

Geosciences 225

Professors:

- Tony Dahlen — Lecturer
- Laurel Goodell — Laboratory Manager
- Karin Sigloch — Laboratory Instructor
- Mark Davidson — Homework Grader

Textbook:

- *Understanding Earth*, Fourth Edition, 2003
Press, Siever, Grotzinger & Jordan
- Useful for vocabulary
- Excellent photos and illustrations
- Not very quantitative
- To be thought of as a third segment of the course (in addition to lectures and labs)

Syllabus:

- first quarter — elements, rocks and time
- second quarter — water and mud
- third quarter — heat and earthquakes
- fourth quarter — the earth as man's abode

Geosciences 225

Homework — 10% of grade

- one problem set every quarter

Exams — 40% of grade

- four closed-book in-class exams — 10% each
- no comprehensive final exam

Laboratories — 25% of grade

- one three-hour lab every week
- one daylong field trip Sunday, October 17

Term Paper: — 25% of grade

- scientific or technical research paper
- no assigned topic — it's your choice
- due on Dean's Date, January 11

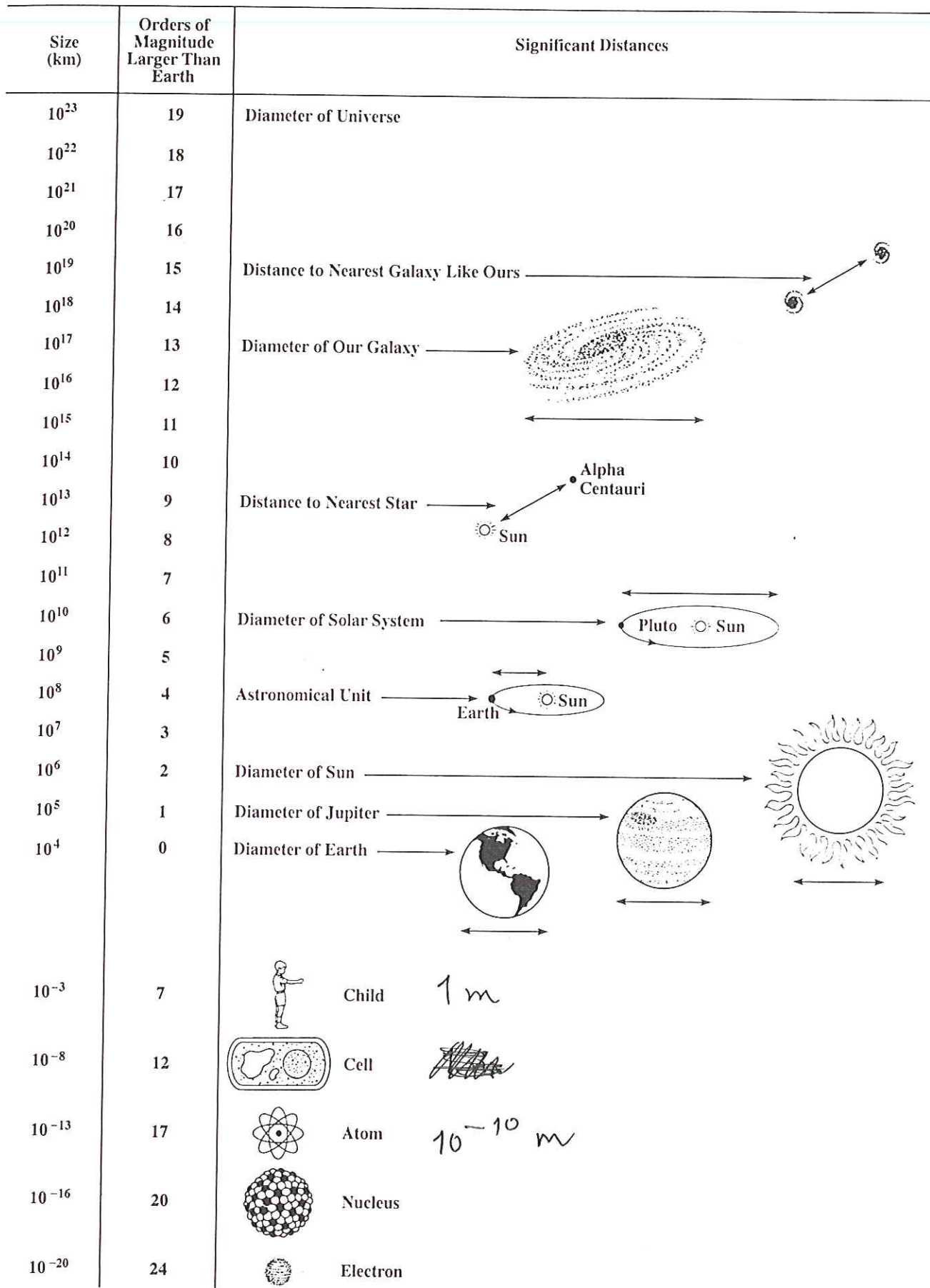


Figure 2.1. Sizes of various objects over the enormous range that the natural world encompasses. From Robbins and Jeffreys (1988) by permission of John Wiley and Sons.

First Class - Friday - Organization

GEO 225 has three ingredients:

- book by ~~J&R~~ ^{Press & Siever} — presents an overview of topic — good for vocabulary & qualitative descriptions
- lectures — pick a few topics, cover in more detail than book — pick topics that lend themselves to simple quantitative analysis
- labs — also quasi-independent, though timing is ~ tied to class

Basis of grading

Learn-by-Teaching
~~lectures~~ / project in lieu of term paper

One day field trip to Delaware Water Gap and Northern New Jersey

Level of math required — only pre-calculus, no calculus

Fig. 2.1 Lunine shows tremendous range of scales studied in geology & astronomy.

Note - we will use power-of-ten (aka "scientific") notation

Question - how many atoms in a person?

Size of atom ~ 10^{-10} m = 1 Å
angstrom

Size of person ~ 1 m

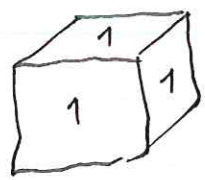
Answer not simply 10^{10} because volumes are involved

Volume of an atom

$$V_{\text{atom}} \approx \frac{4}{3} \pi (10^{-10} \text{ m})^3 \approx 4 \cdot 10^{-30} \text{ m}^3$$

before the age of sex, drugs, rock & roll
Telephone booth packing - underground
fad of 1950s

Volume of a person - ask how many fit in a 1 m^3 box?



Answer - between 10 and 20

[10 100 kg or 20 50 kg people]

$$V_{\text{person}} \sim \frac{1}{20} \text{ m}^3 \rightarrow \text{small people (50 kg each)}$$

$$\# \text{ atoms} = \frac{1/20 \text{ m}^3}{4 \cdot 10^{-30} \text{ m}^3}$$

$$\# \text{ atoms} \approx 10^{28}$$

More accurate answer — since not all atoms same size & difficult to estimate people's volumes —

Use mass instead

Ask — what are elements in a person?
Show periodic table

Answer : CH_2O $\text{C:H:O} = 1:2:1$

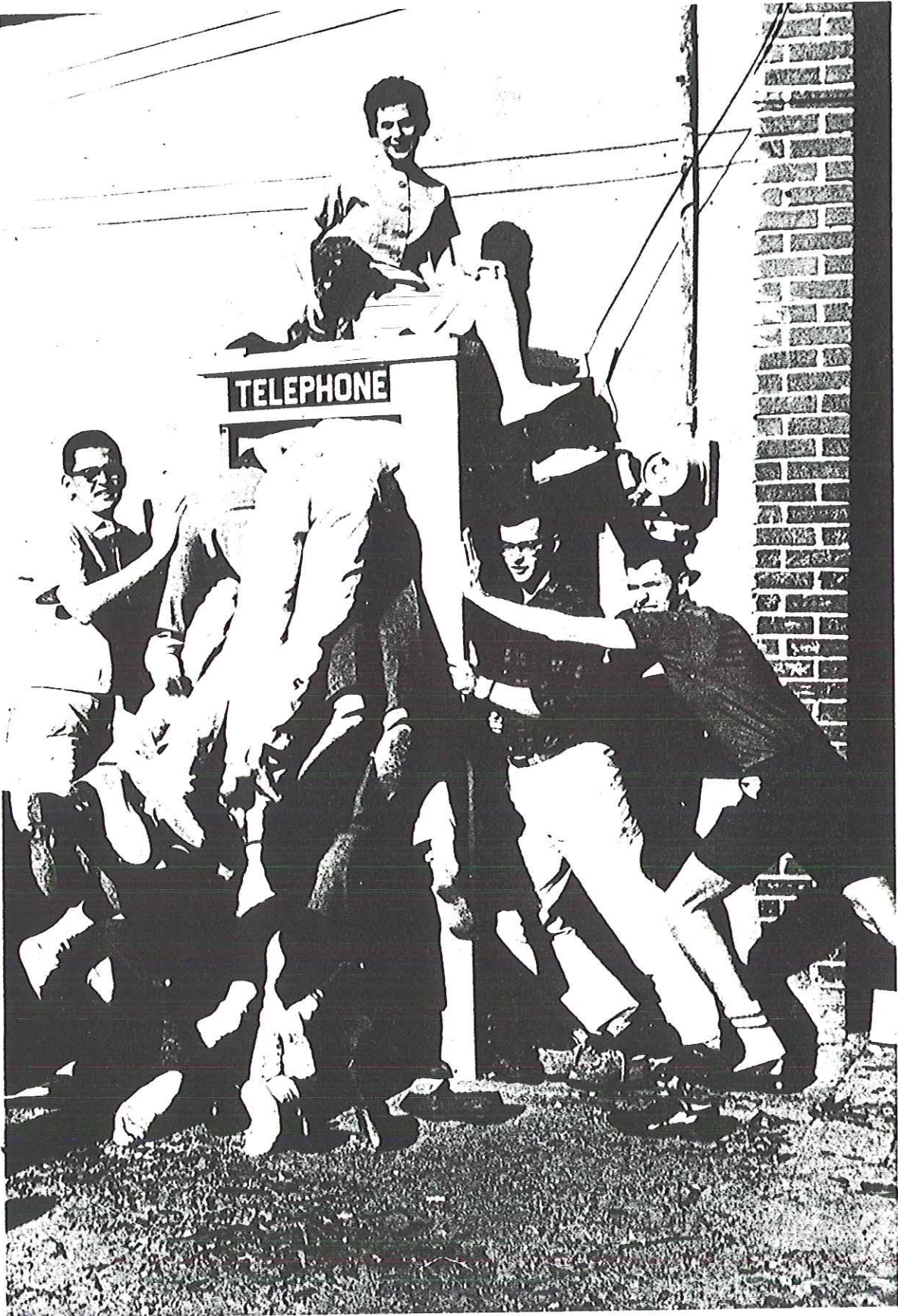
C : 12 gm/mole $12 + (2 \times 1) + 16$

H : 1 gm/mole = 30

O : 16 gm/mole

moles CH_2O in a 60 kg person \downarrow a Cox not a stroke

$$= \frac{60 \text{ kg} \times 10^3 \text{ gm/kg}}{30 \text{ gm/mole}} = 2000 \text{ moles } \text{CH}_2\text{O}$$



PERIODIC TABLE OF THE ELEMENTS

Mn — Chemical Symbol
 25 — Atomic Number
 Manganese — Element Name
 54.94 — Atomic Weight

Strong tendency for outermost electrons to be lost to make full outer shell		Transition elements: valence electrons not in outer shell																Noble gases: outer shells filled; no tendency to gain or lose electrons																																						
H 1 Hydrogen 1.01	Li 3 Lithium 6.94	Be 4 Beryllium 9.01	B 5 Boron 10.81	Al 13 Aluminum 26.98	C 6 Carbon 12.01	N 7 Nitrogen 14.01	O 8 Oxygen 16.00	F 9 Fluorine 19.00	Ne 10 Neon 20.18	Na 11 Sodium 22.99	Mg 12 Magnesium 24.31	K 19 Potassium 39.10	Ca 20 Calcium 40.08	Sc 21 Scandium 44.96	Y 39 Yttrium 88.91	Rb 37 Rubidium 85.47	Sr 38 Strontium 87.62	Ba 56 Barium 137.33	Fr 87 Francium (223)	Ra 88 Radium 226.03	He 2 Helium 4.00	Ne 10 Neon 20.18	Ar 18 Argon 39.95	Kr 36 Krypton 83.80	Xe 54 Xenon 131.30	Rn 86 Radon (222)																														
Tendency to fill outer electron shell by electron sharing and gain or loss of electrons																		Strong tendency to gain electrons to make full outer shell																																						
B 5 Boron 10.81	Al 13 Aluminum 26.98	Si 14 Silicon 28.09	C 6 Carbon 12.01	N 7 Nitrogen 14.01	O 8 Oxygen 16.00	F 9 Fluorine 19.00	Ne 10 Neon 20.18	Na 11 Sodium 22.99	Mg 12 Magnesium 24.31	Al 13 Aluminum 26.98	Si 14 Silicon 28.09	P 15 Phosphorus 30.97	S 16 Sulfur 32.06	Cl 17 Chlorine 35.45	Ar 18 Argon 39.95	K 19 Potassium 39.10	Ca 20 Calcium 40.08	Sc 21 Scandium 44.96	Ti 22 Titanium 47.90	V 23 Vanadium 50.94	Cr 24 Chromium 52.00	Mn 25 Manganese 54.94	Fe 26 Iron 55.85	Co 27 Cobalt 58.93	Ni 28 Nickel 58.70	Cu 29 Copper 63.55	Zn 30 Zinc 65.38	Ga 31 Gallium 69.72	Ge 32 Germanium 72.59	As 33 Arsenic 74.92	Se 34 Selenium 78.96	Br 35 Bromine 79.90	Kr 36 Krypton 83.80	Rb 37 Rubidium 85.47	Sr 38 Strontium 87.62	Y 39 Yttrium 88.91	Zr 40 Zirconium 91.22	Nb 41 Niobium 92.91	Mo 42 Molybdenum 95.94	Tc 43 Technetium (98)	Ru 44 Ruthenium 101.07	Rh 45 Rhodium 102.91	Pd 46 Palladium 106.4	Ag 47 Silver 107.87	Cd 48 Cadmium 112.41	In 49 Indium 114.82	Sn 50 Tin 118.69	Sb 51 Antimony 121.75	Te 52 Tellurium 127.60	I 53 Iodine 126.90	Xe 54 Xenon 131.30	Ba 56 Barium 137.33	La 57 Lanthanum 138.91	Cs 55 Cesium 132.91	Fr 87 Francium (223)	Ra 88 Radium 226.03
IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII B	VIII B	VIII B	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIB	VIII A																																						

Lanthanide (Rare Earth) Elements														
La 57 Lanthanum 138.91	Ce 58 Cerium 140.12	Pr 59 Praseodymium 140.91	Nd 60 Neodymium 144.24	Pm 61 Promethium (145)	Sm 62 Samarium 150.4	Eu 63 Europium 151.96	Gd 64 Gadolinium 157.25	Tb 65 Terbium 158.93	Dy 66 Dysprosium 162.50	Ho 67 Holmium 164.93	Er 68 Erbium 167.26	Tm 69 Thulium 168.93	Lu 71 Lutetium 174.97	
Actinide Elements														
Ac 89 Actinium 227.03	Th 90 Thorium 232.04	Pa 91 Protactinium 231.04	U 92 Uranium 238.03	Np 93 Neptunium 237.05	Pu 94 Plutonium (244)	Am 95 Americium (243)	Cm 96 Curium (247)	Bk 97 Berkelium (247)	Cf 98 Californium (251)	Es 99 Einsteinium (252)	Fm 100 Fermium (257)	Md 101 Mendelevium (258)	No 102 Nobelium (259)	Lr 103 Lawrencium (260)

Table 5.1. Average Chemical Composition of Organic Matter

<i>Element</i>	<i>Percentage Composition by Weight</i>		
	<i>Carbohydrates</i>	<i>Fats</i>	<i>Proteins</i>
O	49.38	17.90	22.4
C	44.44	69.05	51.3
H	6.18	10.00	6.9
P		2.13	0.7
N		0.61	17.8
S		0.31	0.8
Fe			0.1
Total	100.00	100.00	100.00

Source: Rankama and Sahama 1950.