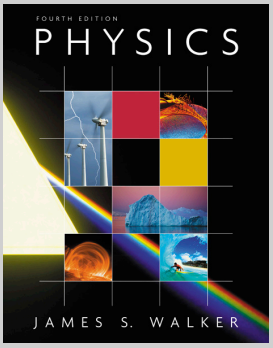


ConcepTest Clicker Questions

Chapter 31

Physics, 4th Edition

James S. Walker

Copyright © 2010 Pearson Education, Inc.

Question 31.1 Ionization

How much energy does it take to ionize a hydrogen atom in its ground state?

a) 0 eV
b) 13.6 eV
c) 41.2 eV
d) 54.4 eV
e) 108.8 eV

Question 31.1 Ionization

How much energy does it take to ionize a hydrogen atom in its ground state?

a) 0 eV
b) 13.6 eV
c) 41.2 eV
d) 54.4 eV
e) 108.8 eV

The energy of the ground state is the energy that binds the electron to the nucleus. Thus, an amount equal to this binding energy must be supplied in order to kick the electron out of the atom.

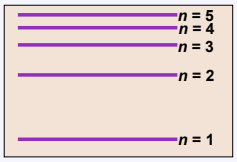
$$E_n = E_1 \frac{Z^2}{n^2}$$

Follow-up: How much energy does it take to change a He^+ ion into a He^{++} ion? Keep in mind that $Z = 2$ for helium.

Question 31.2a Atomic Transitions I

For the possible transitions shown, for which transition will the electron gain the most energy?

a) 2 → 5
b) 5 → 3
c) 8 → 5
d) 4 → 7
e) 15 → 7



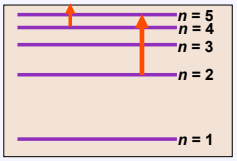
Question 31.2a Atomic Transitions I

For the possible transitions shown, for which transition will the electron gain the most energy?

a) 2 → 5
b) 5 → 3
c) 8 → 5
d) 4 → 7
e) 15 → 7

The electron must go to a higher orbit (higher n) in order for the electron to gain energy.
Because of the $1/n^2$ dependence:

$$E_2 - E_5 > E_4 - E_7$$

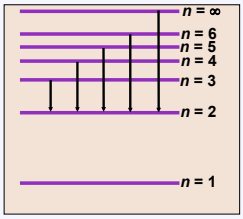


Follow-up: Which transition will emit the shortest wavelength photon?

Question 31.2b Atomic Transitions II

The Balmer series for hydrogen can be observed in the visible part of the spectrum. Which transition leads to the reddest line in the spectrum?

a) 3 → 2
b) 4 → 2
c) 5 → 2
d) 6 → 2
e) ∞ → 2

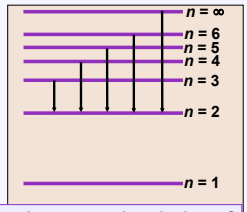


Question 31.2b Atomic Transitions II

The Balmer series for hydrogen can be observed in the visible part of the spectrum. Which transition leads to the reddest line in the spectrum?

a) 3 → 2
b) 4 → 2
c) 5 → 2
d) 6 → 2
e) ∞ → 2

The transition 3 → 2 has the lowest energy and thus the lowest frequency photon, which corresponds to the longest wavelength (and therefore the "reddest") line in the spectrum.

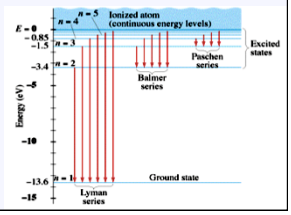


Follow-up: Which transition leads to the shortest wavelength photon?

Question 31.3 Balmer Series

When a broad spectrum of light passes through hydrogen gas at room temperature, absorption lines are observed that correspond only to the Balmer ($n_f = 2$) series. Why aren't other series observed?

a) they're there, but they're invisible
b) only the Balmer series can be excited at room temperature
c) the other series have been ionized
d) all the photons have been used up

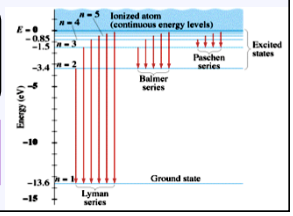


Question 31.3 Balmer Series

When a broad spectrum of light passes through hydrogen gas at room temperature, absorption lines are observed that correspond only to the Balmer ($n_f = 2$) series. Why aren't other series observed?

a) they're there, but they're invisible
b) only the Balmer series can be excited at room temperature
c) the other series have been ionized
d) all the photons have been used up

The Balmer series is the only one that involves wavelengths in the visible part of the spectrum!

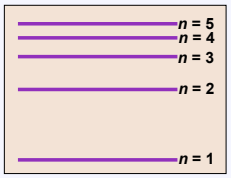


Follow-up: From the diagram at right, where in the EM spectrum is the Lyman series located?

Question 31.4a Energy Levels I

Suppose there is an atom that contains exactly five energy levels. How many different transitions are possible? (Count only one direction!)

a) 4
b) 5
c) 10
d) 20
e) many more than 20



Question 31.4a Energy Levels I

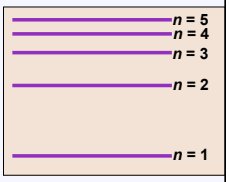
Suppose there is an atom that contains exactly five energy levels. How many different transitions are possible? (Count only one direction!)

a) 4
b) 5
c) 10
d) 20
e) many more than 20

Just count them! Transitions upward:

$n = 1$ →	$n = ?$	4 transitions
$n = 2$ →	$n = ?$	3 transitions
$n = 3$ →	$n = ?$	2 transitions
$n = 4$ →	$n = ?$	1 transition

This gives a total of 10 possible ones.



Question 31.4b Energy Levels II

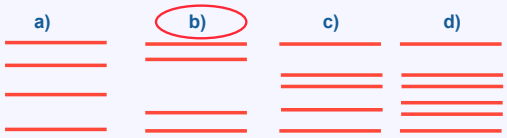
The emission spectrum for the atoms of a gas is shown. Which of the energy level diagrams below corresponds to this spectrum?

a) b) c) d)

Question 31.4b Energy Levels II

The emission spectrum for the atoms of a gas is shown. Which of the energy level diagrams below corresponds to this spectrum?

a) b) c) d)



Each line in the spectrum corresponds to a *transition* between energy levels! Since there are 6 transitions shown, there must be 4 levels
The 2 transitions between the closely spaced levels have less energy, while the other 4 have larger energies.

Question 31.5 Rutherford Model

Suppose the Rutherford model was correct (instead of the Bohr model). What would the absorption spectrum of a hydrogen atom look like?

a) there would be no change
b) the absorption lines would be broader
c) it would be completely black
d) the absorption lines would be shifted
e) the absorption lines would be bright instead of dark

Question 31.5 Rutherford Model

Suppose the Rutherford model was correct (instead of the Bohr model). What would the absorption spectrum of a hydrogen atom look like?

a) there would be no change
b) the absorption lines would be broader
c) it would be completely black
d) the absorption lines would be shifted
e) the absorption lines would be bright instead of dark

In the Rutherford model, all orbits are allowed for the electrons. Thus, the atom would be able to absorb *all* wavelengths of light instead of only the specific ones allowed in the Bohr model.