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**UNIVERSITY OF VICTORIA**

**CHEMISTRY 101**  
**From Atoms to Materials**

**Midterm Test 1**  
**October 18, 2019**  
**6-7 pm**  
**ECS 123, BWC B150, DTB A120 or DTB A110**

**VERSION B**

Display your student ID card on your desk.

Do not begin until instructed by the invigilator.

Print and code your last name, first name, and your student ID number on the blue bubble sheet.

This test has 23 multiple choice questions on 6 pages.

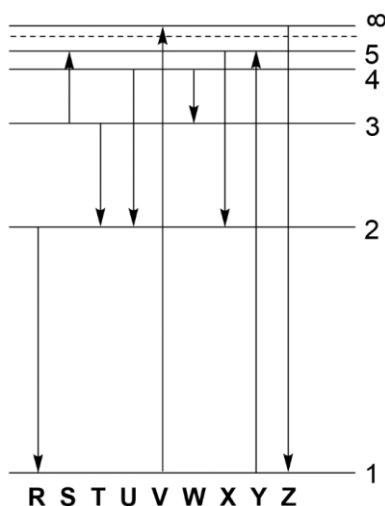
A Data Sheet is provided.

The Sharp EL510 is the only approved calculator for this test.

Select the best response for each question and record your answer on the blue bubble sheet.

Hand in the blue bubble sheet at the end of the test.

Below is the energy level diagram for an electron in a hydrogen atom (not to scale). Use it to answer the next two questions.



1. Which transition represents the combination of a proton and an electron to make a hydrogen atom?

**A**  
R

**B**  
V

**C**  
X

**D**  
Y

**E**  
Z

2. What is the frequency (in Hz) of the light involved in the transition marked W?

**A**  
 $3.65 \times 10^{14}$

**B**  
 $2.05 \times 10^{14}$

**C**  
 $2.74 \times 10^{14}$

**D**  
 $1.60 \times 10^{14}$

**E**  
 $2.30 \times 10^{16}$

3. What is the energy (in J) of an infrared photon with a wavelength of  $10.6 \mu\text{m}$ ?

**A**  
 $2.83 \times 10^{13}$

**B**  
 $1.88 \times 10^{-17}$

**C**  
 $1.88 \times 10^{-20}$

**D**  
 $7.02 \times 10^{-39}$

**E**  
 $3 \times 10^{-7}$

4. Calculate the uncertainty in the position (in pm) of a proton ( $1.67 \times 10^{-27}$  kg) moving at a speed of  $50000 \pm 1000 \text{ ms}^{-1}$ .

**A**  
3.15

**B**  
31.5

**C**  
97

**D**  
126

**E**  
390

5. What is the wavelength (in nm) of X-rays with a frequency of  $3 \times 10^{18} \text{ s}^{-1}$ ?

**A**  
100

**B**  
10

**C**  
1

**D**  
0.1

**E**  
0.001

6. Which type of light travels the fastest in a vacuum?

**A**  
Gamma rays

**B**  
Ultraviolet

**C**  
Green

**D**  
Radio

**E**  
All the same

7. Which of the following set of quantum numbers  $n$ ,  $\ell$ ,  $m_\ell$ ,  $m_s$  is **NOT** possible for a 3p electron?

**A**  
3, 0, 1,  $\frac{1}{2}$

**B**  
3, 1, 0,  $\frac{1}{2}$

**C**  
3, 1, -1,  $\frac{1}{2}$

**D**  
3, 1, 1,  $\frac{1}{2}$

**E**  
3, 1, 1,  $-\frac{1}{2}$

8. Which statement about the hydrogen atom is **INCORRECT**?

**A** the 2s and 2p orbitals have the same energy

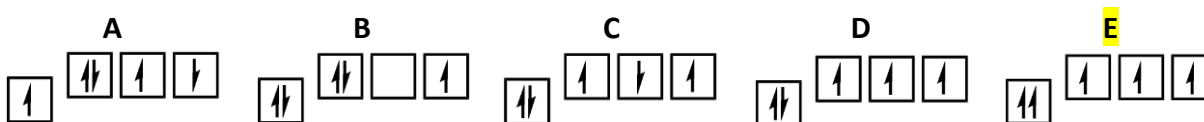
**B** the 4d orbitals are degenerate

**C** higher values of  $n$  correspond to higher energy orbitals

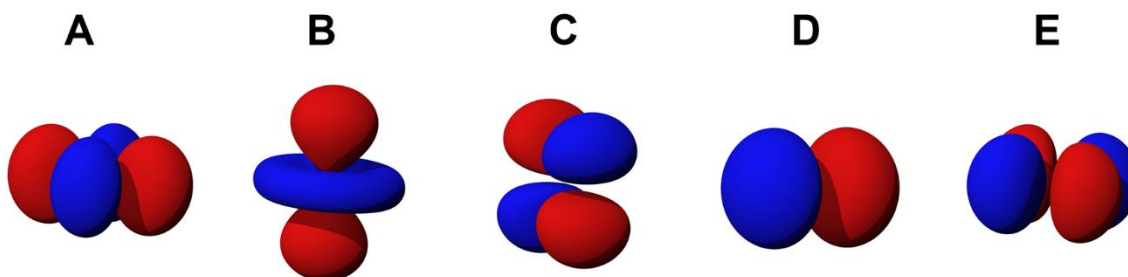
**D** the 2s orbital has one node

**E** the magnetic quantum number ( $m_\ell$ ) can have values from 0 to  $n-1$

9. Which of these electron configurations is forbidden?



10. Which of the shapes below represents an orbital that is NOT a d orbital? Answer D



11. How many electrons have  $n = 3$  and  $\ell = 2$  in a gallium (Ga) atom?

- A: 2  
 B: 4  
 C: 6  
 D: 8  
 E: 10

12. What ion has the ground state electron configuration  $[\text{Ar}] 3d^5$ ?

- A:  $\text{Cr}^{2+}$   
 B:  $\text{Mn}^{2+}$   
 C:  $\text{Fe}^{2+}$   
 D:  $\text{Co}^{2+}$   
 E:  $\text{Co}^{3+}$

13. A possible electron configuration of an electronically excited sulfur (S) atom can be represented by:

- A:  $[\text{Ne}] 3s^2 3p^3$   
 B:  $[\text{Ne}] 3s^2 3p^4$   
 C:  $[\text{Ne}] 3s^2 3p^5$   
 D:  $[\text{Ne}] 3s^1 3p^5$   
 E:  $[\text{Ne}] 3s^2 3p^4 4s^1$

14. Which of these anions is the smallest?

- A:  $\text{N}^{3-}$   
 B:  $\text{O}^{2-}$   
 C:  $\text{F}^-$   
 D:  $\text{S}^{2-}$   
 E:  $\text{Br}^-$

15. Which element has the largest FIRST ionization energy?

**A**  
Na

**B**  
Mg

**C**  
Al

**D**  
Cl

**E**  
Ar

16. In a standardization of a NaOH solution, 0.6712 g of potassium acid phthalate (KHP, molecular weight 204.23 g mol<sup>-1</sup>) react with 21.34 mL of NaOH (molecular weight 40.00 g mol<sup>-1</sup>) to reach the end point of the titration. How many moles of KHP reacted to reach the end point?

**A**  
 $1.540 \times 10^{-4}$

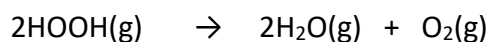
**B**  
 $1.678 \times 10^{-2}$

**C**  
 $3.145 \times 10^{-2}$

**D**  
 $3.286 \times 10^{-3}$

**E**  
0.9443

17. Use bond energies to calculate the energy (in kJ/mol) of the following reaction.



**A**  
-146

**B**  
-614

**C**  
-203

**D**  
203

**E**  
-1137

18. Which of the following molecules is expected to have the largest dipole moment?

**A**  
O<sub>2</sub>

**B**  
CO

**C**  
NO

**D**  
BF<sub>3</sub>

**E**  
BrCl

19. Which of the following ions is the most likely to be formed when antimony reacts with sodium?

**A**  
Sb<sup>2-</sup>

**B**  
Sb<sup>3-</sup>

**C**  
Sb<sup>-</sup>

**D**  
Sb<sup>2+</sup>

**E**  
Sb<sup>3+</sup>

20. How many pairs of bonding electrons (lines) are drawn in the best Lewis structure for  $[\text{CO}_3]^{2-}$ ?

**A**  
2

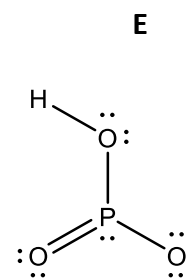
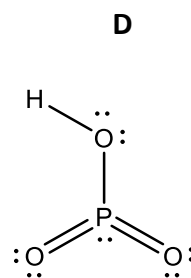
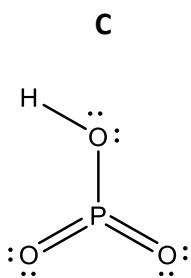
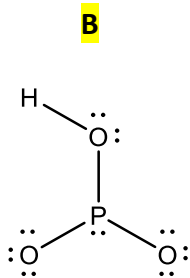
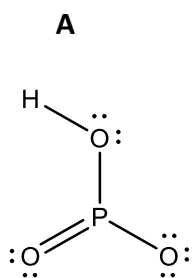
**B**  
3

**C**  
4

**D**  
5

**E**  
6

21. Which of the drawings below is the best Lewis structure for  $[\text{HPO}_3]^{2-}$ ?



22. How many lone pairs are drawn in the best Lewis structure for the cation  $[\text{ClF}_2]^+$ ?

**A**  
9

**B**  
7

**C**  
8

**D**  
6

**E**  
5

23. The volume of 0.13 M HCl required to neutralize a 120 mL sample of 0.52 M NaOH is:

**A**  
1.78 L

**B**  
0.811 mL

**C**  
33.3 L

**D**  
480 mL

**E**  
563 mL

END