Instructions:

This exam should have 25 questions. Each question is worth 4 points for a total of 100 points. A periodic table should follow this page.

Information:
Heat capacity of water = 1.00 cal/g°C
Symbols and names: The symbols and names of the elements, and their atomic numbers, are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org). Names have yet to be proposed for the most recently discovered elements (111-112) and for titanium-76, indium-115, and thallium-117. The common spellings are used here. The spelling of 'cesium' is the common spelling in the UK and elsewhere. The spelling of 'rubidium' is the American spelling.

Group labels: The numeric system (1-18) used here is the current IUPAC convention.

Atomic weights (mean relative masses): The atomic weights are those of the IUPAC 2001 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable isotopes and are represented by the element's longest-lived isotope.

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MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) In an electron-dot structure of an element, the dots are used to represent
   A) the electron arrangement.
   B) only the electrons that will participate in bond formation.
   C) all of the electrons in the atom.
   D) the electrons that the element will gain when it forms a compound.
   E) the valence electrons.

2) The number of dots in the electron dot structure of carbon is
   A) three.          B) one.          C) four.          D) five.          E) two.

3) In ionic compounds, ____ lose their valence electrons to form positively charged ____.
   A) metals, cations
   B) nonmetals, cations
   C) nonmetals, anions
   D) metals, anions
   E) metals, polyatomic ions

4) What is the symbol for the ion with 19 protons and 18 electrons?
   A) K\(^{-}\)                  B) K\(^{+}\)                  C) F\(^{-}\)                  D) F\(^{+}\)                  E) Ar\(^{+}\)

5) The correct formula for a compound formed from the elements Al and O is
   A) Al\(_2\)O.          B) Al\(_2\)O\(_3\).          C) AlO\(_3\).          D) Al\(_3\)O\(_2\).          E) AlO.

6) Which one of the following elements forms two or more ions with different ionic charges?
   A) O                  B) K                  C) Fe                  D) F                  E) Ca

7) Which of the following is the correct electron dot structure for CS\(_2\)?
   A) 
     :\(\ddots\)\(\ddots\)=C=\(\ddots\)\(\ddots\) :
   B) 
     :\(\ddots\)=C=\(\ddots\)\(\ddots\):
   C) 
     :\(\ddots\)=C=\(\ddots\)\(\ddots\):
   D) 
     :\(\ddots\)=C=\(\ddots\):
   E) 
     :\(\ddots\)=C=\(\ddots\)\(\ddots\):

8) Which of the following elements has the lowest electronegativity?
   A) Li                  B) F                  C) N                  D) O                  E) C
9) Ionic bonding is expected in which of these compounds?
   A) KF  B) OP₂  C) HF  D) Cl₂  E) H₂

10) Which of the following is an example of potential energy?
    A) riding an exercise bike
    B) burning wood
    C) water stored in a reservoir
    D) a fan blade turning
    E) chewing food

11) How many calories are required to convert 16.5 g of ice at 0.0°C to liquid water at 32.0°C? The heat of fusion of water is 80.0 cal/g.
    A) 530 cal  B) 42,500 cal  C) 1850 cal  D) 80.0 cal  E) 1320 cal

12) Which of the following is a property of a solid?
    A) The particles move at a rapid rate.
    B) The particles have fixed positions and are very close together.
    C) It fills the volume of the container.
    D) It takes the shape of the container.
    E) The interactions between its particles are very weak.

13) The formation of a gas resulting from the escape of high-energy particles from the surface of a liquid is known as
    A) melting.
    B) sublimation.
    C) evaporation.
    D) boiling.
    E) deposition.

14) In order to calculate the total number of calories needed to melt 1 g of a solid and then convert it to a gas, you must know
    A) the heat of fusion and the specific heat of the substance.
    B) the specific heat and the heat of vaporization of the substance.
    C) the heat of fusion, the specific heat, and the heat of vaporization of the substance.
    D) the heat of fusion of the substance.
    E) the specific heat of the substance.

15) The heat of fusion for water is 80.0 cal/g, and the heat of vaporization of water is 540 cal/g. How many calories are required to convert 10.0 g of ice at 0°C to steam at 100°C?
    A) 620 cal  B) 5,400 cal  C) 7,200 cal  D) 6,200 cal  E) 720 cal
16) A heating curve illustrates
   A) what a substance looks like as it is heated.
   B) what happens to the particles of a substance as it is heated.
   C) the changes in the temperature and physical state of a substance as it is heated.
   D) the chemical changes that occur as the substance is heated.
   E) what happens to the heat applied as the temperature is increased.

17) The main interactions between molecules of hydrogen chloride are examples of
   A) covalent bonds.
   B) hydrogen bonds.
   C) dipole–dipole interactions.
   D) dispersion forces.
   E) ionic bonds.

18) Which of the following is an example of a physical change?
   A) grinding coffee beans
   B) burning coal
   C) digesting a cheeseburger
   D) baking a cake
   E) converting water to hydrogen and oxygen

19) Which of the following gives the balanced equation for this reaction?

   \[ K_3PO_4 + Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + KNO_3 \]

   A) \[ K_3PO_4 + Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + KNO_3 \]
   B) \[ K_3PO_4 + Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + 3KNO_3 \]
   C) \[ 2K_3PO_4 + 3Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + 6KNO_3 \]
   D) \[ KPO_4 + CaNO_3 + KNO_3 \]
   E) \[ 2K_3PO_4 + Ca(NO_3)_2 \rightarrow Ca_3(PO_4)_2 + 6KNO_3 \]
20) The following reaction takes place when an electric current is passed through water. It is an example of a _____ reaction.

\[ 2\text{H}_2\text{O} \xrightarrow{\text{electricity}} 2\text{H}_2 + \text{O}_2 \]

A) decomposition  
B) combination  
C) double replacement  
D) single replacement  
E) combustion

21) Which products would result from the double replacement reaction between MgCl\(_2\)(aq) and Na\(_2\)CO\(_3\)(aq)?

A) NaCl(aq) and Mg\(_2\)CO\(_3\)(s)  
B) Na\(_2\)Cl\(_2\)(aq) and MgCO\(_3\)(s)  
C) MgNa\(_2\)(aq) and CO\(_3\)Cl\(_2\)(aq)  
D) NaCl(aq) and MgCO\(_3\)(s)  
E) NaCl(aq) and Mg(CO\(_3\)\(_2\))(s)

22) What is oxidized and what is reduced in the following reaction?

\[ 2\text{Al} + 3\text{Br}_2 \xleftrightarrow{} 2\text{AlBr}_3 \]

A) AlBr\(_3\) is reduced and Al is oxidized.  
B) Al is oxidized and Br\(_2\) is reduced.  
C) AlBr\(_3\) is oxidized and Al is reduced.  
D) AlBr\(_3\) is reduced and Br\(_2\) is oxidized.  
E) Al is reduced and Br\(_2\) is oxidized.

23) Which of the following describes an oxidation?

A) gain of electrons or gain of oxygen  
B) loss of electrons or gain of oxygen  
C) gain of electrons or loss of H  
D) loss of electrons or loss of oxygen  
E) loss of electrons or gain of hydrogen
24) For the following equilibrium reaction, which cause and effect are correctly matched?

\[ \text{CO(g)} + 2\text{H}_2(\text{g}) \leftrightarrow \text{CH}_3\text{OH(g)} + \text{heat} \]

A) remove \( \text{CH}_3\text{OH} \), shift left
B) remove \( \text{H}_2 \), shift left
C) add \( \text{CO} \), shift left
D) add heat, shift right
E) remove heat, no change

25) To make a chemical reaction occur, the activation energy is the energy that

A) must be released from the mixture.
B) activates the catalyst.
C) is the difference in the energies of the starting materials and products.
D) must be removed from the mixture.
E) initiates the reaction.