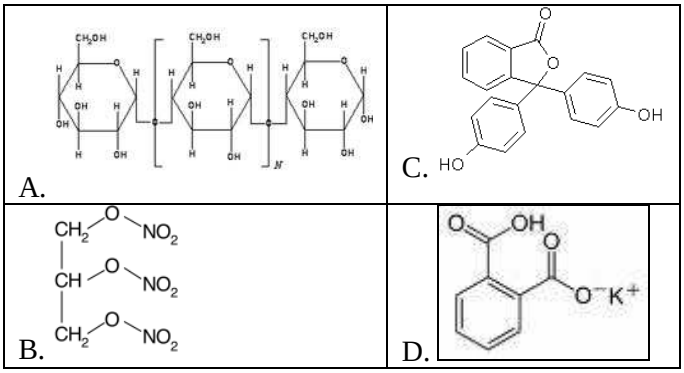
52. Calculate the value of $K_c$ for the reaction below using the following information:

$$NO(g) + \tfrac{1}{2}\, Cl_2(g) \rightleftharpoons NOCl(g)$$

| Equation | Equilibrium Constant |
|---|---|
| $2\ NO(g) + Br_2(g) \rightleftharpoons 2\ NOBr(g)$ | $K_c = 0.013$ |
| $2\ NOCl(g) + Br_2(g) \rightleftharpoons 2\ NOBr(g) + Cl_2(g)$ | $K_c = 0.036$ |

A. 0.021
B. 0.36
C. 0.60
D. 1.7

Use the following figures to answer questions 53-56.



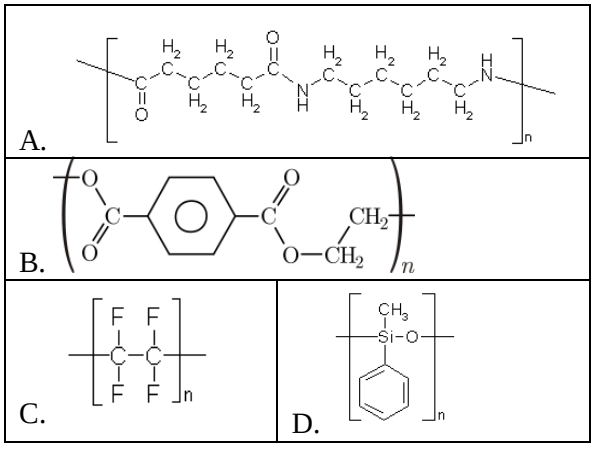

53. It has an "explosive" personality.

54. It's a "standard."

55. It's an "indicator" for iodine clock reaction.

56. It's an "indicator" for acid-base titrations.

Use the following figures to answer questions 57-59.




57. Coating for pots and pans.

58. Most commonly used for fibers.

59. Used for beverage containers.

60. The following reaction occurs at 480°C.

$$2\ Cl_2(g) + 2\ H_2O(g) \rightleftharpoons 4\ HCl(g) + O_2(g)$$

When 0.086 mol of $Cl_2$ and 0.090 mol $H_2O$ vapor are placed into a 2.0-L flask, the concentration of HCl at equilibrium is 0.040 mol/L. $K_c$ for the reaction is:
A. $1.20 \times 10^{-3}$ B. $6.84 \times 10^{-3}$ C. $7.74 \times 10^{-2}$ D. 834

Questions 61 and 62 deal with the following reaction:

$$4\ HBr(g) + O_2(g) \rightleftharpoons 2\ Br_2(g) + 2\ H_2O(g) \qquad K_c = 88.5 \text{ at } 500^oC$$

61. If 0.030 mol HBr, 0.020 mol $O_2$, 0.085 mol $Br_2$, and 0.090 mol $H_2O$ are mixed in a one-liter container at 500ºC, in what direction will the reaction proceed?
A. To the left B. To the right C. Already at equilibrium D. Not enough Information

62. The value of $K_p$ for the above reaction is:
A. 13.9 B. 21.6 C. 885 D. $5.62 \times 10^4$

63. How many of the following molecules have at least one bond angle of approximately 120°?

| $IF_5$ | $SO_3$ | $XeF_4$ | $BF_3$ | $NH_3$ | $CH_4$ | $SF_4$ |
|---|---|---|---|---|---|---|

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

64. The molar mass of a substance that plates 5.00 g of itself in 10.0 minutes with a current of 10.0 A and requires 2 electrons per mole of that substance is: ($F$ = 96,500)
A. 80.4 g/mole B. 20.2 g/mole C. 32.2 g/mole D. 161 g/mole

Use the following information to answer questions 65 to 68.

The Nernst equation is: $E = E^o - \dfrac{0.0592}{n} \log Q_c$, R = 8.314 J/mole K, $F$ = 96,500 C/mole, $\Delta H^o(O_3)$ = 142 kJ/mole

An atmospheric chemist is investigating the reaction below for the production of ozone ($O_3$) is the stratosphere.

$$3\ O_2(g) \rightarrow 2\ O_3(g)$$

From the following standard half cell potentials:

| | |
|---|---|
| $O_3(g) + 2\ H^+ + 2\ e \rightarrow O_2(g) + H_2O(l)$ | $E^o = 2.07$ V |
| $O_2(g) + 4\ H^+(aq) + 4\ e \rightarrow 2\ H_2O(l)$ | $E^o = 1.23$ V |

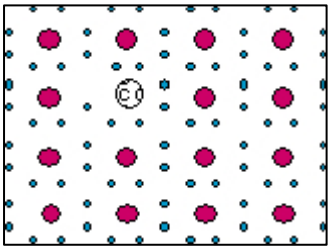
65. The standard cell potential, $E^o$, for the cell which describes the reaction above is:
A. -2.91 V B. -0.84 V C. 0.84 V D. 3.30 V

66. The Gibbs Free Energy, $\Delta G^o$, for the cell is:
A. -562 kJ B. -324 kJ C. 162 k J D. 324 k J

67. Using electrochemical data, the value of the equilibrium constant $K_c$ at 25°C for the reaction is
A. $1.41 \times 10^{-57}$ B. 0.877 C. 1.14 D. $7.08 \times 10^{56}$

68. The temperature of the stratosphere is -60ºC. $K_c$ at this temperature is:
A. $3.33 \times 10^{-80}$ B. $1.54 \times 10^{-70}$ C. 0.83 D. $3.00 \times 10^{79}$

69. In the diagram to the right, the smaller filled circles represent electrons. The larger filled circles represent Si atoms. The patterned circle represents a doping atom. What type of semi-conductor is shown in this diagram?



A. a gallium-doped *p*-type silicon semi-conductor
B. a gallium-doped *n*-type silicon semi-conductor
C. an arsenic-doped *p*-type silicon semi-conductor
D. an arsenic-doped *n*-type silicon semi-conductor

70. If the $CO_2$ molecule were bent rather than linear, you would expect:
A. Both the boiling and freezing points would be higher.
B. Both the boiling and freezing points would be lower.
C. The boiling point would be higher but the freezing point would be lower.
D. The freezing point would be higher but the boiling point would be lower.

Use the following information for Questions 71 to 73

.

You have a sample containing chromate, $CrO_4^{2-}$, to be determined by precipitation with $AgNO_3$. The balanced reaction is given below. You are told the sample will contain between 10% and 30% by weight of chromium. You want both the sample weighed and the silver chromate obtained to weigh **no less than 0.2 grams** for accurate mass measurement. ($Ag_2CrO_4$ = 331.7, Cr = 52.00, O = 16.00, Fe = 55.85)

$$2Ag^+(aq) + 2NO_3^-(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s) + 2NO_3^-(aq)$$

71. The minimum sample size should you weigh out to generate the 0.2 g silver chromate required is:
A. 0.104 g B. 0.200 g C. 0.314 g D. 0.941 g

72. How many mL of 0.1000 M $AgNO_3$ should you use to ensure precipitation of all the chromate in your sample?
A. 5.66 mL B. 18.1 mL C. 36.2 mL D. 69.2 mL

73. A mixture containing only $Al_2O_3$ (101.96) and $Fe_2O_3$ (159.69) weighs 2.019 g. When heated under a stream of $H_2$, the $Al_2O_3$ is unchanged, but the $Fe_2O_3$ is converted to metallic Fe and water vapor, $H_2O(g)$. If the residue weighs 1.774 g, what is the weight percent of $Fe_2O_3$ in the original mixture?
A. 8.48% B. 12.1% C. 40.4% D. 87.9%

74. The number of acidic, basic, or neutral aqueous solutions resulting when the each following compounds is dissolved in water is:

| $CH_3OH$ | $NH_4Br$ | NaClO | $Al(NO_3)_3$ | $KClO_4$ |
|---|---|---|---|---|

| | Acidic | Basic | Neutral |
|---|---|---|---|
| A. | 2 | 2 | 1 |
| B. | 1 | 2 | 2 |
| C. | 0 | 2 | 3 |
| D. | 2 | 1 | 2 |

75. Chemical syntheses of simple small organic molecules are considered essential in order for life to begin. Select all the correct answers below. Potentially important sources of organic compounds can be found in
I. deep oceanic thermal vents (black smokers)
II. tidal pools
III. the solid crust
IV. deep space

A. I and II B. I, II, and III C. II only D. All of the above.

76. A 0.500-gram sample of a weak, nonvolatile acid, HA, was dissolved in sufficient water to make 50.0 milliliters of solution. The solution was then titrated with a standard NaOH solution. Which of the following laboratory procedures will result in the calculated molar mass of HA being **too high**?

I. After rinsing the buret with distilled water, the buret is then filled with the standard NaOH, and the weak acid, HA, is titrated to its equivalence point.
II. Extra water is added to the 0.500-gram sample of HA.
III. An indicator that changes color at pH 5 is used to signal the equivalence point.
IV. An air bubble passes unnoticed through the tip of the buret during the titration.

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

For questions 77 to 79, use the standard enthalpies and entropies at 298 K given below:

In introductory chemistry, students heat copper sulfate pentahydrate to determine its waters of hydration according to the following reaction

$CuSO_4 \cdot 5H_2O(s) \rightarrow CuSO_4(s) + 5\ H_2O(l)$

| Compound | $\Delta H^\circ$(kJ/mole) | $\Delta S^\circ$(J/mole·K) |
|---|---|---|
| $CuSO_4 \cdot 5H_2O(s)$ | -2280 | 300 |
| $CuSO_4(s)$ | -770 | 110 |
| $H_2O(l)$ | -285 | 70 |
| For your calculations | | |

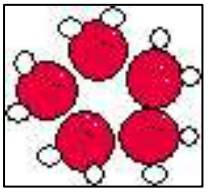
77. The above reaction is:
A. spontaneous at all temperatures
B. nonspontaneous at all temperatures
C. nonspontaneous at lower temperatures but spontaneous at higher temperatures
D. spontaneous at lower temperatures but nonspontaneous at higher temperatures

78. Assume that the above thermodynamic values are independent of temperature. The Celsius equilibrium temperature (°C) in which will begin to spontaneously decompose $CuSO_4 \cdot 5H_2O$ to $CuSO_4$ and $H_2O$ is:
A. around 260°C B. around 530°C C. around 800°C D. No fixed equilibrium temperature

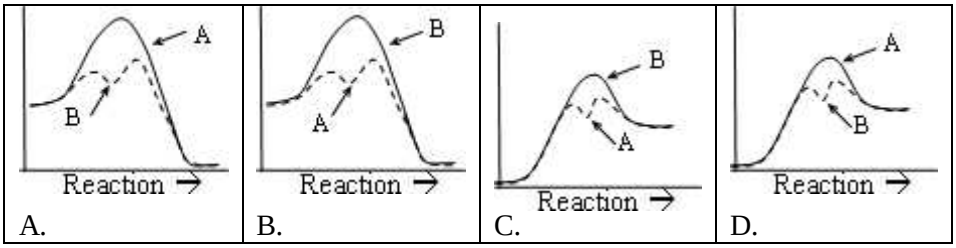
79. The equilibrium constant for the reaction at 298 K is (R = 8.314 J/mole·K):
A. $2.9 \times 10^{-7}$ B. 0.99 C. 1.0 D. $2.2 \times 10^{8}$

80. The safety equipment pictured here is a(n):
A. safety blanket B. first aid kit C. fire alarm D. eye-wash fountain

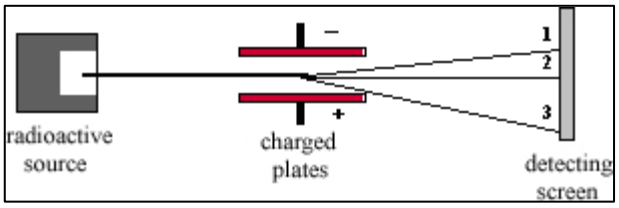
81. A certain bottled water company advertises that its water has been treated so that there are "clusters" of water molecules that can more effectively penetrate through cell walls to provide maximum hydration. Here is a representation of such a cluster. Why is this arrangement of clustered water molecules unlikely?
A. Water in the liquid state is in regular clusters of six molecules, not five.
B. Oxygen atoms in water all have the same partial charge and like charges repel.
C. There are no intermolecular attractions between water molecules.
D. Each water molecule is only attracted to one other water molecule.



82. Which graph shows an endothermic reaction with curve **A** representing the uncatalyzed reaction and curve **B** representing the catalyzed reaction?




83. This figure shows a radioactive source that emits alpha, beta, and gamma radiation. Which number identifies which type of emission?
   A. 1 = gamma, 2 = beta, 3 = alpha
   B. 1 = beta, 2 = gamma, 3 = alpha
   C. 1 = beta, 2 = alpha, 3 = gamma
   D. 1 = alpha, 2 = gamma, 3 = beta




84. A 10.250 g sample of window cleaner containing $NH_3$ was diluted with 39.769 g of $H_2O$. Then 4.373 g of the solution was titrated with 14.22 mL of 0.1050 M HCl to reach the bromocresol green end point. The weight percent of $NH_3$ in the cleaner is: ($NH_3$ = 17.031)
   A. 1.68%  B. 2.27%  C. 2.86%  D. 12.49%

85. Germanium crystallizes in diamond lattice structure with 8 atoms in one unit cell. The unit cell length is 5.65 Å. The density of Ge in grams/cm$^3$ is: (Ge = 72.6 amu. 1 Å = $10^{-10}$ m, $N_o$= 6.022 x $10^{23}$)
   A. 2.67  B. 3.22  C. 5.35  D. 12.8

86. In terms of the unit cell length a, the distance between nearest neighbors in a body centered cubic cell (bcc) is:
   A. $\frac{\mathbf{a\sqrt{2}}}{\mathbf{2}}$  B. $\frac{\mathbf{a\sqrt{3}}}{\mathbf{2}}$  C. $\frac{\mathbf{a}}{\mathbf{2}}$  D. $\frac{\mathbf{a\sqrt{2}}}{\mathbf{3}}$

Questions 87 and 88 refer to the following procedure:

Ammonia can be determined spectrophotometrically by reaction of phenol with hypochlorite. The following steps were taken:

- A 4.37 mg sample of protein was chemically digested to convert all its nitrogen to ammonia and then the volume of the sample was diluted to 100.00 mL in a volumetric flask.
- A 10.0 mL portion of the above sample was treated with phenol and sodium hypochlorite and diluted to 50.0 mL. The absorbance of this solution at 625 nm measured in a 1.00 cm cuvette. See data table.
- A reference solution was prepared by dissolving 10.00 g of $NH_4Cl$ (MW=53.50) in 1.00 L of water. A 10.0 mL portion of this was prepared in the same way as above and diluted to 50.0 mL. See data table.
- A reagent blank was prepared using distilled water in place of the standard. See data table.

| Sample | Absorbance |
|---|---|
| Blank | 0.140 |
| Reference | 0.308 |
| Unknown | 0.592 |

87. The molar absorptivity, ε, for the product is ($\varepsilon = \frac{A}{bc}, M^{-1}cm^{-1}$).
   A. 84  B. 890  C. 4490  D. 8240

88. The weight percentage of nitrogen in the protein is:
   A. 1.15 %  B. 3.22%  C. 16.1%  D. 21.1%

89. Use the following table of standard electrode reduction potentials:

| Reaction | $E^o$ (Volts) |
|---|---|
| $Cu^{2+}(aq) + 2e^- \rightarrow Cu$ | +0.339 V |
| $Cu(OH)_2 + 2e^- \rightarrow Cu + 2\ OH^-(aq)$ | -0.224 V |
| $Cu(NH_3)_4^{2+}(aq) + 2e^- \rightarrow Cu + 4\ NH_3(aq)$ | -0.0510 V |

The Nernst equation is: $E = E^o - \frac{0.0592}{n} \log Q_c$,

The equilibrium constant, K, for the following reaction at 298 K is: ($K_b$ ($NH_3$) = 1.8 x $10^{-5}$)

$Cu(OH)_2(s) + 4\ NH_3(aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq) + 2\ OH^-(aq)$

A. 4.94 x $10^{-10}$ B. 1.40 x $10^{-6}$ C. 7.15 x $10^{5}$ D. 2.02 x $10^{9}$

90. A "rule of thumb" for chemists is that the reaction rate doubles for every 10ºC rise in temperature. If a reaction is initially run at nearly room temperature of 27ºC, and applying the above rule (10º rise = 2 x rate), the activation energy is of a "typical" reaction is:
A. 0.58 kJ B. 36.4 kJ C. 53.6 kJ D. 111 kJ