

Chemistry 1110
Fall 2001
Test #3

Thursday, November 22, 2001

Time: 1 hour 50 minutes

Name: _____

Student Number: _____

*This test consists of **five** pages of questions, a sheet containing useful formulae and constants, and a periodic table. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. Good luck!*

1) **[4 marks total]** The first ionization potential of sodium is 495.8 kJ/mol.

a) **[3 marks]** What frequency of light will ionize sodium?

b) **[1 mark]** Is this light visible? If so, what colour is it? If not, to what region of the spectrum does it belong?

2) **[3 marks]** EGSM (Fido and Cantel) cellular phones operate at an approximate frequency of 1.90 GHz. The phone transmits its signal with an approximate power of 0.2 J/s. How long will it take the phone to generate 1×10^{30} photons?

3) [4 marks] When ionizing from an initial $n=3$, the ionization potential for F^{8+} is exactly 20.25 times the ionization potential of a different hydrogen-like ion being ionized from $n=6$. What is the identity of the other hydrogen-like ion? Include the charge.

4) [4 marks] Which of the following quantum numbers are not possible? Why?

n	ℓ	m_ℓ	m_s	reason (if impossible)
1	0	0	0	_____
3	2	3	-1/2	_____
5	5	5	-1/2	_____
7.5	6	5	+1/2	_____

5) [4 marks] How many:

- a) electrons have $n = 3$ in an atom of Xe? _____
- b) electrons may have $n = 3, \ell = 3$? _____
- c) electrons are there in the $\ell = 2$ subshell(s) of Zr? _____
- d) orbitals does the $n = 20$ shell contain? _____

6) [4 marks] Identify the atom or ion (*with charge*) that matches the following configurations.:

a) (no charge) $[\text{Ar}]4s^13d^{10}$, _____

b) (-2 charge) $[\text{Ne}]$, _____

c) (+3 charge) $[\text{Kr}]$, _____

d) (+1 charge) $[\text{Ar}]4s^1$, _____

7) [4 marks] Which of the following configurations correspond to ground state configurations for the indicated atom or ion? If the configurations given are not for the ground state, give the correct ground state configuration for the indicated atom or ion.

atom/ion	configuration	ground state configuration
Cl^-	$[\text{Ne}]3s^23d^6$	_____
Cr	$[\text{Ar}]4s^23d^4$	_____
Se	$[\text{Ar}]4s^24d^{10}4p^4$	_____
V^{3+}	$[\text{Ar}]4s^2$	_____

8) [4 marks] Suppose that, instead of the usual rules, the following were true:

$$n = 1 \dots \infty$$

$$l = 1 \dots n$$

$$m_l = -l \dots l$$

$$m_s = 0$$

What would be the names of the first two noble gases?

9) [10 marks] Circle the correct answer for each of the properties given below:

Smallest radius	N^{-3}	O^{-2}	F^{-}
Largest radius	Ne	Na^{+}	Mg^{+2}
Highest 1 st IP	O	N	Xe
Highest 2 nd IP	Na^{-}	Mg^{-}	Al^{-}
Most unpaired electrons	N^{-}	O^{-}	F^{-}
Largest atomic radius	Na	Ca	Y
Most electronegative	O	Cl	Kr
Impossible subshell designation	3f	4f	5f
Most paramagnetic	C	S	N
lowest E_a	K	Fe	Br

10) **[14 marks total]** Draw all possible resonance forms for the molecules or ions indicated below. In each case, circle any resonance forms that are especially unlikely and briefly indicate why they are unlikely. The central atom in each molecule is underlined and, if no atom is underlined, you may assume the atoms are drawn in the order they are attached. You must indicate both the formal charges on each atom and the lone pairs of electrons. None of these molecules or ions is cyclic.

a) **[5 marks]** NNO

b) **[4 marks]** NO_2^+

c) **[5 marks]** CNO^-

11) **[2 marks]** PF_5 exists. Does NF_5 ? If not, why not?

Useful formulae and some constants:

$$E_n = -2.179 \times 10^{-18} Z^2/n^2 \text{ J}$$

$$E = hc/\lambda = h\nu$$

$$h = 6.6260755 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$c = 2.99792458 \times 10^8 \text{ m/s}$$

$$N_a = 6.0221367 \times 10^{23} \text{ mol}^{-1}$$

$$1 \text{ nm} = 10^{-9} \text{ m}$$