Instructions

1. Do not open the exam until you are told to start.

2. This exam is closed note and closed book. You are not allowed to use any outside material while taking this exam.

3. Use the spaces provided to write down your answers. To receive full credit, you must show all work. Do not write answers on any other pieces of paper. If you need more room, write on the back of the exam and be sure to include a note describing where the work is located.

4. When solving numerical problems, make sure you include the proper units in your final answer.

5. If a question asks for a response in sentence or paragraph form, make sure you respond in that format.

6. Useful data for the exam and a periodic table are provided on the last page of the exam. Carefully tear out these sheets if you wish.

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Multiple Choice
1. Which of the following elements has physical and chemical properties most similar to Oxygen?
   a. N
   b. Ne
   c. Na
   d. Se
   e. F

2. How many significant figures should be in the answer to the calculation shown below?
   \[ 12.220 - 1.0251 - 3.1949 = 8.000 \]
   a. 1
   b. 2
   c. 4
   d. 5
   e. None of the above.

3. A sample of matter has a volume of 23.219 km³, what is the volume in cm³?
   a. 2.3219x10⁶ cm³
   b. 2.3219 cm³
   c. 2.3219x10¹³ cm³
   d. 2.3219x10¹⁶ cm³
   e. None of the above.

\[ \frac{23.219 \text{ km}^3}{1 \times 10^9 \text{ cm}^3} = 2.3219 \times 10^6 \text{ cm}^3 \]

4. Express 96400x10⁶ in standard scientific notation.
   a. 9.6400x10²
   b. 9.64x10³
   c. 9.6400x10¹⁰
   d. 9.64x10⁶
   e. None of the above.

5. Which subatomic particle supplies the “glue” that holds the nucleus of an atom together?
   a. The protons.
   b. The electrons.
   c. The neutrons.
   d. The nucleons.
   e. None of the above.
6. How many significant figures should be in the answer to the calculation shown below?

$$\frac{4.042 \times 10^{-3} - 4.2 \times 10^{-5}}{4.0000} = \frac{4.042 \times 10^{-3} - 0.042 \times 10^{-3}}{4.0000}$$

d. 4

e. None of the above.

7. How many significant figures are in the measurement below?

0.030450 km

b. 6
c. 5

d. 4
e. 3

8. What is the mass (in µg) of Kr(gas) occupied by a 234 mL sample of Kr(gas)? The density of Kr(gas) is 3.733 g/L.

a. 6.27 \times 10^4 µg
b. 8.74 \times 10^3 µg
c. 8.74 \times 10^2 µg
d. 6.27 \times 10^8 µg
e. None of the above.

9. Of the following, the smallest and lightest subatomic particle is the ________.

a. neutron
d. nucleus
b. proton
e. alpha particle
c. electron

10. Which pair of atoms constitutes a pair of isotopes of the same element? In the problems, X can represent any atom.

a. $^{14}_6 X$ $^{14}_7 X$
b. $^{20}_{10} X$ $^{21}_{11} X$
c. $^{17}_{9} X$ $^{9}_{17} X$
d. None of the above.
The diagrams below represent different types of matter. Additionally, each box represents a different physical state. Assume that the black, grey, and striped balls represent different elements and the boxes represent the same volume of space.

11. Under normal conditions (i.e. the temperature and pressure of the classroom right now), a sample of matter is best represented by box I. How do the attractive forces of the particles contained in this sample of matter compare to those of water particles under the same conditions?

   a. They are stronger than those of water particles.
   b. They are weaker than those of water particles.
   c. They are the same strength as those of water particles.

12. The matter identified in the box II would be best classified as a ________.

   a. pure element
   b. pure compound
   c. homogeneous mixture
   d. heterogeneous mixture
   e. both a pure element and a pure compound

13. How many significant figures should be in the answer to the calculation shown below?

\[
\frac{3.215 \times (2.30 \times 10^{-3}) \times 2.4}{1.2000}
\]

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

14. The SI unit for temperature is ________.

   a. °C
   b. °F
   c. °T
   d. K
   e. None of the above.
15. The chemical formula for the ionic compound formed between ions of P and ions of Mg contains how many total ions? (add up the total # of P and Mg ions in the formula)

a. 2  

b. 3  

c. 4  

d. 5  

e. None of the above.

16. An object has a mass of $2.41 \times 10^{-8}$ kg, what is the mass in ng?

a. $2.41 \times 10^4$ μg ng

b. $2.41 \times 10^8$ μg ng

c. $2.41 \times 10^{-10}$ μg ng

d. $2.41 \times 10^{-7}$ μg ng

e. None of the above.

\[
\frac{2.41 \times 10^{-8} \text{ kg}}{1 \text{ kg}} \times \frac{1 \times 10^9 \text{ ng}}{1 \text{ g}} = 2.41 \times 10^4 \text{ ng}
\]

17. Which of the following compounds is/are ionic compounds?

I. HCl

II. PCl₅

III. IrS₂

IV. NO₂

V. KI

a. I, II, III  

d. III, V  

de. I, II, IV  
 
bc. III, IV, V
18. You are travelling in New Zealand and you see that a liter of gas costs $1.78. What is the cost of 3.25 ft$^3$ of gas? You must use one line dimensional analysis as we did in class to receive full credit for this problem. For partial credit, fill in the table on the right with the conversion factors you intend to use. There is space for more conversion factors than you will need. (7 points)

\[
3.25 \text{ ft}^3 \times 1728 \text{ in}^3/\text{ft}^3 \times 1 \text{ in}^3/1 \text{ cm}^3 \times 1 \text{ cm}^3/1 \text{ mL} \times 1 \text{ mL}/1 \text{ L} \times 1.78 = \]

\[
= \$163.812
\]

\[
= \$164
\]

Conversion Factors
1. \( \frac{12 \text{ in}^3}{1 \text{ ft}^3} \)
2. \( \frac{2.54 \text{ cm}^3}{1 \text{ in}^3} \)
3. \( \frac{1 \text{ cm}^3}{1 \text{ mL}} \)
4. \( \frac{1 \text{ cm}^3}{1 \text{ mL}} \)
5. \( \frac{1 \text{ mL}}{1 \text{ L}} \)
6. 

19. In an experiment, I determined the area of a card by measuring its length and width. I measured the length of the card to be 11.25 cm and the width to be 7.87 cm. If the true area of the card is 91.25 cm$^2$, determine the absolute error (a.e.) and the percent relative error (% r.e.) of my calculated area. You must show all your work and use a"" in any intermediate values. For all of the calculations, show unrounded and rounded answers, with a box around your rounded values. (7 points)

\[ A = 11.25 \text{ cm} \times 7.87 \text{ cm} \]

\[ = 88.5137 \text{ cm}^2 \]

\[ = 88.5 \text{ cm}^2 \]

\[ \text{a.e.} = |91.25 \text{ cm}^2 - 88.5137 \text{ cm}^2| \]

\[ = 2.712 \text{ cm}^2 \]

\[ = 2.7 \text{ cm}^2 \]

Area = Length x Width
a.e. = |A-X| \hspace{1cm} A = True Value
% r.e. = \( \frac{\text{a.e.}}{A} \times 100\% \) \hspace{1cm} X = My Value

\[ X \text{, a.e.} = \frac{2.712 \text{ cm}^2}{91.25 \text{ cm}^2} \times 100\% \]

\[ = 2.972\% \]

\[ = 3.0\% \]
20. Fill in the missing information into the table. (10 points)

<table>
<thead>
<tr>
<th>Element Name</th>
<th>Element Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osmium</td>
<td>Os</td>
</tr>
<tr>
<td>Fluorine</td>
<td>F</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni</td>
</tr>
<tr>
<td>Antimony</td>
<td>Sb</td>
</tr>
<tr>
<td>Tin</td>
<td>Sn</td>
</tr>
</tbody>
</table>

21. For the following questions fill in the blank with a word, phrase, or number that best completes the sentence. Put your answer in the column on the right. (11 points)

a. The absolute uncertainty associated with the number shown below is __________.

\[ 96230.0 \text{ kL} \]

\[ 0.1 \text{ kL} \]

b. The number of total atoms indicated by the formula and coefficient written below is __________.

\[ 3 \text{ CHCl}_3 \]

\[ 3 \times 5 = 15 \]

c. The number shown below contains __________ significant figures.

\[ 3.0404 \times 10^{-5} \text{ g} \]

\[ 4 \]

d. An atom forms a 2+ ion during a reaction. If the ion has 38 electrons and 50 neutrons, the elemental notation for the ion would be __________.

\[ \frac{90}{2^+} \]

\[ 40 \]

\[ Z \]

\[ 2^+ \]

\[ 90 \]
22. On the left hand side of the arrow below, draw a picture of the aluminum (Al) atom. Assume the aluminum has 14 neutrons. On the right hand side of the arrow, draw a picture of the ion that aluminum forms. In your diagrams, include the location and number of the protons, neutrons, and electrons. Label the nucleus and make sure the relative sizes of the atom and ion are accurate. Underneath the ion, label it as a cation or anion. (7 points)

23. Shown in the box to the left of the arrow (box A) is a sample of matter containing two different elements. In the empty box to the right of the arrow (box B), draw what it would look like if the matter in box A underwent a chemical change only. Do not introduce any more elements. (3 points)

24. This question is extra credit. Answer the following questions about the linear scale shown below. (2 points)

a. What is the size of the increment? $2^\circ C$

b. What is the family? $2^\circ S$

c. What is the temperature indicated by the thermometer? $37^\circ C$