Shedding Light on Atoms Episode 5: Protons, Neutrons, and Electrons Name: _____

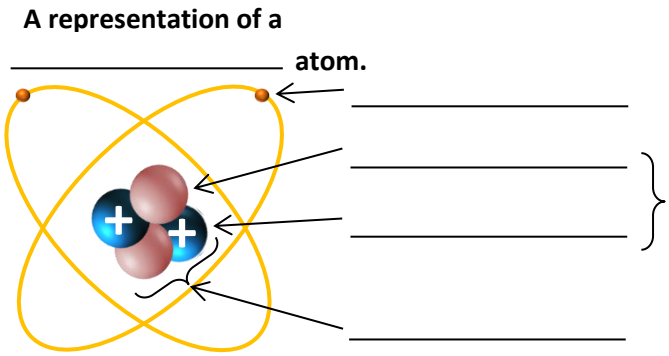
Part A

1. For a long time people thought that the smallest particles in nature were atoms. We now know that atoms are made of _____, _____, and _____.
2. Mendeleev organised the elements into Groups based on similarities in the way that they behaved chemically. For example, the atoms of the elements within each Group form compounds with oxygen atoms only in specific ratios. Fill in the table below. The first row has been done for you.

	Group							
Oxides Formed Between Each Element and Oxygen	**1** (Mendeleev's Group 1)		**2** (Mendeleev's Group 2)		**13** (Mendeleev's Group 3)		**14** (Mendeleev's Group 4)	
	Na	Na_2O	Mg	MgO	Al	Al_2O_3	Si	SiO_2
	K		Ca		Ga		Ge	
	Rb		Sr		In		Sn	

Part B

3. Label the diagram below.



4. We can tell it is a representation of a _____ atom because it has _____ protons in its _____. If it had 3 protons in its nucleus it would be a _____ atom.

5. _____ have a _____ charge, _____ have a _____ charge, and _____ are neutral.
6. Why do the electrons keep moving around the nucleus instead of flying off away from it?

_____

_____

_____

7. Why don't the protons, which all have the same positive charge, repel each other and fly apart?

_____

_____

_____

8. What stops us from flying off into space every time we jump into the air?

_____

_____

(Your three answers above relate to three of the four "fundamental forces of nature". The other one is called the "weak interaction", which you might study if you decide to study Physics at university.)

9. The **atomic number** of an atom (given the symbol Z) is defined as _____

_____

10. How does the number of protons in an atom compare to the number of electrons in an atom?

_____

_____

11. Fill in the tables below. (You may need to consult a Periodic Table.)

Element	Element Symbol	Atomic Number (Z)	No. of electrons
Sodium			
Fluorine			
Carbon			
Chlorine			

Element	Element Symbol	Atomic Number (Z)	No. of electrons
	O		
	N		
	U		
	Li		

12.

A (mass number) = no. of _____ + no. of _____ in the nucleus.

Z (atomic number) = no. of _____ in the nucleus.

$^{A}_{Z}X$

X is the name of the element

$^{9}_{4}Be$

No. of protons + no. of neutrons in the nucleus of a $^{9}_{4}Be$ atom: _____
No. of protons in the nucleus of a $^{9}_{4}Be$ atom: _____
No. of neutrons in the nucleus of a $^{9}_{4}Be$ atom: _____
No. of electrons moving around the nucleus of a $^{9}_{4}Be$ atom: _____

13. While all the atoms of any given element have the same number of protons, they don't all have the same number of neutrons. How many protons, neutrons, and electrons are in the following atoms?

(a) $^{19}_{9}F$ _____

(b) $^{20}_{9}F$ _____

(c) $^{1}_{1}H$ _____

(d) ^{11}B (This notation is often used on webpages. You may need a Periodic Table.)

_____

(e) Ti-48 _____

14. $^{12}_{6}C$, $^{13}_{6}C$, and $^{14}_{6}C$ are all naturally occurring **isotopes** of carbon. Write down **three** things that they all have in common and describe **one** thing that is different about them.

_____

_____

_____

15. Fill in the table below. You will need a periodic table.

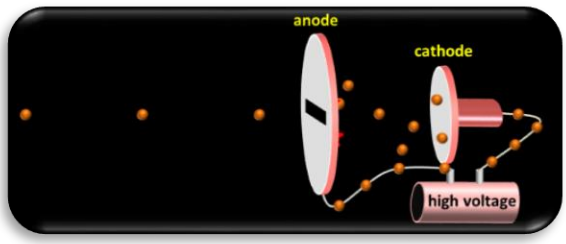
Element	Isotope	Atomic Notation $^{A}_{Z}X$	Number of protons (Atomic Number, Z)	Number of nucleons (Mass Number, A)	Number of neutrons	Number of electrons
lithium	lithium-7	$^{7}_{3}$Li				
	lithium-6					
			8	16		
				17	9	
				235		92
uranium				238		

16. Draw a representation of a Lithium-6 atom, labelling the three types of subatomic particles that make it up.

Part C

17. Two balloons are rubbed on cloth and it is then found that they repel one another. Why does this happen?

18. What happened (in 1895) when J.J. Thomson connected a high-voltage power supply to two metal plates?



19. How does the mass of an electron compare with the mass of a proton?

20. Describe and draw a diagram of Thomson's (incorrect) "Plum Pudding" model of the atom (which he proposed before protons and neutrons were discovered).

21. What is an alpha particle, and where do they come from?

Part D

22. Uranium-238 is an alpha-particle emitter. Write down the **nuclear equation** which express what happens when the uranium atom ejects an alpha particle.

23. Complete the following nuclear equations. You will need a periodic table.

mass number (number of protons + neutrons)

atomic number (number of protons)

$^{210}_{84}Po \rightarrow \square\!\!\square Pb + {}^{4}_{2}alpha$

$^{241}_{95}Am \rightarrow \square\!\!\square\,\square + {}^{4}_{2}alpha$

$\square\!\!\square Pu \rightarrow \square\!\!\square\,\square + \square\!\!\square\,\alpha$

24. How are alpha particles similar to helium atoms and how are they different?

Part E

25. Briefly describe Rutherford's Gold Foil Experiment and explain how it led to the discovery that most of the atom's mass is concentrated in a small "nucleus".

26. Approximately how large is an atom compared to its nucleus.

Part F

27. In 1913, Henry Moseley found a way of calculating the amount of positive charge in the nucleus of the atoms of each element. How did he do this?

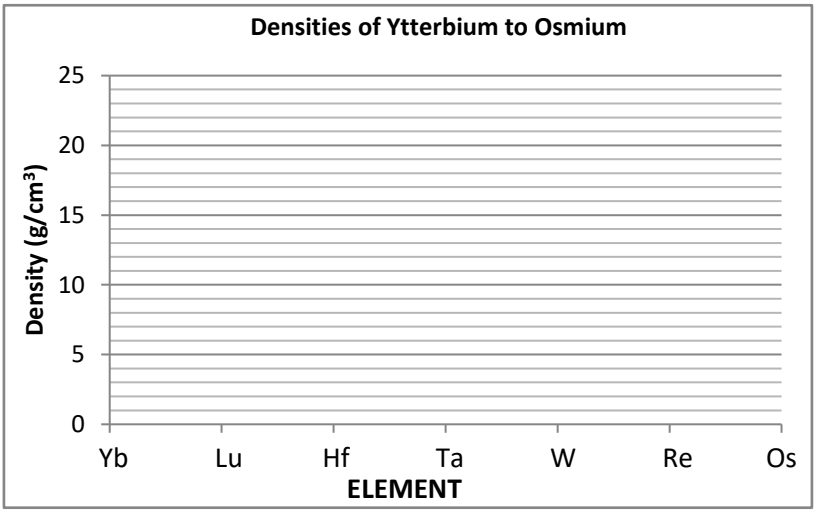
28. In 1917, Earnest Rutherford discovered that the nucleus of a hydrogen atom is made of

29. Neutrons were discovered in the year _____

30. Why did it take so long for neutrons to be discovered?

31. Mendeleev used trends in the order of the elements to predict properties of undiscovered elements. He used the elements' atomic weights, but the trends work better if atomic number is used instead.
Plot the data in the table and then determine the density of Hafnium.

Element	Symbol	Atomic Number (Z)	Density
Ytterbium	Yb		6.9
Lutetium	Lu		9.84
Hafnium	Hf		
Tantalum	Ta		16.7
Tungsten	W		19.4
Rhenium	Re		21.0
Osmium	Os		22.6



Question 30 relates to a trend in a physical property—density—of the elements. Most of the trends in the physical and chemical properties of the elements relate not just to the number of protons in the nucleus, but, just as importantly, to the way the electrons are arranged within atoms in so-called "electron shells", so that's what we'll be looking at in our next episode.