

CHAPTER 0

THE NATURE OF LIGHT

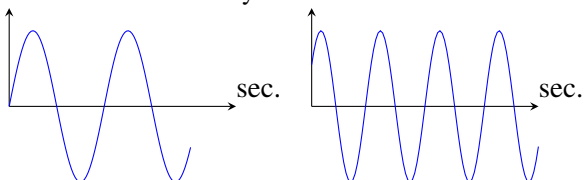
0.1 Calculate the following properties: (a) The energy in joules of a radiation with frequency 2.0×10^{18} Hz? (b) The frequency of a radiation with energy 5.6×10^{-20} J? (c) The energy in joules of a radiation with wavelength 653 nm?

0.2 Calculate the following properties: (a) The wavelength of a radiation with energy 5.34×10^{-16} J? (b) The wavelength of a radiation with frequency of 3.4×10^{14} Hz?

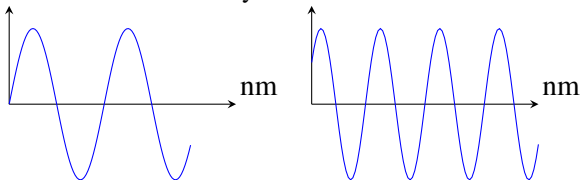
0.3 Calculate the following properties: (a) The color of a radiation with $\lambda = 510$ nm. (b) Indicate the color of a radiation with $\lambda = 580$ nm.

0.4 Classify the nature of a radiation (a) A radiation with $\gamma = 3.4 \times 10^8$ Hz (b) A radiation with $\lambda = 1 \times 10^{-4}$ nm

0.5 Sections of two electromagnetic waves A and B are represented below. Rank them in order of (a) increasing frequency; (b) increasing energy; (c) If wave B represents visible radiation, is wave A more likely to be IR or UV radiation?



0.6 Sections of two electromagnetic waves A and B are represented below. Rank them in order of (a) increasing wavelength; (b) increasing energy; (c) If wave B represents visible radiation, is wave A more likely to be IR or UV radiation?



THE ATOMIC SPECTRUM OF HYDROGEN

0.7 Which of these electron transitions correspond to absorption of energy and which to emission? (a) $\Delta E_{1 \rightarrow 2}$ (b) $\Delta E_{2 \rightarrow 1}$ (c) $\Delta E_{3 \rightarrow 1}$ (d) $\Delta E_{3 \rightarrow 5}$ (e) $\Delta E_{5 \rightarrow 3}$ (f) $\Delta E_{1 \rightarrow 3}$

0.8 Use the Bohr equation to: (a) find the energy of the photon emitted when an H atom undergoes a transition

from $n = 1$ to $n = 4$. (b) find the wavelength (in nm) of the photon emitted when an H atom undergoes a transition from $n = 2$ to $n = 4$.

0.9 Use the Bohr equation to find the frequency (in Hz) of the photon emitted when an H atom undergoes a transition from $n = 1$ to $n = 5$.

0.10 An electron in the lowest energy level of H atom absorbs a photon of wavelength 96.97 nm. Indicate the final energy level of the electron moved.

QUANTUM MECHANICS

0.11 Indicate if the following combination of quantum numbers are allowed:

n	ℓ	m_ℓ	m_s	Allowed?
4	4	1	$+1/2$	
2	1	4	$+1/2$	
4	2	-2	$-1/2$	

0.12 Indicate if the following combination of quantum numbers are allowed:

n	ℓ	m_ℓ	m_s	Allowed?
0	1	2	$+1/2$	
1	0	0	$+1/2$	
2	1	1	$-1/2$	

0.13 For each of the following sublevels, give the values of the n and ℓ quantum numbers and indicate the number of orbitals in the sublevel: (a) 6s (b) 4d (c) 2p

0.14 For each of the following sublevels, give the values of the n and ℓ quantum numbers and indicate the number of orbitals in the sublevel: (a) 2p (b) 1s (c) 4f

0.15 Describe the shape of the following orbitals using the terms lobular, spherical, or lobular(dumbbell shape): (a) 3d (b) 1s (c) 2p (d) 2s

0.16 Describe the shape of the following orbitals using the terms lobular, spherical, or lobular(dumbbell shape): (a) 4p (b) 4d (c) 3p (d) 3s

0.17 Match the following statements with: (1) have the same shape (2) can fit the same number of electrons (3) belong to the same energy level (4) can fit the same number of electrons (a) 1s and 2s orbitals (b) five 3d orbitals (c) 2p and 3p sublevels (d) 3s and 3p sublevels

0.18 Match the following statements with: (1) have the same shape (2) can fit the same number of electrons (3) belong to the same energy level (4) can fit the same number of electrons (a) 4p and 3p orbitals (b) three 3p orbitals (c) 3d and 3s sublevels (d) 3p and 5p sublevels

0.19 Indicate the following: (a) orbitals in a 1s sublevel (b) sublevels in the fourth energy level (c) orbitals in the fourth energy level

0.20 Indicate the following: (a) orbitals in a 3p sublevel (b) sublevels in the third energy level (c) orbitals in the third energy level

0.21 Indicate the following: (a) the maximum number of electrons in a 3d sublevel (b) the maximum number of electrons in a 4f sublevel (c) the maximum number of electrons in a 1s sublevel

0.22 Indicate the following: (a) the maximum number of electrons in a 1s orbital (b) the maximum number of electrons in a 3d orbital (c) the maximum number of electrons in a 4f orbital

0.23 Indicate the number of orbitals that can have the following designations: (a) 2s (b) 3p (c) 0p (d) $n = 4$

0.24 Indicate the number of orbitals that can have the following designations: (a) 1d (b) $n = 1$ (c) 3d (d) 4f

0.25 What is the element with the electron configuration (a) $1s^2 2s^2 2p^6 3s^1$ (b) $[Ar] 3d^5 4s^1$ (c) $1s^2 2s^2 2p^6 3s^1$ (d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$

0.26 What is the element with the electron configuration (a) $1s^2 2s^2 2p^6 3s^2 3p^5$ (b) $1s^2 2s^2 2p^6 3s^2 3p^4$ (c) $[Kr] 5s^2 4d^8$

0.27 Write down the abbreviated electron configuration for the following elements: (a) Cobalt (b) Chromium (c) Argon (d) Potassium (e) Chlorine (f) Vanadium

0.28 Write down the abbreviated electron configuration for the following elements: (a) Calcium (b) Manganese (c) Iron (d) Nickel (e) Copper (f) Titanium

0.29 Write down the full electron configuration for the following elements: (a) Barium (b) Samarium (c) Vanadium

0.30 Write down the full electron configuration for the following elements: (a) Aluminum (b) Potassium (c) Nickel

0.31 Write down the orbital diagram for the following elements: (a) Argon (b) Silicon (c) Sulfur (d) Chlorine

0.32 Write down the orbital diagram for the following elements: (a) Phosphorus (b) Boron (c) Carbon (d) Nitrogen

0.33 Indicate whether the following orbital diagram is possible for an atom on its fundamental state:



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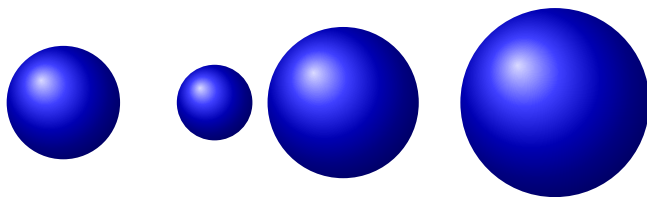


PERIODIC PROPERTIES

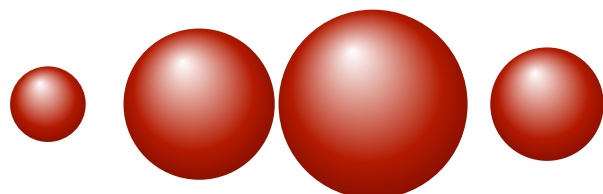
0.37 Among the elements, indicate the element with the largest atomic radius (a) B (b) C (c) F (d) Li (e) Na

0.38 Among the elements, indicate the element with the smallest atomic radius (a) C (b) N (c) O (d) S (e) Se

0.39 Match the spheres (far left, center left, center right, far right) with the atoms: Be, Li, Na, B



0.40 Match the spheres (far left, center left, center right, far right) with the atoms: P, S, Si, Cl.



0.41 Among the elements, indicate the element with the largest electronegativity (a) B (b) C (c) F (d) Li

0.42 Among the elements, indicate the element with the largest electronegativity (a) Si (b) P (c) S (d) Se

0.43 Among the elements, indicate the element with the smallest ionization energy (a) B (b) C (c) F (d) Li (e) Na

0.44 Among the elements, indicate the element with the largest ionization energy (a) Al (b) Si (c) P (d) As (e) Sb

0.45 Among the elements, indicate the element with the largest metallic character (a) B (b) C (c) F (d) Li (e) Na

0.46 Among the elements, indicate the element with the largest metallic character (a) K (b) Rb (c) Cs (d) Ca

- Answers 0.1** (a) $1.32 \times 10^{-15} \text{J}$ (b) $8.5 \times 10^{13} \text{Hz}$ (c) $3.03 \times 10^{-19} \text{J}$ **0.2** (a) 0.37 nm (b) 882 nm **0.3** (a) Green (b) Yellow **0.4** (a) Microwaves (b) Gamma **0.5** (a) $\gamma_A < \gamma_B$ (b) $E_A < E_B$ (c) IR **0.6** (a) $\lambda_B < \lambda_A$ (b) $E_A < E_B$ (c) UV **0.7** (a) Absorption (b) Emission (c) Emission (d) Absorption (e) Emission (f) Absorption **0.8** (a) $2.04 \times 10^{-18} \text{J}$ (b) 485 nm **0.9** $3.16 \times 10^{15} \text{Hz}$ **0.10** $n = 5$ **0.11** (a) $n=4$; $\ell=4$; $m_\ell=1$; $m_s=+1/2$; Allowed=no (b) $n=2$; $\ell=1$; $m_\ell=4$; $m_s=+1/2$; Allowed=no (c) $n=4$; $\ell=2$; $m_\ell=-2$; $m_s=-1/2$; Allowed=yes **0.12** (a) $n=0$; $\ell=1$; $m_\ell=2$; $m_s=+1/2$; Allowed=no (b) $n=1$; $\ell=0$; $m_\ell=0$; $m_s=+1/2$; Allowed=yes (c) $n=2$; $\ell=1$; $m_\ell=1$; $m_s=-1/2$; Allowed=yes **0.13** (a) 6s ($n = 6$; $\ell = 0$) (b) 4d ($n = 4$; $\ell = 2$) (c) 2p ($n = 2$; $\ell = 1$) **0.14** (a) 2p ($n = 2$; $\ell = 1$) (b) 1s ($n = 1$; $\ell = 0$) (c) 4f ($n = 4$; $\ell = 3$) **0.15** (a) lobular (b) spherical (c) lobular(dumbbell shape) (d) spherical **0.16** (a) lobular(dumbbell shape) (b) lobular (c) lobular(dumbbell shape) (d) spherical **0.17** (a) have the same shape and can fit the same number of electrons (b) can fit the same number of electrons (c) can fit the same number of electrons (d) belong to the same energy level **0.18** (a) have the same shape and can fit the same number of electrons (b) can fit the same number of electrons (c) belong to the same energy level (d) can fit the same number of electrons **0.19** (a) 1 orbital (b) 4 sublevels (c) 16 orbitals **0.20** (a) 3 orbitals (b) 3 sublevels (c) 9 orbitals **0.21** (a) 10 electrons (b) 14 electrons (c) 2 electrons **0.22** (a) 2 electrons (b) 2 electrons (c) 2 electrons **0.23** (a) 1 orbital (b) 3 orbitals (c) 0 orbital (d) 16 orbitals **0.24** (a) 0 orbital (b) 1 orbitals (c) 5 orbital (d) 7 orbital **0.25** (a) Na (b) Cr (c) Na (d) Ti **0.26** (a) Cl (b) S (c) Pd **0.27** (a) $[\text{Ar}]3d^74s^2$ (b) $[\text{Ar}]3d^54s^1$ (c) $[\text{Ne}]3s^23p^6$ (d) $[\text{Ar}]4s^1$ (e) $[\text{Ne}]3s^23p^5$ (f) $[\text{Ar}]3d^34s^2$ **0.28** (a) $[\text{Ar}]4s^2$ (b) $[\text{Ar}]3d^54s^2$ (c) $[\text{Ar}]3d^64s^2$ (d) $[\text{Ar}]3d^84s^2$ (e) $[\text{Ar}]3d^{10}4s^1$ (f) $[\text{Ar}]3d^24s^2$ **0.29** (a) $1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^{10}5p^66s^2$ (b) $1s^22s^22p^63s^23p^64s^23d^{10}4p^65s^24d^{10}5p^66s^24f^6$ (c) $1s^22s^22p^63s^23p^64s^23d^3$ **0.30** (a) $1s^22s^22p^63s^23p^1$ (b) $1s^22s^22p^63s^23p^64s^1$ (c) $1s^22s^22p^63s^23p^64s^23d^8$
- 0.31** (a) $[\text{Ne}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow \\ \hline \end{array}$ 3s 3p (b) $[\text{Ne}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 3s 3p (c) $[\text{Ne}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow & \uparrow \\ \hline \end{array}$ 3s 3p
- (d) $[\text{Ne}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 3s 3p **0.32** (a) $[\text{Ne}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 3s 3p (b) $[\text{He}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 2s 2p
- (c) $[\text{He}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 2s 2p (d) $[\text{He}] \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array} \begin{array}{|c|c|c|c|} \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$ 2s 2p **0.33** Not possible **0.34** Not possible **0.35** possible **0.36** not possible **0.37** Na **0.38** O **0.39** far left (Be), center left (B), center right (Li), far right (Na) **0.40** far left (Si), center left (P), center right (S), far right (Cl) **0.41** F **0.42** S **0.43** Na **0.44** P **0.45** Li **0.46** Cs

