5.3 The Big Bang Theory & Evidence

January 10, 2019 12:18 PM

SCIENCE 10

unit 5: astronomy

book 2: the big bang theory & stars

NAME: _____ BLOCK: _____

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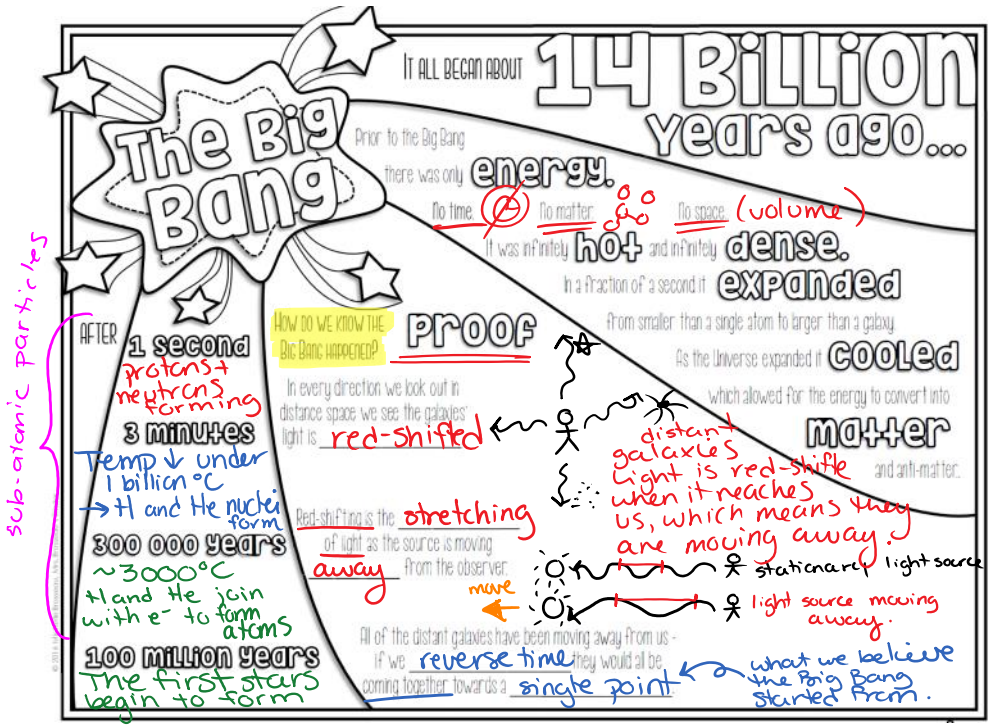
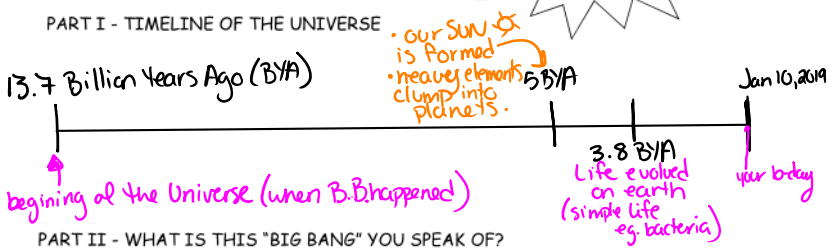


5.3) THE BIG BANG THEORY & EVIDENCE

BIG BANG NOTES

PART I - TIMELINE OF THE UNIVERSE



PART II - WHAT IS THIS "BIG BANG" YOU SPEAK OF?

The Beginning of Everything -- The Big Bang -- https://www.youtube.com/watch?v=wNDGgL73ihY

The big bang theory is a theory about...

- current "faucrite" model (amongst scientists)
- how our universe began
- how + what we came from

The three most important things to remember about this theory are:

1. The universe is ___EXPANDING___, and has always been expanding since it began.
   The "BANG" was not an explosion at all, it refers to the rapid expansion of the universe triggered by some unknown event.
2. In the beginning, the universe was ___very small___, ___not___, and ___dense___.
   All matter was crammed into a space smaller than the period at the end of this sentence.
3. The Universe is ___cooling___ down as it ___expands.___.

What caused the big bang?

=> no one knows what caused the original small dense object to suddenly expand

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The Expanding Universe: A Model

Introduction

In this activity you will use a balloon to model the expansion of the universe. You will place several dots on the balloon to represent galaxies and you will blow the balloon up in several stages. At each stage you will measure the distance between the dots.

Materials

balloon	felt pen
25cm of string	ruler

Procedure

1. Draw 6 dots on the uninflated balloon. Label the dot closes to the balloon neck "M" to represent the Milky Way. Label the other 5 dots "A" through "E"- these represent other galaxies in space.

2. **Predict/Explain** In your group, predict what will happen to the "galaxies" on the balloon when the balloon is blown up. Why might the distance between galaxies increase?

   _____

   _____

3. Inflate the balloon slightly – to where it begins to become round. Keep the balloon at this size by pinching the balloon's neck tightly. Don't tie the balloon as you will need to inflate it again.

4. **Observe** Imagine that you are located in "M". The other dots represent other galaxies. Measure how far apart each galaxy is from the others. and record it in your data table *(next page)*

5. Blow up the balloon to 10 cm in diameter. This represents the universe after 1 billion years.

6. Do not tie off balloon, but twist the neck and hold it tightly closed. Use a piece of string to measure the distances between the galaxy you are in (M) and the other three galaxies. You will measure around the curve of the balloon.

7. Blow up the balloon to a diameter of 20 cm and repeat the measurements.

8. Blow up the balloon to a diameter of 30 cm and repeat the measurements.

9. Draw a graph with "Initial distance from M" on the x-axis and "Final distance from M" on the y-axis. Draw a dot on the graph for each of the galaxies A through E

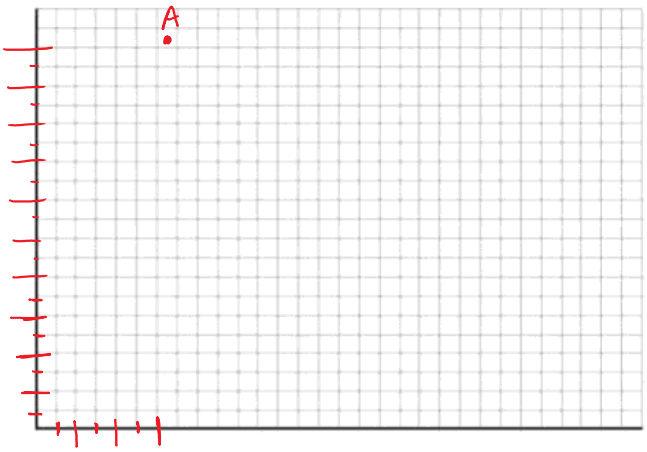
Data & Results:

Table 1:_____

Galaxy	Distance to M (cm)			
	Initial distance (barely inflated)	10 cm diameter	20 cm diameter	30 cm diameter
A	3.1			10.2
B				
C				
D				
E				

Final

Graph 1: _____



Final dist. to M (cm)

Initial dist to m (cm)

*Total of 5 dots.

5

Analysis Questions:

1. When measured from point M, which dots moved the furthest between the initial and final distance measurements?

2. Which distances did not increase as much?

3. Without naming particular dots / galaxies, summarize the trend in your answers.

4. Is the increase in distance constant for all galaxies? If not, how does it differ?

5. How do you think this experiment models what is occurring in an expanding universe?

6. In what way(s) do you think the balloon model is *different* than an expanding universe?

7. You measured how far away the dots / galaxies are from M. Explain what you predict your results would be if you were to repeat the experiment, but this time measured the distance to other dots / galaxies from point E.

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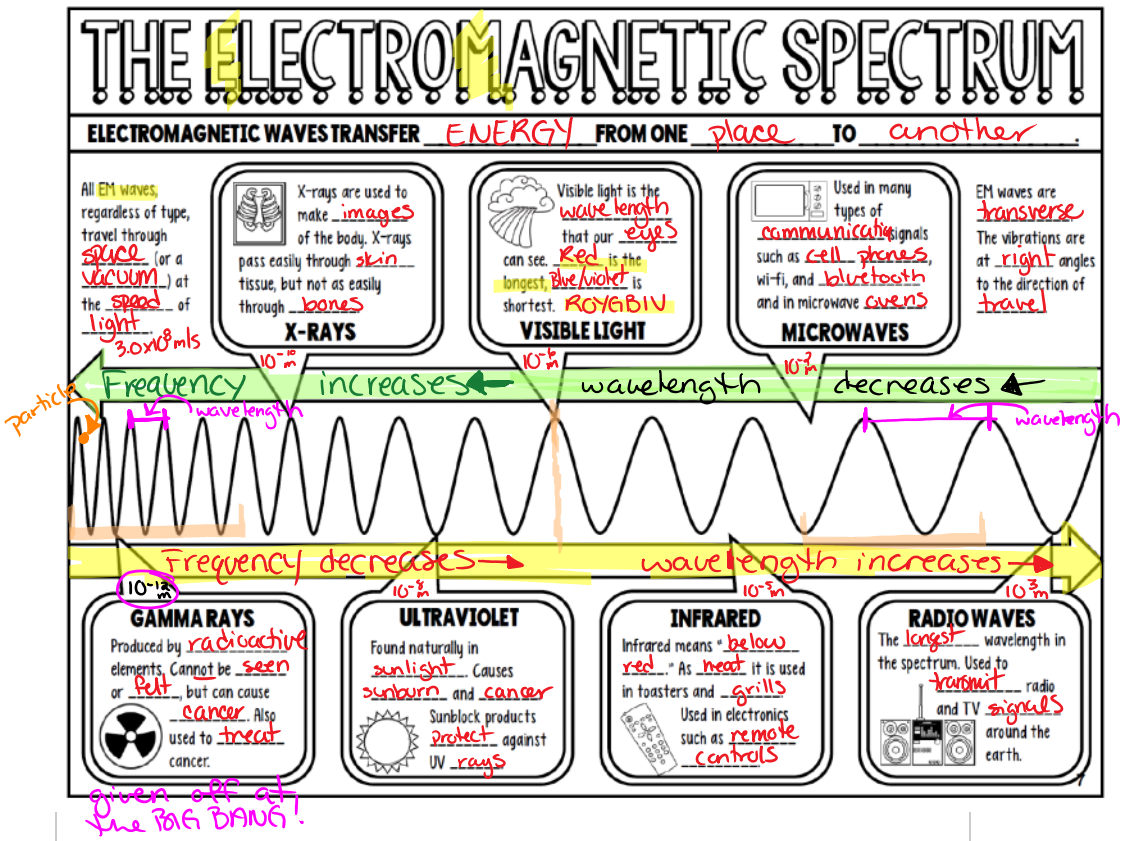
https://www.youtube.com/watch?v=ijy-eqWM38g



the BIG BANG!

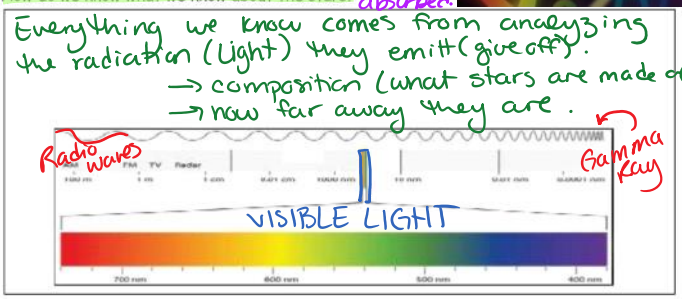
Light: Crash Course Astronomy #24

PART III - A REVIEW OF LIGHT

Why do we see the colors that we see when we look at things? Because of the light that reaches our eyes. eg. grass is green because green light is reflected, all other colours absorbed.

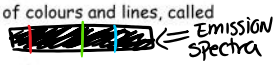
How do we know what we know about the stars?

Everything we know comes from analyzing the radiation (light) they emit (give off).
→ composition (what stars are made of)
→ how far away they are.



Astronomers use a Spectroscope to analyze the light from stars to determine their composition.

A spectroscope is an instrument that produces a pattern of colours and lines, called a spectrum, from a narrow beam of light.



in the 1820s Joseph von Fraunhofer, a German optician, used a spectrocope to observe the Sun's spectrum, and noticed hundreds of lines against the coloured *spectrum or "background"*

Figure 4.31 Each element is uniquely identified by its spectrum.

Like a fingerprint

When viewing a stars spectrum through a spectroscope spectra lines are shown as black lines on the image.

These lines identify the elements the star is made of.

...more on this later :)

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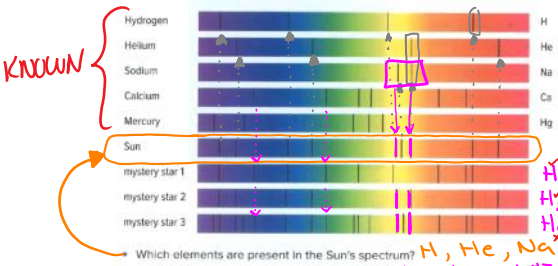
Homework

Activity

Identify the Composition of Three Mystery Stars

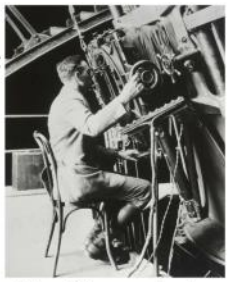
Examine the spectral lines below. Compare the patterns of the known elements to those of the Sun and the three unknown stars.



H, Ca
H, Na, He
Hg, Ca, Na, H, He

- Which elements are present in the Sun's spectrum? H, He, Na
- In which two mystery stars is calcium present? star #1 and #3
- Which mystery star contains sodium? #2 and 3
- Only one mystery star contains mercury. Which one is it? #3
- Which mystery star's composition is least like that of the Sun? #1
- Describe, in writing or orally with a partner, how you can infer a star's composition by analyzing the pattern of its spectra.

PART IV - IT'S ALL ABOUT THE EVIDENCE



The Doppler Effect : http://www.youtube.com/watch?v=Kg9F5pN5tII

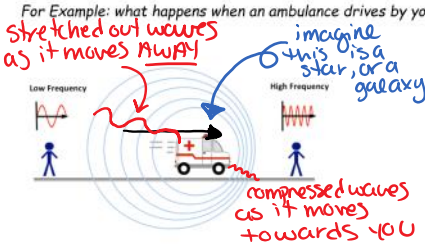
Edwin Hubble used the Mount Wilson Observatory telescope in California to observe something unusual about the spectra (light) of galaxies.

The spectral lines were shifted from their "normal" positions.

This is known as the Doppler effect.

It is when sound or light waves seem to be stretched out or compressed because of the positions of the person hearing the sound wave, or seeing the light wave in relation to the object giving off the sound or light.

For Example: what happens when an ambulance drives by you with it's siren going?



stretched out waves as it moves AWAY

imagine this is a star, or a galaxy, etc.

compressed waves as it moves towards you

- as it approaches the sound seems to build up, gets louder (↑pitch) and it seems to fade as it drives away.
- But... we know that the actual siren (volume, pitch, etc) is NOT changing; it only appears to.

The Results:

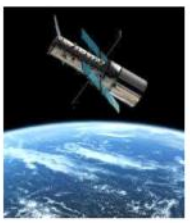
Hubble's study of the spectra of the observable distant galaxies revealed that the spectral lines of most of these galaxies are redshifted.

Redshifted galaxies are moving AWAY from the Milky Way galaxy.

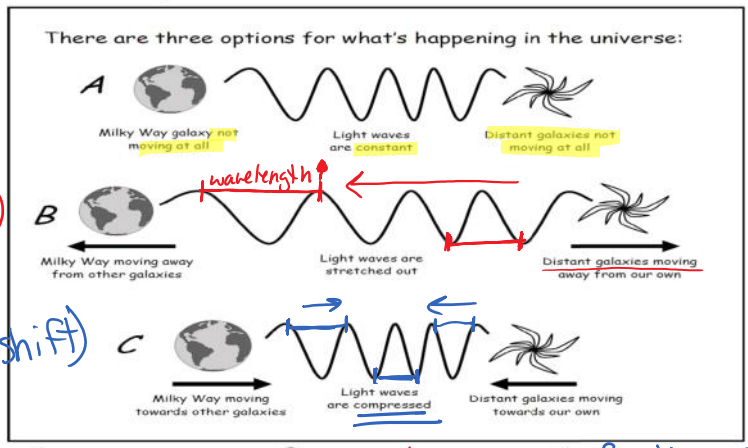
In honour of Hubble's observations, the first large space telescope was named the Hubble Space Telescope.

The Hubble Space Telescope is a space telescope that was launched into low Earth orbit in 1990 and remains in operation today.

Hubble is one of the largest and most versatile telescopes, and is well known as both a vital research tool and a public relations boon for astronomy.



One Shift Two Shift, Red Shift Blue shift



(Redshift)

(Blueshift)

A "Steady State Theory"
- the universe is and will always be standing still.

B Expanding Universe
- starlight is stretched out (longer wavelengths) because galaxies are moving away from us.

C If the universe was collapsing.
- starlight is compressed.
- shorter wavelengths.

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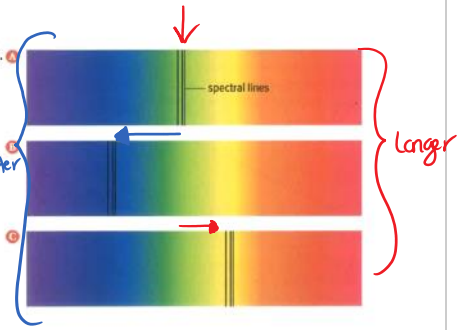
Redshift & Blueshift

Examine the spectral images shown to the right.

In A the star is not moving. In B the spectral lines have shifted towards the BLUE end of the spectrum. In C the spectral lines have shifted toward the RED end of the spectrum.

As we know from the **Electromagnetic Spectrum**, Longer wavelengths are associated with the red end of the spectrum.

When an object moves away from an observer, the wavelengths lengthens. We know this from the Doppler Effect.



Since the wavelength has lengthened, and the spectral lines have shifted toward the RED end of the spectrum, astronomers say that the spectrum of the object has "red-shifted"

The opposite effect occurs when an object moves ***towards*** an observer, the wavelengths short/compressed. When the wavelength has shortened, and the spectral lines have shifted toward the Blue end of the spectrum, astronomers say that the spectrum of the object has "blue-shifted"

How is redshift evidence of the big bang?

Hubble's study of the spectra of the observable distant galaxies revealed that the spectral lines of most of these galaxies are redshifted.

This means that these galaxies are moving AWAY from our galaxy, the Milky Way Galaxy.

This suggests that our universe is expanding, not standing still or collapsing.

" Universe Expansion" is a key part to the Big Bang Theory.


EDWIN HUBBLE'S CAR

Summary: Match the following terms: *(draw a line to connect)*

Redshifted

Blueshifted

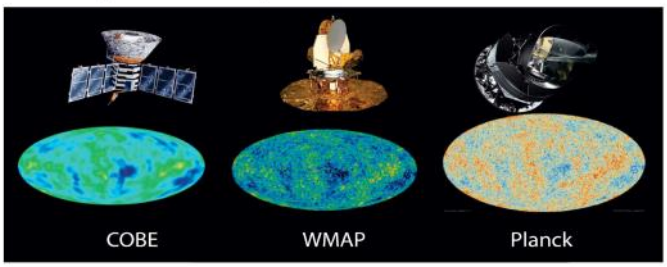
moving toward an observer, the effect of shortening of their wavelengths toward the blue end of the visible spectrum

moving ~~toward~~ away from an observer, the effect of ~~shortening~~ lengthening of their wavelengths toward the ~~blue~~ red end of the visible spectrum

Evidence of The Big Bang Theory: Cosmic Microwave Background Radiation

The idea of an expanding universe was proposed in 1922 by a Russian physicist, Alexander Friedmann, and further developed in 1927 by a Belgian priest and astrophysicist Georges Lemaitre. He suggested that if the universe is expanding, ist must have started out very small and dense.

The Hubble telescope was able to collect data and "look back in time: to show that the universe began its expansion about 13.8 billion years ago in and event called the Big Bang. The universe began expanding with unimaginable violence from a hot and incredibly dense state to it's present state.



The COBE (1989) and WMAP (2001) missions by NASA were able to take images and collect data like never before. PLANCK was a space observatory operated by the European Space Agency from 2009 to 2013, which mapped cosmic microwave background at microwave and infra-red frequencies, with high sensitivity and small angular resolution.

what type of waves.

All these staellites were designed to measure Cosmic Microwave Background Radiation (CMB Radiation).

very high energy

This is radiation left over from the Big Bang. At the time of the Big Bang, when the universe first began to expand, it was very hot and very dense. It was filled with short wavelength gumma rays. As the universe expanded, the gamma rays stretched and the radiation changed from gamma rays to visible light (longer wavelength).

more

As the universe continued to expand over billions over years the wavelengths stretched, the radiation changed further into cooler parts of the electromagnetic spectrum. (lower energy)

Today, the wavelength of the CMB radiation that astronomers observe is about 1.07 nm, which is in the microwave part of the spectrum.

The colours represent slight variations in the temperature.

Blue spots are cooler, valleys which are mostly low density ~~dense~~, empty space.

very little "stuff" matter

Yellow-red spots are ridge. These "hot spots" represent peaks of HIGH density, where more matter is. more "stuff"

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Homework

Assignment #5.3 Complete the Periodic Table Assignment in the space provided.

I. Find the elements below on the periodic table (next page) and put a star in the top-right corner of the box of each one.

1. Hydrogen (H)
2. Helium (He)
3. Oxygen (O)
4. Carbon (C)
5. Neon (Ne)
6. Iron (Fe)
7. Nitrogen (N)
8. Silicon (Si)
9. Magnesium (Mg)
10. Sulfur (S)

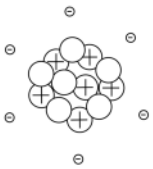
II. Circle the heavier element of each element pair listed below.
(don't circle it on your periodic table, just circle it below)

1. Gold (Au) or Silver (Ag)
2. Aluminium (Al) or Iron (Fe)
3. Calcium (Ca) or Silicon (Si)
4. Carbon (C) or Sulfur (S)
5. Hydrogen (H) or Helium (He)
6. Einsteinium (Es) or Europium (Eu)

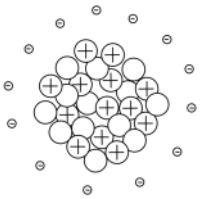
Top Ten Elements in The Universe

III. Name the elements shown in the following drawings:

1.



2.



IV. Draw a diagram to represent each of the following atoms:

1. Helium (He)
2. Oxygen (O)

V. On your periodic table, shade all of the elements that came from the big bang in light yellow, all of the elements that came from nuclear fusion in light green, and all of the elements that come from supernovas in light red (use your notes or your purple packets to help you out if you need).

VI. For each of the following elements identify whether it most likely originated from the big bang, nuclear fusion in stars, or through supernovas

1. Gold (Au): _____
2. Sodium (Na): _____
3. Hydrogen (H): _____
4. Carbon (C): _____
5. Helium (He): _____
6. Uranium (U): _____

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Answer Key

I. Check to make sure that they put a star in the boxes of the elements specified

II. Heavier elements are bolded in the pairs below:

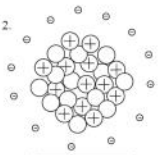
1. **Gold (Au)** or Silver (Ag)
2. Aluminium (Al) or **Iron (Fe)**
3. **Calcium (Ca)** or Silicon (Si)
4. Carbon (C) or **Sulfur (S)**
5. Hydrogen (H) or **Helium (He)**
6. **Einsteinium (Es)** or Europium (Eu)

III. Element names are listed below each diagram.

1.

carbon

2.

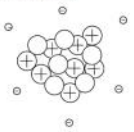


aluminum

IV. Appropriate diagrams are drawn below

1. Helium (He)

2. Oxygen (O)



V. The element Hydrogen and half of the element Helium should be shaded in light yellow since they come from the big bang. The other half of the element helium and all of the elements up until iron should be shaded in light green since they come from nuclear fusion. All of the rest of the elements should be shaded in light red since they come from supernova explosions.

VI. Answers listed below

1. Gold (Au): *Supernova*
2. Sodium (Na): *Nuclear Fusion*
3. Hydrogen (H): *Big Bang*
4. Carbon (C): *Nuclear Fusion*
5. Helium (He): *Big Bang or Nuclear Fusion*
6. Uranium (U): *Supernova*

PERIODIC TABLE OF ELEMENTS

If you were absent the day that we went over this as a class then you will need to use the "Periodic Table Overview" paper to help you fill this out. Ask your teacher where to find it.

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

AN ELEMENT IS...

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