

Use a scantron to complete the exam. There is *only* one best answer for each question. Good luck!

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- If a 21.00 gram sample of a Cu-Zn-Ni alloy contains 7.75 g Cu and 10.58 g Ni, what is the percent composition of Zn?
  - 36.9%
  - 2.67%
  - 50.4%
  - 20.7%
  - 12.7%
- What is the atomic symbol for an element with 39 protons and 50 neutrons?
  - $^{89}_{11}\text{Na}$
  - $^{50}_{39}\text{Y}$
  - $^{89}_{39}\text{Y}$
  - $^{89}_{50}\text{Sn}$
  - $^{227}_{89}\text{Ac}$
- Rubidium (Rb) has two naturally occurring isotopes. The average mass of Rb is 85.4678 u. If 72.15% of Rb is found as Rb-85 (84.9117 u), what is the mass of the other isotope?
  - 0.56 u
  - 85.68 u
  - 86.91 u
  - 86.02 u
  - 83.47 u
- When strongly heated, boric acid breaks down to boric oxide and water. What mass of boric oxide is formed from the decomposition of 15.0 g  $\text{B}(\text{OH})_3$ ?  $2 \text{B}(\text{OH})_3(\text{s}) \rightarrow \text{B}_2\text{O}_3(\text{s}) + 3 \text{H}_2\text{O}(\text{g})$ 
  - 7.50 g
  - 15.0 g
  - 8.44 g
  - 16.9 g
  - 33.8 g
- Which formula represents the compound formed by aluminum and carbonate ions?
  - $\text{AlCO}_3$
  - $\text{Al}(\text{CO}_3)_2$
  - $\text{Al}(\text{CO}_3)_3$
  - $\text{Al}_2(\text{CO}_3)_3$
  - $\text{Al}_3(\text{CO}_3)_2$
- What is the correct formula for barium nitrate?
  - $\text{Ba}(\text{NO}_3)_2$
  - $\text{BNO}_2$
  - $\text{Ba}(\text{NO}_2)_2$
  - $\text{BaN}$
  - $\text{BaNO}_3$

7. What is the correct formula for cobalt(III) oxide?
- CoO
  - Co<sub>3</sub>O
  - Co<sub>3</sub>O<sub>2</sub>
  - Co<sub>2</sub>O<sub>3</sub>
  - CoO<sub>3</sub>
8. Which of the following formulas is not correct?
- Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>
  - NaClO<sub>3</sub>
  - Ba<sub>2</sub>O<sub>3</sub>
  - Mg(NO<sub>3</sub>)<sub>2</sub>
  - KH<sub>2</sub>PO<sub>4</sub>
9. What is the molar mass of cobalt(II) iodide hexahydrate?
- 212.8 g/mol
  - 293.9 g/mol
  - 312.7 g/mol
  - 420.8 g/mol
  - 465.1 g/mol
10. Ammonia is prepared by reacting nitrogen and hydrogen gases at high temperature according to the *unbalanced* chemical equation:  $\underline{\hspace{1cm}} \text{N}_2(\text{g}) + \underline{\hspace{1cm}} \text{H}_2(\text{g}) \rightarrow \underline{\hspace{1cm}} \text{NH}_3(\text{g})$  What are the respective coefficients when the equation is balanced with the smallest whole numbers?
- 1, 1, 1
  - 1, 3, 1
  - 1, 3, 2
  - 2, 1, 2
  - 2, 3, 2
11. When methanol undergoes complete combustion, the products are carbon dioxide and water:  $\underline{\hspace{1cm}} \text{CH}_3\text{OH}(\text{l}) + \underline{\hspace{1cm}} \text{O}_2(\text{g}) \rightarrow \underline{\hspace{1cm}} \text{CO}_2(\text{g}) + \underline{\hspace{1cm}} \text{H}_2\text{O}(\text{g})$  What are the respective coefficients when the equation is balanced with the smallest whole numbers?
- 1, 1, 1, 1
  - 1, 2, 1, 2
  - 2, 2, 2, 4
  - 2, 3, 2, 4
  - 2, 4, 6, 4
12. What is the net ionic equation for the reaction of aqueous lead(II) nitrate with aqueous sodium bromide?
- $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaBr}(\text{aq}) \rightarrow \text{PbBr}_2(\text{aq}) + 2 \text{NaNO}_3(\text{s})$
  - $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$
  - $\text{Pb}^{2+}(\text{aq}) + 2 \text{Br}^-(\text{aq}) \rightarrow \text{PbBr}_2(\text{s})$
  - $\text{Pb}^{2+}(\text{aq}) + 2 \text{Na}^+(\text{aq}) \rightarrow \text{PbNa}_2(\text{s})$
  - $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaBr}(\text{aq}) \rightarrow \text{PbBr}_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$

13. Which of the following are oxidation-reduction reactions?
1.  $\text{Zn(s)} + \text{CuSO}_4\text{(aq)} \rightarrow \text{ZnSO}_4\text{(aq)} + \text{Cu(s)}$
  2.  $\text{Pb(ClO}_4)_2\text{(aq)} + 2 \text{KI(aq)} \rightarrow \text{PbI}_2\text{(s)} + 2 \text{KClO}_4\text{(aq)}$
  3.  $\text{CaCO}_3\text{(s)} \rightarrow \text{CO}_2\text{(g)} + \text{CaO(s)}$
- a. 1 only
  - b. 2 only
  - c. 1 and 2
  - d. 1 and 3
  - e. 2 and 3
14. What is the oxidation number of each atom in potassium nitrate,  $\text{KNO}_3$ ?
- a.  $\text{K} = +1, \text{N} = -3, \text{O} = -2$
  - b.  $\text{K} = +1, \text{N} = +5, \text{O} = -2$
  - c.  $\text{K} = +1, \text{N} = -3, \text{O} = +2$
  - d.  $\text{K} = -1, \text{N} = +3, \text{O} = -2$
  - e.  $\text{K} = 0, \text{N} = 0, \text{O} = 0$
15. If 0.3000 g of impure soda ash ( $\text{Na}_2\text{CO}_3$ ) is titrated with 17.66 mL of 0.1187 M HCl, what is the percent purity of the soda ash?
- $$\text{Na}_2\text{CO}_3\text{(aq)} + 2 \text{HCl(aq)} \rightarrow 2 \text{NaCl(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$$
- a. 11.11%
  - b. 22.22%
  - c. 57.91%
  - d. 37.03%
  - e. 74.06%
16. If 2.891 g  $\text{MgCl}_2$  is dissolved in enough water to make 500.0 mL of solution, what is the molarity of the magnesium chloride solution?
- a.  $5.782 \times 10^{-3} \text{ M}$
  - b.  $1.518 \times 10^{-2} \text{ M}$
  - c.  $6.073 \times 10^{-2} \text{ M}$
  - d. 0.5505 M
  - e. 5.782 M
17. How many liters of 0.1107 M  $\text{KCl(aq)}$  contain 15.00 g of  $\text{KCl}$ ?
- a. 0.02227 L
  - b. 0.5502 L
  - c. 1.661 L
  - d. 1.818 L
  - e. 123.8 L
18. When 27.0 g of an unknown metal at  $88.4^\circ\text{C}$  is placed in 115 g  $\text{H}_2\text{O}$  at  $21.0^\circ\text{C}$ , the final temperature of the water is  $23.7^\circ\text{C}$ . What is the specific heat capacity of the metal?
- a. 0.34 J/g·K
  - b. 0.51 J/g·K
  - c. 0.74 J/g·K
  - d. 0.94 J/g·K
  - e. 1.4 J/g·K

19. Calculate the amount of heat required to change 50.0 g ice at  $-20.0\text{ }^{\circ}\text{C}$  to steam at  $135\text{ }^{\circ}\text{C}$ . (Heat of fusion =  $333\text{ J/g}$ ; heat of vaporization =  $2260\text{ J/g}$ ; specific heat capacities: ice =  $2.09\text{ J/g}\cdot\text{K}$ , steam =  $1.84\text{ J/g}\cdot\text{K}$ )
- 4.18 kJ
  - 32.4 kJ
  - 78.8 kJ
  - 135 kJ
  - 156 kJ
20. Hydrazine,  $\text{N}_2\text{H}_4$ , is a liquid used as a rocket fuel. It reacts with oxygen to yield nitrogen gas and water:  $\text{N}_2\text{H}_4(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ . The reaction of 3.80 g  $\text{N}_2\text{H}_4$  evolves 73.7 kJ of heat. Calculate the enthalpy change per mole of hydrazine combusted.
- 8.74 kJ/mol
  - 19.4 kJ/mol
  - $-2.80 \times 10^2$  kJ/mol
  - 622 kJ/mol
  - $-8.98 \times 10^3$  kJ/mol
21. Which of the following chemical equations corresponds to the standard molar enthalpy of formation of  $\text{N}_2\text{O}$ ?
- $\text{NO}(\text{g}) + 1/2\text{N}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $\text{N}_2(\text{g}) + 1/2\text{O}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $2\text{N}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $\text{N}_2(\text{g}) + \text{O}(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $2\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{N}_2\text{O}(\text{g})$
22. Determine  $\Delta H$  for the reaction:  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$  given the thermochemical equations below.
- |   |                               |
|---|-------------------------------|
| $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$                                    | $\Delta H = +180.8\text{ kJ}$ |
| $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$ | $\Delta H = -906.2\text{ kJ}$ |
| $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$                          | $\Delta H = -483.6\text{ kJ}$ |
- 1209.0 kJ
  - 1189.0 kJ
  - 756.5 kJ
  - 241.8 kJ
  - 91.5 kJ
23. An argon ion laser emits light at 488 nm. What is the frequency of this radiation?
- $4.07 \times 10^{-19}\text{ s}^{-1}$
  - $1.63 \times 10^{-15}\text{ s}^{-1}$
  - $1.46 \times 10^2\text{ s}^{-1}$
  - $2.05 \times 10^6\text{ s}^{-1}$
  - $6.14 \times 10^{14}\text{ s}^{-1}$
24. A microwave oven emits radiation with an energy of  $3.98 \times 10^{-23}\text{ J/photon}$ . What is the frequency of this radiation?
- $1.67 \times 10^{-11}\text{ s}^{-1}$
  - $6.67 \times 10^{-7}\text{ s}^{-1}$
  - $2.00\text{ s}^{-1}$
  - $1.50 \times 10^6\text{ s}^{-1}$
  - $6.01 \times 10^{10}\text{ s}^{-1}$
25. What is the energy of a mole of photons of red light with a wavelength of 632 nm?
- 189 kJ
  - 252 kJ
  - 314 kJ
  - 515 kJ
  - 756 kJ

26. For a neutron (mass =  $1.675 \times 10^{-27}$  kg) moving with a velocity of  $5.2 \times 10^3$  m/s, what is the de Broglie wavelength?
- $7.6 \times 10^{-11}$  m
  - $4.5 \times 10^{-9}$  m
  - $2.1 \times 10^{-6}$  m
  - 486 m
  - $1.3 \times 10^{10}$  m
27. What type of orbital is designated  $n = 3, l = 2, m_l = -1$  and  $m_s = +1/2$ ?
- 3s
  - 3p
  - 3d
  - 2f
  - 2d
28. Which of the following is a possible set of quantum numbers for an electron in an atom?
- $n = 1, l = 1, m_l = 1$
  - $n = 2, l = 0, m_l = -1$
  - $n = 0, l = 0, m_l = 0$
  - $n = 3, l = 1, m_l = -1$
  - $n = 4, l = 5, m_l = -2$
29. What is the maximum number of orbitals that can be identified with the following quantum numbers:  $n = 3, l = 1, m_l = 0$ ?
- 0
  - 1
  - 3
  - 5
  - 7
30. Which of the following particles would be most paramagnetic?
- Se
  - Cd
  - Ar
  - He
  - Ca
31. Place the following atoms in order of increasing atomic radii: Se, O, S, and As.
- $O < S < Se < As$
  - $O < S < As > Se$
  - $As < Se < S < O$
  - $Se < As < S < O$
  - $S < As < O < Se$
32. What is the ground state electron configuration for  $Cr^{3+}$ ?
- [Ar]
  - [Ar]3d<sup>3</sup>4s<sup>2</sup>
  - [Ar]3d<sup>4</sup>4s<sup>1</sup>
  - [Ar]3d<sup>3</sup>
  - [Ar]3d<sup>7</sup>4s<sup>2</sup>