

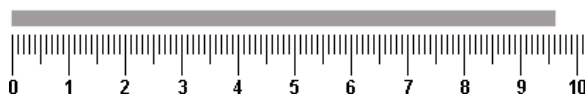
# Spring Final Practice Test #2

The following information may be helpful.

|  |   |   |  |
|--|---|---|--|
| $D = \frac{m}{V}$                                  | $K = ^\circ C + 273$  | $q = m \cdot C_p \cdot \Delta T$                              | $q = m \cdot \Delta H$                               |
| $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$        | $P \cdot V = n \cdot R \cdot T$                                   | $R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$                  | Molar Mass = $\frac{m}{n}$                           |
| $\frac{n_A}{n_{total}} = \frac{P_A}{P_{total}}$    | Atomic Mass = $\sum (\text{isotopic mass})(\% \text{ abundance})$ |   |  |
| 1 atm = 760 mmHg = 760 torr = 14.7 psi = 101.3 kPa |   | 1 mole = $6.022 \times 10^{23}$ particles = 22.4 L gas at STP |  |
| $m_t = m_o \left( \frac{1}{2} \right)^{t/t_{1/2}}$ | $c = \lambda \cdot \nu = 3.00 \times 10^8 \text{ m/s}$            | $E = h \cdot \nu = \frac{h \cdot c}{\lambda}$                 | $h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$ |

**Part 1: Multiple Choice.** Select the answer choice that best completes the question.

1. Consider this ruler:



What is the length of the line read to the correct number of significant figures?

- (A) 9 cm  
(B) 9.6 cm  
(C) 9.62 cm  
(D) 9.615 cm
2. In scientific notation, the number 0.00270 should be written as:  
(A)  $2.70 \times 10^{-3}$   
(B)  $2.70 \times 10^3$   
(C)  $2.70 \times 10^{-5}$   
(D)  $270. \times 10^{-3}$
3. How should the following be recorded with the correct number of significant figures?
- |               |
|---------------|
| 110           |
| (8.314)(3.16) |
- (A) 4.2  
(B) 4.18  
(C) 4.187  
(D) 41.8

4. Several teams of students measure the density of aluminum (density 2.70 g/mL). The student data is averaged and the  $\pm$  uncertainty is determined. Here are the class results:

| Period | Average   | $\pm$ |
|--------|-----------|-------|
| 1      | 2.75 g/mL | 0.2   |
| 2      | 2.79 g/mL | 0.1   |
| 3      | 2.70 g/mL | 0.5   |

How do the accuracy and precision of Period 3 compare with those from the other periods?

- (A) least accurate most precise  
(B) least accurate, least precise  
(C) most accurate, least precise  
(D) most accurate, most precise
5. Iron has a known density of 7.86 g/mL. A student measures the density of an iron cylinder as 7.75 g/mL. What is the percent error in the student's measurement?  
(A) 0.017%  
(B) 0.99%  
(C) 1.1%  
(D) 1.4%
6. The measurement 0.256 mL can also be expressed in which units?  
(A)  $\text{cm}^3$   
(B) g/L  
(C) K  
(D) mg

7. Which of the following statements is incorrect?

- (A)  $1 \text{ cm} = \frac{1}{100} \text{ m}$
- (B)  $1 \text{ kg} = 1000 \text{ g}$
- (C)  $1 \text{ mg} = 0.001 \text{ g}$
- (D)  $1 \text{ mL} = 1000 \text{ L}$

8. The number of seconds in 2.89 years =

- (A)  $9.11 \times 10^{-7} \text{ s}$
- (B)  $1.22 \times 10^{-2} \text{ s}$
- (C)  $1.22 \times 10^3 \text{ s}$
- (D)  $9.11 \times 10^7 \text{ s}$

9. What conversion factor would you use to convert milligrams to grams?

- (A)  $\frac{1000 \text{ mg}}{1 \text{ g}}$
- (B)  $\frac{1 \text{ g}}{1000 \text{ mg}}$
- (C)  $\frac{1 \text{ mg}}{1000 \text{ g}}$
- (D)  $\frac{1000 \text{ g}}{1 \text{ mg}}$

10. A slab of metal has the following measurements

|        |        |       |            |
|--------|--------|-------|------------|
| length | 8.0 cm | width | 2.0 cm     |
| height | 0.5 cm | mass  | 71.4 grams |

The slab is composed of which metal?

- (A) copper, density =  $8.92 \text{ g/cm}^3$
- (B) iron, density =  $7.86 \text{ g/cm}^3$
- (C) silver, density =  $10.5 \text{ g/cm}^3$
- (D) zinc, density =  $7.14 \text{ g/cm}^3$

11. A liquid has a density of  $1.6 \text{ g/mL}$ . What is the mass of a  $80.0 \text{ mL}$  sample of the liquid?

- (A) 8 g
- (B) 32 g
- (C) 80 g
- (D) 128 g

12. The densities of ethanol and water are  $0.789 \text{ g/mL}$  and  $1.00 \text{ g/mL}$ , respectively. If  $50.0 \text{ g}$  samples of each liquid are obtained, which liquid has the larger volume?

- (A) The sample of ethanol
- (B) The sample of water
- (C) Both samples have the same volume
- (D) More information is needed to compare their volumes

13. Two balloons are filled to  $2.0 \text{ L}$  at  $20^\circ\text{C}$ . One is filled with helium gas, while the other is filled with hydrogen gas. If the pressure exerted by the balloons are the same, we can conclude that:

- I. The mass of each balloon including the filled gases is the same.
- II. The number of molecules of gas in each balloon is the same.
- III. The number of moles of gas in each balloon is the same.

- (A) I only.
- (B) II only.
- (C) II and III only.
- (D) I, II, and III.

14. A pressure of  $745 \text{ mmHg}$  equals \_\_\_\_ kPa.

- (A)  $0.980 \text{ kPa}$
- (B)  $55.89 \text{ kPa}$
- (C)  $99.3 \text{ kPa}$
- (D)  $745 \text{ kPa}$

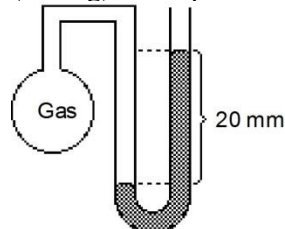
15. A gas has a temperature of  $50^\circ\text{C}$ . A gas with twice as much kinetic energy has a temperature of:

- (A)  $50 \text{ K}$
- (B)  $273 \text{ K}$
- (C)  $100^\circ\text{C}$
- (D)  $373^\circ\text{C}$

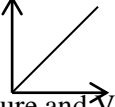
16. How does the average kinetic energy (KE) of hydrogen molecules compare with that of oxygen molecules when both gases are at  $25^\circ\text{C}$ ?

- (A) They have equal KEs.
- (B) The KE of hydrogen is  $1/4$  as great.
- (C) The KE of hydrogen is  $1/16$  as great.
- (D) The KE of hydrogen is 4 times as great.

17. The open-end manometer in the diagram is filled with mercury and the difference in levels is  $20 \text{ mm}$ . When the atmospheric pressure is  $760 \text{ torr}$  (mmHg), what pressure is exerted by the gas?

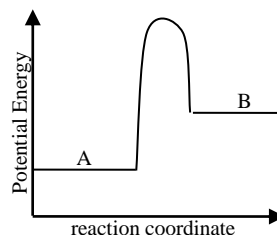


- (A)  $20 \text{ torr}$
- (B)  $740 \text{ torr}$
- (C)  $760 \text{ torr}$
- (D)  $780 \text{ torr}$

18. 15.0 K is the same temperature as  
 (A)  $-288^{\circ}\text{C}$   
 (B)  $-258^{\circ}\text{C}$   
 (C)  $258^{\circ}\text{C}$   
 (D)  $288^{\circ}\text{C}$
19. A sample of He (g) is in a balloon. With which of the following conditions will the volume of the balloon be the largest?  
 (A)  $P = 0.80\text{ atm}$      $T = 10^{\circ}\text{C}$   
 (B)  $P = 0.80\text{ atm}$      $T = 50^{\circ}\text{C}$   
 (C)  $P = 1.50\text{ atm}$      $T = 10^{\circ}\text{C}$   
 (D)  $P = 1.50\text{ atm}$      $T = 50^{\circ}\text{C}$
20. The graph below shows the relationship between which set of changing conditions of a gas sample?
- 
- I. Pressure and Volume  
 II. Volume and Temperature  
 III. Pressure and Temperature
- (A) I only.  
 (B) II only.  
 (C) II and III only.  
 (D) I, II, and III
21. A gas at  $25.0^{\circ}\text{C}$  and 680 mmHg occupies 50 mL. A cylinder equipped with a movable piston contains 50.0 mL of a gas. What is the new volume when the pressure is doubled at constant temperature?  
 (A) 25.0 mL  
 (B) 50.0 mL  
 (C) 75.0 mL  
 (D) 100 mL
22. A gas at  $25.0^{\circ}\text{C}$  and 680 mmHg occupies 345 mL. What is the volume of the gas at STP?  
 (A) 283 mL  
 (B) 306 mL  
 (C) 336 mL  
 (D) 421 mL
23. A gas has a pressure of 800 torr at  $27^{\circ}\text{C}$ . At what temperature would this gas measure a pressure of 1600 torr if the volume remains constant?  
 (A)  $14^{\circ}\text{C}$   
 (B)  $54^{\circ}\text{C}$   
 (C)  $224^{\circ}\text{C}$   
 (D)  $327^{\circ}\text{C}$

24. A sample of a gas at STP has a volume of 1.00 L. How many moles of this gas are contained in this sample?  
 (A) 0.0446 moles  
 (B) 0.0821 moles  
 (C) 1.00 mole  
 (D) 22.4 moles

25. The potential energy diagram below represents the reaction  $A \rightarrow B$ .



Which of the following is true for this reaction?

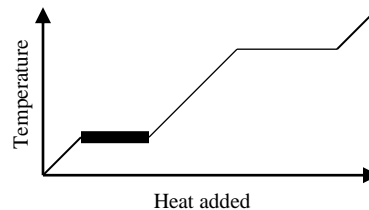
- (A) Heat is released.  
 (B) The process is exothermic.  
 (C) The value of  $C_p$  is positive.  
 (D) The value of  $q$  is positive.
26. Which of the following processes is exothermic?  
 (A) Freezing water at  $0^{\circ}\text{C}$ .  
 (B) The expansion of a balloon when left outside under the hot sun.  
 (C) The heating of an aluminum slab when placed in boiling water.  
 (D) Dissolving a sample of  $\text{NH}_4\text{Cl}$  (s) in water gets cold.
27. As a block of aluminum is heated with 600 J of energy, its temperature increases from  $10^{\circ}\text{C}$  to  $47^{\circ}\text{C}$ . What is the mass of this block? (specific heat of Al =  $-0.900\text{ J/g}\cdot^{\circ}\text{C}$ )  
 (A) 0.055 g  
 (B) 14.6 g  
 (C) 18.0 g  
 (D) 33.3 g
28. A 40.0 g metal slab that is  $100^{\circ}\text{C}$  is placed in a beaker filled with 200. g of water at  $22.0^{\circ}\text{C}$ . If the water heats up to  $25.0^{\circ}\text{C}$ , what is the specific heat of unknown metal? (Assume no heat is lost to the surroundings.)  $C_p$  of water =  $4.18\text{ J/g}\cdot^{\circ}\text{C}$ .  
 (A)  $0.562\text{ J/g}\cdot^{\circ}\text{C}$   
 (B)  $0.627\text{ J/g}\cdot^{\circ}\text{C}$   
 (C)  $0.836\text{ J/g}\cdot^{\circ}\text{C}$   
 (D)  $5.23\text{ J/g}\cdot^{\circ}\text{C}$

29. Four 10-gram samples of metal at room temperature are heated with the same amount of energy. Which will get the hottest?
- (A) Sample A (specific heat =  $0.32 \text{ J/g}\cdot^\circ\text{C}$ )  
 (B) Sample B (specific heat =  $0.98 \text{ J/g}\cdot^\circ\text{C}$ )  
 (C) Sample C (specific heat =  $0.25 \text{ J/g}\cdot^\circ\text{C}$ )  
 (D) Sample D (specific heat =  $0.56 \text{ J/g}\cdot^\circ\text{C}$ )
30. Blocks of nickel ( $C_p = 0.44 \text{ J/g}\cdot^\circ\text{C}$ ) and zinc ( $C_p = 0.39 \text{ J/g}\cdot^\circ\text{C}$ ) are heated with  $100.0 \text{ J}$  of energy and their temperatures increased from  $15^\circ\text{C}$  to  $30^\circ\text{C}$ . Which block has a greater mass?
- (A) The nickel block  
 (B) The zinc block  
 (C) Both blocks have the same mass  
 (D) It cannot be determined
31. Which of the following describes the condensation of steam?
- (A)  $\text{H}_2\text{O}(\ell) + \text{heat} \rightarrow \text{H}_2\text{O}(\text{g})$   
 (B)  $\text{H}_2\text{O}(\ell) \rightarrow \text{H}_2\text{O}(\text{g}) + \text{heat}$   
 (C)  $\text{H}_2\text{O}(\text{g}) + \text{heat} \rightarrow \text{H}_2\text{O}(\ell)$   
 (D)  $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\ell) + \text{heat}$
32. A  $30.6 \text{ g}$  sample of glycerol requires  $6.14 \text{ kJ}$  of energy to melt completely at its melting point,  $18^\circ\text{C}$ . What is the  $\Delta H_{\text{fus}}$  for glycerol?
- (A)  $0.200 \text{ kJ/g}$   
 (B)  $3.60 \text{ kJ/g}$   
 (C)  $5.00 \text{ kJ/g}$   
 (D)  $90.0 \text{ kJ/g}$

Questions 33-34. For water,  $C_{p,\text{ice}} = 2.10 \text{ J/g}\cdot^\circ\text{C}$ ,  $C_{p,\text{water}} = 4.18 \text{ J/g}\cdot^\circ\text{C}$ ,  $C_{p,\text{steam}} = 2.08 \text{ J/g}\cdot^\circ\text{C}$ ,  $\Delta H_{\text{fus}} = 333 \text{ J/g}$ ,  $\Delta H_{\text{vap}} = 2260 \text{ J/g}$

33. How much energy is needed to heat  $120 \text{ grams}$  of water from  $10^\circ\text{C}$  to  $50^\circ\text{C}$ ?
- (A)  $20,064 \text{ J}$   
 (B)  $25,080 \text{ J}$   
 (C)  $40,128 \text{ J}$   
 (D)  $48,064 \text{ J}$
34. How much ice melts when  $3000 \text{ J}$  of energy is applied at  $0^\circ\text{C}$ ?
- (A)  $1.3 \text{ g}$   
 (B)  $9.0 \text{ g}$   
 (C)  $718 \text{ g}$   
 (D)  $1430 \text{ g}$

35. Heat is added to a sample of ice at  $-15^\circ\text{C}$ , until it becomes steam at  $115^\circ\text{C}$ . The temperature for this process is shown below.



What process is represented by the heavy portion of the graph?

- I. Heating of ice.  
 II. Heating of liquid water.  
 III. Melting of ice.
- (A) I only.  
 (B) III only.  
 (C) I and III only.  
 (D) I, II, and III.
36. A  $30.0 \text{ g}$  sample of ethanol in a closed container is heated at its boiling point,  $78^\circ\text{C}$ . Which of the following is occurring?
- I. The particles move faster.  
 II. The temperature is increasing.  
 III. The attractions between particles are strengthening
- (A) I only.  
 (B) I and II only.  
 (C) II and III only.  
 (D) I, II, and III.
37. The atom represented by  $^{52}\text{Cr}^{2+}$  has:
- (A) 24 protons, 28 neutrons, 22 electrons  
 (B) 24 protons, 28 neutrons, 26 electrons  
 (C) 24 protons, 52 neutrons, 26 electrons  
 (D) 54 protons, 52 neutrons, 53 electrons
38. All of the following describe the electron except:
- (A) It carries a negative charge.  
 (B) It has a much smaller mass than a proton.  
 (C) It is located around the atom's nucleus.  
 (D) Its number determines the identity of the atom.
39. Which of the following atoms has the same number of electrons as  $^{40}\text{K}^{+}$ ?
- (A)  $^{37}\text{Cl}^{-}$   
 (B)  $^{38}\text{Ar}^{+}$   
 (C)  $^{39}\text{K}$   
 (D)  $^{40}\text{Ca}$

40. The atomic mass of arsenic is 74.92. Which of the following is true?
- (A) A mole of arsenic has a mass of 74.92 amu.
  - (B) A mole of arsenic has a mass of 74.92 g.
  - (C) An atom of arsenic has a mass of 74.92 g.
  - (D) There are 74.92 atoms of arsenic in one gram

41. The element bromine, Br, forms an ion with a charge of:
- (A) -2
  - (B) -1
  - (C) +1
  - (D) +2

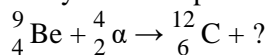
42. Which of the following elements is expected to be a solid at room temperature and does not conduct electricity?
- (A) Silver
  - (B) Sodium
  - (C) Strontium
  - (D) Sulfur

43. Which element is diatomic and forms -1 ions?
- (A) calcium
  - (B) iodine
  - (C) oxygen
  - (D) potassium

44. Which of the following statements refers to an alpha particle?
- (A) a highly energetic form of light.
  - (B) a high-speed electron.
  - (C) a nucleus of a helium atom.
  - (D) has the symbol,  ${}^0_1\text{e}$

45. When  ${}^{209}_{84}\text{Po}$  undergoes alpha decay, the resulting isotope is
- (A)  ${}^{207}\text{Hg}$
  - (B)  ${}^{205}\text{Po}$
  - (C)  ${}^{205}\text{Pb}$
  - (D)  ${}^{213}\text{Rn}$

46. Which symbol completes this nuclear equation?

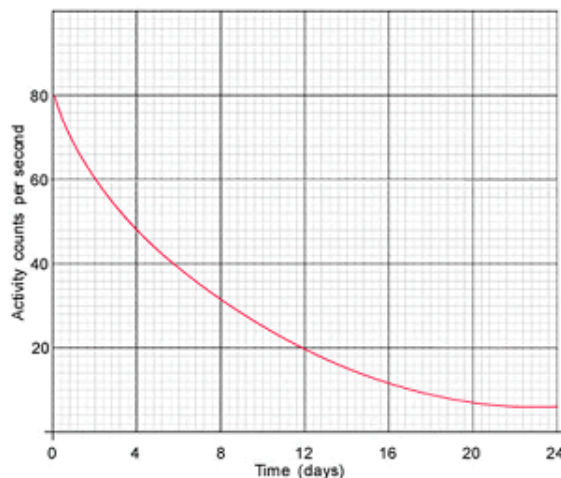


- (A)  ${}^0_{-1}\beta$
- (B)  ${}^2_1\text{H}$
- (C)  ${}^1_0\text{n}$
- (D)  ${}^1_1\text{p}$

47. A radioactive substance has a half-life of 20 minutes. How long will it take for a 64-gram sample to decay to 2 grams?

- (A) 40 minutes
- (B) 60 minutes
- (C) 80 minutes
- (D) 100 minutes

48. What is the half-life of this substance?



- (A) 4 days
- (B) 6 days
- (C) 12 days
- (D) 24 days

49. What is the electron configuration for the Te atom?

- (A)  $[\text{Kr}] 5s^2 4d^{10} 5p^4$
- (B)  $[\text{Kr}] 5s^2 4d^{10} 5p^6$
- (C)  $[\text{Kr}] 5s^2 5d^{10} 5p^4$
- (D)  $[\text{Kr}] 5s^2 5p^6$

50. The electrons in vanadium (atomic number 23) that are farthest from the nucleus occupy the \_\_\_\_ orbital.

- (A) 3p
- (B) 3d
- (C) 4s
- (D) 4p

51. What is the ground state electron configuration of the  $\text{As}^{3+}$  ion?

- (A)  $[\text{Ar}] 3d^9 4p^3$
- (B)  $[\text{Ar}] 3d^{10} 4p^2$
- (C)  $[\text{Ar}] 4s^2 3d^{10}$
- (D)  $[\text{Ar}] 4s^2 3d^{10} 4p^3$

52. Which of the following is a correct ground state electron configuration for a neutral atom?

- (A)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$
- (B)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
- (C)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^4$
- (D)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^4$

53. What is the maximum number of electrons that can occupy all of the orbitals in the third shell?

- (A) 2
- (B) 6
- (C) 8
- (D) 18

54. Phosphorus has the same number of valence electrons as:

- (A) N
- (B) O
- (C) S
- (D) Si

55. Which of the following lists elements in increasing atomic radius?

- (A)  $Pb < Sn < Sb$
- (B)  $Sb < Pb < Sn$
- (C)  $Sb < Sn < Pb$
- (D)  $Sn < Sb < Pb$

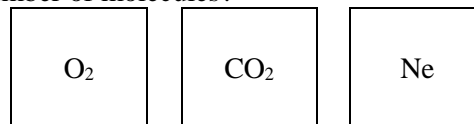
56. Which of the following elements has the highest electronegativity value?

- (A) N
- (B) O
- (C) P
- (D) S

57. Why is Rb expected to have a smaller ionization energy than K?

- (A) Rb has a greater mass than K.
- (B) Rb has more electron than K.
- (C) Rb has more layers of electrons than K.
- (D) Rb has more protons than K.

58. Three equal-sized containers are filled with gases at STP. Which container holds the greatest number of molecules?



- (A) O<sub>2</sub>
- (B) CO<sub>2</sub>
- (C) Ne
- (D) All contain the same number of molecules

59. A 1.00-L sample of gas (at STP) has a mass of 1.25 g. What is the molar mass of the gas?

- (A) 7.53 g/mol
- (B) 22.4 g/mol
- (C) 28.0 g/mol
- (D) 32.0 g/mol

60. What is the volume of 0.750 mole of hydrogen gas, H<sub>2</sub>, measured at STP?

- (A) 5.60 L
- (B) 16.8 L
- (C) 33.6 L
- (D) 44.8 L

## Part 2: Free Response.

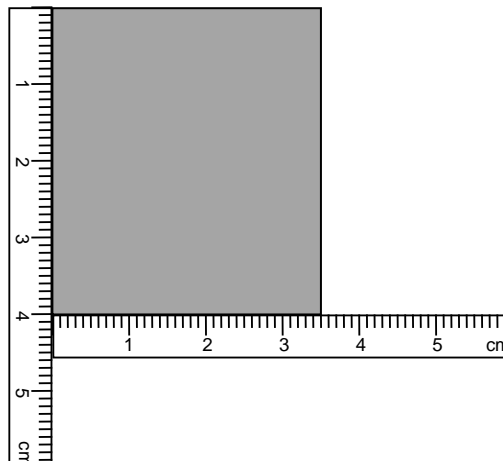
For each question, write your response in the space provided. If the problem requires mathematical computation, show your work (steps) neatly, reporting your answer with the correct number of significant digits and units. Partial credit is given only when the process taken is clearly shown. Place a box around or circle your final answer.

- Unit conversions should be shown using dimensional analysis, showing how all units cancel out.
- Work for problems involving formulas should follow the I.E.S.A. form.

1. Tin has a density of  $7.28 \text{ g/cm}^3$ . A rectangular sheet of tin has a mass of  $1.282 \text{ g}$ . The length and width of the sheet are measured using rulers, as shown to the right.

- a. Record the dimensions of the foil. (2 points)

- b. Find the thickness of the foil, in cm. Write the result in scientific notation. (6 points).



- c. Convert the density of tin into  $\text{lb/in}^3$ . [ $1 \text{ kg} = 2.2046 \text{ lb}$        $1 \text{ in} = 2.54 \text{ cm}$ ] (4 points)

2. A sample of gas is in a cylinder with a piston against a constant pressure of 0.60 atm. At 30°C, the sample of gas occupies 3.11 L.

a. What is the volume of this gas when this sample is brought to 1.00 atm and 120°C? (4 points)

b. How many moles of gas are in this sample? (4 points)

c. This sample is a mixture of helium and argon gases. If there are 0.025 mol helium gas, find the partial pressure of argon gas in the original sample. (4 points)

3. A 5.00 g cylinder of solid gallium (molar mass = 69.72 g/mol) is at 5.0°C.

$C_{p,\text{solid}} = 0.371 \text{ J/g}\cdot^\circ\text{C}$ ,  $\Delta H_{\text{fus}} = 5.59 \text{ kJ/mol}$ ,  $\Delta H_{\text{vap}} = 256 \text{ kJ/mol}$

a. How much energy is required to bring this cylinder to its melting point, 29.8°C? (3 points)

b. How much energy is required to melt this sample fully at its melting point? (3 points)



4. A 2.0 L container is filled with water vapor and sealed. After 1 hour, 5 mL of liquid water is found in the container.

a. How did the liquid form? Explain what is happening on the particle level. (2 points)

b. How does the temperature of the container compare to that of the surroundings? Explain briefly. (2 points)

c. Is this process of the formation of liquid water endothermic or exothermic? Explain briefly using your response to part b.

5. Complete the following table. (4 points)

| Isotope               | Atomic Number | Mass Number | # of Protons | # of Neutrons | #of Electrons | Net Charge |
|-----------------------|---------------|-------------|--------------|---------------|---------------|------------|
| $^{69}\text{Zn}^{2+}$ |               |             |              |               |               |            |
|                       |               | 127         |              |               | 54            | -2         |

6. Chlorine naturally exists in two isotopes: Cl-35 (isotopic mass 34.9689 amu) and Cl-37 (36.9659 amu). If chlorine has a molar mass of 35.453 g/mol, find the % abundance of each isotope. (4 points)

7. Ti-44 undergoes electron capture and has a half life of 60 years.

a. Write the nuclear equation for this process. (1 point)

b. How long will it take a 50.00 g sample to decay to 1.56 g? (3 points)

8. Consider the element thallium, Tl (atomic number 81).

a. Write the long form electron configuration for thallium. (1 point)

b. How many valence electrons does thallium have? (1 point) \_\_\_\_\_

c. What ion is thallium likely to form? (1 point) \_\_\_\_\_

d. Write the short form electron configuration for the ion written in part c. (1 point)

e. Which element has a higher first ionization energy, Tl or Pb? Explain fully. (4 points)

f. How many atoms of Tl are in a sample that occupies 78 cm<sup>3</sup>? The density of solid Tl is 11.85 g/cm<sup>3</sup>. (4 points)