

Test CHAPTER 6 AP Chemistry

MC. 1pt each

1. Which one of the following types of radiation has the shortest wavelength, the greatest energy AND the highest frequency?
- a) ultraviolet radiation
  - b) infrared radiation
  - c) visible red light
  - d) visible blue light
  - e) none because short wavelength is associated with low energy and low frequency, not high energy and high frequency
2. How many f orbitals have  $n = 3$ ?
- a) 0
  - b) 3
  - c) 5
  - d) 7
  - e) 1
3. From the following list of observations choose the one that most clearly supports the following conclusion: the electrons in atoms have quantized energies.
- a) Emission spectrum of hydrogen.
  - b) The photoelectric effect.
  - c) Scattering of alpha particles by metal foil.
  - d) Diffraction.
  - e) Cathode "rays."
4. Ti has \_\_\_\_\_ in its d orbitals.
- a) 1 electron
  - b) 2 electrons
  - c) 3 electrons
  - d) 4 electrons
  - e) none of these
5. How many electrons can be contained in all of the orbitals with  $n = 4$ ,  $l = 3$ ,  $m_l = 0$ ?
- a) 2
  - b) 8
  - c) 10
  - d) 18
  - e) 32

6. Which of the following atoms or ions has 5 UNPAIRED electrons:
- a) N
  - b) O
  - c) Al
  - d)  $S^{2-}$
  - e)  $Zn^{2+}$
7. In which of the following groups do all the elements have the same number of valence electrons?
- a) P, S, Cl
  - b) Ag, Cd, Ar
  - c) Na, Ca, Ba
  - d) P, As, Se
  - e) none
8. When ignited, a uranium compound burns with a green flame. The wavelength of the light given off by this flame is greater than that of:
- a) red light
  - b) infrared light
  - c) radio waves
  - d) ultraviolet light
  - e) none of these
9. An atom of manganese has \_\_\_\_\_ unpaired electrons and is \_\_\_\_\_.
- A. 0, diamagnetic
  - B. 2, diamagnetic
  - C. 3, paramagnetic
  - D. 5, paramagnetic
  - E. 7, paramagnetic
10. Which of the following would be the electron configuration of an excited state of an oxygen atom?
- A.  $1s^2 2s^2 2p^4$
  - B.  $1s^2 2s^2 2p^5$
  - C.  $1s^2 2s^2 2p^3 3s^1$
  - D.  $1s^2 2s^2 2p^6$
  - E.  $1s^2 2s^2 2p^3$

11. Consider the portion of the energy-level diagram for hydrogen given below.

n = 4	-0.1361	$\times 10^{-18}$	J	↑ ENERGY
n = 3	-0.2420	$\times 10^{-18}$	J	
n = 2	-0.5445	$\times 10^{-18}$	J	
n = 1	-2.178	$\times 10^{-18}$	J	

For which of the following transitions does the light emitted have the longest wavelength?

- a) n = 4 to n = 3  
b) n = 4 to n = 2  
c) n = 4 to n = 1  
d) n = 3 to n = 2  
e) n = 2 to n = 1
12. The valence electron configuration of phosphorus is
- a)  $1s^2 2s^2 2p^6 3s^2 3p^3$   
b)  $1s^2 2s^2 2p^3$   
c)  $2s^2 2p^3$   
d)  $3s^2 3p^3$   
e) none of these
13. In an investigation of the electronic absorption spectrum of a particular element, it is found that a photon having  $\lambda = 500$  nm provides just enough energy to promote an electron from the second quantum level to the third. From this information, we can deduce
- a) the energy of the n = 2 level.  
b) the energy of the n = 3 level.  
c) the sum of the energies of n = 2 and n = 3.  
d) the difference in energies between n = 2 and n = 3.  
e) all of the above.
14. How many electrons in an atom can have the quantum numbers n = 3, l = 2?
- a) 2  
b) 5  
c) 10  
d) 18  
e) 6

15. A possible set of quantum numbers for the last electron added to complete an atom of germanium in its ground state is

n	l	$m_l$	$m_s$
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- A. 4 0 0 + 1/2
- B. 3 0 +1 - 1/2
- C. 4 1 -1 + 1/2
- D. 3 1 +1 - 1/2
- E. 4 2 +2 - 1/2

16. Electrons in an orbital with  $l = 3$  are in a/an

- A. d orbital.
- B. f orbital.
- C. g orbital.
- D. p orbital.
- E. s orbital.

17. The maximum number of electrons in an atom with the following set of quantum numbers is

$$n = 4 \quad l = +3 \quad m_l = -2 \quad m_s = + 1/2$$

- A. 0
- B. 1
- C. 2
- D. 6
- E. 10

18. When a hydrogen electron makes a transition from  $n = 3$  to  $n = 1$ , which of the following statements are true?

1. Energy is emitted.
2. Energy is absorbed.
3. The electron loses energy.
4. The electron gains energy.
5. The electron cannot make this transition.

- a) 1, 4
- b) 1, 3
- c) 2, 3
- d) 2, 4
- e) 5

19. An atom of fluorine contains 9 electrons. How many of these electrons are in s orbitals?

- a) 2
- b) 4
- c) 6
- d) 8
- e) none

20. Fe has \_\_\_\_\_ that is(are) unpaired in its d orbitals.

- a) 1 electron
- b) 2 electrons
- c) 3 electrons
- d) 4 electrons
- e) none of these

21. Which of the following combinations of quantum numbers do NOT represent permissible solutions of the Schroedinger equation for the electron in the hydrogen atom [i.e., which combination of quantum numbers is NOT allowed]?

- |    | n | l  | m  | s (or m <sub>s</sub> ) |
|----|---|----|----|------------------------|
| a) | 9 | 8  | -4 | 1/2                    |
| b) | 8 | 2  | 2  | 1/2                    |
| c) | 6 | -5 | -1 | 1/2                    |
| d) | 6 | 5  | -5 | 1/2                    |
- e) all are allowed

22. The electron configuration of an element with atomic number 109 should be:

- a) [Rn]7s<sup>2</sup>5f<sup>14</sup>6d<sup>7</sup>
- b) [Rn]7s<sup>2</sup>6f<sup>14</sup>6d<sup>1</sup>7p<sup>6</sup>
- c) [Rn]8s<sup>2</sup>7f<sup>14</sup>6d<sup>7</sup>
- d) [Xe]7s<sup>2</sup>5f<sup>14</sup>6d<sup>7</sup>
- e) [Rn]7s<sup>2</sup>6d<sup>7</sup>

23. Of the following types of radiation, how many have energies greater than that of visible blue light?

visible green	ultraviolet
infrared	x-rays
visible red	

- a) 0
- b) 1
- c) 2
- d) 3
- e) 4

24. How many electrons can be described by the quantum numbers  $n = 3$ ,  $l = 3$ ,  $m_l = 1$ ?

- a) 0
- b) 2
- c) 6
- d) 10
- e) 14

25. From the following list of observations choose the one that most clearly supports the following conclusion: most of the mass of the atom is located in the nucleus.

- a) Emission spectrum of hydrogen.
- b) The photoelectric effect.
- c) Scattering of alpha particles by metal foil.
- d) Diffraction.
- e) Cathode "rays."

26. Given the energy-level diagram for the energy levels in the H atom as shown, select the true statement.

↑ e n e r g y		$n = \infty$	a) A transition from $n = 5$ to $n = 3$ involves greater energy than one from $n = 4$ to $n = 2$ .  b) A transition from $n = 4$ to $n = 2$ will emit radiation of longer wavelength than one from $n = 5$ to $n = 1$ .  c) All transitions from states for which $n > 1$ to the $n = 1$ state involve the absorption of energy by the atom.  d) A transition from $n = 2$ to $n = \infty$ corresponds to the ionization energy of the H atom.  e) All (a through d) are false.
		$n = 6$	
		$n = 5$	
		$n = 4$	
		$n = 3$	
		$n = 2$	
	$n = 1$		

27. Which element has the following electron configuration?  
 $[Kr] 5s^2 4d^{10} 5p^3$

- A. Sn
- B. Sb
- C. Pb
- D. Bi
- E. Te

28. What is the electron configuration of calcium?

29. Give the core electron configuration for Ag.

30. Give the core orbital notation of indium.

31. Give the electron configuration of  $V^{3+}$ .

32. Give the core electron configuration of thallium (Tl).

33. Give the orbital notation of phosphorus.

34. Give the core orbital notation of Gallium (Ga).

35. Give the core electron configuration of  $Ni^{3+}$ .

36. Give the core orbital notation of  $Br^{-1}$ .

37. Give the electron dot notations for the following:  
a.  $Ra^{+2}$     b. Sb     $Te^{-2}$

38. Green light has a wavelength of  $5.50 \times 10^2$  nm. What is the energy of a photon of green light? (3pts)

39. What is the maximum wavelength of light capable of removing an electron from principal level  $n=2$  in a hydrogen atom? (3pts)

40. Calculate the wavelength of light emitted for the transition of an electron from  $n=4 \rightarrow n=2$  in a hydrogen atom. What form of radiation is this? (3pts)

41. Identify each of the following elements:

a. An excited state of this element has the electron configuration  $1s^2 2s^2 2p^4 3s^1$  (3pts)

b. The +3 ion of this element has a core electron configuration of  $[Kr] 5s^2 4d^{10}$

42. What is the energy in joules of a mole of photons associated with red light of wavelength  $7.00 \times 10^2$  nm? (3pts)

Answer the following questions regarding light and its interactions with molecules, atoms, and ions.

- a. The longest wavelength of light with enough energy to break the Cl-Cl bond in  $\text{Cl}_2$  (g) is 495 nm.
- Calculate the frequency, in  $\text{s}^{-1}$ , of the light.
  - Calculate the energy, in J, of a photon of the light.
  - Calculate the minimum energy, in  $\text{kJ mol}^{-1}$ , of the Cl-Cl bond.
- b. A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the sixth energy level ( $n = 6$ ) to the second energy level ( $n = 2$ ).
- Indicate whether the H atom emits energy or whether it absorbs energy during the transition. Justify your answer.
  - Calculate the wavelength, in nm, of the radiation associated with the spectral line.
  - Account for the observation that the amount of energy associated with the same electronic transition ( $n = 6$  to  $n = 2$ ) in the  $\text{He}^+$  ion is greater than that associated with the corresponding transition in the H atom.

6pts

4pts

2pts extra credit

Helpful

Equations &amp; Constants

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$R_H = 2.178 \times 10^{-18} \text{ J}$$

$$E = R_H \left( \frac{1}{n^2} \right)$$

$$E = R_H \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$$

# WebElements: the periodic table on the world-wide web

<http://www.webelements.com/>

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
hydrogen 1 <b>H</b> 1.0079																	helium 2 <b>He</b> 4.0026	
lithium 3 <b>Li</b> 6.941	beryllium 4 <b>Be</b> 9.0122											boron 5 <b>B</b> 10.811	carbon 6 <b>C</b> 12.011	nitrogen 7 <b>N</b> 14.007	oxygen 8 <b>O</b> 15.999	fluorine 9 <b>F</b> 18.998	neon 10 <b>Ne</b> 20.180	
sodium 11 <b>Na</b> 22.990	magnesium 12 <b>Mg</b> 24.305											aluminium 13 <b>Al</b> 26.982	silicon 14 <b>Si</b> 28.086	phosphorus 15 <b>P</b> 30.974	sulfur 16 <b>S</b> 32.065	chlorine 17 <b>Cl</b> 35.453	argon 18 <b>Ar</b> 39.948	
potassium 19 <b>K</b> 39.098	calcium 20 <b>Ca</b> 40.078	scandium 21 <b>Sc</b> 44.956	titanium 22 <b>Ti</b> 47.867	vanadium 23 <b>V</b> 50.942	chromium 24 <b>Cr</b> 51.996	manganese 25 <b>Mn</b> 54.938	iron 26 <b>Fe</b> 55.845	cobalt 27 <b>Co</b> 58.933	nickel 28 <b>Ni</b> 58.693	copper 29 <b>Cu</b> 63.546	zinc 30 <b>Zn</b> 65.39	gallium 31 <b>Ga</b> 69.723	germanium 32 <b>Ge</b> 72.61	arsenic 33 <b>As</b> 74.922	selenium 34 <b>Se</b> 78.96	bromine 35 <b>Br</b> 79.904	krypton 36 <b>Kr</b> 83.80	
rubidium 37 <b>Rb</b> 85.468	strontium 38 <b>Sr</b> 87.62	yttrium 39 <b>Y</b> 88.906	zirconium 40 <b>Zr</b> 91.224	niobium 41 <b>Nb</b> 92.906	molybdenum 42 <b>Mo</b> 95.94	technetium 43 <b>Tc</b> [98]	ruthenium 44 <b>Ru</b> 101.07	rhodium 45 <b>Rh</b> 102.91	palladium 46 <b>Pd</b> 106.42	silver 47 <b>Ag</b> 107.87	cadmium 48 <b>Cd</b> 112.41	indium 49 <b>In</b> 114.82	tin 50 <b>Sn</b> 118.71	antimony 51 <b>Sb</b> 121.76	tellurium 52 <b>Te</b> 127.60	iodine 53 <b>I</b> 126.90	xenon 54 <b>Xe</b> 131.29	
caesium 55 <b>Cs</b> 132.91	barium 56 <b>Ba</b> 137.33	* 57-70	lutetium 71 <b>Lu</b> 174.97	hafnium 72 <b>Hf</b> 178.49	tantalum 73 <b>Ta</b> 180.95	tungsten 74 <b>W</b> 183.84	rhenium 75 <b>Re</b> 186.21	osmium 76 <b>Os</b> 190.23	iridium 77 <b>Ir</b> 192.22	platinum 78 <b>Pt</b> 195.08	gold 79 <b>Au</b> 196.97	mercury 80 <b>Hg</b> 200.59	thallium 81 <b>Tl</b> 204.38	lead 82 <b>Pb</b> 207.2	bismuth 83 <b>Bi</b> 208.98	polonium 84 <b>Po</b> [209]	astatine 85 <b>At</b> [210]	radon 86 <b>Rn</b> [222]
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Key:  
 element name  
 atomic number  
 symbol  
 atomic weight (mean relative mass)

lanthanum 57 <b>La</b> 138.91	cerium 58 <b>Ce</b> 140.12	praseodymium 59 <b>Pr</b> 140.91	neodymium 60 <b>Nd</b> 144.24	promethium 61 <b>Pm</b> [145]	samarium 62 <b>Sm</b> 150.36	europium 63 <b>Eu</b> 151.96	gadolinium 64 <b>Gd</b> 157.25	terbium 65 <b>Tb</b> 158.93	dysprosium 66 <b>Dy</b> 162.50	holmium 67 <b>Ho</b> 164.93	erbium 68 <b>Er</b> 167.26	thulium 69 <b>Tm</b> 168.93	ytterbium 70 <b>Yb</b> 173.04
actinium 89 <b>Ac</b> [227]	thorium 90 <b>Th</b> 232.04	protactinium 91 <b>Pa</b> 231.04	uranium 92 <b>U</b> 238.03	neptunium 93 <b>Np</b> [237]	plutonium 94 <b>Pu</b> [244]	americium 95 <b>Am</b> [243]	curium 96 <b>Cm</b> [247]	berkelium 97 <b>Bk</b> [247]	californium 98 <b>Cf</b> [251]	einsteinium 99 <b>Es</b> [252]	fermium 100 <b>Fm</b> [257]	mendelevium 101 <b>Md</b> [268]	nobelium 102 <b>No</b> [259]

\*lanthanoids

\*\*actinoids

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\*lanthanoids

\*\*actinoids

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