

NOVA: Hunting the Elements

Part 1: Basic Chemistry

Blank Periodic Table

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

1 H	noble metals																2 He	
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne	
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
19 K	20 Ca	* 21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 *	32 *	33 As	34 Se	35 Br	36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
55 Cs	56 Ba	57-70 *	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-102 * *	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

* Lanthanide series

** Actinide series

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

*
Mendeleev
lived
to see
these
found.
scandium
gallium
germanium

¹⁹⁷
Gold - Au
₇₉

1. Write the number of subatomic particles in gold:

- a. Protons: 79
- b. Neutrons: 118
- c. Electrons: 79

2. Give one property of gold.

high density, malleable, electrical conductivity

3. 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
iridium, platinum, gold - sometimes Hg & rhenium.

7. Why is gold so heavy?

high density

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

Copper - $\overset{64}{\text{Cu}}$
 $\underset{29}{\text{Cu}}$

8. Write the number of subatomic particles in copper:

a. Protons: 29

b. Neutrons: 35

c. Electrons: 29

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?

soft and easy to dent

bronze produces the lasting ring

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

20-30% Au in rate. hold making

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
Ca
Calcium
40.08

atomic number

symbol.

atomic mass (mass number)

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

a. Calcium - bone, chalk, milk

b. Bismuth - stomach medicine

c. Bromine - soda

21. What is a family of elements?

group / column in periodic table.

22. Where did the noble gases get their name?

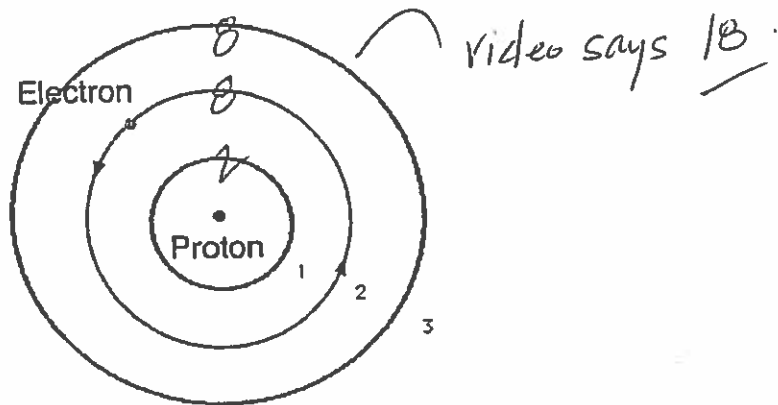
don't combine with other elements

23. What do electrons determine?

reactivity



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



Chlorine - ³⁵Cl
17

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⁻) (want to gain e⁻)

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 eg. NaCl	poison disinfects H ₂ O	salt

Oxygen - O



30. What is ANFO? *fertilizer bomb*

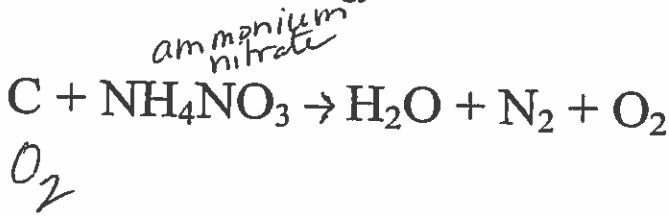
1995
4000 lbs
Oklahoma City Federal Building

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

fragments of original explosive — *different elements*

eg Oxygen.

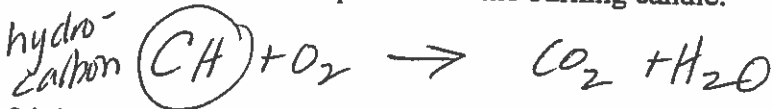
32. This is the chemical reaction of the ANFO explosion. Explain what happens during this reaction to release so much heat energy.



+ CO₂

creation of bonds releases energy

33. Write the chemical equation for the burning candle.



combustion rxns incl. cellular respiration

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



- all same except for speed.

P₂
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 of sound

C4 (fastest) burns fast enough to cut steel.

O, N, H, C - combine extremely quickly. ∴ releases high amts 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 <i>nanotubes graphene</i>	- 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	

97% of body

Gatorade
Sports Science
Insights

1:11:18

P. 1.

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

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

- Calcium - bone density
- Iron - oxygen use (iron in hemoglobin)
- Potassium - nervous system
- Zinc - energy metabolism
- Magnesium - energy metabolism
- 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?

light + water . oxygen .
blue/green algae

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
light
H₂O and CO₂

Origin of the Elements

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.

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

fuse He making larger (atomic number) elements - up to Fe .
"turning mass into energy"

10. What is created in supernova explosion?

(collapse) (elements heavier than Fe are created)

Silicon and Glass

11. What elements is sand made of?

silicon + oxygen

5000 yrs of glass making

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

sodium / potassium / aluminum (Puts small particles of metals in the glass to make it stronger.)
70 mi/hr. ice balls for testing.

Rare Earth Elements

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

98% from China but Chinese gov + limits exports

eg. neodymium .
Nd
for magnet-making .

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

- identical outer electron shells .

semi-conductors

one mine in U.S. (California)

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

neodymium
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 (avoid or eat)

Experimental Group - samarium + tuna = avoided by shark.

Control Group - lead + tuna = eaten by sharks.

shark fin \ominus \oplus 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 after death.

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

} up to 40,000 yrs old

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 atoms)

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.

