

This exam consists of six pages. Make sure you have one of each. Print your name at the top of each page now. A seventh page contains a periodic chart and other information you may need. You may tear this sheet off and use it for scratch paper. Show your work on calculations, be sure to include units in the calculations, and give answers to the correct number of significant figures. You may use atomic weight values rounded to the nearest 0.1 amu.

**Page** **Points**

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

4 \_\_\_\_\_

5 \_\_\_\_\_

6 \_\_\_\_\_

**If anything confuses you or is not clear, raise your hand and ask!**

**Total** \_\_\_\_\_

Points

(3) 1. Name the following molecular compounds:

(a)  $P_2O_3$

(b)  $NI_3$

(c)  $PCl_5$

(3) 2. Give the empirical formula for the following ionic compounds:

(a) magnesium sulfide

(b) potassium phosphate

(c) sodium bicarbonate

(4) 3. What is the difference between a **molecular formula** and an **empirical formula**?

(2) 4. Give the name and chemical symbol for the four major constituents in a dry atmosphere.

(1) 5. Of the gases listed in question 4, which are **elements**?

(1) 6. Of the gases listed in question 4, which are **diatomic**?

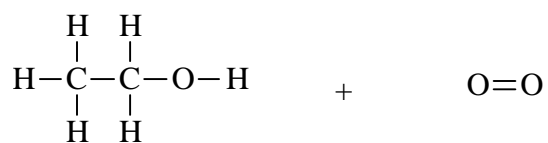
- (5) 7. Draw the Lewis dot structure for **ozone**. Explain where it is found in the atmosphere, and why it is a **pollutant** in one place and a **necessary component** in another.
- (3) 8. In each of the following pairs, circle the form of electromagnetic radiation that has the **longer wavelength**.
- (a) X-ray and ultraviolet
- (b) radio waves and visible
- (c) infrared and microwaves
9. Radiation of a wavelength of 220 nm is said to have enough energy to break a chemical bond. Calculate: ( $h = 6.63 \times 10^{-34} \text{ Js}$ ;  $c = 3.00 \times 10^8 \text{ ms}^{-1}$ ;  $E = h\nu$ ;  $\lambda\nu = c$ )
- (3) (a) The energy in Joules of a photon of this wavelength.
- (2) (b) The energy of a **mole of photons** of this wavelength. ( $N = 6.02 \times 10^{23} \text{ entities/mole}$ )
- (2) 10. Of the following forms of electromagnetic radiation, circle those forms with enough energy per photon to break a chemical bond:
- microwave, ultraviolet, infrared, X-ray
- (4) 11. Draw Lewis dot structures for  $\text{CO}_2$  and  $\text{SO}_2$ . What is the **molecular geometry** of each?

12. One gallon of octane,  $C_8H_{18}$ , has a mass of 2620 g. The heat of combustion of  $C_8H_{18}$  is 47.8 kJ/g.

- (2) (a) Write the balanced equation for the combustion of octane.
- (3) (b) Calculate the **moles of  $CO_2$**  produced by burning one gallon of octane. (Hint: first calculate the moles of octane in one gallon, or 2620 g.)
- (3) (c) If a car using octane is driven 15,000 miles in one year and gets 25 miles to the gallon of octane, what is the total energy consumption in one year by the car (in kJ)?

13. Ethyl alcohol ( $C_2H_5OH$ ) is suggested as an alternative fuel to gasoline.

- (2) (a) Complete and balance the following equation for combustion of ethyl alcohol, giving Lewis structures for the products:



- (3) (b) Using the bond energies on the last page, calculate the energy produced in the combustion of **one mole** of ethanol according to the equation in part (a).
- (3) (c) What are the **advantages** and **disadvantages** of using ethyl alcohol as a fuel as compared to gasoline?

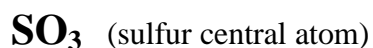
- (3) 14. Circle the following compounds that can form hydrogen bonds between the molecules of the compound:



- (4) 15. For each of the following **pairs** of bonds, draw an arrow indicating the direction of polarity of the bond, and **circle** the bond that will be the **more polar** of the two in the pair.

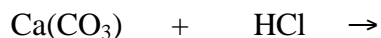


- (4) 16. For the following molecular substances, draw a correct **Lewis dot structure**, indicate the **molecular geometry**, and use an **arrow** to indicate the direction of polarity of each polar bond in the molecule. Indicate whether the overall molecule will be **polar** or **non-polar**.



- (4) 17. Why is sea water unfit to drink, and what type of purification steps are necessary to make it fit?

- (3) 18. Complete and balance the following acid-base reactions:



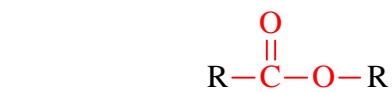
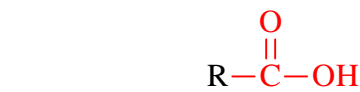
- (5) 19. Potassium phosphate ( $K_3PO_4$ ) completely dissociates in aqueous solution into potassium ions and phosphate ions. If you prepare a solution containing 2.25 g of potassium phosphate in 250.0 mL of solution, what will be the final molar concentration of potassium ions,  $[K^+]$ ?
- (4) 20. Give the **Arrhenius** and **Bronsted-Lowry** definitions of a base:
- Arrhenius base
- Bronsted-Lowry base
- (3) 21. Calculate the  $[H^+]$  and  $[OH^-]$  of a solution which has a pH of 5.36. Is it **acidic** or **basic**? ( $K_w = 10^{-14}$ )
- (2) 22. Calculate the pH of a solution in which  $[H^+] = 3.7 \times 10^{-9}$ . Is it **acidic** or **basic**?
- (5) 23. CaO (lime) reacts with water to form  $Ca(OH)_2$ , which completely dissociates into  $Ca^{2+}$  and  $OH^-$  ions. If you dissolve 0.75 g of CaO in 225 mL of water, what will be the final  $[OH^-]$  and the pH?

24. Uranium-238 undergoes alpha decay to form thorium-234, which subsequently undergoes beta decay.

(2) (a) Write the nuclear reaction describing the alpha decay of uranium-238.

(2) (b) Write the nuclear reaction describing the subsequent beta decay of thorium-234, identifying the products of that decay.

(6) 25. Identify the following functional groups by filling in the blank to the left of the structure with one of the names from the key list at the right:

**Key List:**

alcohol  
aldehyde  
amide  
amine  
benzene ring  
carboxylic acid  
ester  
ether  
ketone

(4) 26. Associate the following statements with a drug from the key list at the right by placing the name of the drug in the blank to the left of the statement.

\_\_\_\_\_ Described by Hippocrates as a tea from the willow bark effective against fevers, this current over-the-counter drug is used to treat both fevers and pain.

\_\_\_\_\_ A sedative used in Europe, but not approved in the United States, which was subsequently found to be a **teratogen**, damaging developing embryos.

\_\_\_\_\_ Discovered accidentally by Alexander Fleming, this drug was one of the early effective antibiotics.

\_\_\_\_\_ Obtained from a tree growing in the Andies at an elevation of 5000 feet, this drug effectively treats malaria, one of the most lethal diseases world-wide.

**Key List:**

aspirin  
ibuprofen  
lovastatin  
morphine  
norethynodrel  
penicillin  
progesterone  
pseudoephedrine  
quinine  
taxol  
thalidomide