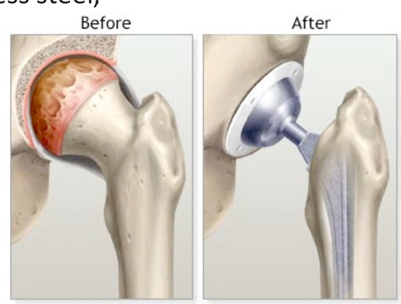
Central Oklahoma Rural Partnership For Science

Name____ Teacher_________________

PERIODIC TABLE TRENDS: DON'T OVERREACT! | FORMATIVE ASSESMENT TASK HS-PS1-1

Read the following information carefully. You will use this information in the tasks on the following pages.

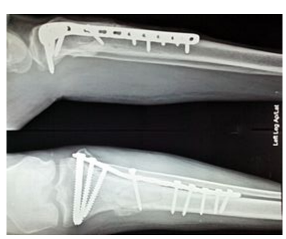
Often when we severely injure our body's skeletal system, such as when we break a bone or wear out an important joint, some type of medical implant is used to repair the damage or replace the worn-out parts. Metal surgical implants were first used as early as the 1920s[1]. Many implants are made of metals or metal alloys (mixtures of different types of metals). Stainless steel, cobalt-chromium-based alloys, and titanium alloys are commonly used[2].



While numerous issues could arise following surgery, one of the most fundamental issues is the interaction between the surrounding tissues and body fluids and the surface of the implant itself[3]. A negative interaction can lead to either a failure of the implant to function as it was intended or an immune response resulting in rejection of the metal implant[3].

It is critically important for surgical devices to be made of a metal alloy that will perform well in its implanted location[2]. Therefore, when choosing an alloy, biomedical engineers must consider the physical properties of the metals, such as density, specific heat, melting point, thermal conduction and expansion, malleability (ability to be molded and bent), and susceptibility to corrosion[3].

The human body's internal environment is highly oxygenated, has a slightly basic pH (about 7.4), and has a temperature of 98.6°F (37°C). The body is not a hospitable environment for an implanted metal alloy[3]. Corrosion of the metal alloys that make up medical implants is heavily influenced by small changes in the pH of the body[2].



[1] Markatos, Konstantinos; Tsoucalas, Gregory; Sgantzos, Markos. "Hallmarks in the History of Orthopaedic Implants for Trauma and Joint Replacement," 2016. Acta Medico-Historica Adriatica 14(1); pp.161-176
[2] Hansen, Douglas C. "Metal Corrosion in the Human body: The Ultimate Bio-Corrosion Scenario," 2008 The Electrochemical Society Interface Summer pp. 31-34
[3] Walley, Kempland C.; Bajraliu, Mergim; Gonzalez, Tyler; Nazarian, Ara. "The Chronicle of a Stainless Steel Orthopaedic Implant," 2016 The Orthopaedic Journal @ The Harvard Medical School pp.68-74

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The same chemical interactions caused by changes in body pH that result in corrosion of metal medical implants can also cause some peoples' bodies to react with metal jewelry. This reaction can result in discolorations to your skin and your jewelry, and can even cause pitting to occur on some of the metal exposed to your skin.

TASK 1

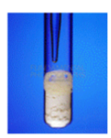
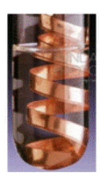
A group of students planned and conducted an investigation to determine the reactivity of metals by placing them in simple diluted acid. They did this by placing a small piece of each of the following metals into a test tube:

- Zinc
- Calcium
- Copper
- Magnesium

They then added 15 mL of the diluted acid to the test tubes and recorded the following observations.

1. Based on the students' observations, **number the metals in order (in the empty boxes on the right)** from:
    - 1-Least reactive
      to
    - 4- Most reactive

Ex. **1**

Picture of Reaction	Student Observations	Order of Reactivity 1- 4
	Zinc bubbled a little.	
	Calcium made lots of bubbles, got warm and made a large pop	
	Copper did not have any bubbles or other visible reaction.	
	Magnesium made lots of bubbles and made a smaller pop	

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2. Using the students' observations as evidence, provide an explanation for why you placed the metals in the order you did.

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TASK 2

Obtain the *Metal Reactivity Series* handout from your teacher. The table shows a selection of common metals and describes their reactivity with water, air, and diluted acids. In reactions involving metal compounds, a more reactive metal will displace a less reactive metal.

3. What patterns/trends do you observe in the data presented in the *Metal Reactivity Series* handout that could help you understand why some metals react to the human body and others don't? (For example, what happens as you move down the chart?)

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<u>Locate the elements found on the *Metal Reactivity Series* handout on a periodic table to answer the following question.</u>

4. What patterns do you observe about the location of the **most reactive** and **the least reactive** metals and where they are found **<u>on the periodic table</u>**?

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TASK 3

Locate the elements from the Reactivity Series of Non-Metal Elements table below on the periodic table to answer the following question.

Reactivity Series of Non-Metal Elements		
Most Reactive	**Element Name**	**Symbol**
	Fluorine	F
	Chlorine	Cl
	Oxygen	O
	Bromine	Br
	Iodine	I
	Sulfur	S
	Phosphorus	P
Least Reactive		

5. What patterns do you observe about the location of the **most reactive** and **the least reactive** non-metal elements **<u>on the periodic table</u>**?

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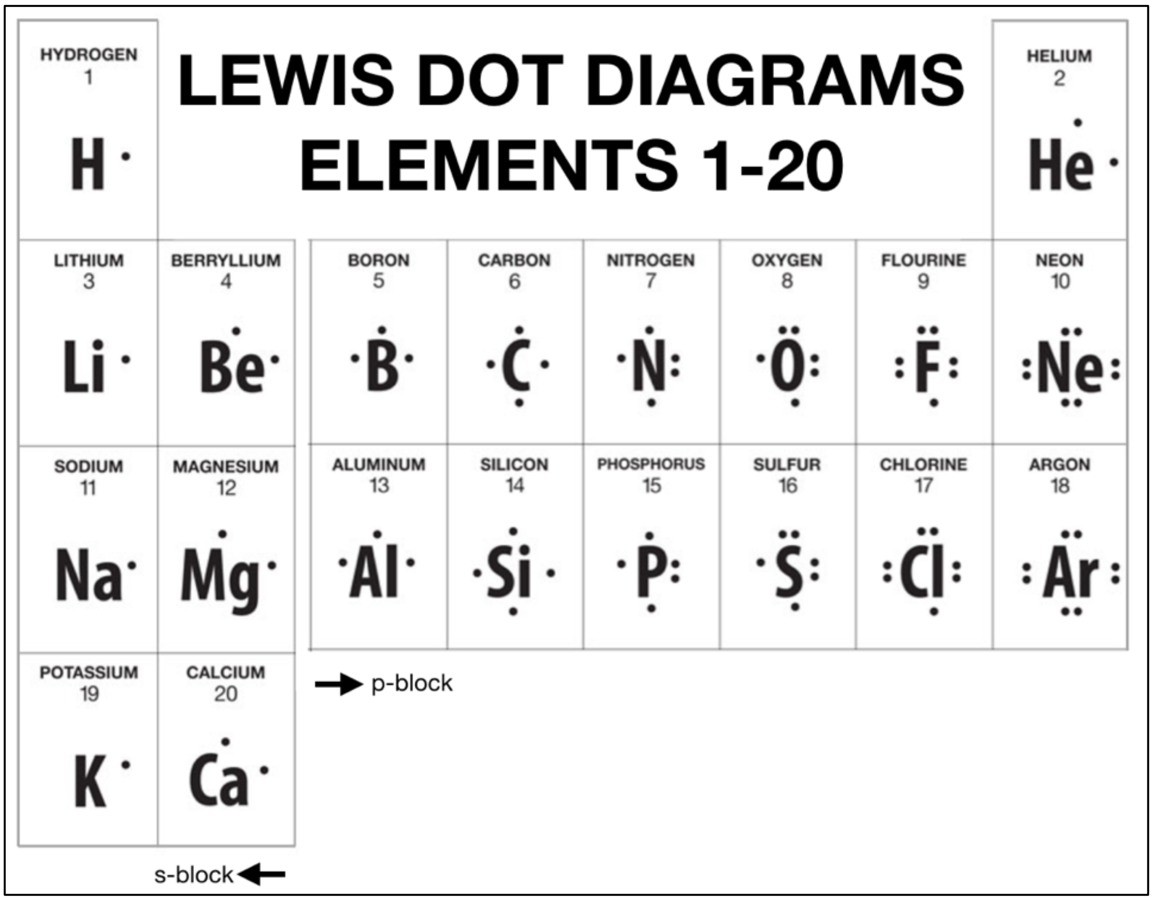
TASK 4

All existing elements tend to react in ways that create a more stable form. In order to do this, most atoms tend to gain or lose electrons so that the outer level of the atom has as many electrons as it can hold. Elements in groups 1-2 & 13-18 (main group elements) generally need 8 electrons to have a full outer shell, or orbital level. Elements in the top row, Hydrogen and Helium, need only 2 electrons. The model below shows the number of electrons in the outermost level (valence electrons) for the first 20 elements on the periodic table.



6. What do you notice about the valence electrons of the elements shown on the periodic table models above? (What happens as you move left to right or top to bottom on the periodic table?)

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7. How are the valence electrons related to the locations of the **most reactive** and **least reactive** metals and non-metals on the periodic table from **Task 2 and Task 3**?

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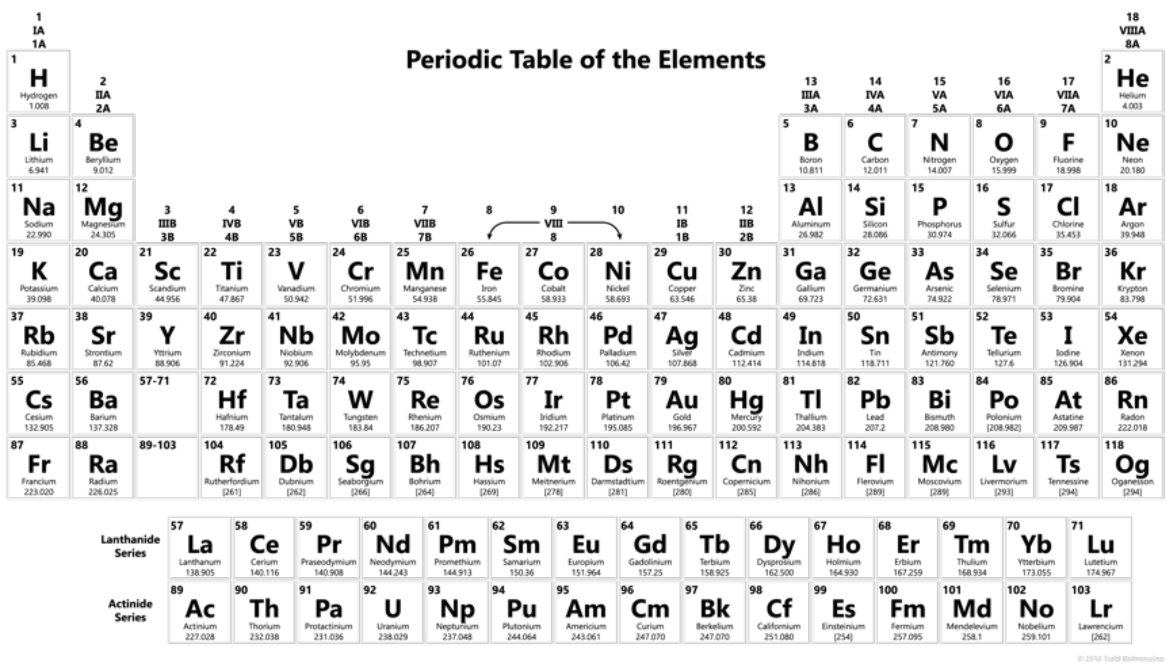
8. On the periodic table below, draw and **<u>label</u>** arrows (← , → , ↑ , ↓) to show the following trends or patterns that you previously identified:
    a. Reactivity
    b. Number of outer electrons (valence electrons)



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9. Construct a claim to answer the following question:

“Why do you think that most medical implants and jewelry are made from metal alloys located toward the center of the periodic table?”

Use your understanding of the periodic table, how atoms interact with each other, and any information in this learning activity to help you provide evidence to support the claim that you are making.

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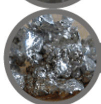
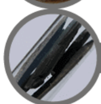
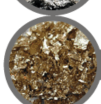
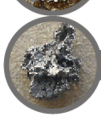
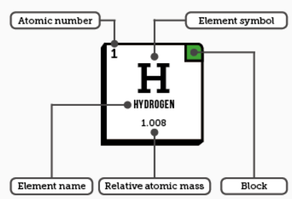
THE METAL REACTIVITY SERIES

Metals can be ordered according to their reactivities; the table below shows a selection of common metals and their reactivities with water, air, and dilute acids. A more reactive metal will displace a less reactive metal from a compound.

METAL NAME & SYMBOL	REACTION WITH COLD WATER *Produces metal hydroxide & hydrogen*	REACTION WITH STEAM *Produces metal oxide & hydrogen*	REACTION WITH AIR/OXYGEN *Produces metal oxide*	REACTION WITH DILUTE ACIDS *Produces metal salt & hydrogen*	EXTRACTION METHOD
 POTASSIUM (K)	VIOLENT REACTION	VIOLENT REACTION	REACTS READILY	VIOLENT REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
 SODIUM (Na)	STRONG REACTION	VIOLENT REACTION	REACTS READILY	VIOLENT REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
 CALCIUM (Ca)	MODERATE REACTION	VIOLENT REACTION	REACTS READILY	VIOLENT REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
 LITHIUM (Li)	MODERATE REACTION	STRONG REACTION	REACTS READILY	VIGOROUS REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
 MAGNESIUM (Mg)	VERY SLOW REACTION	STRONG REACTION	SLOW REACTION	VIGOROUS REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
 ALUMINIUM (Al)	NO REACTION	MODERATE REACTION	SLOW REACTION	MODERATE REACTION	ELECTROLYSIS OF MOLTEN METAL ORE
(Carbon)					
 ZINC (Zn)	NO REACTION	MODERATE REACTION	REACTS WHEN HEATED	MODERATE REACTION	METAL ORE SMELTED WITH CARBON
 IRON (Fe)	NO REACTION	REVERSIBLE REACTION	REACTS WHEN HEATED	MODERATE REACTION	METAL ORE SMELTED WITH CARBON
 NICKEL (Ni)	NO REACTION	SLOW REACTION	REACTS WHEN HEATED	SLOW REACTION	METAL ORE SMELTED WITH CARBON
 TIN (Sn)	NO REACTION	NO REACTION	REACTS WHEN HEATED	SLOW REACTION	METAL ORE SMELTED WITH CARBON
 LEAD (Pb)	NO REACTION	NO REACTION	REACTS WHEN HEATED	SLOW REACTION	METAL ORE SMELTED WITH CARBON
(Hydrogen)					
 COPPER (Cu)	NO REACTION	NO REACTION	REACTS WHEN HEATED	NO REACTION	HEAT OR PHYSICAL EXTRACTION
 MERCURY (Hg)	NO REACTION	NO REACTION	REVERSIBLE REACTION	NO REACTION	HEAT OR PHYSICAL EXTRACTION
 SILVER (Ag)	NO REACTION	NO REACTION	NO REACTION	NO REACTION	HEAT OR PHYSICAL EXTRACTION
 GOLD (Au)	NO REACTION	NO REACTION	NO REACTION	NO REACTION	HEAT OR PHYSICAL EXTRACTION
 PLATINUM (Pt)	NO REACTION	NO REACTION	NO REACTION	NO REACTION	HEAT OR PHYSICAL EXTRACTION

THE PERIODIC TABLE OF ELEMENTS

Symbol Key



Colour Key

Groups of elements

- s block elements
- p block elements
- d block elements
- f block elements

1 H HYDROGEN 1.008																	2 He HELIUM 4.003
3 Li LITHIUM 6.941	4 Be BERYLLIUM 9.012											5 B BORON 10.811	6 C CARBON 12.011	7 N NITROGEN 14.007	8 O OXYGEN 15.999	9 F FLUORINE 18.998	10 Ne NEON 20.180
11 Na SODIUM 22.990	12 Mg MAGNESIUM 24.305											13 Al ALUMINIUM 26.982	14 Si SILICON 28.086	15 P PHOSPHORUS 30.974	16 S SULFUR 32.065	17 Cl CHLORINE 35.453	18 Ar ARGON 39.948
19 K POTASSIUM 39.098	20 Ca CALCIUM 40.078	21 Sc SCANDIUM 44.956	22 Ti TITANIUM 47.867	23 V VANADIUM 50.942	24 Cr CHROMIUM 51.996	25 Mn MANGANESE 54.938	26 Fe IRON 55.845	27 Co COBALT 58.933	28 Ni NICKEL 58.693	29 Cu COPPER 63.546	30 Zn ZINC 65.382	31 Ga GALLIUM 69.723	32 Ge GERMANIUM 72.640	33 As ARSENIC 74.922	34 Se SELENIUM 78.971	35 Br BROMINE 79.904	36 Kr KRYPTON 83.798
37 Rb RUBIDIUM 85.468	38 Sr STRONTIUM 87.620	39 Y YTTRIUM 88.906	40 Zr ZIRCONIUM 91.224	41 Nb NIOBIUM 92.906	42 Mo MOLYBDENUM 95.951	43 Tc TECHNETIUM (97.907)	44 Ru RUTHENIUM 101.072	45 Rh RHODIUM 102.906	46 Pd PALLADIUM 106.421	47 Ag SILVER 107.868	48 Cd CADMIUM 112.414	49 In INDIUM 114.818	50 Sn TIN 118.711	51 Sb ANTIMONY 121.760	52 Te TELLURIUM 127.603	53 I IODINE 126.904	54 Xe XENON 131.294
55 Cs CAESIUM 132.905	56 Ba BARIUM 137.328	E57-71	72 Hf HAFNIUM 178.492	73 Ta TANTALUM 180.948	74 W TUNGSTEN 183.841	75 Re RHENIUM 186.207	76 Os OSMIUM 190.233	77 Ir IRIDIUM 192.217	78 Pt PLATINUM 195.084	79 Au GOLD 196.967	80 Hg MERCURY 200.592	81 Tl THALLIUM 204.383	82 Pb LEAD 207.210	83 Bi BISMUTH 208.980	84 Po POLONIUM (208.982)	85 At ASTATINE (209.987)	86 Rn RADON (222.018)
87 Fr FRANCIUM (223.020)	88 Ra RADIUM (226.025)	E89-103	104 Rf RUTHERFORDIUM (261.109)	105 Db DUBNIUM (262.114)	106 Sg SEABORGIUM (266.122)	107 Bh BOHRIUM (264.120)	108 Hs HASSIUM (277.000)	109 Mt MEITNERIUM (268.139)	110 Ds DARMSTADTIUM (281.000)	111 Rg ROENTGENIUM (280.000)	112 Cn COPERNICIUM (285.000)	113 Nh NIHONIUM (286.000)	114 Fl FLEROVIUM (289.000)	115 Mc MOSCOVIUM (289.000)	116 Lv LIVERMORIUM (293.000)	117 Ts TENNESSINE (294.000)	118 Og OGANESSON (294.000)

57 La LANTHANIUM 138.905	58 Ce CERIUM 140.116	59 Pr PRASEODYMIUM 140.908	60 Nd NEODYMIUM 144.242	61 Pm PROMETHIUM (144.000)	62 Sm SAMARIUM 150.362	63 Eu EUROPIUM 151.964	64 Gd GADOLINIUM 157.253	65 Tb TERBIUM 158.925	66 Dy DYSPROSIUM 162.500	67 Ho HOLMIUM 164.930	68 Er ERBIUM 167.259	69 Tm THULIUM 168.934	70 Yb YTTERBIUM 173.054	71 Lu LUTECIUM 174.967
89 Ac ACTINIUM (227.028)	90 Th THORIUM (232.038)	91 Pa PROTACTINIUM (231.036)	92 U URANIUM (238.029)	93 Np NEPTUNIUM (237.048)	94 Pu PLUTONIUM (244.064)	95 Am AMERICIUM (243.061)	96 Cm CURIUM (247.070)	97 Bk BERKELIUM (247.070)	98 Cf CALIFORNIUM (251.080)	99 Es EINSTEINIUM (252.083)	100 Fm FERMIUM (257.095)	101 Md MENDELEVIUM (258.098)	102 No NOBELIUM (259.101)	103 Lr LAWRENCIUM (262.110)