Directions:  (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated.
(2) Sign the Aggie Code on PART 2 of this exam.
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, put the same answer down for both questions for 5 pts. If you cannot decide between two answers, put your BEST answer down for the ODD/FIRST question for 3 pts and your SECOND BEST answer down for the EVEN/SECOND question for 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer.
(4) Do NOT write on the envelope.
(5) When finished, put both parts of the exam in the envelope with the scanning sheet. You can leave during announced times. You can pick up your multiple choice and answers outside my office after the exam.
(5) There are a total of 64 questions (33 actual questions + course evaluation). Total value is 165 points plus 5pts for having done the course evaluation = 170 pts.

PART 1

1&2. The name of the 2A group is:
(a) alkali metals  (b) alkaline earths  (c) halogens
(d) transition metals  (e) metalloids

3&4. We know that gas properties are functions of pressure, temperature, volume and the number of moles of gas. Which of the following relationships is TRUE assuming the other two variables are constant?
(a) $P \propto 1/n$  (b) $V \propto 1/T$  (c) $P \propto T$  (d) $n \propto T$  (e) $P \propto V$

5&6. The substance Na$_2$S(s) would be classified as a(n) ________ solid.
(a) ionic  (b) covalent (network)  (c) molecular
(d) metallic  (e) amorphous

7&8. Determine the oxidation number of phosphorus in the phosphite ion, PO$_3^{3-}$.
(a) $-3$  (b) $+3$  (c) $+4$  (d) $+5$  (e) $+6$

© Keeney-Kennicutt, 2009
9&10. Which of the following is NOT a strong acid?
   (a) HF  (b) HClO₃  (c) HBr  (d) HNO₃  (e) HI

11&12. The \( ^{42}\text{Ca}^{2+} \) ion has:
   (a) 20 p, 22 n, 22 e  (b) 22 p, 20 n, 20 e  (c) 40 p, 2 n, 38 e
   (d) 20 p, 22 n, 18 e  (e) some other combination of p, n, e

13&14. In 3 moles of Cu\((\text{SO}_4)_2\), there are
   (a) 24 x Avogadro’s number of atoms of O
   (b) 6.0 x \(10^{23}\) moles of Cu
   (c) 3 Cu\(^{2+}\) cations
   (d) 3 formula units of Cu\((\text{SO}_4)_2\)
   (e) 4 moles of \(\text{SO}_4^{2-}\) anions

15&16. In this precipitation reaction, the spectator ions will be:
   \(\text{Fe(NO}_3)_3(aq) + \text{Na}_3\text{PO}_4(aq) \rightarrow \)
   (a) \(\text{Fe}^{3+}\) and \(\text{NO}_3^-\)  (b) \(\text{Na}^+\) and \(\text{PO}_4^{3-}\)
   (c) \(\text{PO}_4^{3-}\) and \(\text{NO}_3^-\)
   (d) \(\text{Fe}^{3+}\) and \(\text{Na}^+\)  (e) \(\text{Na}^+\) and \(\text{NO}_3^-\)

17&18. The oxidizing agent in the following unbalanced reaction is:
   \(\text{Ag} + \text{H}_2\text{S} + \text{O}_2 \rightarrow \text{Ag}_2\text{S} + \text{H}_2\text{O} \) (unbalanced)
   (a) \(\text{Ag}\)  (b) \(\text{H}_2\text{S}\)  (c) \(\text{O}_2\)
   (d) \(\text{Ag}_2\text{S}\)  (e) \(\text{H}_2\text{O}\)

19&20. Which of the following bonds is a nonpolar covalent bond?
   (a) Na–Br  (b) P–Cl  (c) H–As  (d) H–F  (e) Cu–Cu

21&22. The electronic configuration of Ti can be given as:
   (a) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^6\) 4s\(^2\) 3d\(^2\)  (b) \([\text{Kr}]\) 4s\(^2\) 3d\(^2\)
   (c) \([\text{Ar}]\) 4s\(^2\) 4p\(^2\)  (d) \([\text{Kr}]\) 5s\(^2\) 4d\(^{10}\) 5p\(^2\)
   (e) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^6\) 3d\(^4\)
23&24. Consider this reaction: \(2 \text{C} + \text{O}_2 \rightarrow 2 \text{CO}\). If you had 4 moles of C and 4 moles of \(\text{O}_2\) (as shown in the picture below), which picture would represent the final situation?

Let \(\bigcirc = \text{C}\) and \(\bigotimes = \text{O}\)

25&26. Which statement is NOT correct?

(a) If an exothermic reaction is reversed, the resulting reaction is endothermic.
(b) The symbol for internal energy is \(E\).
(c) Under conditions of constant volume, the heat change that occurs during a chemical reaction is equal to \(\Delta E\).
(d) The heat generated when 10.0 grams of \(\text{CH}_4\) is combusted is twice as much as the heat generated when 5.0 gram of \(\text{CH}_4\) is combusted.
(e) For an endothermic reaction, \(\Delta H < 0\).
27&28. Which of the following sets of quantum numbers could apply to the sixteenth electron of any atom?

<table>
<thead>
<tr>
<th>n</th>
<th>l</th>
<th>m_\ell</th>
<th>m_s</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(b)</td>
<td>2</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>(c)</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(d)</td>
<td>3</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>(e)</td>
<td>3</td>
<td>2</td>
<td>-1</td>
</tr>
</tbody>
</table>

29&30. A sample of CH_4 gas behaves most ideally at:

- (a) 0°C and 1 atm
- (b) 100°C and 1 atm
- (c) 0°C and 10 atm
- (d) 100°C and 10 atm
- (e) 0°C and 5 atm

31&32. The correct ranking of substances according to their boiling points from lowest boiling point to highest boiling point is:

- (a) KCl < H_2 < HCl < HF
- (b) HCl < H_2 < HF < KCl
- (c) H_2 < HCl < HF < KCl
- (d) H_2 < HCl < KCl < HF
- (e) H_2 < KCl < HCl < HF

33&34. The pH of a 0.00250 M solution of HCl is

- (a) 1.60
- (b) 2.60
- (c) 5.99
- (d) 1.01
- (e) 2.15

35&36. Calculate the change in internal energy, ΔE, of a system when it releases 30 J of heat into the surroundings, and 20 J of work is done on the system by the surroundings.

- (a) +50 J
- (b) −50 J
- (c) +10 J
- (d) −10 J
- (e) 0 J
37&38. What is the formula weight of Co(ClO$_4$)$_2$•5H$_2$O?

(a) 275    (b) 315    (c) 336    (d) 359    (e) 348

39&40. A sample of CO$_2$ occupies 3.70 liters at 20°C and 1.50 atm. What volume does it occupy at STP?

(a) 3.24 L    (b) 5.17 L    (c) 75.0 L    (d) 16.3 L    (e) 40.2 L

41&42. What is the empirical formula for an oxide of bromine that is 65.2% Br by mass?

(a) BrO    (b) BrO$_3$    (c) Br$_2$O$_3$    (d) Br$_3$O$_7$    (e) Br$_3$O$_8$
43&44. What is the name for the temperature determined by the intersection of the curve with the line at 760 torr?

(a) triple point  (b) normal freezing point  (c) normal boiling point
(d) critical point  (e) evaporation

45&46. How many grams of oxygen are required to react with 4.4 grams of C₃H₈?

\[ C₃H₈ + O₂ \rightarrow CO₂ + H₂O \] (UNBALANCED)

(a) 12 g  (b) 8.0 g  (c) 64 g  (d) 32 g  (e) 16 g

47&48. What is the molarity of a solution made by dissolving 4.76 g of MgCl₂ in water and making the solution up to 1500 mL?

(a) 0.025 M  (b) 0.033 M  (c) 0.011 M  (d) 0.050 M  (e) 0.075 M
49&50. Evaluate $\Delta H_{\text{rxn}}$ for the following reaction from the given bond dissociation energies.

$$2 \text{HBr(g)} \rightarrow \text{H}_2(\text{g}) + \text{Br}_2(\text{g})$$

$D_{\text{H-H}} = 435 \text{ kJ/mol}$, $D_{\text{Br-Br}} = 192 \text{ kJ/mol}$, $D_{\text{H-Br}} = 368 \text{ kJ/mol}$

(a) +109 kJ  (b) −143 kJ  (c) −109 kJ  (d) +142 kJ  (e) +259 kJ

51&52. What could be the identity of a gas if its density is 3.17 g/L at STP?

(a) Ar  (b) PH$_3$  (c) Kr  (d) Cl$_2$  (e) SO$_2$

53&54. The following reaction is used for storage of energy in solar-heated homes:

$$\text{Na}_2\text{SO}_4\cdot10\text{H}_2\text{O(s)} \rightarrow \text{Na}_2\text{SO}_4(\text{s}) + 10\ \text{H}_2\text{O(\ell)}$$

Calculate the heat at constant pressure (in kJ) required to drive all the water out of one mole of Na$_2$SO$_4$•10H$_2$O(s).

<table>
<thead>
<tr>
<th>Compound</th>
<th>$\Delta H^\circ$ (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na$_2$SO$_4$•10H$_2$O(s)</td>
<td>−4324</td>
</tr>
<tr>
<td>Na$_2$SO$_4$(s)</td>
<td>−1384</td>
</tr>
<tr>
<td>H$_2$O(\ell)</td>
<td>−286</td>
</tr>
</tbody>
</table>

(a) +2654 kJ/mol  (b) +80. kJ/mol  (c) +1384 kJ/mol  (d) +8568 kJ/mol  (e) +2848 kJ/mol
55&56. Given: water: m.p. 0°C, b.p. 100°C

- heat of fusion = 333 J/g at 0°C
- heat of vaporization = 2260 J/g at 100°C

specific heat (g) = 2.03 J/g°C
specific heat (l) = 4.18 J/g°C
specific heat (s) = 2.09 J/g°C

Calculate the amount of heat that must be absorbed to convert 20.0 g of water at 45.0°C to water vapor at 100.0°C (in kJ).

(a) 14.2 kJ  (b) 25.7 kJ  (c) 57.1 kJ  (d) 49.8 kJ  (e) 40.3 kJ

57&58. Air bags for automobiles are inflated during a collision by the explosion of sodium azide, NaN₃ (FW = 65.0 g/mol). The equation for the decomposition is:

2NaN₃(s) → 2Na(s) + 3N₂(g)

What mass of sodium azide is needed to inflate a 25.0 L bag with nitrogen gas to a pressure of 1.40 atm at 20°C?

(a) 14.4 g  (b) 88.1 g  (c) 93.1 g  (d) 63.1 g  (e) 155 g

59&60. Your course evaluation on e-learning. If you didn’t take it and want to, let me know. It’s now closed off.
(4 pts) 61. Give the name or formula of the following:

(a) ammonium sulfate ________________________

(b) SO₃ _____________________

(10 pts) 62. Draw the correct dot structure for the following 2 species showing all valence electrons and fill in the appropriate information.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SF₂</td>
<td>BrF₂⁻</td>
<td></td>
</tr>
<tr>
<td>(a) Dot structure:</td>
<td>(a) Dot structure:</td>
<td></td>
</tr>
<tr>
<td>(b) molecular (ionic) geometry:</td>
<td>(b) molecular (ionic) geometry:</td>
<td></td>
</tr>
<tr>
<td>(c) hybridization of central atom:</td>
<td>(c) hybridization of central atom:</td>
<td></td>
</tr>
<tr>
<td>(d) has a dipole moment (yes/no):</td>
<td>(d) has a dipole moment (yes/no):</td>
<td></td>
</tr>
<tr>
<td>(is polar)</td>
<td>(is polar)</td>
<td></td>
</tr>
</tbody>
</table>

OVER
(3 pts) **63.** Sketch a phase diagram. Label the axis and where the solid, liquid and gas phases are stable.

(3 pts) **64.** How many sigma and pi bonds are in the organic compound, propanal? \( \text{CH}_3\text{CH}_2\text{C} = \text{H} \)?

- Sigma bonds
- Pi bonds