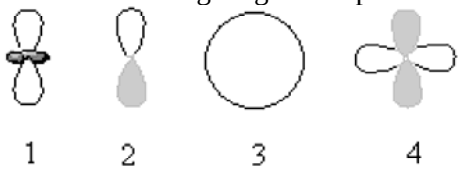
Name: _____ **Class:** _____ **Date:** _____ **ID: E**

Exam 2

Multiple Choice
Identify the choice that best completes the statement or answers the question.
Record your name on the top of this exam and on the scantron form.
Record the test ID letter in the top right box of the scantron form.
Record all of your answers on the scantron form.

1. An argon ion laser emits light at 457.9 nm. What is the frequency of this radiation?
   a. $4.338 \times 10^{-19}\ s^{-1}$
   b. $1.527 \times 10^{-15}\ s^{-1}$
   c. $1.373 \times 10^{11}\ s^{-1}$
   d. $6.547 \times 10^{14}\ s^{-1}$
   e. $2.305 \times 10^{18}\ s^{-1}$

2. Which of the following diagrams represent *d*-orbitals?



   a. 1 only
   b. 2 only
   c. 3 only
   d. 4 only
   e. 1 and 4

3. For a hydrogen atom, calculate the energy of a photon in the Balmer series that results from the transition $n = 3$ to $n = 2$.
   a. 3.03×10^{-19} J
   b. 3.63×10^{-19} J
   c. 4.36×10^{-19} J
   d. 2.18×10^{-18} J
   e. 1.09×10^{-17} J

4. All of the following sets of quantum numbers are allowed EXCEPT
   a. $n = 1, \ell = 0, m_\ell = 0$
   b. $n = 3, \ell = 2, m_\ell = +2$
   c. $n = 4, \ell = 3, m_\ell = -1$
   d. $n = 5, \ell = 5, m_\ell = -4$

5. If the same amount of energy in the form of heat is added to 5.00 g samples of each of the metals below, which metal will undergo the largest temperature change?

Metal	Specific Heat Capacity (J/g·K)
Ag	0.235
Al	0.897
Cu	0.385
Fe	0.449
Mg	1.017

   a. Ag
   b. Al
   c. Cu
   d. Fe
   e. Mg

6. Which one of the following statements is INCORRECT?
   a. Energy is neither created nor destroyed in chemical reactions.
   b. Potential energy is the energy associated with motion.
   c. Endothermic processes transfer heat from the surroundings into the system.
   d. Increasing the thermal energy of a gas increases the motion of its atoms.

7. According to the Bohr model for the hydrogen atom, the energy necessary to excite an electron from $n = 4$ to $n = 5$ is ____ the energy necessary to excite an electron from $n = 3$ to $n = 4$.
   a. less than
   b. greater than
   c. equal to
   d. either equal to or greater than
   e. either less than or equal to

8. Which of the following statements is/are CORRECT?
   1. A system is defined as an object or collection of objects being studied.
   2. Surroundings are defined as everything outside of the system being studied.
   3. In an exothermic reaction, heat is transferred from the system to the surroundings.

   a. 1 only
   b. 2 only
   c. 3 only
   d. 1 and 3
   e. 1, 2, and 3

9. Which of the following regions of the electromagnetic spectrum has the longest wavelength?
   a. ultraviolet
   b. x-ray
   c. radio
   d. visible
   e. gamma ray

10. What mass of iron can be produced from the reaction of 175 kg Fe_2O_3 with 385 kg CO?

    $Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$

    a. 2.19 kg
    b. 30.6 kg
    c. 61.2 kg
    d. 122 kg
    e. 512 kg

11. Ice at 0.0 °C is used to cool water. What is the minimum mass of ice required to cool 325 g of water from 30.5 °C to 4.0 °C? (Heat of fusion = 333 J/g; specific heat capacities: ice = 2.06 J/g·K, liquid water = 4.184 J/g·K)

    a. 108 g
    b. 125 g
    c. 325 g
    d. 605 g
    e. 1.75×10^4 g

12. The ____ of a photon of light is ____ proportional to its frequency and ____ proportional to its wavelength.

    a. energy, directly, inversely
    b. energy, inversely, directly
    c. velocity, directly, inversely
    d. intensity, inversely, directly
    e. amplitude, directly, inversely

13. Which of the following properties is associated with the value of the ℓ quantum number?

    a. the shape of an orbital
    b. the size of an orbital
    c. the number of electrons in an orbital
    d. the energy of an orbital
    e. the orientation in space of an orbital

14. Which one of the following statements is CORRECT?

    a. The larger the heat capacity of an object, the more thermal energy it can store.
    b. Specific heat capacity is a positive value for liquids and a negative value for solids.
    c. When heat is transferred from the surroundings to the system, q is negative.
    d. Heat is transferred from the system to the surroundings in an endothermic process.

15. One statement of the first law of thermodynamics is that
    a. the amount of work done on a system is dependent of pathway.
    b. the total work done on a system must equal the heat absorbed by the system.
    c. the total work done on a system is equal in magnitude, but opposite in sign of the heat absorbed by the system.
    d. the total energy change for a system is equal to the sum of the heat transferred to or from the system and the work done by or on the system.

16. Determine $\Delta_r H$ for the following reaction,

    $4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$

    given the thermochemical equations below.

    $N_2(g) + O_2(g) \rightarrow 2\ NO(g)$ $\Delta_r H° = +180.8$ kJ
    $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$ $\Delta_r H° = -91.8$ kJ
    $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$ $\Delta_r H° = -483.6$ kJ

    a. –1272.8 kJ
    b. –905.6 kJ
    c. –394.6 kJ
    d. –211.0 kJ
    e. +1272.8 kJ

17. A chemical reaction in a bomb calorimeter evolves 4.66 kJ of heat. If the heat capacity of the calorimeter is 1.38 kJ/°C, what is the temperature change of the calorimeter?
    a. 0.296 °C
    b. 3.28 °C
    c. 3.38 °C
    d. 6.04 °C
    e. 6.43 °C

18. For a neutron (mass = 1.675×10^{-27} kg) moving with a velocity of 3.10×10^4 m/s, what is the de Broglie wavelength (in pm)?
    a. 0.128 pm
    b. 1.23 pm
    c. 12.8 pm
    d. 78.4 pm
    e. 123 pm

19. Which of the following statements is INCORRECT?
    a. It is not possible to know the exact location of an electron and its exact energy simultaneously.
    b. The energies of an atom's electrons are quantized.
    c. Quantum numbers define the energy states and the orbitals available to an electron.
    d. The behavior of an atom's electrons can be described by circular orbits around a nucleus.

20. What is the oxidation number of each atom in sodium phosphate, $NaHCO_3$?
    a. Na = +1, H = +1, C = –4, O = –2
    b. Na = +1, H = +1, C = +4, O = –2
    c. Na = +1, H = +1, C = –4, O = +2
    d. Na = –1, H = +1, C = +4, O = –2
    e. Na = 0, H=0, C = 0, O = 0

21. Which of the following chemical equations show oxidation-reduction reactions?
    1. $Mg(s) + I_2(aq) \rightarrow MgI_2(s)$
    2. $Pb(ClO_4)_2(aq) + 2\ KI(aq) \rightarrow PbI_2(s) + 2\ KClO_4(aq)$
    3. $Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$

    a. 1 only
    b. 2 only
    c. 1 and 2
    d. 1 and 3
    e. 2 and 3

22. Which of the following chemical equations does not correspond to a standard molar enthalpy of formation?
    a. $Ca(s) + C(s) + 3/2\ O_2(g) \rightarrow CaCO_3(s)$
    b. $C(s) + O_2(g) \rightarrow CO_2(g)$
    c. $NO(g) + 1/2\ O_2(g) \rightarrow NO_2(g)$
    d. $N_2(g) + 2\ O_2(g) \rightarrow N_2O_4(g)$

23. Calculate $\Delta_r H°$ for the combustion of gaseous dimethyl ether,

$CH_3OCH_3(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 3\ H_2O(\ell)$

using standard molar enthalpies of formation.

molecule	$\Delta_f H°$ (kJ/mol)
$CH_3OCH_3(g)$	–184.1
$CO_2(g)$	–393.5
$H_2O(\ell)$	–285.8

a. –76.4 kJ
b. –495.2 kJ
c. –863.4 kJ
d. –1460.3 kJ
e. –1828.5 kJ

24. Which of the following sets of quantum numbers refers to a 4*d* orbital?
a. $n = 2, \ell = 1, m_\ell = -1$
b. $n = 2, \ell = 4, m_\ell = -1$
c. $n = 4, \ell = 2, m_\ell = -1$
d. $n = 4, \ell = 3, m_\ell = 0$
e. $n = 4, \ell = 3, m_\ell = +2$

25. Which type of experiment demonstrates that an electron has the properties of a wave?
a. nuclear fission
b. electron diffraction
c. light emission from atomic gases
d. mass spectroscopy
e. photoelectric effect

26. The thermochemical equation for the combustion of propane is shown below.

$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(\ell)$ $\Delta_r H° = -2220$ kJ/mol-rxn

What is the enthalpy change for the following reaction?

$6\ CO_2(g) + 8\ H_2O(\ell) \rightarrow 2\ C_3H_8(g) + 10\ O_2(g)$

a. -1.33×10^4 kJ
b. +2220 kJ
c. +370 kJ
d. +1110 kJ
e. +4440 kJ