

General Instructions: Read each question carefully and express your answers in the expected format, using proper English grammar and punctuation. Show *all* of your work for *all* calculation problems and include units on answers where appropriate. Express your answers in the correct number of significant figures. To speed calculations, round all atomic weights to one decimal place. Draw a box around your final answer.

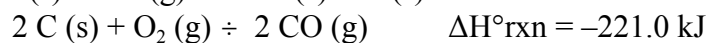
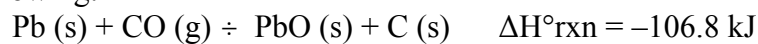
Part A. Definitions (2 points each). Define each term or differentiate between the pairs of terms.

1. Exothermic –
2. _____ is a property that does not depend on the amount of matter.
3. _____ is the lowest possible energy state for an atom.
4. Wavelength –
5. _____ is the basis for electrons spreading out in degenerate orbitals before spin-pairing.
6. _____ is the amount of pull an atom has on shared electrons.
7. p orbital –
8. Bond length –
9. Covalent vs. ionic bond –
10. Temperature vs. heat

Part B Short answer

11. A piece of metal with a mass of 6.625 g but of unknown specific heat was heated in a boiling water bath to a temperature of 99.7°C. The hot metal is added to 50.0 mL of water at a temperature of 22.3°C (d=0.9984 g/mL) and the temperature is observed to rise to 26.1°C. What is the specific heat of the metal? (6 points)

12. Given the following:



- What is the enthalpy change for the formation of PbO (s) from lead metal and oxygen gas? (4 points)

13. What is the frequency of UV light with a $\lambda=280 \text{ nm}$, used by biochemists to quantitate protein? (3 points)

14. According to the Bohr model, the electron moved around the nucleus only in certain allowed orbitals, according to the equation

$$E = -2.178 \times 10^{-18} \text{ J} \frac{Z^2}{n^2}$$

- Assuming this model were to work on all atoms, what energy is required to excite the 1s electron of carbon from the ground state to a 2p orbital? (5 points)

15. Give the electron configuration of the following species. (5 points)

A. Cl^-

B. C

C. Fe

D. Ga

E. Ca^{2+}

16. The alkali metal of period five is _____. (2 points)

17. Draw the Lewis dot structure of the following species and use them to predict the shape of the compound. Include all lone pairs in the structure. (6 points)

a. NF_3

b. HOBr

c. SO_3^{2-}

shape:

18. Draw all possible resonance structures of the nitrate ion. (6 points)

19. Calculate the formal charge of all atoms of ammonia. (3 points)

Part C. Multiple choice (2 points each) Place the *capital* letter of the *best* answer in the blank to the left of the answer.

- _____ 20. A gas absorbs 0.0 J of heat and then performs 15.2 J of work. The change in internal energy of the gas is
- a) -24.8 J
 - b) -15.2 J
 - c) 14.8 J
 - d) 55.2 J
 - e) none of these
- _____ 21. If 5.0 kJ of energy is added to a 10.0-g sample of water at 10.°C, the water is
- a) boiling.
 - b) completely vaporized.
 - c) frozen solid.
 - d) decomposed.
 - e) still a liquid.
- _____ 22. Two metals of equal mass with different heat capacities are subjected to the same amount of heat. Which undergoes the smallest change in temperature?
- a) The metal with the higher heat capacity.
 - b) The metal with the lower heat capacity.
 - c) Both undergo the same change in temperature.
 - d) You need to know the initial temperatures of the metals.
 - e) You need to know which metals you have.
- _____ 23. Which of the following properties is (are) intensive properties?
- | | | | |
|-------------------|-----------------|-------------|--|
| I. mass | II. temperature | III. volume | |
| IV. concentration | V. energy | | |
- a) I, III, and V
 - b) II only
 - c) II and IV
 - d) III and IV
 - e) I and V
- _____ 24. In the lab, you mix two solutions (each originally at the same temperature) and the temperature of the resulting solution decreases. Which of the following is true?
- a) The chemical reaction is releasing energy.
 - b) The energy released is equal to $s \times m \times T$.
 - c) The chemical reaction is absorbing energy.
 - d) The chemical reaction is exothermic.
 - e) More than one of these.

- _____ 25. If a student performs an endothermic reaction in a calorimeter, how does the calculated value of ΔH differ from the actual value if the heat exchanged with the calorimeter is not taken into account?
- ΔH_{calc} would be more negative because the calorimeter always absorbs heat from the reaction.
 - ΔH_{calc} would be less negative because the calorimeter would absorb heat from the reaction.
 - ΔH_{calc} would be more positive because the reaction absorbs heat from the calorimeter.
 - ΔH_{calc} would be less positive because the reaction absorbs heat from the calorimeter.
 - ΔH_{calc} would equal the actual value because the calorimeter does not absorb heat.
- _____ 26. When ignited, a uranium compound burns with a green flame. The wavelength of the light given off by this flame is greater than that of
- red light.
 - infrared light.
 - radio waves.
 - ultraviolet light.
 - none of these
- _____ 27. Which form of electromagnetic radiation has the longest wavelengths?
- gamma rays
 - microwaves
 - radio waves
 - infrared radiation
 - x-rays
- _____ 28. In an investigation of the electronic absorption spectrum of a particular element, it is found that a photon having $\lambda = 500 \text{ nm}$ provides just enough energy to promote an electron from the second quantum level to the third. From this information, we can deduce
- the energy of the $n = 2$ level.
 - the energy of the $n = 3$ level.
 - the sum of the energies of $n = 2$ and $n = 3$.
 - the difference in energies between $n = 2$ and $n = 3$.
 - all of these
- _____ 29. Which of the following is incorrect?
- The importance of the equation $E = mc^2$ is that energy has mass.
 - Electromagnetic radiation can be thought of as a stream of particles called photons.
 - Energy can only occur in discrete units called quanta.
 - The energy of matter is not continuous and is actually quantized.
 - All of these are correct.

- _____30. For which of the following transitions does the light emitted have the longest wavelength?
- a) $n = 4$ to $n = 3$
 - b) $n = 4$ to $n = 2$
 - c) $n = 4$ to $n = 1$
 - d) $n = 3$ to $n = 2$
 - e) $n = 2$ to $n = 1$
- _____31. The number of orbitals having a given value of l is equal to
- a) $2l + 1$
 - b) $2n + 2$
 - c) $3l$
 - d) $l + m_l$
 - e) the number of lobes in each orbital
- _____32. Which of the following electron configurations are different from those expected?
- a) Ca
 - b) Sc
 - c) Ti
 - d) V
 - e) Cr
- _____33. Which of the following atoms or ions has 3 unpaired electrons?
- a) N
 - b) O
 - c) Al
 - d) S^{2-}
 - e) Zn^{2+}