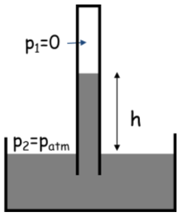
Name: ______________________________ DISC: ________

Q1	Q2	Q3	Q4
5	5	5	5

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers.

1. A barometer can be used to measure atomspheric pressure (P_{atm}). In a barometer an evacuated tube is inserted into a pool of liquid, in this case alcohol. Let's investigate what happens:



ρ **Alcohol**	P_1	P_{atm}
$697\frac{kg}{m^3}$	$0\ Pa$	$101{,}325\ Pa$

Explanation (2 pts):

a. Why does the alcohol rise up the tube inside?

   i. The air, which has mass, pushes down on the pool of alcohol. The force is caused by gravity.

   ii. The force of gravity causes pressure on the top of the pool of alcohol.

   iii. In response, the alcohol rises up the evacuated tube governed by Pascal's Principle.

Pressure (3 pts):

b. How high does the alcohol rise up the tube inside relative to the level outside? (hint: $P_{atm} = P_1 + \rho g h$)

   i. $P_{atm} = P_1 + \rho g h = 0\ Pa + \left(697\frac{kg}{m^3}\right)\left(9.8\frac{m}{s}\right)h = 101325\ Pa$

   ii. $h = \frac{(101325\ Pa)}{\left(697\frac{kg}{m^3}\right)\left(9.8\frac{m}{s}\right)} = 14.83\ m$

2. Consider an iceberg floating in an ocean as appearing in the movie *Titanic*. The density is 0.917 *g/ml* for ice and 1.025 *g/ml* for the surrounding water. What percentage of the iceberg's volume is above water?

ARCHIMEDES' PRINCIPLE	ρ_{ice}	ρ_{sea}
$F_B = \rho_{fluid} V_{displaced} g$	$0.917\ g/ml$	$1.025\ g/ml$

Floating Iceberg (5 pts):

Archimedes' Principle states that if an object is able to displace its mass in the fluid it will float. In equilibrium, the buoyant force applied by the fluid on the object should be balanced by the weight of the object. That is: $\rho_{fluid} V_{fluid} g = \rho_{solid} V_{solid} g$. V_{fluid} is the volume of the displaced fluid and is equal to the volume of the object for the part immersed in the fluid, i.e., $V_{fluid}/V_{solid} = \rho_{solid}/\rho_{fluid}$.

Thus, the portion of the iceberg's volume above water can be found as follows.
$1 - \frac{V_{water}}{V_{iceberg}} = 1 - \frac{\rho_{iceberg}}{\rho_{water}} = 1 - \frac{0.917}{1.025} = 0.105$, i.e., 10.5%

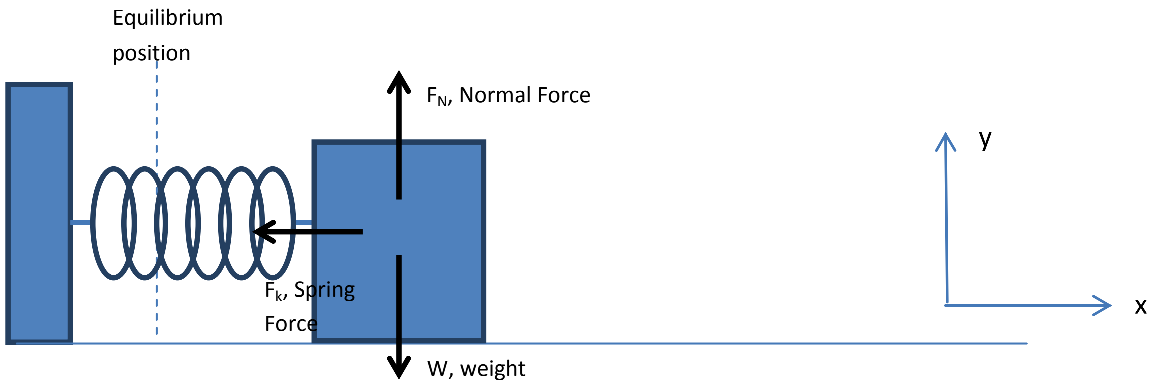
3. Hook's Law, $F_{spring} = -kx$, describes the force exerted on an object by a spring.

Answer (1 pt):

a. A rectangular block is attached to a horizontal spring and rests on a frictionless surface. A lab assistant pulls the block displacing it from its equilibrium position and then releases it. Does the block experience *constant* acceleration just after it is released **(yes/no)**?

Free-body Diagram (2 pts):

b. Draw a free-body diagram describing the situation in part (a). Remember to include a coordinate system and all force labels.



Explanation (2 pts):

c. Using $U_{spring} = \frac{1}{2}kx^2$ and *energy conservation*, explain why the *speed* of the block depends on its *position* (x). Let the initial displacement of the spring be x_{ini}.

i. From conservation of energy we know that the total energy at all times must be equal to the initial energy of the system, in this case: $U_{spring} = \frac{1}{2}kx_{ini}^2$.

ii. We know that total energy at any time is: $U + K = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 = \frac{1}{2}kx_{ini}^2$

iii. We can now solve for v: $v^2 = \frac{k}{m}(x_{ini}^2 - x^2)$. So, $v = \sqrt{\frac{k}{m}(x_{ini}^2 - x^2)}$, which is clearly a function of the position of the block!

4. Foucault's Pendulum can be approximated as a simple harmonic oscillator. It was used to demonstrate the rotation of the earth.

Answer (1 pt):

a. Does Foucault's Pendulum experience constant acceleration **(yes/no)**?

Period (2 pts):

b. If the pendulum length is 5 m, use $T = 2\pi\sqrt{\frac{L}{g}}$ to find the period of the pendulum's swing.

$$T = 2\pi\sqrt{\frac{5\ m}{9.8\ m/s^2}} = 4.49s$$

g_{new} (2 pts):

c. Now take your Foucault's Pendulum to another planet. You want to measure the acceleration of gravity on that planet. You set up your pendulum and notice that $T = 2T_{Earth}$. What is the acceleration of gravity on the new planet, g_{new}?

$$g_{new} = \frac{(2\pi)^2 L}{T^2} = \frac{(2\pi)^2(5\ m)}{(2 * 4.49s)^2} = 2.45\ m/s^2$$