Everyone has seen a rainbow, but what exactly is a rainbow? The sun produces white light with wavelengths in a visible spectrum, creating a continuous spectrum when passed through a prism. This continuous spectrum is what we see as a rainbow. A line spectrum is a broken rainbow, or a rainbow that only contains certain colors. This type of spectrum contains only certain wavelengths and is produced from excited atoms. This is how light bulbs produce their light: by exciting atoms and letting the atoms fall back to their original energy level. But different light bulbs contain different mechanisms in order to produce their light. Though similar, incandescent and fluorescent light bulbs have very different methods of producing their light and emission spectra. Even more dissimilar is the emission spectra of gaseous hydrogen and its electron transitions.

Incandescent and fluorescent lights are similarly produced. Incandescent light bulbs are made with a halogen-gas composition, increasing efficiency (U.S. Dept. of Energy, 2013). Fluorescent lights are made up of mercury, argon gas, two electrodes, and phosphor powder. This makes fluorescent lights even more efficient then incandescent lights (Harris 2001). Both incandescent and fluorescent lights use the idea of exciting electrons in order to emit light, or photons, as seen by Einstein's photoelectric effect, but the process used to get there is a bit unlike. In incandescent lights, electrons are excited by heat in order to make the bulb glow. The light seen is actually the photons being emitted as they return to their initial energy level (Sargosis). Conventional incandescent lights emit a large amount of photons in the ultraviolet spectra, meaning much of its light is lost. Also, because incandescent light bulbs excite their atoms through heat, they lose much energy through heat emission (Harris 2001). In fluorescent light bulbs, a current flows between the two electrodes, causing some of the liquid mercury in the tube to convert to gas. When electrons strike into this mercury gas, the electrons are suddenly excited and are bumped up to higher energy levels (Harris 2001). When the mercury atom's electrons return back to their original energy levels, they emit light photons, also in the ultraviolet spectrum. The phosphor coating on the tube converts the ultraviolet light into the visible light spectrum humans can see, making fluorescent lights much more resourceful than incandescent lights (Harris 2001). When observing these two lights through a diffraction grating slide, an incandescent light will show a red, green, and blue-violet band, while a fluorescent light will show a red, orange, green, turquoise, and purple band. These different wavelengths signify the amount of energy produced from each photon; the electrons with the greatest and most transitions will release the most energy.

Hydrogen atoms may go through multiple electron transitions before returning to ground state (Roser, C.). This means they will emit several photons of many different wavelengths. If observed through a diffraction grating slide, hydrogen contains 4 lines: violet, blue-violet, green, and red (Purdue). Using the Bohr model, E = -Rhc [1/n(final)2- '/n(initial)2], the energy levels of the Balmer series can be calculated. The energy level when the n(initial) = 6 is -4.842xl0"-19, n(initial) = 5 is -4.576xl0"-19, n(initial) = 4 is -4.086xl0"-19, and n(initial) = 3 is -3.026xl0"- 19. As shown, the energy emitted decreases as the energy level decreases. Their wavelengths (in nm) respectively are 410.1 in violet, 434 in blue-violet, 486.1 in green, and 656.2 in red; so as energy level decreases, wavelength increases. Bohr's model works well for hydrogen atoms because they have one electron, but most atoms have far more electrons then this. This is a huge limitation to Bohr's, as it can only effectively be used on hydrogen. Bohr's model also suggests that electrons travel around the nucleus in circular orbits, not elliptical orbits. Essentially, Bohr's model does not fully describe the atom (Docker).

Even though Bohr's model is limited exclusively to hydrogen, it is still helpful in understanding and determining the energies and wavelengths of atoms. It explains why several electron transitions in an atom before its return to ground state will emit more photons. The knowledge of a line spectrum, a broken rainbow, and how it's formed has allowed scientists to invent light sources, such as incandescent and fluorescent lights. Excited electrons have enabled different methods to be produced that are more efficient and cost effective. A knowledge of spectrums and the process electrons undergo to create them is essential to the creation every day necessities, such as light.

Works Cited

Docker. *Bohr's Model of the Atom.* Retrieved from http://www.dpcdsb.org/NR/rdonlyres/9B6E4EF6-77F0-407F-A858-FODF78B6896C/104231/32BohrsModeloftheAtom.pdf

Einstein Year. *Photoelectric Effect.* Retrieved from http://www.einsteinyear.org/facts/photoelectric_effect/

Harris, T. (2001, December 7). *How Fluorescent Lamps Work.* Retrieved from http://home.howstuffworks.com/fluorescent-lamp7.htm

Langsam. *Assignment #3*. Retrieved from http://eilat.sci.brooklyn.cuny.edu/cis1_5/0ld%20HWs/HW2d_C.htm

Purdue. *Development of Current Atomic Theory: Emission Spectrum of Hydrogen.* Retrieved from http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch6/bohr.html

Roser, C. *Hydrogen Spectrum Activity.* Retrieved from http://www.carolina.com/teacher-resources/interactive/hydrogen-spectrum-activity/tr10770.tr

Sargosis Solar and Electric. *The Photoelectric and Photovoltaic Effects.* Retrieved from http://sargosis.com/articles/science/how-pv-modules-work/the-photoelectric-and-photovoltaic-effects/

U.S. Department of Energy (2013, October 17). *Incandescent Lighting.* Retrieved from http://energy.gov/energysaver/articles/incandescent-lighting

Calculations

Balmer series:

$E = -2.179 \times 10^{-18}$ J/atom$\left(\frac{1}{2^2} - \frac{1}{6^2}\right) = -4.842 \times 10^{-19}$

$E = -2.179 \times 10^{-18}$ J/atom$\left(\frac{1}{2^2} - \frac{1}{5^2}\right) = -4.576 \times 10^{-19}$

$E = -2.179 \times 10^{-18}$ J/atom$\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = -4.086 \times 10^{-19}$

$E = -2.179 \times 10^{-18}$ J/atom$\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = -3.026 \times 10^{-19}$

Wavelength:

$-4.842 \times 10^{-19} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(2.998 \times 10^{8}\ \frac{m}{s})}{\lambda}$ = 410.1 nm violet

$-4.576 \times 10^{-19} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(2.998 \times 10^{8}\ \frac{m}{s})}{\lambda}$ = 434.0 nm blue-violet

$-4.086 \times 10^{-19} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(2.998 \times 10^{8}\ \frac{m}{s})}{\lambda}$ = 486.1 nm green

$-3.026 \times 10^{-19} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(2.998 \times 10^{8}\ \frac{m}{s})}{\lambda}$ = 656.2 nm red

!

511#/'/0#17F&.2$&@"##":,(%&$A,)$(=$&@*"3&42$&:"*/&-'3<#$&'()&42$&*$A,$:$*B-&="33$(4-&-><<"*4&42$&-="*$-&'9"A$?&C'%$&'()&#,($&(>39$*-&*$@$*&
4"&42$&"*,%,('#&:"*/&-'3<#$?&

& &

&4#$019!:$0/+$0'!	>'9+!G!	H01+!G!	:#((+1/'$C!'2#./!/?+! I #$%!7' ()*+!
A+7+'$4?!'18!;1-+7/09'/0#1F! /0.%1-)2#,3&0*,.3&# -)4353)43)167#%)480,# -43)1-97-)2#-)90,:%1-0)# ;-1<-)#5,0=-434#13>1&#	D&	DDEDF&	.2$&-4>)$(4&>-$-&*$@$*$(=$-&->=2&'-&GH8&I$<'*43$(4&"@&J($*%5K&42'4&'*$&*$#$A'(4&4"&42$&4"<,=&'4&2'()?&&L4&,-& ,3<"*4'(4&@"*&42$&-4>)$(4&4"&>()$*-4'()&42$&),@@$*$(=$&9$4:$$(&,(='()$-=$(4&'()&@#>"*$-=$(4&9>#9-&,(& 4$*3-&"@&$($*%5&>-'%$M&$-<$=,'##5&)>*,(%&">*&=>**$(4&G$($*%5&=*,-,-?K&
	N&	&	.2$&:"*/&-'3<#$&,(=#>)$-&(>3$*">-&*$@$*$(=$-?&&&
	N&	DDEDF&	.2$&-4>)$(4&>-$-&9"42&="##$%$&:$9-,4$-&'()&GO":&84>@@&6"*/-K&@"*&*$@$*$(=$-?&L@&42$5&2')&'==$--$)&<*,(4$)& '=')$3,=&-">*=$-&'()&*$<>4'9#$&:$9-,4$-&"(#5M&42$,*&-="*$&:">#)&2'A$&9$$(&2,%2$*?&
;8+'7!'18!:#1/+1/F! ?,3&3)1-)2#%#1<3&-&#%)4# *)43,&1%)4-)2#.0).351&#	D&	PEDQ&	.2$&:"*/&-'3<#$&2'-&'&42$-,-M&="><#$)&:,42&'&),-=>--,"(&"@&42$&),@@$*$(=$-&,(&#,%24?&.2$&),-=>--,"(&$R<#',(-& :25&42"-$&#,%24-&<*")>=$&9*"/$(&*',(9":-&:2$(&A,$:$)&42*">%2&'&),@@*'=4,"(&%*'4,(%?&
	DES&	&	.2$&,(@"*3'4,"(&<*$-$(4$)&,(&42$&:"*/&-'3<#$&,-&*$#$A'(4&'()&'<<*"<*,'4$&@"*&42$&4"<,=&9$,(%&$R<#',($)?&&.2$& :*,4$*&,(=#>)$-&42$&#,3,4'4,"(-&"@&0"2*B-&3")$#&:2$(&$R<#',(,(%&42$&$($*%5&#A#-&A,$:$)&,(&'(&'4"3?&
A+'8019!'18!51'*C707F! @=%6*%1-)2#&0*,.3&#%)4# &363.1-)2#3=-43).3#10# &*550,1#1<3#.3)1,%6#-43%#	DEN&	&	.2$&>-$&"@&3"*$&*$<>4'9#$&-">*=$-&,(&42$&:"*/&-'3<#$&=">#)&2'A$&,(=*$'-$)&42$&-="*$&,(&42,-&-$=4,"(?&&.2$& -">*=$-&=2"-$(&95&42$&-4>)$(4&:$*$&("4&'('#5T$)&@"*&-4*$(%42&"*&#,3,4'4,"(-?&&&
	D&	FD&	.2$&-4>)$(4&<*"A,)$)&#,3,4$)&4"&9'-,=&)$@,(,4,"(-&'()&$R<#'('4,"(&"@&42$&,(@"*3'4,"(&<*$-$(4$)?&.2$&-4>)$(4&),)&("4&$R<'()&"(&42$&,(@"*3'4,"(&42$5&%"4&@*"3&42$-$&-">*=$-?&&&
:#((.104'/0#1F! A&-)2#&*+B3.1C%55,05,-%13# 6%)2*%23#%)4#.0)&-43,-)2# %*4-3).3!	D&	DN&	62,#$&42$*$&:$*$&-"3$&%*'33'4,='#&$**"*-&,(&42$&:"*/&-'3<#$M&42$&="33"(&3,->-$&"@&42$(U42'(&"==>*-&,(& #,($&DN?&
	D&	DPEDV&	.2$&>-$&"@&G,-&'&9,4&>(#,/$K&='(&#$'A$&42$&*$')$*&:"()$*,(%&:2'4&42$&:*,4$*&3$'(-?&&.2,-&#'(%>'%$&,-&("4& '<<*"<*,'4$&@"*&42,-&45<$&"@&'--,%(3$(4?&
D$9'10E'/0#1F! D1,*.1*,-)2#:%-)#-43%&#%)4# &*550,1-)2#-)90,:%1-0)!	DES&	&	.2$&:"*/&-'3<#$&>-$-&-><<"*4,(%&$A,)$(=$&@*"3&3$'->*$3$(4&A'#>$-&,(&42$&0'#3$*&8$*,$-?&
	DES&	&	.2$&"*%'(,T'4,"(&"@&42$&:"*/&-'3<#$&@#":-&:$##&@"*&42$&*$')$*?&&.2$*$&:'-&'(&,(4*")>=4,"(&:,42&'&42$-,-& -4'4$3$(4M&'&<'*'%*'<2&'9">4&A'*,">-&45<$-&"@&#,%24M&'&<'*'%*'<2&'9">4&0"2*B-&$R<$*,3$(4&'()&,4-& #,3,4'4,"(-M&'()&="(=#>-,"(&"(&42$&),@@$*$(4&45<$-&"@&#,%24&,(A$-4,%'4$)?&
544.$'4CF! E113)4-)2#10#431%-6F# 2,%::%,F#&5366-)2F# .0)=3)1-0)&F#.-1%1-0)&F#%)4# 90,:%11-)2#	DES&	&	.2$&>-$&"@&%*'33'*&:'-&("4&'(&,-->$&:2$(&*$'),(%&42$&)"=>3$(4?&L(&"42$*&:"*)-M&42$*$&:$*$&("&),@@,=>#4,$-& ,(&>()$*-4'(),(%&:2'4&42$&:*,4$*&:'-&4*5,(%&4"&="(A$5?&
	D&	DW&	.2$&,(E4$R4&=,4'4,"(-&:$*$&("4&'#:'5-&)"($&="**$=4#5?&&&

&

!