Name: _____

INTRODUCTION TO QUANTUM MECHANICS

1. Define the terms:

electromagnetic radiation

wave

wavelength

frequency

amplitude

velocity

2. Write the equation that describes the mathematical relationship between wavelength and frequency using the standard symbol for each quantity.

3. Calculate the frequency of light which has a wavelength of 6.7×10^{-5} cm.

4. Define quantization. What is a quantum of matter? What is a quantum of light (radiant energy)?

5. Write the relationship between the energy of a photon of light and its frequency.

6. Calculate the energy of a photon of orange light with a frequency of $5.0 \times 10^{14}\ sec^{-1}$.

7. Calculate the energy of a mol of photons of orange light with a frequency of $5.0 \times 10^{14}\ sec^{-1}$.

8. Calculate the energy of a photon of light with a wavelength of 425 nm.

9. The energy required to break the oxygen-oxygen bond in O_2 is $496\ \frac{kJ}{mol}$. Calculate the minimum wavelength of light that can break the oxygen-oxygen bond.

10. List the postulates about the behavior in atoms that Bohr invoked to explain the occurrence of emission lines and their associated energies in the hydrogen spectrum.

11. Briefly describe the difference between the continuous model of matter and quantized view of matter.

12. Which color of light is higher energy, blue of red? Explain.

13. An argon laser emits light with a wavelength of 488 nm. Calculate the energy of a photon of light emitted from the laser.

14. Calculate the energy and the wavelength of light emitted when an electron in an excited hydrogen atom falls from the n = 5 level to the n = 1 level.

15. An electron initially in the n = 2 energy level in a hydrogen atom absorbs a photon of light with a frequency of $6.167 \times 10^{14}\ s^{-1}$. Calculate the new energy level the electron will occupy.

16. Will a photon of light of wavelength 480 nm excite an electron in the hydrogen atom from the n = 1 level to the n = 2 level? Explain.

17. Define the terms *excited state*, *ground state* and *ionization energy*.

18. Calculate the ionization energy for the hydrogen atom using the Bohr model.

19.What was the importance of De Broglie's postulate of the wave nature of matter?

20. Define the uncertainty principle and explain its importance.

21.What are the critical shortcomings of the Bohr model of the atom? How does the quantum mechanical description of the atom overcome these shortcomings.

22.Define the term *orbital*.

23. Define the three quantum numbers, principal, azimuthal and magnetic using mathematical relationships. How are these quantum numbers related to the terms shell, subshell and orbital?

24.How are these quantum numbers related to energy, shape and orientation of the electron?

25. Prepare a table of the possible sets of quantum numbers for an electron in the $n = 1$, 2, 3 and 4 levels.

Principle quantum # n	Azimuthal quantum # l	Magnetic quantum # m_l

26. Which of the following combinations of quantum numbers is allowed for an electron in a hydrogen atom?

i) $n = 2; l = 2; m_i = 0$

ii) $n = 3; l = 1; m_i = -1$

iii) $n = 5; l = 0; m_i = +1$

iv) $n = 1; l = 0; m_i = 0$

27. How many orbitals are available with the following combination of quantum numbers?

i) $n = 2; l = 0$

ii) $n = 3; l = 2$

iii) $n = 4; l = 3$

28. What is the subshell designation for an electron with the following set quantum numbers?

(i) $n = 1; l = 0$

(ii) $n = 3; l = 2; m_l = -1$

(iii) $n = 4; l = 3$

(iv) $n = 2; l = 0; m_l = 0$

29. What is the maximum number of electrons in a

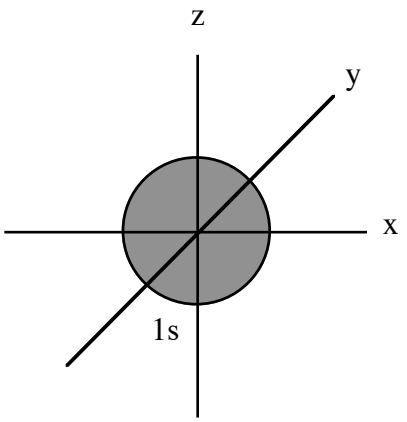
i) *2s* subshell

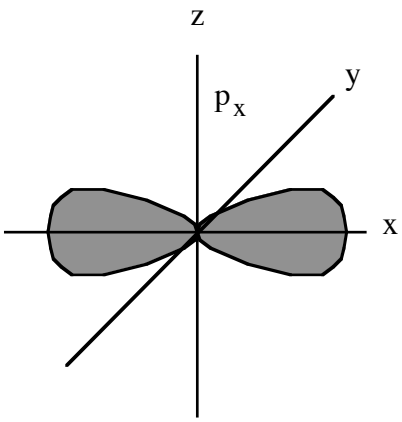
ii) *3d* subshell

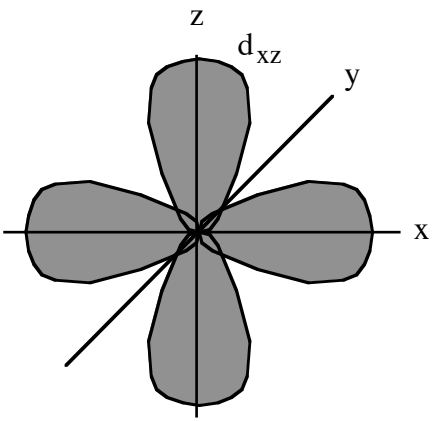
iii) $n = 4$ shell

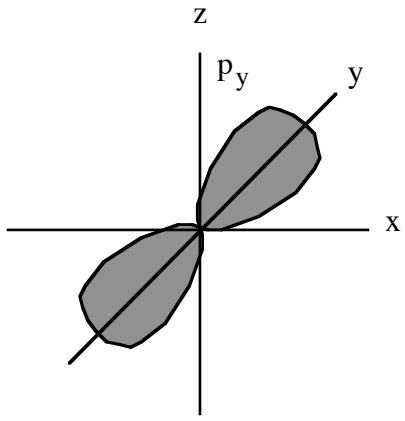
iv) *2p* orbital

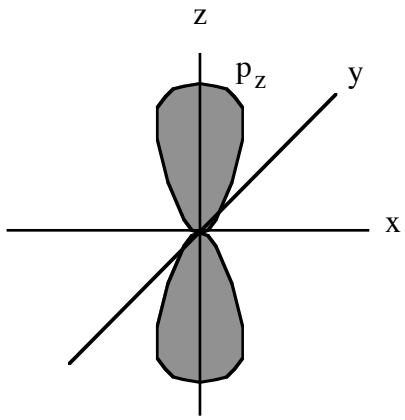
31. Draw the contour representation that depicts the shape of an *s* orbital, a p_x, p_y, p_z, orbital and a d_{xz} orbital. **See Appendix III for recommended demonstration, video, or computer resources.**











32.How does the contour representation of a *1s* orbital differ from that of a *2s* orbital?

The *2s* orbital is larger than the *1s* orbital. The *2s* orbital also contains a node which is not present in the *1s* orbital.