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Last name *First name*

First letter of your last name:

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perm number

FINAL EXAM – **FORM A**
9 June 2009

Chem 1B
Instructor: Ortony

INSTRUCTIONS:

Use a pencil, fill in the bubbles dark and completely.
Bubble in **Form A** on your Scantron Form
Write your perm number and **bubble in your perm number**, write your name.

Work out the answer to each problem on this exam then bubble in the correct answer on your scantron. **Turn in BOTH the Scantron form and the exam**.

The equation sheet is on the last page, you may remove it from your exam.

The key to the exam will be posted on the course webpage this afternoon.

Exam scores will be posted on "Online Grades". To access your grade you must create an account first, there is a link on our course webpage (everyone in Chem 1B must create an account – even if you already did so in the past).

*CHEM 1B FINAL EXAM – **FORM A***
SPRING 2009 - ORTONY

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Last name *First name*

1. One mole of an ideal gas is expanded from a volume of 1.50 L to a volume of 10.18 L against a constant external pressure of 1.03 atm. Calculate the work.
   A) -8.79×10^2 J
   B) –8.94 J
   C) -9.06×10^2 J
   D) –0.0883 J
   E) 9.06 J

2. Calculate the work for the expansion of an ideal gas from 3.5 to 5.4 L against a pressure of 2.2 atm at constant temperature.
   A) 4.2 L•atm
   B) –4.2 L•atm
   C) 0
   D) 4.0 L•atm
   E) –0.9 L•atm

3. Calculate ΔE for a system that releases 24 J of heat while 57 J of work is done on it.
   A) 33 J
   B) 81 J
   C) –81 J
   D) –33 J
   E) 24 J

4. Consider the following reaction:
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ $\Delta H = -198$ kJ

Calculate the energy change associated with 23.8 g of SO_2 reacting with excess O_2.

A) -73.5 kJ
B) -36.8 kJ
C) -147 kJ
D) -4.71×10^3 kJ
E) -198 kJ

5. $CH_4 + 4Cl_2(g) \rightarrow CCl_4(g) + 4HCl(g)$, $\Delta H = -434$ kJ
Based on the above reaction, what energy change occurs when 1.5 mol of methane reacts?

A) 6.5×10^5 J is released.
B) 6.5×10^5 J is absorbed.
C) 2.9×10^5 J is released.
D) 2.9×10^5 J is absorbed.
E) 4.3×10^2 J is released.

6. The total volume of hydrogen gas needed to fill the *Hindenburg* was 2.00×10^8 L at 1.00 atm and 25.0°C. How much energy was evolved when it burned?
$H_2(g) + (1/2)O_2(g) \rightarrow H_2O(l)$, $\Delta H = -286$ kJ

A) 3.5×10^{11} kJ
B) 8.18×10^6 kJ
C) 2.86×10^4 kJ
D) 2.34×10^9 kJ
E) 5.72×10^{10} kJ

7. A 22.4-g piece of aluminum (which has a molar heat capacity of 24.03 J/mol°C) is heated to 84.8°C and dropped into a calorimeter containing water (the specific heat capacity of water is 4.18 J/g°C) initially at 22.8°C. The final temperature of the water is 27.0°C. Calculate the mass of water in the calorimeter.
   A) 6.6×10^1 g
   B) 1.8×10^3 g
   C) 7.0×10^1 g
   D) 2.0 g
   E) 0.35 g

8. Using Hess's law and equations 1-3 below, find $\Delta H°$ at 25°C for the oxidation of $C_2H_5OH(l)$.

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 3H_2O(l) + 2CO_2(g)$$

1. $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ $\Delta H° = -1411$ kJ
2. $C(\text{graphite}) + 3H_2(g) + (1/2)O_2(g) \rightarrow C_2H_5OH(l)$ $\Delta H° = -278$ kJ
3. $C_2H_4(g) + H_2O(l) \rightarrow C_2H_5OH(l)$ $\Delta H° = -44$ kJ

   A) 44 kJ
   B) 632 kJ
   C) -1367 kJ
   D) -1742 kJ
   E) none of these

9. The enthalpy of formation of an element in its standard state is
   A) the enthalpy of its reaction with hydrogen.
   B) the enthalpy of its reaction with oxygen.
   C) determined by its melting point.
   D) zero.
   E) none of these

10. Using the information below, calculate $\Delta H°_f$ for PbO(*s*).

$PbO(s) + CO(g) \rightarrow Pb(s) + CO_2(g)$, $\Delta H° = -131.4$ kJ

$\Delta H°_f$ for $CO_2(g) = -393.5$ kJ/mol

$\Delta H°_f$ for $CO(g) = -110.5$ kJ/mol

A) –151.6 kJ/mol
B) –283.0 kJ/mol
C) +283.0 kJ/mol
D) –372.6 kJ/mol
E) +252.1 kJ/mol

11. Consider the process A(*l*) $\rightleftharpoons$ A(*s*). Which direction favors greater entropy of the system?
A) to the right
B) to the left
C) neither

12. Consider the process A(*l*) $\rightleftharpoons$ A(*s*). An increase in temperature favors which direction?
A) to the right
B) to the left
C) neither
D) More information is needed.

Use the following to answer questions 13 – 15:

At 1 atm, a liquid is heated above its normal boiling point.

13. ΔS_{surr} for this process is
A) greater than zero.
B) less than zero.
C) equal to zero.
D) cannot be determined

14. ΔS for this process is
A) greater than zero.
B) less than zero.
C) equal to zero.
D) cannot be determined

15. ΔS_{univ} for this process is
    A) greater than zero.
    B) less than zero.
    C) equal to zero.
    D) cannot be determined

16. 5.50 mol of a monatomic ideal gas is cooled from 246°C to 27°C at constant volume. Calculate ΔS.
    A) –62.7 J/K
    B) –16.3 J/K
    C) –27.2 J/K
    D) –37.6 J/K
    E) -1.52×10^2 J/K

17. For the process involving compound A: A(s) $\rightarrow$ A(*l*), $\Delta H°$ = 7.5 kJ/mol, and $\Delta S°$ = 43.4 J/mol•K. What is the melting point of compound A?
    A) –100°C
    B) 173°C
    C) –222°C
    D) 100°C
    E) –173°C

18. What is the oxidation state of Mn in MnO_2?
    A) +2
    B) +4
    C) +9
    D) -1
    E) +3

19. How many electrons are transferred in the following reaction?
    $2Cr_2O_7^{2-} + 14H^+ + 6Cl^- \rightarrow 2Cr^{3+} + 3Cl_2 + 7H_2O$
    A) 2
    B) 4
    C) 6
    D) 8
    E) none of these

20. Which metal, Al or Ni, could reduce Zn^{2+} to Zn(*s*) if placed in a Zn^{2+}(*aq*) solution?

$Zn^{2+} + 2e^- \rightarrow Zn$ $\quad E° = -0.76$ V

$Al^{3+} + 3e^- \rightarrow Al$ $\quad E° = -1.66$ V

$Ni^{2+} + 2e^- \rightarrow Ni$ $\quad E° = -0.23$ V

A) Al
B) Ni
C) Both Al and Ni would work.
D) Neither Al nor Ni would work.
E) This cannot be determined.

Use the following to answer questions 21 - 23:

Reaction	*E*° (volts)
$Na^+ + e^- \rightarrow Na$	–2.71
$Al^{3+} + 3e^- \rightarrow Al$	–1.66
$Fe^{2+} + 2e^- \rightarrow Fe$	–0.44
$Co^{2+} + 2e^- \rightarrow Co$	–0.28
$Cu^{2+} + 2e^- \rightarrow Cu$	+0.34
$Ag^+ + e^- \rightarrow Ag$	+0.80
$Cl_2 + 2e^- \rightarrow 2Cl^-$	+1.36
$F_2 + 2e^- \rightarrow 2F^-$	+2.87

21. Which of the following would be the best reducing agent?
A) Cl_2
B) F_2
C) Na
D) Na^+
E) F^-

22. Silver will spontaneously reduce which of the following?
A) Fe^{2+}
B) Co^{2+}
C) Na^+
D) Al^{3+}
E) none of these

23. Determine the standard potential, $E°$, of a cell that employs the reaction
$Co + Ag^+ \rightarrow Co^{2+} + Ag$

A) 1.08 V
B) 1.88 V
C) -1.08 V
D) -0.52 V
E) none of these

24. The standard potential for the reaction $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$ is 1.56 V. Given that the standard reduction potential for $Ag^+ + e^- \rightarrow Ag$ is 0.80 V, determine the standard reduction potential for $Zn^{2+} + 2e^- \rightarrow Zn$.
A) -0.76 V
B) 0.04 V
C) 0.76 V
D) -0.38 V
E) none of these

25. An electrolytic cell process involves plating Zr(*s*) from a solution containing Zr^{4+}. If 8.28 amp is run through this mixture for 1.86 h, what mass of Zr is plated?
A) 0.071 g
B) 0.144 g
C) 7.18 g
D) 36.7 g
E) none of these

26. The rate expression for a particular reaction is Rate = $k[A][B]^2$. If the initial concentration of B is increased from 0.1 *M* to 0.3 *M*, the initial rate will increase by which of the following factors?
A) 3
B) 27
C) 4
D) 6
E) 9

Use the following to answer question 27:

For the reaction $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$, the following data were collected.

t (minutes)	$[N_2O_5]$ (mol/L)
0	1.24×10^{-2}
10.	0.92×10^{-2}
20.	0.68×10^{-2}
30.	0.50×10^{-2}
40.	0.37×10^{-2}
50.	0.28×10^{-2}
70.	0.15×10^{-2}

27. The half-life of this reaction is approximately
    A) 15 min
    B) 18 min
    C) 23 min
    D) 36 min
    E) 45 min

28. The reaction

    $3NO \rightarrow N_2O + NO_2$

    is found to obey the rate law Rate = $k[NO]^2$. If the first half-life of the reaction is found to be 4.4 s, what is the length of the fourth half-life?

    A) 8.3 s
    B) 18 s
    C) 70 s
    D) 26 s
    E) 66 s

29. The rate constant for a reaction increases from 10.0 s^{-1} to 100. s^{-1} when the temperature is increased from 317 K to 427 K. What is the activation energy for the reaction in kJ/mol?
    A) 23.6 kJ/mol
    B) 10.2 kJ/mol
    C) 1.74 kJ/mol
    D) 21.1 kJ/mol
    E) 0.0756 kJ/mol

30. The reaction $2H_2O_2 \rightarrow 2H_2O + O_2$ has the following mechanism:

$$H_2O_2 + I^- \rightarrow H_2O + IO^-$$

$$H_2O + IO^- \rightarrow H_2O + O_2 + I^-$$

What is the catalyst in the reaction?

A) H_2O
B) I^-
C) H_2O_2
D) IO^-

31. Which of the following frequencies corresponds to light with the longest wavelength?
A) $3.00 \times 10^{13}\ s^{-1}$
B) $4.12 \times 10^{5}\ s^{-1}$
C) $8.50 \times 10^{20}\ s^{-1}$
D) $9.12 \times 10^{12}\ s^{-1}$
E) $3.20 \times 10^{9}\ s^{-1}$

32. A photographic film needs a minimum of 80.0 kJ/mol for exposure. What is the longest wavelength of radiation with sufficient energy to expose the film?
A) 1.50×10^{-3} m
B) 1.50×10^{-12} m
C) 1.50×10^{-9} m
D) 1.50×10^{-6} m
E) none of these

33. Consider an atom traveling at 1% of the speed of light. The de Broglie wavelength is found to be 3.31×10^{-3} pm. Which element is this? (*hints* $\lambda = h/mv$ and $1\ pm = 1*10^{-12}$ m)
A) He
B) Ca
C) F
D) Be
E) P

34. What is the wavelength of light that is emitted when an excited electron in the hydrogen atom falls from the $n = 5$ level to the $n = 2$ level?
    A) 5.12×10^{-7} m
    B) 4.34×10^{-7} m
    C) 6.50×10^{-7} m
    D) 5.82×10^{-7} m
    E) none of these

Use the following to answer questions 35 -36:

Consider the following portion of the energy-level diagram for hydrogen:

$n = 4$	-0.1361×10^{-18} J
$n = 3$	-0.2420×10^{-18} J
$n = 2$	-0.5445×10^{-18} J
$n = 1$	-2.178×10^{-18} J

35. For which of the following transitions does the light emitted have the longest wavelength?
    A) $n = 4$ to $n = 3$
    B) $n = 4$ to $n = 2$
    C) $n = 4$ to $n = 1$
    D) $n = 3$ to $n = 2$
    E) $n = 2$ to $n = 1$

36. In the hydrogen spectrum, what is the wavelength of light associated with the $n = 2$ to $n = 1$ electron transition?
    A) 1.097 nm
    B) 364.9 nm
    C) 0.1097×10^{-8} cm
    D) 9.122×10^{-8} m
    E) 1.216×10^{-7} m

37. Which of the following is *not* determined by the principal quantum number, *n*, of the electron in a hydrogen atom?
    A) the energy of the electron
    B) the minimum wavelength of the light needed to remove the electron from the atom.
    C) the size of the corresponding atomic orbital(s)
    D) the shape of the corresponding atomic orbital(s)
    E) All of the above are determined by *n*.

38. What is the electron configuration for the barium atom?
    A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
    B) [Xe] $6s^2$
    C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
    D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
    E) none of these

39. In which groups do all the elements have the same number of valence electrons?
    A) P, O, Cl
    B) Ag, Cd, Ar
    C) Na, Ca, Ba
    D) P, As, Se
    E) N, P, As

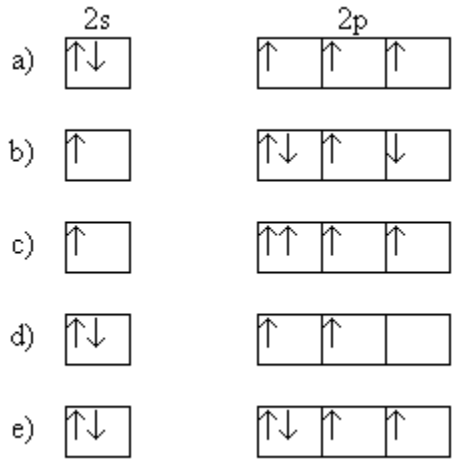
40. Of the following elements, which needs 3 electrons to complete its valence shell?
    A) Ba
    B) K
    C) Si
    D) P
    E) Cl

41. How many unpaired electrons are there in an atom of sulfur in its ground state?
    A) 0
    B) 1
    C) 2
    D) 3
    E) 4

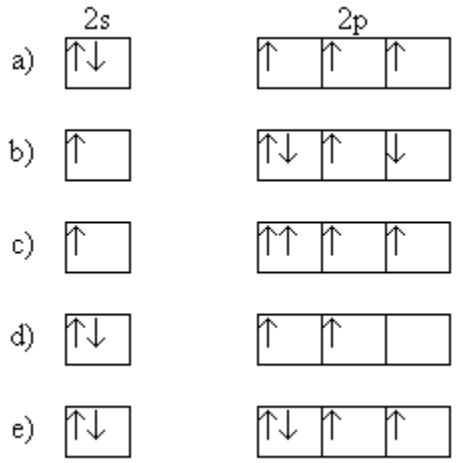
42. Place the elements C, N, and O in order of increasing ionization energy.
    A) C, N, O
    B) O, N, C
    C) C, O, N
    D) N, O, C
    E) none of these

43. Which element is most likely to form an ion with a charge of 2+?
    A) Br
    B) Mg
    C) K
    D) O
    E) B

44. Which represents the ground state for N?



45. Which represents the ground state for the N^- ion?



Have a nice summer!