

Name: Stewart Date: \_\_\_\_\_ Period: \_\_\_\_\_

# NOVA: Hunting the Elements

## Part 1: Basic Chemistry

### Blank Periodic Table

Fill in the parts of this periodic table covered by the documentary.

Hydrogen	1	H
Lanthanide	2	He
Alkali metals	3	Li
Alkaline earth metals	4	Be
Post-transition metals	5	Sc
Transition metals	6	Ti
Post-transition metals	7	V
Metals	8	Cr
Post-transition metals	9	Mn
Metals	10	Fe
Post-transition metals	11	Co
Metals	12	Ni
Post-transition metals	13	Cu
Metals	14	Zn
Post-transition metals	15	Ga
Metals	16	Ge
Nonmetals	17	Al
Nonmetals	18	Si
Nonmetals	19	P
Nonmetals	20	S
Nonmetals	21	Cl
Nonmetals	22	Ar
Halogens	23	K
Halogen	24	Ca
Alkaline earth metals	25	Sc
Post-transition metals	26	Ti
Transition metals	27	V
Post-transition metals	28	Cr
Metals	29	Mn
Post-transition metals	30	Fe
Metals	31	Co
Post-transition metals	32	Ni
Metals	33	Cu
Post-transition metals	34	Zn
Metals	35	Ga
Post-transition metals	36	Ge
Metals	37	Al
Post-transition metals	38	Si
Metals	39	P
Post-transition metals	40	S
Metals	41	Cl
Post-transition metals	42	Ar
Metals	43	K
Post-transition metals	44	Ca
Metals	45	Sc
Post-transition metals	46	Ti
Metals	47	V
Post-transition metals	48	Cr
Metals	49	Mn
Post-transition metals	50	Fe
Metals	51	Co
Post-transition metals	52	Ni
Metals	53	Cu
Post-transition metals	54	Zn
Metals	55	Ga
Post-transition metals	56	Ge
Metals	57	Al
Post-transition metals	58	Si
Metals	59	P
Post-transition metals	60	S
Metals	61	Cl
Post-transition metals	62	Ar
Metals	63	K
Post-transition metals	64	Ca
Metals	65	Sc
Post-transition metals	66	Ti
Metals	67	V
Post-transition metals	68	Cr
Metals	69	Mn
Post-transition metals	70	Fe
Metals	71	Co
Post-transition metals	72	Ni
Metals	73	Cu
Post-transition metals	74	Zn
Metals	75	Ga
Post-transition metals	76	Ge
Metals	77	Al
Post-transition metals	78	Si
Metals	79	P
Post-transition metals	80	S
Metals	81	Cl
Post-transition metals	82	Ar
Metals	83	K
Post-transition metals	84	Ca
Metals	85	Sc
Post-transition metals	86	Ti
Metals	87	V
Post-transition metals	88	Cr
Metals	89	Mn
Post-transition metals	90	Fe
Metals	91	Co
Post-transition metals	92	Ni
Metals	93	Cu
Post-transition metals	94	Zn
Metals	95	Ga
Post-transition metals	96	Ge
Metals	97	Al
Post-transition metals	98	Si
Metals	99	P
Post-transition metals	100	S
Metals	101	Cl
Post-transition metals	102	Ar
Metals	103	K
Post-transition metals	104	Ca
Metals	105	Sc
Post-transition metals	106	Ti
Metals	107	V
Post-transition metals	108	Cr
Metals	109	Mn
Post-transition metals	110	Fe
Metals	111	Co
Post-transition metals	112	Ni
Metals	113	Cu
Post-transition metals	114	Zn
Metals	115	Ga
Post-transition metals	116	Ge
Metals	117	Al
Post-transition metals	118	Si
Metals	119	P
Post-transition metals	120	S
Metals	121	Cl
Post-transition metals	122	Ar

noble metals

Hydrogen	1	H
Lanthanide	2	He
Alkali metals	3	Li
Alkaline earth metals	4	Be
Post-transition metals	5	B
Transition metals	6	C
Post-transition metals	7	N
Metals	8	O
Post-transition metals	9	F
Metals	10	Ne
Post-transition metals	11	K
Metals	12	Ca
Post-transition metals	13	Sc
Metals	14	Ti
Post-transition metals	15	V
Metals	16	Cr
Post-transition metals	17	Mn
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Post-transition metals	27	P
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Post-transition metals	29	Cl
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Post-transition metals	49	Cl
Metals	50	Ar
Post-transition metals	51	K
Metals	52	Ca
Post-transition metals	53	Sc
Metals	54	Ti
Post-transition metals	55	V
Metals	56	Cr
Post-transition metals	57	Mn
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Post-transition metals	65	Al
Metals	66	Si
Post-transition metals	67	P
Metals	68	S
Post-transition metals	69	Cl
Metals	70	Ar
Post-transition metals	71	K
Metals	72	Ca
Post-transition metals	73	Sc
Metals	74	Ti
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Post-transition metals	91	K
Metals	92	Ca
Post-transition metals	93	Sc
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Post-transition metals	105	Al
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Post-transition metals	107	P
Metals	108	S
Post-transition metals	109	Cl
Metals	110	Ar
Post-transition metals	111	K
Metals	112	Ca
Post-transition metals	113	Sc
Metals	114	Ti
Post-transition metals	115	V
Metals	116	Cr
Post-transition metals	117	Mn
Metals	118	Fe
Post-transition metals	119	Co
Metals	120	Ni
Post-transition metals	121	Cu
Metals	122	Zn

\* Lanthanide series

\* Actinide series

Lanthanide	57	La
Actinide	58	Ce
Actinide	59	Pr
Actinide	60	Nd
Actinide	61	Pm
Actinide	62	Sm
Actinide	63	Eu
Actinide	64	Gd
Actinide	65	Tb
Actinide	66	Dy
Actinide	67	Ho
Actinide	68	Er
Actinide	69	Tm
Actinide	70	Yb

Mendeleev  
lived  
to see  
these  
found.

Scandium  
gallium  
germanium

197  
Gold - Au

79

- Write the number of subatomic particles in gold:

a. Protons: 79

b. Neutrons: 118

c. Electrons: 79

- Give one property of gold.

high density, malleable, electrical conductivity

- How much gold is in one ton of the mined rock?

1 oz

4. How much is each truckload of ore worth, once the gold is extracted?

\$ 720 000

5. What determines how reactive an element is?

- ability to give up/take on electrons

6. Write and color code the noble metals \* on the blank periodic table.

ruthenium, rhodium, palladium, silver, osmium  
indium, platinum, gold - sometimes Hg & rhenium.

7. Why is gold so heavy?

high density

Copper - Cu  
<sup>64</sup>  
<sub>29</sub>

8. Write the number of subatomic particles in copper:

a. Protons: 29

b. Neutrons: 35

c. Electrons: 29

\* resistant to oxidation  
and corrosion  
\* usually precious due  
to rarity

9. List three uses of copper. infrastructure. wire, plumbing.  
electronics, jewelry, cookware, roofing material.

10. Give one property of copper.

conductivity, ductility, malleability, antibacterial.

## The Alloy

11. What alloy does tin make when mixed with copper?

$\text{Sn}^{20\%} \text{ Cu}^{80\%} = \text{bronze}$  (first man-made metal alloy)

12. How are atoms arranged in pure metals?

- orderly rows & columns

13. Why isn't pure copper used for bells instead of bronze?

bronze produces the lasting ring

soft and easy  
to dent

\* adding Sn restricts Cu atoms, makes the alloy harder.

20-30% tin/manganese  
held molten

## Electron Microscope

14. How much would you have to zoom in on a map of the United States to replicate the power of an electron microscope?

100,000,000 X

15. Why is the microscope wrapped in acoustic blankets?

absorb & reflect sound.

16. What part of the atom is actually visible under the microscope?

outer boundary of atom (interior of atom is 10,000X smaller)

17. What do protons determine about an element?

determine identity of element

18. What is the number of protons called?

atomic number

19. Label the atomic number, symbol, and atomic mass of calcium below:

20	atomic number
Ca	symbol
40.08	atomic mass (mass number)

20. Give an example of a real-life object made from each of the following elements:

- Calcium - bone, chalk, milk
- Bismuth - stomach medicine
- Bromine - soda

21. What is a family of elements?

group / column in periodic table

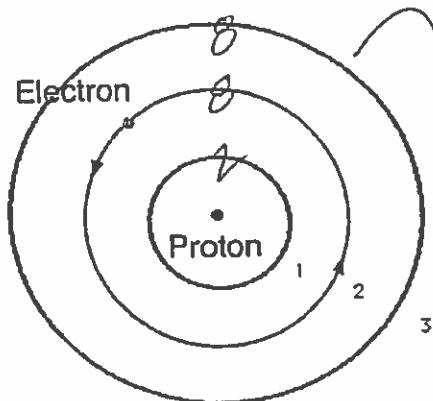
22. Where did the noble gases get their name?

don't combine with other elements

23. What do electrons determine?

reactivity

24. How many electrons can fill each of the orbital levels in the diagram below?



video says 18

<sup>35</sup>  
Chlorine - Cl  
<sup>17</sup>

25. Give the number of atomic particles in chlorine:

a. Protons - 17

b. Neutrons - 18

c. Electrons - 17

26. Chlorine wants to (take) give away one electron, becoming an ion isotope.

27. Why do alkali metals and halogens react so strongly with other elements?

want to lose e<sup>-</sup>      want to gain e<sup>-</sup>

28. What do sodium and chlorine make when combined?

NaCl

29. Compare the properties of each of the following:

	Sodium (Na)	Chlorine (Cl)	Sodium Chloride (NaCl)
State of Matter	Solid	gas	Solid
Reactive or Stable	reactive (poison)	reactive (poison)	stable
Practical Use	Sodium compounds e.g. NaCl	Poison disinfects H <sub>2</sub> O	salt

## Oxygen - O

30. What is ANFO? fertilizer bomb

1995

4000 lbs

Oklahoma

city. Federal

Buildin

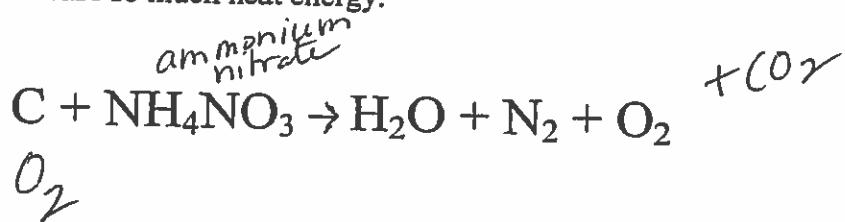
31. What do each of the spikes on the ion chromatograph represent?

fragments  
of original explosive

different elements

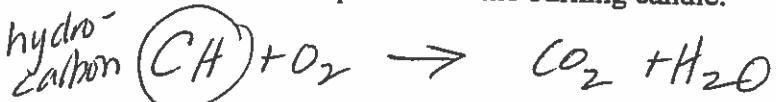
④ Oxygen.

32. This is the chemical reaction of the ANFO explosion. Explain what happens during this reaction to release so much heat energy.



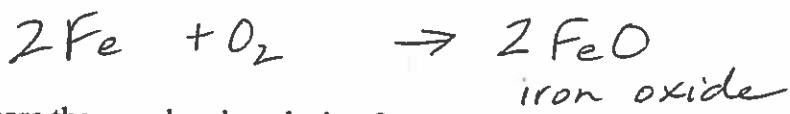
creation  
of bonds releases  
energy

33. Write the chemical equation for the burning candle.



combustion rxns  
cellular  
ind. respiration  
- all same except  
for speed.

34. Write the chemical equation for the formation of rust.



P<sub>2</sub>  
56! 30

35. Compare the speed and explosive force of gunpowder, emulsion-gel, and C4. Which is the fastest?  
Explain why.

✓ oxygen  
powers  
all of these  
reactions

relatively slow

ammonium  
nitrate  
more nitrogen  
→ oxygen  
- faster than speed  
if weighed

C4 (fastest)

burns fast enough to cut steel

O, N, H, C - combine extremely quickly.  
- releases high amounts of energy

# NOVA: Hunting the Elements

Part 2: Chemistry of Life, Rare Earth Elements, and Radioactivity

## Elements of Life

1. List the six most common elements of life, a common object they are found in, and an important property.

Element Symbol	Element Name	Common Object	Important Property
C 18%	carbon	graphite charcoal diamond	- can form long chains because it can form 4 bonds per carbon
H	hydrogen	water	lightest atom in universe
N 3%	nitrogen	fertilizer	
O 65%	oxygen	water	
P 1%	phosphorus	urine	- important for ATP (energy)
S	sulfur	matches car tire	

Gatorade  
Sports  
Science  
Institute

What can happen when excessive trace elements are lost from the body?

- lack of iron can lead to poor oxygen use
- can get cramps

sports  
medicine  
athletes

1:11:18

3. Describe a body function or part that utilizes each of these trace elements:

a. Calcium - bone density

b. Iron - oxygen use (iron in hemoglobin)

c. Potassium - nervous system

d. Zinc - energy metabolism

e. Magnesium - energy metabolism

f. Sodium - nervous system function

25  
elements  
in human  
beings

3-4 b.y.a

Yellowstone

4. What conditions did the earliest bacteria need for energy production?

5. What do cyanobacteria use for energy production? What do they release as waste?

blue/green algae  
light + water  
oxygen

6. In the core sample collected from Yellowstone, which layer is the cyanobacteria?

the top layer - so it has the best chance of survival / production

## Origin of the Elements

light  
 $H_2O$  and  $CO_2$

7. What is the origin of hydrogen, the smallest element?

made by the big bang.

8. Describe the process of fusion and how it produces helium.

process that forces two H atoms to merge to form helium.

"turning mass into energy"

9. What happens when a star runs low on hydrogen fuel?

fuse He making larger (atom<sup>z</sup> number) elements - up to Fe.

10. What is created in supernova explosion?

(collapse) (elements heavier than Fe are created)

## Silicon and Glass

semiconductor

5000 yrs of glass making

silicon + oxygen

70 miles  
ice balls for testing

12. What is added to Gorilla Glass to make it stronger than normal glass?

sodium / potassium / aluminum. (Puts small particles of metals in)  
(ire glass to make it stronger.)

## Rare Earth Elements

one in U.S. (California)

- mine 13. Where do most of the rare earth elements come from?

98% from China but Chinese gov't limits exports

e.g.  
neodimium  
Nd  
for magnet-making

14. How are the fifteen rare earth elements chemically similar?

- identical outer electron shells

15. What elements are rare earth magnets usually made of?

neodimium  
iron  
boron } made in the lab

16. Why are rare earth elements in such short supply?  
- hard to separate  
- new uses  $\therefore$   $\uparrow$  demand  
China limits exports.

17. How do sharks react to rare earth metals?

Sharks are repelled by strong magnets

- non-magnetic  
rare earths also  
repel. - shocks.

18. Describe the following parts of the lemon shark experiment:

Independent Variable - material used with bait

Dependent Variable - reaction of shark (avoided)

Experimental Group - selenium + tuna = avoided by shark.

Control Group - lead + tuna = eaten by shark.

Shark fin  $\ominus$

(+) ions from rare earths.

## Carbon Isotopes

19. What is the difference between the compositions of these carbon isotopes?

	Protons	Electrons	Neutrons
Carbon-12	6	6	6
Carbon-13	6	6	7
Carbon-14	6	6	8

20. What happens to Carbon-14 over time?

- radioactive decays b/c it's unstable  $\rightarrow$  turns to nitrogen.

21. Define radioactive half-life: (time to decay)

Carbon 12 stays same. Carbon-14 decays.

] up to 40,000 yrs old

22. Based on carbon dating, how long ago did the tree die? of living thing.

accelerator  
C-14: C-12

150 yrs ago tree died. - used for understanding climate change.

## Nuclear Radiation

23. Give the number of subatomic particles in uranium:

a. Protons - 92

b. Neutrons - 146

c. Electrons - 92

26 new elements

24. How is the mousetrap simulation similar to a fission chain reaction?

uranium      ping pong balls = neutrons .      - single neutron = chain reaction .

25. What element was used as fuel for the "Little Boy" bomb?

1945

U-235. (rare)

↳ used in WWII against

26. What element was used as fuel for the "Fat Man" bomb?

↳ Pu — 150      Plutonium .

27. The scientists at Lawrence Livermore Lab have been able to produce 6 new, synthetic elements. Why isn't there yet a practical use for these elements?

6 new elements in cyclotron . - decay almost instantly  
∴ not practical for developing applications .

