

X3.a

Physics 107 (Kaldon-23825)

Name _____

107

WMU - Spring 2000

Exam 3 - 100,000 points

Yes! I will be turning in Topic 1 and Topic 2 on time!

Rev. 6/08/00 Th.r.2

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Short Answers Should Be Short! – Feel Free to Ask Any Questions

“Fact or Fiction” (30,000 points) Multiple-Guess-Pick-The-Best-Answer-Fill-In-The-Bubbles

- 1.) (a) The _____ efficiency of an engine is *always* the *largest* of the three efficiencies.
A = Actual B = Carnot C = Second Law D = None of these
 A B C D
- (b) The _____ efficiency of an engine is *always* the *smallest* of the three efficiencies.
A = Actual B = Carnot C = Second Law D = None of these
 A B C D
- (c) A piece of metal is cut into the shape of a capital letter E. If you heat this metal, the width of the hot E will get:
A = Larger B = Smaller C = The Same D = None of these
 A B C D
- (d) The height of the hot E will get:
A = Larger B = Smaller C = The Same D = None of these
 A B C D
- (e) If you compared the proportions of the hot E with the cold E, the hot E will look:
A = Fatter B = Thinner C = The Same D = None of these
 A B C D
- (f) A temperature gauge reads 100. This temperature would be the highest in:
A = °F B = °C C = Kelvins D = None of these
 A B C D
- (g) A temperature gauge reads 100. This temperature would be the lowest in:
A = °F B = °C C = Kelvins D = None of these
 A B C D

A sealed steel can is completely filled with water. $\alpha_{\text{steel}} = 12 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$, $\beta_{\text{water}} = 860 \times 10^{-6} \text{ }^\circ\text{C}^{-1}$.

- (h) If the can is heated, the volume of the water will expand _____ than the volume of the can.
A = More B = Less C = The Same D = None of these
 A B C D
- (i) If the can is frozen, the volume of the ice will be _____ than the volume of the can.
A = More B = Less C = The Same D = None of these
 A B C D
- (j) If the sealed can is *not* completely filled with water, then the pressure of the heated water will be _____ than the pressure of the cold water.
A = More B = Less C = The Same D = None of these
 A B C D

Physics 107 / Exam 3

Spring 2000

Page 2

Breakfast is the Most Important Meal of the Day (35,000 points)

Rev. 6/11/2000 Su

2.) According to careful study by Dr. Phil, there are 300. **Cheerios**TM in 1 cup (30.0 grams = 0.0300 kg, 8.00 fluid ounces = 473.6 cm³). That means one dry **Cheerio**TM has a mass of 0.000100 kg and a volume of $1.58 \times 10^{-6} \text{ m}^3$. According to the box, 1 cup of **Cheerios**TM cereal with ½ cup of vitamin A&D fortified skim milk has 160 Calories (669,000 J). (a) If Joey has a mass of 90.0 kg, how many soggy **Cheerios**TM must Joey eat to have enough energy to walk up the 102 stories to the top of the “little” building at 34th Street & 5th Avenue, Manhattan, New York? *The height of the Empire State Building is 1250 feet or 381 m. Assume all the Calories are available for doing Physics work. You must make a proper calculation to get any credit.*

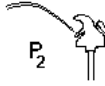


Empire State Building, New York City
Sandra Baker/Gamma Liaison
Microsoft Bookshelf '95

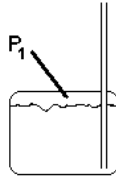
(b) Show that a dry **Cheerio**TM will float in milk. $\rho_{\text{milk}} = 1.06 \text{ g/cm}^3 = 1060 \text{ kg/m}^3$.

(c) Find the mass of milk that one **Cheerio**TM can absorb before it gets soggy and sinks to the bottom of the cereal bowl.

(d) Joey is thirsty when he gets to the top of the Empire State Building. If the water comes out of the water fountain at 0.4952 m/s, what would be the air pressure P_1 in the water tank on the ground floor of the building? Assume $P_2 = 100,000$ Pa and that the tank is large.



(e) The engine that drives the water pump to pressurize the tank has an actual efficiency of 41.8%. If the engine has to do 165,000 J of work, how much energy is wasted?



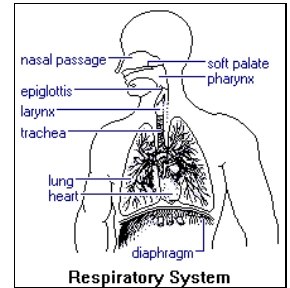
“Dive,” He Said. (35,000 points)

3.) (a) In the movie *U-571*, a submarine goes down to a depth of 935 meters. What is the gauge pressure of the seawater on the hull of the ship? The sub has the same pressure inside as the surface (101,300 Pa). $\rho_{\text{seawater}} = 1030 \text{ kg/m}^3$.

(b) If the sub were to spring a leak, with what speed would water pour in?

(c) At what air pressure inside the sub would the water *stop* coming in?

(d) Although this is really *way* too deep to safely do this maneuver (because of the nitrogen in air), the U.S. Navy used to train submariners in an escape maneuver called a *Blow and Go*: When you reach the air pressure in (c), you can take a deep breath, open a hatch and go out. Because people float, you will rise. As you rise you have to exhale all the way as your lungful of air expands as the pressure drops. Use our version of the Ideal Gas Law to find the volume of your lungful of air at the surface, compared to deep down. Assume temperature remains constant. *If you didn't get an answer to (c), use a submerged air pressure of 100. atmospheres.*



(e) The density of air at the surface is 1.29 kg/m^3 . What would be the density of the air in (c)? Is this still less than the density of seawater – so that you really will float in (d)? *If you didn't get an answer to (c), use a submerged air pressure of 100. atmospheres.*