Physics 2C 1/7/20

1. Go over Syllabus
2. Definitions: Density, Fluids, Pressure
3. Variation of pressure with depth in a fluid
4. Pascal's Principle
5. ~~Buoyancy & Archimedes' Principle~~

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2. Density $\rho = \frac{\text{Mass}}{\text{Volume}}$

SI units: $\frac{[kg]}{[m^3]}$

$\rho_{water} = 1000\ kg/m^3$

$\rho_{air} = 1.3\ kg/m^3$

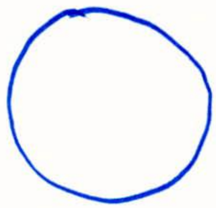
Non-SI
$\rho_{water} = 1\ g/cm^3$

(2 clicker Q's)

Fluids: - a substance that "flows"
- takes the shape of its container

States of matter: ~~solids~~, liquids, gases
Which are fluids?
similarity: both flow
difference: gas compressible, liquid incompressible (diff. in thermo)

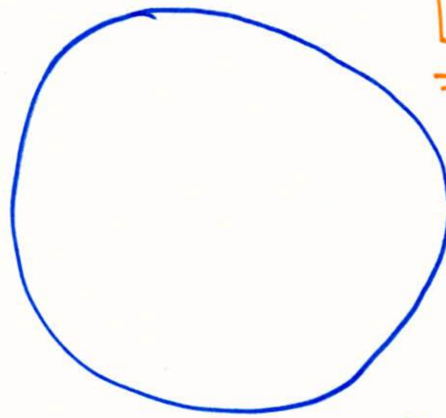
Ball 1



Mass M, Radius R

$\rho_1 = \frac{M}{CR^3}$

Ball 2



Mass 2M, Radius 2R

$\rho_2 = \frac{2M}{C(2R)^3} = \frac{2}{8}\frac{M}{CR^3} = \frac{2}{8}\rho_1$

$\boxed{V = \frac{4}{3}\pi r^3}$

$\Rightarrow V \propto r^3$

$V = C r^3$

Which of the following describes how the average densities of the two balls compare?

(A) Ball 1 is 4x the density of ball 2

(B) Ball 1 is 2x the density of ball 2

(C) Ball 1 is the same density as ball 2

~~(D)~~ None of the above

Estimate the mass of air in this room (GH 242)

1 sig fig

$\rho_{air} \approx 1 \frac{kg}{m^3}$

(A) 3 kg

(B) 100 kg

(C) 3000 kg

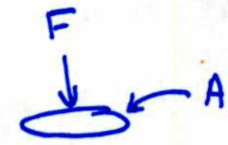
(D) 100,000 kg

$V_{room} \approx (10\,m)(30\,m)(5\,m) \approx 2000\ m^3$

$m_{air} = \rho_{air} \cdot V_{room} = 2000\ kg$

Pressure: $p = \dfrac{\text{force}}{(\text{area})_\perp}$

Force is perpendicular to the are



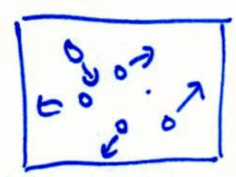
- Which direction? All directions!
- which area? All areas!

See Fig. 14.4

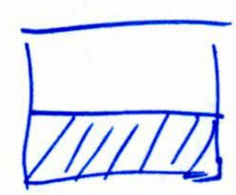
SI units $\dfrac{[N]}{[m^2]} = [Pa]$ "Pascal"

Both gases and liquids exert/have pressure
Under "normal", every day conditions, there's two different causes:

gases have a thermal contribution to pressure



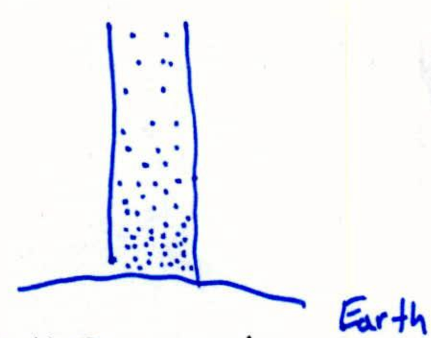
liquids have a gravitational contribution to pressure



Vacuum pressure $p = 0$

Atmospheric Pressure

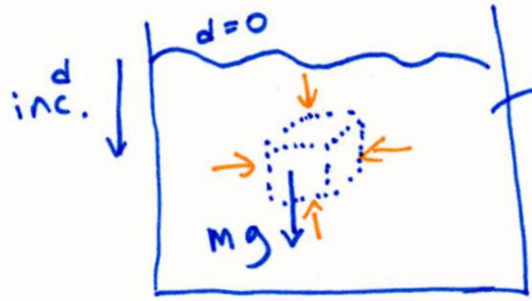
$P_0 = 1.01 \times 10^5$ Pa $\simeq$ 1 atm
760 mm Hg



How much force do you feel from the atmosphere on your forearm~~hand~~? $(0.02\ m^2)(10^5\ Pa) = 2000\ N \simeq 450$ pounds

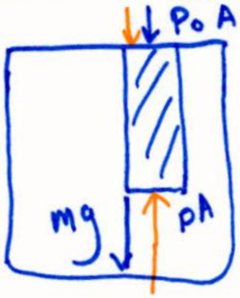
But no net force!

(3)



why does this box stay put?

As book derives:



Since cylinder of water is not moving, $\vec{F}_{net} = \vec{0}$

So the upward force balances the 2 donward forces

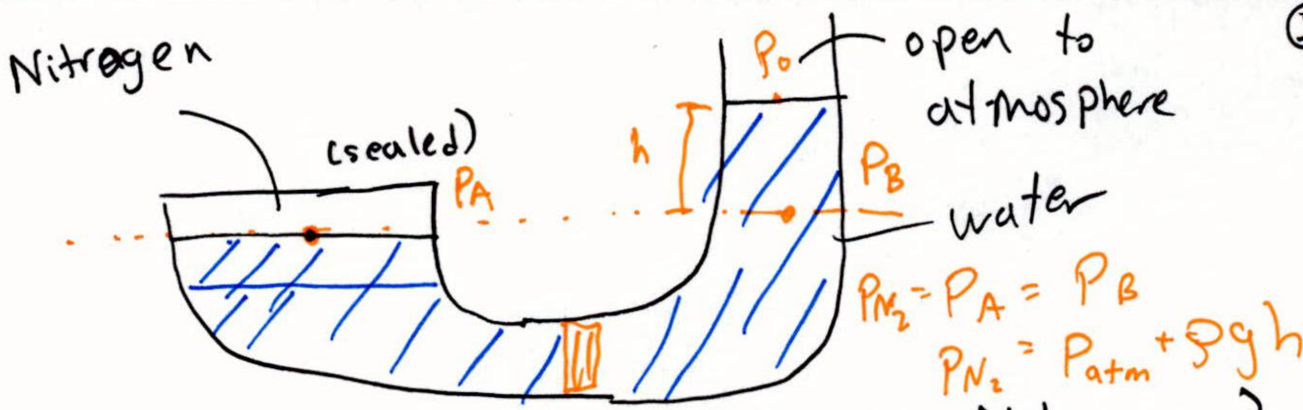
$$pA = p_o A + mg$$

fluid mass $m = \rho A d$

$$\boxed{p = p_o + \rho g d}$$

Important Consequence: (a) A connected liquid in hydrostatic equilibrium rises to the same height in all open regions of the container

(b) The pressue is the same at all points on a horizontal line through a connected liquid in hydrostatic equil.

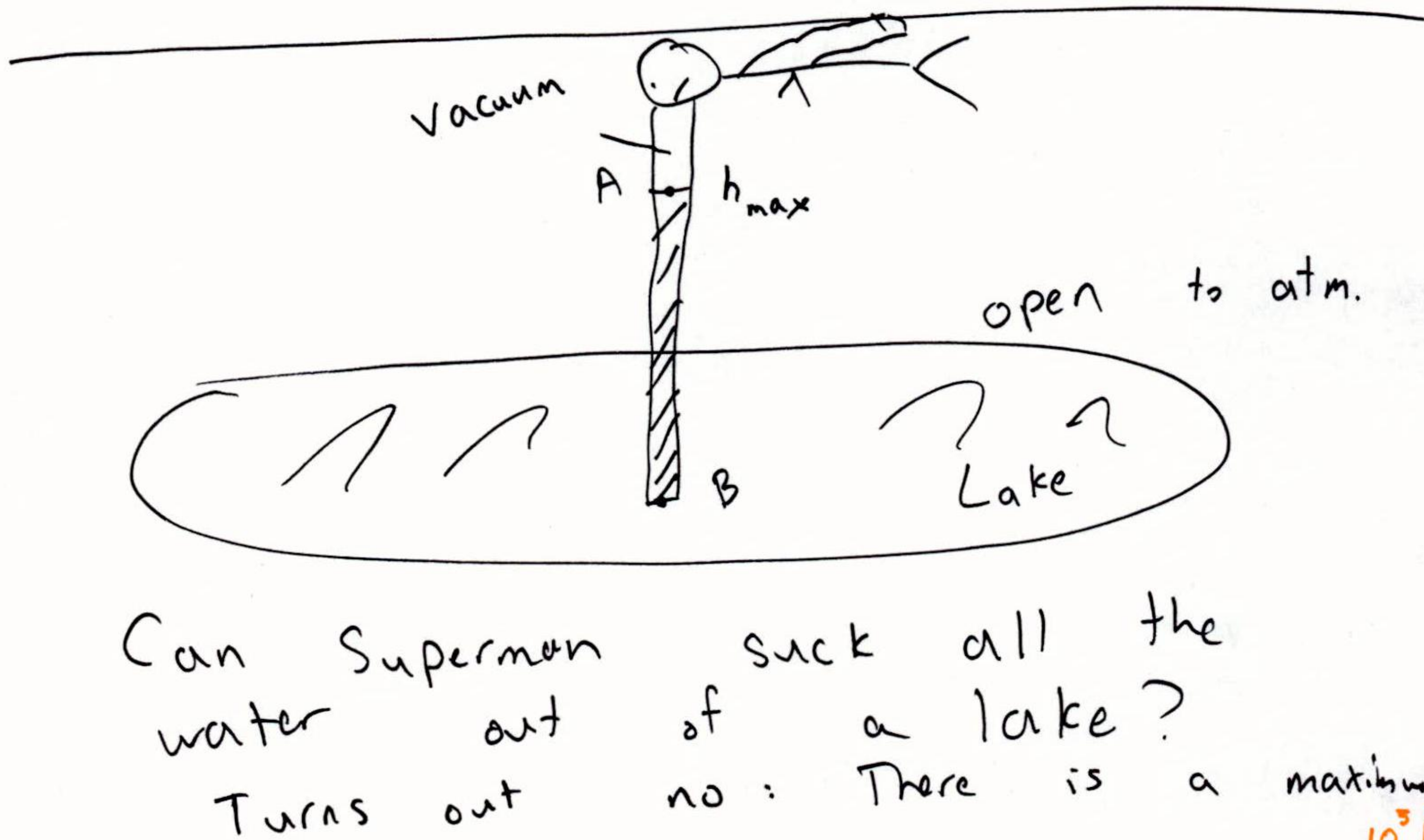


What is the pressure of the Nitrogen?

(A) Equal to 1 atm

(B) Less than 1 atm

(C) Greater than 1 atm



Can Superman suck all the water out of a lake?

Turns out no: There is a maximum height h_{max}:

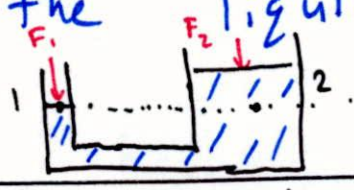
$$P_B = P_A + \rho g h_{max}$$

$$P_0 = \rho g h_{max} \Rightarrow h_{max} = \frac{P_0}{\rho g}$$

$$\frac{10^5\ Pa}{10^3\ 10} = 10\ m$$

④ Pascal's Principle: if you increase the pressure at one point in a liquid, that pressure increase is transmitted to all points in the liquid.

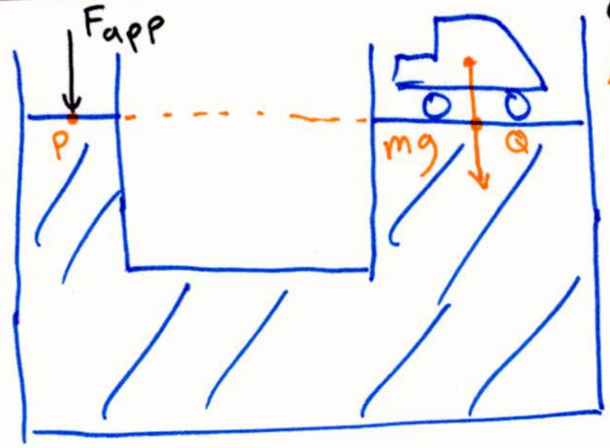
Hydraulic lift eq:



$$p_0 + \frac{F_1}{A_1} = p_0 + \frac{F_2}{A_2} + \rho g h$$

$$F_2 = \frac{A_2}{A_1} F_1 - \rho g h A_2$$

$A_1 = \pi r_1^2$



Cybertruck, 2000 kg?

$A_2 = \pi r_2^2 = \pi (10 r_1)^2 = 100\pi r_1^2 = 100 A_1$

If the radius of the larger platform is 10x the radius of the smaller cylinder, what force F_{app} is required to hold the truck up?

(A) 20 N

(B) 200 N

(C) 2000 N

(D) 20,000 N

(E) None of the above

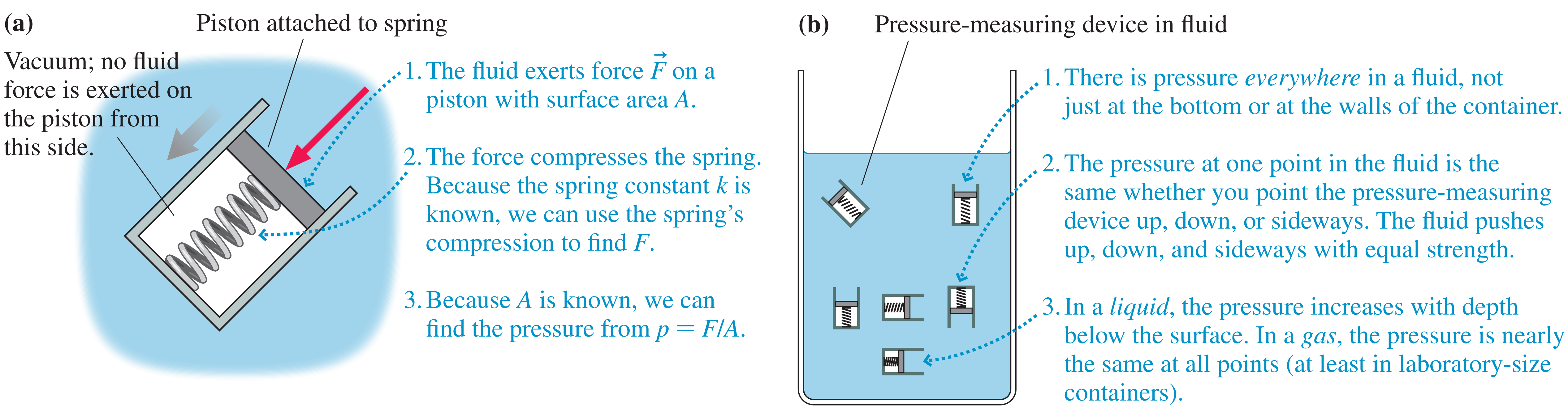
$$P_P = P_Q$$

$$\cancel{p_0} + \frac{F_{app}}{A_1} = \cancel{p_0} + \frac{mg}{A_2}$$

$$F_{app} = \frac{A_1}{A_2} mg = \frac{1}{100}(2000\,\text{kg}) \times 10\,\text{m/s}^2 = 200\,\text{N}$$

Note: we're just amplifying force, but conservation of energy still holds!
So I'd have to push piston down 100 cm to lift truck 1 cm

FIGURE 14.4 Learning about pressure.



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CENTR 207 8:00am-8:50am	HSS 2154 8:00am-8:50am	APM 2301 8:00am-8:50am	Mayer 5301 4:00pm-4:50pm	CENTR 207 4:00pm-4:50pm	CENTR 218 4:00pm-4:50pm
A01	A02	A03	A04	A05	A06
Platt	Fu	Huang	Fu	Wang	Kambalur
993461	993462	993463	993464	993465	993466

Wednesday

CENTR 207 5:00pm-5:50pm	CENTR 218 5:00pm-5:50pm	CENTR 207 6:00pm-6:50pm	CENTR 218 6:00pm-6:50pm	CENTR 207 7:00pm-7:50pm	CENTR 218 7:00pm-7:50pm
A07	A08	A09	A10	A11	A12
Wang	Kambalur	Huang	Kambalur	Huang	Wang
993467	993468	993469	993470	993471	

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Density table of the elements

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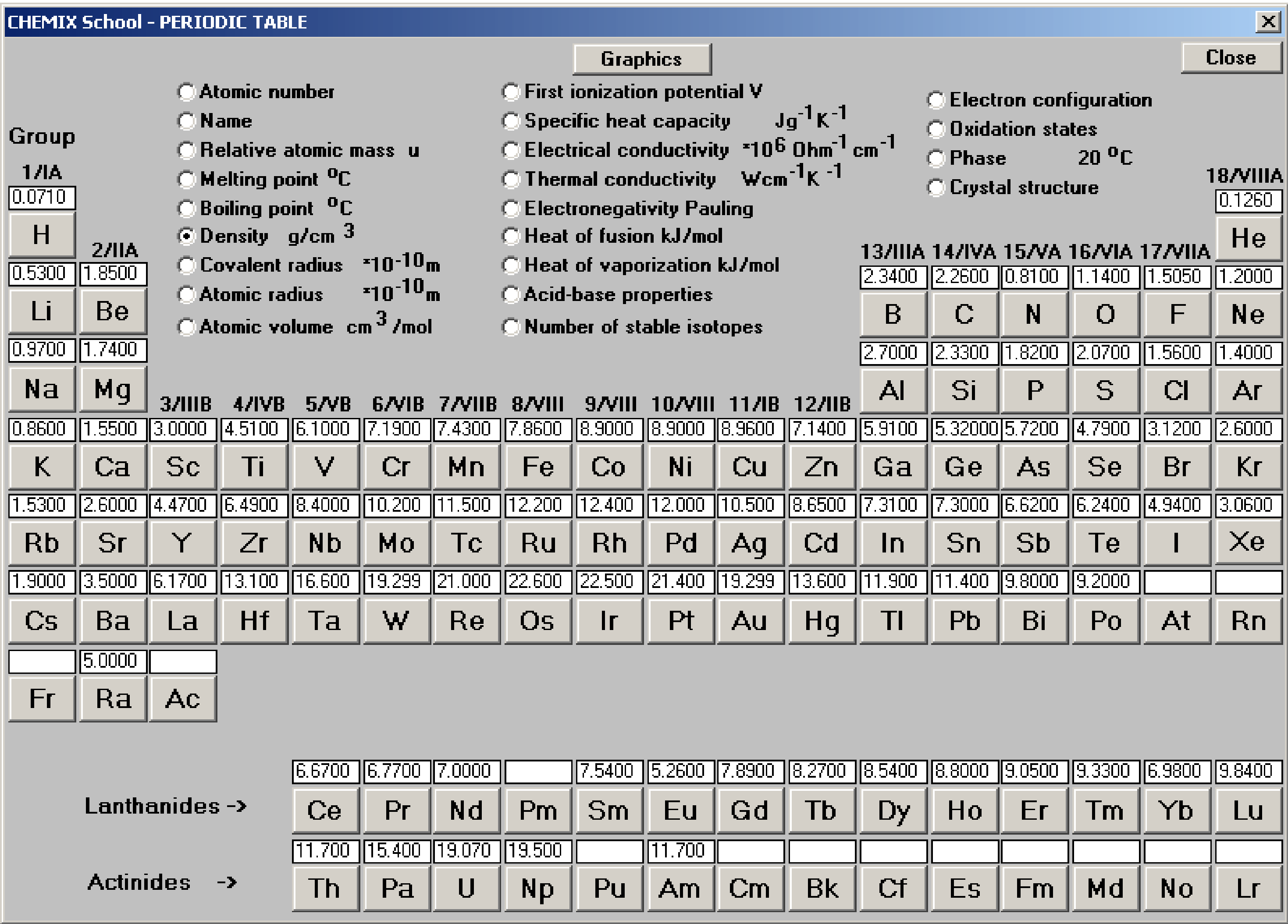
Density table of the elements



Group	1/IA	2/IIA	3/IIIB	4/IVB	5/VB	6/VIB	7/VIIB	8/VIII	9/VIII	10/VIII	11/IB	12/IIB	13/IIIA	14/IVA	15/VA	16/VIA	17/VIIA	18/VIIIA
	H 0.0710																	He 0.1260
	Li 0.5300	Be 1.8500											B 2.3400	C 2.2600	N 0.8100	O 1.1400	F 1.5050	Ne 1.2000
	Na 0.9700	Mg 1.7400											Al 2.7000	Si 2.3300	P 1.8200	S 2.0700	Cl 1.5600	Ar 1.4000
	K 0.8600	Ca 1.5500	Sc 3.0000	Ti 4.5100	V 6.1000	Cr 7.1900	Mn 7.4300	Fe 7.8600	Co 8.9000	Ni 8.9000	Cu 8.9600	Zn 7.1400	Ga 5.9100	Ge 5.32000	As 5.7200	Se 4.7900	Br 3.1200	Kr 2.6000
	Rb 1.5300	Sr 2.6000	Y 4.4700	Zr 6.4900	Nb 8.4000	Mo 10.200	Tc 11.500	Ru 12.200	Rh 12.400	Pd 12.000	Ag 10.500	Cd 8.6500	In 7.3100	Sn 7.3000	Sb 6.6200	Te 6.2400	I 4.9400	Xe 3.0600
	Cs 1.9000	Ba 3.5000	La 6.1700	Hf 13.100	Ta 16.600	W 19.299	Re 21.000	Os 22.600	Ir 22.500	Pt 21.400	Au 19.299	Hg 13.600	Tl 11.900	Pb 11.400	Bi 9.8000	Po 9.2000	At	Rn
	Fr	Ra 5.0000	Ac															
Lanthanides ->					Ce 6.6700	Pr 6.7700	Nd 7.0000	Pm	Sm 7.5400	Eu 5.2600	Gd 7.8900	Tb 8.2700	Dy 8.5400	Ho 8.8000	Er 9.0500	Tm 9.3300	Yb 6.9800	Lu 9.8400
Actinides ->					Th 11.700	Pa 15.400	U 19.070	Np 19.500	Pu	Am 11.700	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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