PHYS 1020 Final Exam

Monday, December 17, 6 - 9 pm

The whole course
30 multiple choice questions
Formula sheet provided

Seating (from exam listing on Aurora)

Brown Gym

A - SIM

Gold Gym

SIN - Z

GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007 (lecture schedule is approximate)

11	M	12	**Remembrance Day**			Experiment 4: Centripetal Force
	W	14	28	Chapter 11 exclude 11.11	Fluids	
	F	16	29			
12	M	19	30	Chapter 12 sections 1 - 8	Temperature and heat (some small sections, notably thermal stress will be omitted)	Tutorial and Test 4 (chapters 8, 9, 10)
	W	21	31			
	F	23	32			
13	M	26	33	Chapter 13	Transfer of Heat -- Self study only. **Required for last lab.** This chapter **IS** examinable on the final.	Experiment 5: Thermal Conductivity of an Insulator
	W	28	34	Chapter 14	The Ideal Gas Law & Kinetic Theory	
	F	30	35			
14	M	**Dec 3**	36			No lab or tutorial
	W	5	37	**Last Day of Classes**		

Week of November 19

Tutorial & Test 4: chapters 8, 9, 10

Week of November 26

Experiment 5: Thermal conductivity

An Opportunity

You can switch to the calculus stream next term and study even more physics...

(if you want!)

– PHYS 1070 and beyond –

if you get a B (B^+ for honours physics) in PHYS 1020

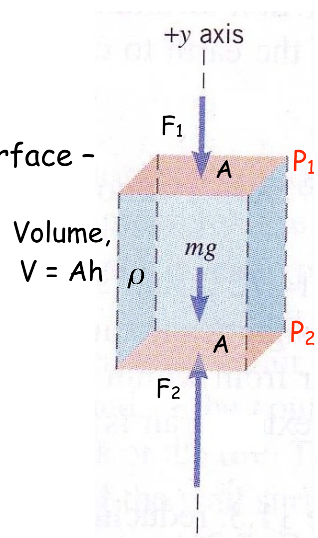
Fluids, the story so far...

Density = Mass/Volume

$$\text{Specific gravity} = \frac{\text{Density of substance}}{\text{Density of water at } 4^\circ\text{C}}$$

Pressure = Force/Area

Pressure – due to impact of molecules with a surface – acts equally in all directions



Increase of pressure with depth:
Mass m of fluid is in equilibrium, so $mg = F_2 - F_1$

As $m = V\rho = Ah\rho$,

$Ah\rho g = A(P_2 - P_1) \rightarrow P_2 = P_1 + \rho gh$

Pressure depends only on depth

11.20: The blood pressure in the heart is 16 kPa. If an artery in the brain is 0.45 m above the heart, what is the pressure in the artery? Ignore any pressure changes due to blood flow.

P_1 The brain

h = 0.45 m

P_2 The heart

$P_2 = P_1 + \rho gh$,

so $P_1 = P_2 - \rho gh$

Density of blood = 1060 kg/m^3

$P_1 = 16{,}000 - (1060\ kg/m^3)\times(9.8\ m/s^2)\times(0.45\ m) = 11{,}325$ Pa.

Note: P_1, P_2 are pressures **above** atmospheric pressure, the so-called "gauge pressure". A tire pressure gauge measures gauge pressure – zero on the gauge means the tire is flat and the pressure inside the tire is atmospheric pressure.

Pumping water from a well

Which method will pump water from a deep well?

For the pipe at the right:

$P_1 = P_{atmos} - \rho gh$

water

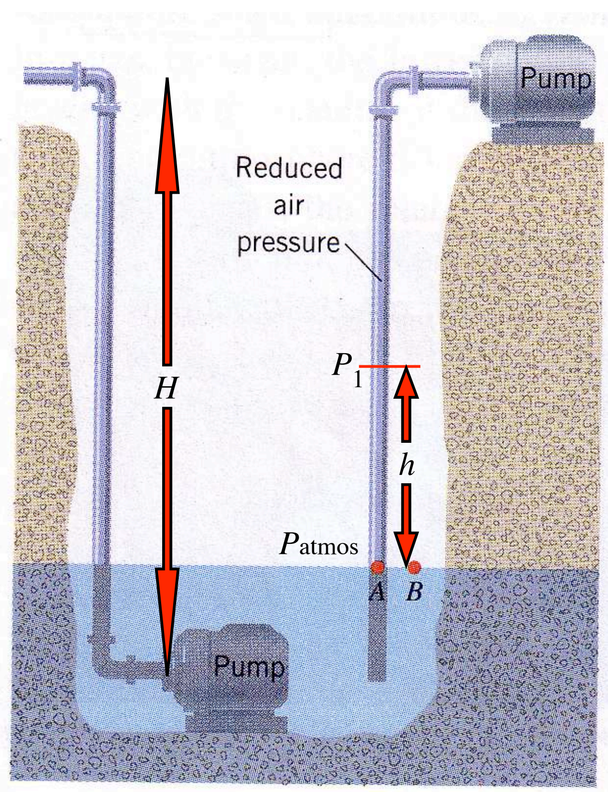
P_1 is reduced to zero (vacuum), when

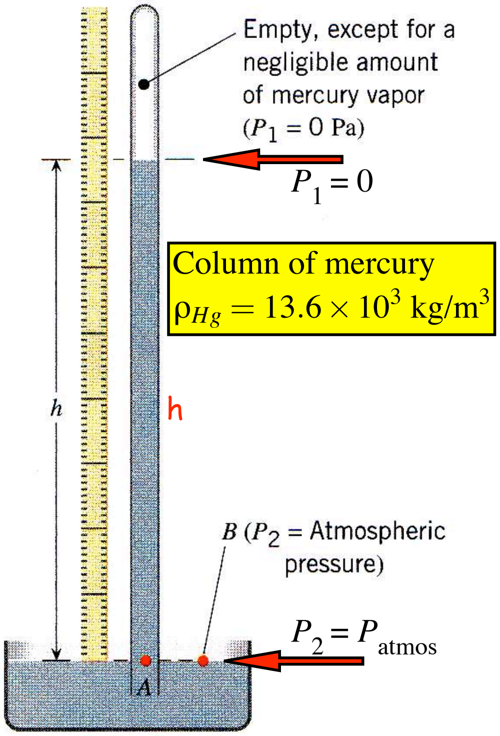
$h = P_{atmos}/\rho g$

$= 101{,}300/(1000\times9.8)$

$= 10.3$ m

= maximum depth





Mercury Barometer

$$P_2 = P_{atmos} = P_1 + \rho g h$$

$$P_{atmos} = 0 + \rho g h$$

Atmospheric pressure can be measured in "mm of mercury".

Standard atmospheric pressure:

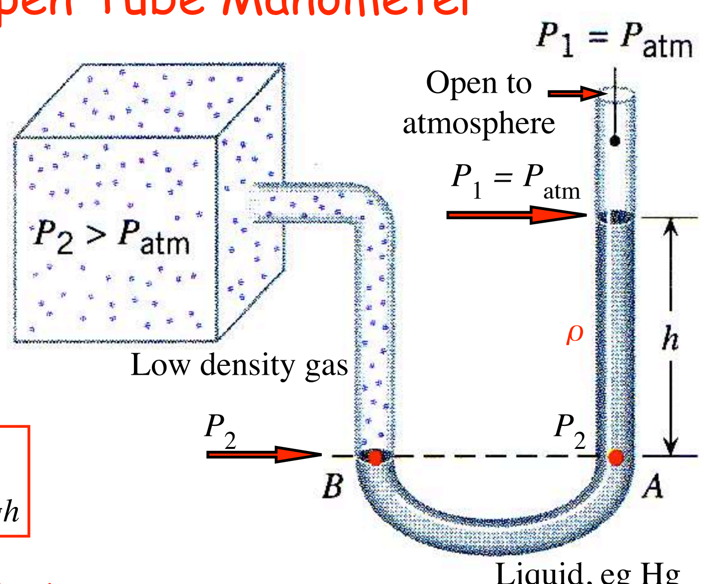
$$101.3 \times 10^3 \text{ Pa} = \rho_{Hg}\, g h$$

$$h = \frac{101.3 \times 10^3}{13.6 \times 10^3 \times 9.8}$$

h = 0.76 m = 760 mm Hg

1 mm Hg = 1 Torr

Open Tube Manometer



$$P_2 = P_1 + \rho g h$$
$$= P_{atm} + \rho g h$$

P_1, P_2, P_{atm} are absolute pressures

$P_2 - P_{atm} = \rho g h =$ "gauge pressure" inside the box

11.-/26: A mercury manometer reads 747 mm on the roof of a building and 760 mm on the ground. Assuming a constant value of 1.29 kg/m^3 for the density of the air, find the height of the building.

$$P_{ground} = P_{roof} + \rho_{air}\, gh$$

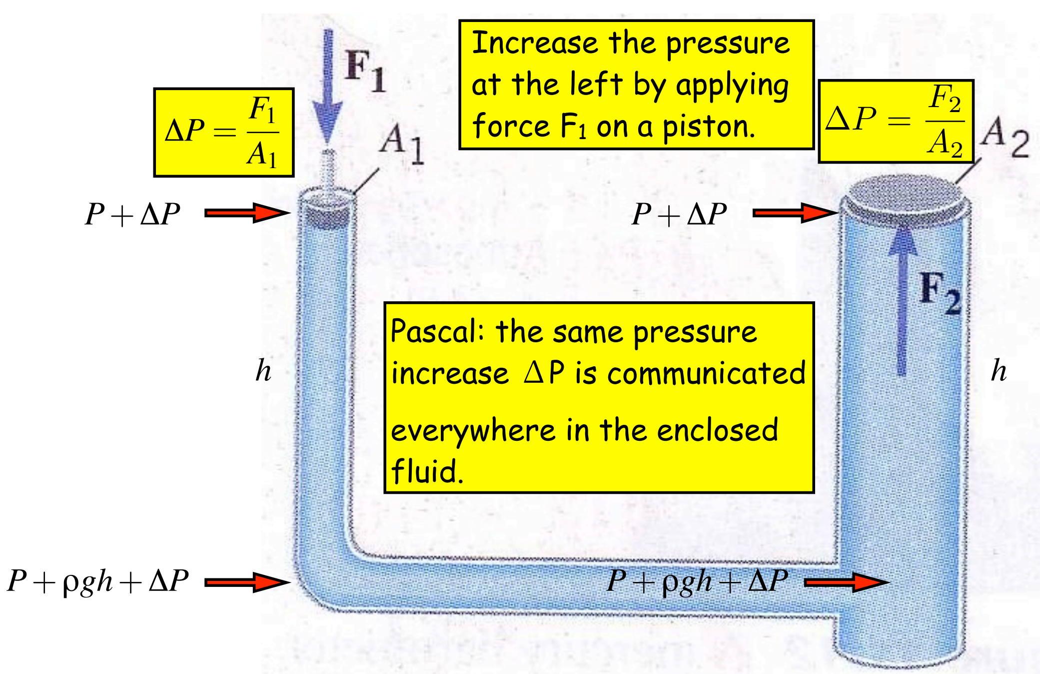
$$\text{So, } h = \frac{P_{ground} - P_{roof}}{\rho_{air}\, g}$$

The atmospheric pressure increases by 13 mm Hg, that is, by:

$$\frac{13}{760} \text{ atmospheres} = \frac{13}{760} \times 101.3 = 1.733 \text{ kPa}$$

$$\text{Therefore, } h = \frac{1733}{1.29 \times 9.8} = 137 \text{ m}$$

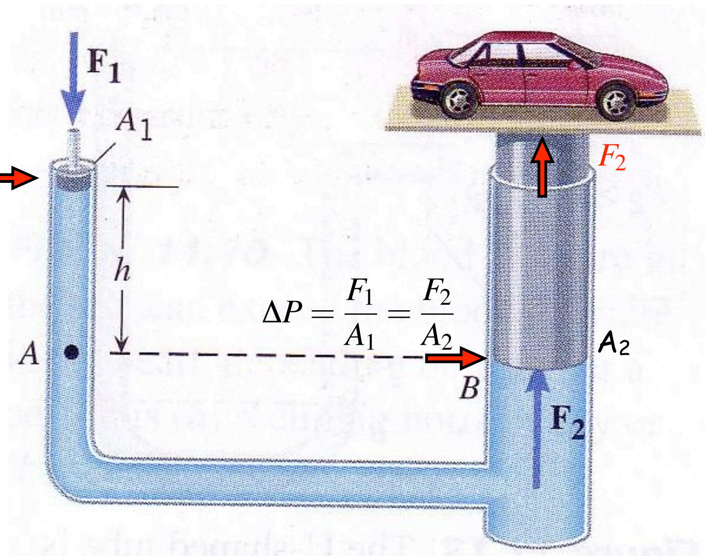
Pascal's Principle



Pascal's Principle

Apply a small force F_1 at the left:

$$\Delta P = \frac{F_1}{A_1}$$



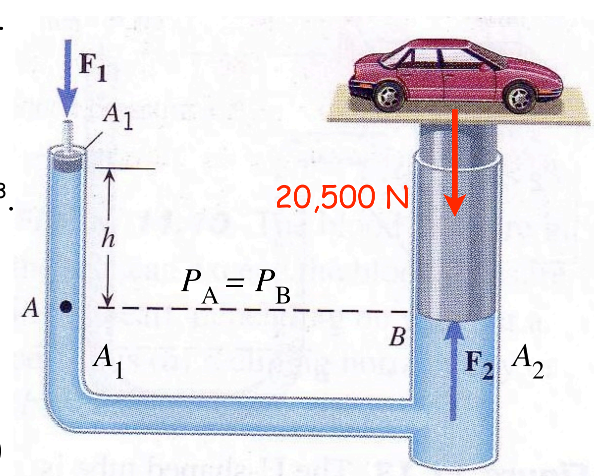
The force is multiplied:

$$F_2 = F_1 \times \frac{A_2}{A_1}$$

Hydraulic jack

The input piston (on the left) has a radius $r_1 = 0.012$ m and at the right $r_2 = 0.15$ m. The combined weight of car and plunger is 20,500 N. The oil in the jack has density 800 kg/m^3.

(a) What force F_1 is needed to support the car and output plunger when the bottom surfaces of piston and plunger are at the same height? (h = 0)



$$F_2 = F_1 \times \frac{A_2}{A_1} = 20,500 \text{ N} \quad \text{so, } F_1 = 20,500 \times \left(\frac{0.012}{0.15}\right)^2 = 131 \text{ N}$$

Hydraulic jack

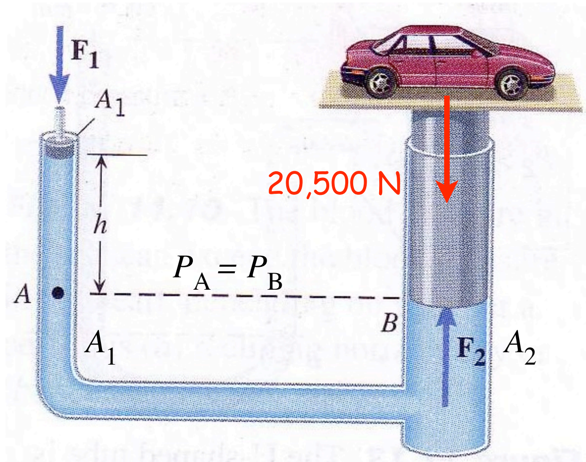
(b) When h = 1.1 m?

$$P_B = P_A = \frac{F_1}{A_1} + \rho g h$$

$$P_B = \frac{F_2}{A_2}$$

$$\text{So, } \frac{F_2}{A_2} = \frac{F_1}{A_1} + \rho g h$$

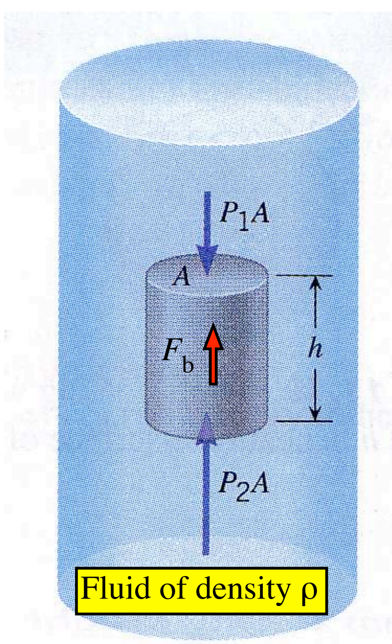
$$\frac{F_1}{A_1} = \frac{F_2}{A_2} - \rho g h$$



$$\frac{F_1}{\pi \times 0.012^2} = \frac{20,500}{\pi \times 0.15^2} - 800 \times 9.8 \times 1.1$$

$F_1 = 127$ N (was 131 N when $h = 0$)

Archimedes' Principle



Consider the equilibrium of the column of fluid. It experiences pressure forces from above and below.

The net upward force (buoyant force) on the column is:

$$F_b = (P_2 - P_1)A$$

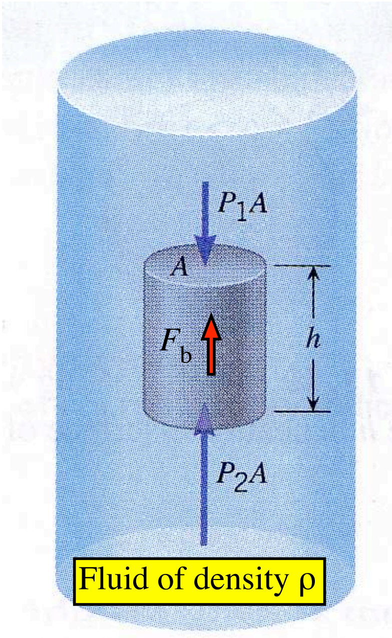
and $P_2 - P_1 = \rho g h$ increase of pressure with depth

$$\text{So, } F_b = \rho h A g = \rho V g$$

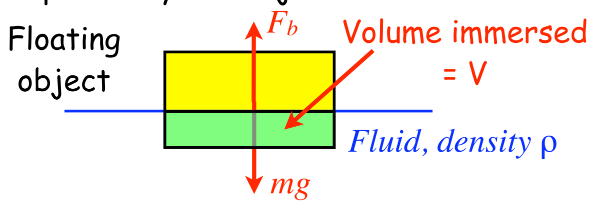
ρ V = mass of fluid that occupied the volume V.

Buoyant force = weight of displaced fluid

Archimedes' Principle



Buoyancy force = ρVg = weight of fluid displaced by the object



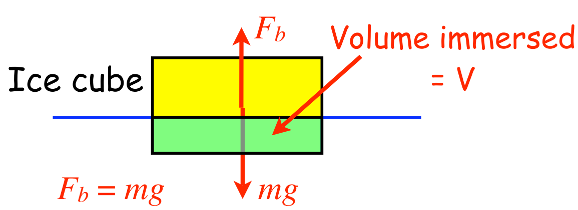
The buoyant force acting on an object partially or completely immersed in a fluid is the weight of the fluid that is displaced.

For a floating object, $F_b = mg$

That is, $\rho Vg = mg$

Clickers!

11.C14: You put an ice cube in a glass and fill the glass with water. As the ice cube melts, does the water level drop, stay the same, or rise?



A) The level of water rises
B) The level of water falls
C) The level of water remains the same

The ice cube floats by displacing its own weight of liquid water.

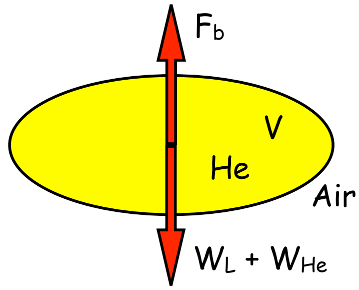
So, when the ice cube melts, it occupies a volume equal to that of the liquid water it displaced when it was floating...

That is, the ice cube contracts into the volume coloured green...

The Goodyear blimp contains 5400 m^3 of helium of density 0.179 kg/m^3. Find the weight of the load W_L that the airship can carry if the density of the air is 1.2 kg/m^3.

To float in the air:

$F_b = W_L + W_{He}$



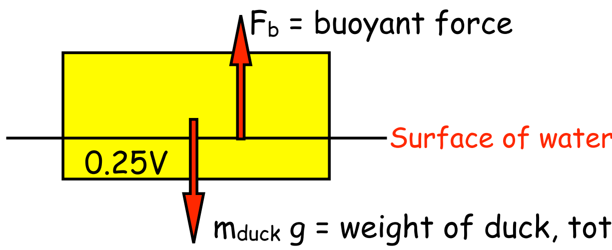
The buoyant force is, F_b = weight of air displaced by balloon

$= V\rho_{air}\, g = 5400 \times 1.2g = 63{,}500$ N

The weight of the helium is $W_{He} = V\rho_{He}\, g = 5400 \times 0.179g = 9473$ N

So, $63{,}500 = W_L + 9473$ N $\rightarrow W_L = 54{,}000$ N

11.38: A duck is floating on a lake with 25% of its volume beneath the water. What is the average density of the duck?



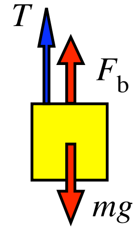
The duck floats, so the weight of the duck is equal to the weight of water with 25% of the volume of the duck.

That is, $m_{duck}\, g = \rho_{water} \times 0.25V\, g$

But, $m_{duck} = \rho_{duck} \times V$

Therefore, $\rho_{duck} = 0.25\rho_{water} = 250\ kg/m^3$

11.44/46: A solid object has an apparent weight of 15.2 N when completely immersed in ethyl alcohol. When completely submerged in water, its apparent weight is 13.7 N. What is the volume of the object? Density of ethyl alcohol = 806 kg/m^3.



Weigh the object by supporting it by a string and measuring the tension in the string.

In ethyl alcohol: $T_1 = mg - F_{b1} = 15.2\text{ N}$

In water: $T_2 = mg - F_{b2} = 13.7\text{ N}$

$$\text{So, } mg = 15.2 + F_{b1} = 13.7 + F_{b2}$$

$$F_{b2} - F_{b1} = 1.5\text{ N} \quad \text{and, } F_{b2} - F_{b1} = (\rho_{H_20} - \rho_{ethyl})Vg$$

$$\text{Therefore, } 1.5 = (1000 - 806)gV$$

$$V = \frac{1.5}{194g} = 7.9 \times 10^{-4}\text{ m}^3$$