

NAME (please print clearly) \_\_\_\_\_

**Instructions:** First print your full name clearly at the top of **each sheet** of this examination. Answer all questions and show all work and calculations in the spaces provided on these sheets. Use the blank page on the back of the previous sheet for any scratch work and calculations. Please do not make any marks on the periodic table. Always take time to think before you write.

You must show all work and the reasoning used to solve problems on this examination. No credit will be given for correct answers without any reasoning or calculations shown. Partial credit will be given for any correct reasoning, even if the answers are wrong. A problem set up correctly, but with no calculations done, will receive partial credit.

Report all numerical answers (in any section) with the correct number of significant figures.

This examination is administered under the standards and expectations of Barnard's Honor Code.

**The examination begins at 9:00 and ends at 10:25 exactly.**

**Total time: 85 minutes**

**Number of pages: 6**

**Number of questions: 5**

**Total points: 125**

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### DATA

Use the periodic table, provided on a separate sheet, to find atomic weights.

Please do not make any marks whatsoever on this periodic table. We want to reuse them.

#### Numerical values of constants and conversion factors:

Avogadro's number  $N_A = 6.0221415 \times 10^{23}$  particles/mole

$T(K) = t(^{\circ}C) + 273.15$

$1\text{ L} = 1000\text{ mL}$

$1\text{ mL} = 1\text{ cm}^3$

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#### Credit:

Question 1 \_\_\_\_\_ / 25

Question 2 \_\_\_\_\_ / 22

Question 3 \_\_\_\_\_ / 27

Question 4 \_\_\_\_\_ / 27

Question 5 \_\_\_\_\_ / 24

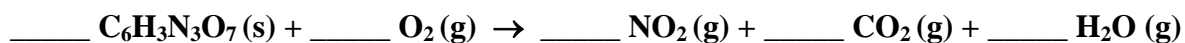
TOTAL \_\_\_\_\_ / 125

Question 1 (25 points)

NAME \_\_\_\_\_

Picric acid,  $C_6H_3N_3O_7(s)$ , can explode in air, forming  $NO_2(g)$ ,  $CO_2(g)$ , and  $H_2O(g)$ .

a) (4) Balance the chemical reaction for the explosion:



b) (4) A glass bulb is evacuated and weighed. Oxygen ( $O_2$ ) gas is added, and the bulb reweighed. The empty bulb weighed 44.118 g, and the filled bulb 50.153 g. How many moles of  $O_2(g)$  are present?

c) (7) 6.00 grams of picric acid is added to the container. Which will be the limiting reagent in the explosion?

d) (10) Based on the amounts given in parts b and c, how many moles each of the following are present after the explosion goes to completion?

moles  $C_6H_3N_3O_7(s)$  \_\_\_\_\_ moles  $O_2(g)$  \_\_\_\_\_

moles  $NO_2(g)$  \_\_\_\_\_ moles  $CO_2(g)$  \_\_\_\_\_

moles  $H_2O(g)$  \_\_\_\_\_

Calculations:

Question 2 (22 points)

NAME \_\_\_\_\_

A drug used in the treatment of AIDS is azidothymidine, or AZT. Elemental analysis of AZT shows that it contains the following percents by weight: C (45.11%), N (26.30%), O (24.04%), and the rest H.

a) (19) What is the empirical formula of AZT?

b) (3) It is determined that the molecular weight of AZT is approximately 270. What is the molecular formula of AZT?

Question 3 (27 points)

NAME \_\_\_\_\_

Specify the total number of valence electrons and write the Lewis electron dot structure for each of the following. If there are multiple resonance structures, include them. Specify the *molecular* geometry, including approximate angles. Finally, indicate whether the molecule is polar. In each case, the first atom listed is in the center, the others bound to it.

a)  $\text{ICl}_4^-$  # valence electrons: \_\_\_\_\_

molecular geometry: \_\_\_\_\_

polar? \_\_\_\_\_

Cl-I-Cl angle: \_\_\_\_\_

b) bromate:  $\text{BrO}_3^-$  # valence electrons: \_\_\_\_\_

molecular geometry: \_\_\_\_\_

polar? \_\_\_\_\_

O-Br-O angle: \_\_\_\_\_

c) nitrite:  $\text{NO}_2^-$  # valence electrons: \_\_\_\_\_

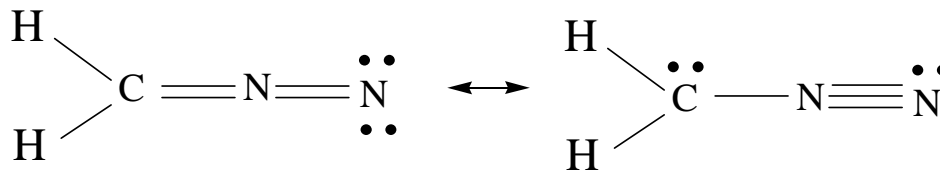
molecular geometry: \_\_\_\_\_

polar? \_\_\_\_\_

O-N-O angle: \_\_\_\_\_

Question 4 (27 points)

NAME \_\_\_\_\_

*The three parts of this question are not related to each other*A) (10 points) Resonance structures for diazomethane,  $\text{CH}_2\text{N}_2$  are

Label each atom in each structure with its formal charge.

What would you predict for the approximate bond order of the N-N bond? Why?

B) (12 points) Nanoscience is in the news: the science dealing with structures whose dimensions are on the order of nanometers ( $10^{-9}$  m). Consider a cube of gold with length 15 nm. If the density of gold is 19.3 g/mL, what mass of gold is in the cube? How many gold atoms are present?

C) (5 points) In an imaginary world the element Bo (Bogusium) has two isotopes.

$^{14}\text{Bo}$  weighs 13.976532 with natural abundance 56.45%, and  $^{16}\text{Bo}$  weighs 15.995432 with natural abundance 43.55%. Calculate the atomic weight of Bo.

Question 5 (24 points)

NAME \_\_\_\_\_

*The two parts of this question are not related to each other.*

A. (12) Complete the blank entries in the list of chemical formulas and compound names below. Indicate whether each compound is ionic or molecular by circling I or M.

CHEMICAL FORMULA	COMPOUND NAME	IONIC or MOLECULAR	
MgI <sub>2</sub>	_____	I	M
SO <sub>3</sub>	_____	I	M
PCl <sub>5</sub>	_____	I	M
NH <sub>4</sub> NO <sub>2</sub>	_____	I	M
_____	Calcium phosphate	I	M
_____	Carbon disulfide	I	M
_____	Potassium sulfite	I	M
_____	Lead (II) hydroxide	I	M

B. (12) Explain the following observations. Use complete sentences. Chemical equations may be helpful in some cases.

a) Alkali metals form +1 cations exclusively (never +2 or +3).

b) CaO(s) mixed with water makes a basic solution.

c) Aqueous solutions containing transition metal ions are frequently colored.