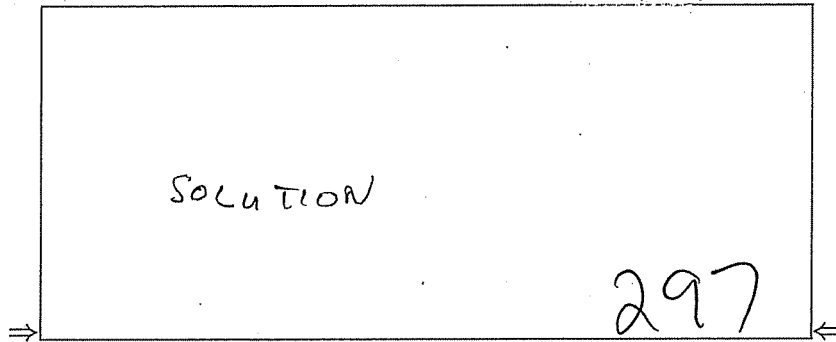


Physics 116 - Second In-Class Exam  
Prof. Schnetzer and Kloet  
November 15, 2011



Your name sticker with exam code

**Turn off and put away cell phones!**

1. The exam will last from 5:00 pm to 6:20 pm Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labelled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit student ID.
4. Enter 161 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and one **handwritten** 8.5 x 11 inch sheet with formulas and notes, without attachments.
7. There are 15 multiple-choice questions on the exam. For each question mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. **At the end of the exam, hand in the answer sheet and the cover page.** Retain this question paper for future reference and study.
8. When you are asked to open the exam, make sure that your copy contains all 15 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.

Good Luck!

1. A small object starts from rest at the position shown and slides along the frictionless loop-the-loop track of radius  $R$ . What is the smallest value of  $y$  such that the object will slide without losing contact with the track?

a)  $R$   
 b)  $2R$   
 c)  $R/4$   
 - d)  $R/2$   
 e) zero

$E_A = mgh_A$   
 $E_B = mgh_B + \frac{1}{2}mv_B^2$   
 $mgy = \frac{1}{2}mv_B^2$

$2gy = v_B^2$

$2gy = gR$   
 or  $y = \frac{R}{2}$

AT B ONLY FORCE  
 $mg = ma$   
 $mg = \frac{mv_B^2}{R}$   
 $v_B^2 = gR$

HARD

2. Two particles each of mass  $m$  are a distance  $d$  apart. How much work is done to bring a third particle, also with mass  $m$ , from far away to the point midway between the original two particles?

a)  $4Gm^2/d$   
 - b)  $-4Gm^2/d$   
 c)  $4Gm^2/d^2$   
 d)  $-4Gm^2/d^2$   
 e) None of the other answers

FINAL STATE HAS LOWER P.E.  
 SO WORK IS NEGATIVE

$\Delta PE = -Gm^2 \frac{2}{d} - Gm^2 \frac{2}{d}$   
 $= -4Gm^2 \frac{1}{d}$

3. Ideal monatomic gas A is composed of molecules with mass  $m$  while ideal gas B is composed of molecules of mass  $4m$ . The root mean square velocities are the same if the ratio of the temperatures  $T_A/T_B$  is:

- a)  $1/4$   
 b)  $1/2$   
 c) 1  
 d) 2  
 e) 4

$v_A = v_B$

FROM  $\frac{1}{2}mv^2 = \frac{3}{2}kT \Rightarrow v^2 = \frac{3kT}{m}$

$\frac{T_A}{m_A} = \frac{T_B}{m_B}$  or  $\frac{T_A}{T_B} = \frac{m_A}{m_B} = \frac{1}{4}$

4. A sample of an ideal gas is compressed from  $10 \text{ m}^3$  to  $5 \text{ m}^3$  and simultaneously cooled from  $273^\circ \text{C}$  to  $0^\circ \text{C}$ . As a result there is:

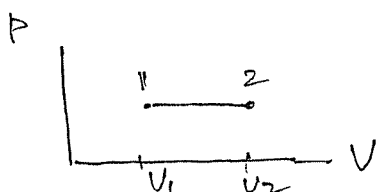
EASY

a) an increase in pressure  
 b) a decrease in pressure  
 c) a decrease in density  
 d) no change in density  
 - e) no change in pressure

$V_1 = 10 \text{ m}^3$        $V_2 = 5 \text{ m}^3$   
 $T_1 = 546 \text{ K}$        $T_2 = 273 \text{ K}$

SINCE  $p = nR \frac{T}{V} \Rightarrow p_1 = p_2$

DENSITY  $\rho = \frac{m}{V}$  increases because  $V$  decreases



$$P_2 = P_1$$

$$\Delta U = \frac{3}{2} n R \Delta T$$

$$W^{BY} = P \Delta V = n R \Delta T = -W^{ON}$$

5. The temperature of  $n$  moles of an ideal monatomic gas is increased by  $\Delta T$  at constant pressure. The energy  $Q$  absorbed as heat, change in internal energy  $\Delta U$ , and work  $W$  done on the gas are given by:

EASY

- a)  $Q = (5/2)nR\Delta T, \Delta U = 0, W = -nR\Delta T$
- b)  $Q = (3/2)nR\Delta T, \Delta U = (5/2)nR\Delta T, W = -(3/2)nR\Delta T$
- c)  $Q = (5/2)nR\Delta T, \Delta U = (5/2)nR\Delta T, W = 0$
- d)  $Q = (3/2)nR\Delta T, \Delta U = 0, W = -nR\Delta T$
- e)  $Q = (5/2)nR\Delta T, \Delta U = (3/2)nR\Delta T, W = -nR\Delta T$

FROM  $\Delta U = Q^{ADD} + W^{ON}$

$$\frac{3}{2} n R \Delta T = Q^{ADD} - n R \Delta T$$

$$Q = \frac{5}{2} n R \Delta T$$

6. The energy absorbed by an ideal gas for an isothermal process equals:

- a) the work done by the gas
- b) the work done on the gas
- c) the change in the internal energy of the gas
- d) the negative of the change in the internal energy of the gas
- e) zero since the process is isothermal

$$\Delta T = 0 \Rightarrow \Delta U = 0$$

OR  $Q^{ADD} + W^{ON} = 0$

OR  $Q^{ADD} = W^{BY}$

7. A heat engine operates between 200 K and 100 K. In each cycle, it takes 100 J from the hot reservoir, loses 25 J to the cold reservoir and does 75 J of work. This heat engine violates:

- a) both the first and second laws of thermodynamics
- b) the first law but not the second law of thermodynamics
- c) the second law but not the first law of thermodynamics
- d) neither the first law nor the second law of thermodynamics
- e) cannot answer without knowing the entropy change

$$T_H = 200 \text{ K}$$

$$T_C = 100 \text{ K}$$

$$e_{CARNOT} = 1 - \frac{100}{200} = 0.5$$

$$e_{ENGINE} = 1 - \frac{25}{100} = 0.75$$

$\Rightarrow$  VIOLATES 2<sup>ND</sup> LAW

8. A 0.01 kg bullet moving at 2000 m/s plunges into 1 kg of paraffin wax with specific heat 2800 J/kg·C°. The wax was initially at 20° C. Assuming that all of the bullet's energy heats the wax, its final temperature is:

EASY

- a) 20.1° C
- b) 23.5° C
- c) 25.0° C
- d) 27.1° C
- e) 30.2° C

$$KE_{BULLET} = \frac{1}{2} (0.01) (2000)^2 = 20000 \text{ J}$$

$$WAX: m = 1 \text{ kg}; c = 2800 \frac{\text{J}}{\text{kg}^\circ\text{C}}; T_i = 20^\circ\text{C}$$

$$Q = m c \Delta T$$

$$20000 = 1 \cdot 2800 (T_f - 20)$$

$$T_f - 20 = 7.14 \Rightarrow T_f = 27.14^\circ\text{C}$$

9. Fifty grams of ice at  $0^\circ\text{C}$  is placed in a thermos bottle containing one hundred grams of water at  $6^\circ\text{C}$ . How many grams of ice will melt? The heat of fusion of water is  $333\text{ J/g}$  and the specific heat of water is  $4.19\text{ J/g}\cdot\text{K}$ .

a) 7.5  
 b) 2.0  
 c) 8.3  
 d) 17  
 e) 50

TO MELT ALL ICE NEED  $Q = 50 \cdot 333 = 16,650\text{ J}$   
 TO COOL WATER  $6^\circ\text{C} \rightarrow 0^\circ\text{C}$   
 $Q = 100 \cdot 4.19 \cdot (6-0) = 2514\text{ J}$   
 SO ONLY  $m'$  GRAM ICE WILL MELT  
 $2514 = m' \cdot 333 \Rightarrow m' = 7.55\text{ GRAM}$

10. According to the first law of thermodynamics, applied to a gas, the increase in the internal energy during any process:

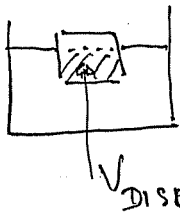
EASY

- a) is the work done on the gas minus the heat input  
 b) is independent of the heat input  
 c) equals the heat input minus the work done on the gas  
 d) equals the heat input plus the work done on the gas  
 e) is independent of the work done on the gas

$$U_f = U_i + Q + W^{ON}$$

$$\Delta U = Q + W^{ON}$$

11. The density of ice is  $0.92\text{ g/cm}^3$ ; and the density of seawater is  $1.03\text{ g/cm}^3$ . A large iceberg floats in Arctic waters. What fraction of the volume of the iceberg is exposed?



- a) 8.0 %  
 b) 11 %  
 c) 89 %  
 d) 92 %  
 e) 99 %

$$\rho_{ICE} = 0.92 \quad \rho_{WATER} = 1.03$$

$$m_{ICE} g = B = \rho_{WATER} V_{DISP} g$$

$$\rho_{ICE} V_{ICE} g = \rho_{WATER} V_{DISP} g$$

$$FRAC: \frac{V_{ICE} - V_{DISP}}{V_{ICE}} = 1 - \frac{V_{DISP}}{V_{ICE}} = 1 - \frac{\rho_{ICE}}{\rho_{WATER}} = 1 - \frac{0.92}{1.03} = 0.107$$

12. A 2 kg block displaces 10 kg of water when it is held fully immersed in water. The object is then tied down as shown in the figure; and it displaces 5 kg of water. What is the tension in the string?

- a) 10 N  
 b) 70 N  
 c) 100 N  
 d) 20 N  
 e) 30 N

$$V(10\text{ kg WATER}) = 10^{-2}\text{ m}^3$$

$$V_{DISP} = 0.5 \cdot 10^{-2}\text{ m}^3$$

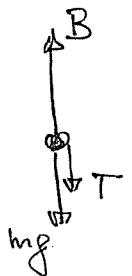
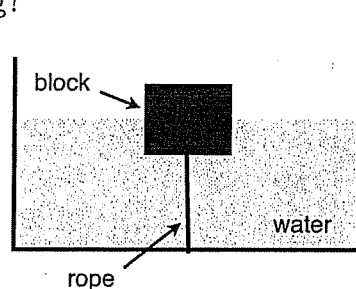
$$mg = 2 \cdot 9.8 = 19.6\text{ N}$$

FORCES

$$B = mg + T$$

$$\rho_{WATER} V_{DISP} g = mg + T$$

$$1000 \cdot 0.5 \cdot 10^{-2} \cdot 9.8 = 19.6 + T$$



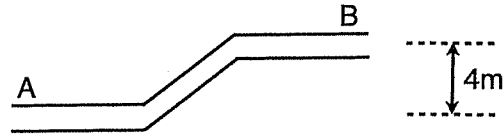
$$\Rightarrow T = 49 - 19.6 = 29.4\text{ N}$$

13. Oil of density  $\rho = 925 \text{ kg/m}^3$  is flowing through a pipeline at a constant speed when it encounters a vertical bend in the pipe raising it 4.0 m. The cross sectional area of the pipe does not change. What is the difference in pressure ( $P_B - P_A$ ) in the portions of the pipe before and after the bend? (Assume that the oil is an ideal fluid.)

EASY

- a)  $+2.4 \times 10^4 \text{ Pa}$   
 b)  $-3.6 \times 10^4 \text{ Pa}$   
 c)  $+5.1 \times 10^5 \text{ Pa}$   
 d)  $-7.2 \times 10^5 \text{ Pa}$   
 e)  $-1.8 \times 10^3 \text{ Pa}$

$$v_A = v_B$$



BERNOULLI

$$P_A + \frac{1}{2} \rho v_A^2 + \rho g y_A = P_B + \frac{1}{2} \rho v_B^2 + \rho g y_B$$

$$P_B - P_A = \rho g (y_A - y_B) = 925 \cdot 9.8 (-4) = -36260 \text{ Pa}$$

14. The specific heat of object B is twice that of object A. The mass of object B is twice the mass of object A. Initially A is at a temperature of 300 K and B is at a temperature of 450 K. After thermal equilibrium the final temperature of both objects is:

EASY

- a) 330 K  
 b) 400 K  
 c) 420 K  
 d) 450 K  
 e) 375 K

$$c_B = 2c_A \quad m_B = 2m_A \quad T_A = 300 \text{ K} \quad T_B = 450 \text{ K}$$

$$\text{HEAT TO A: } Q_A = m_A c_A (T_f - T_A)$$

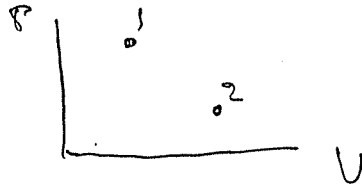
$$\text{HEAT FROM B: } Q_B = m_B c_B (T_B - T_f)$$

$$m_A c_A (T_f - T_A) = m_B c_B (T_B - T_f) \Rightarrow T_f - T_A = 4(T_B - T_f)$$

15. In an adiabatic process, the temperature of one mole of an ideal monatomic gas increases from 200 K to 400 K. How much work was done on the gas during this process?

EASY

- a) 0  
 b)  $500R$   
 c)  $300R$   
 d)  $200R$   
 e)  $400R$



$$T_1 = 200 \text{ K}$$

$$T_2 = 400 \text{ K}$$

$$U_1 = \frac{3}{2} n R T_1 = \frac{3}{2} R \cdot 200$$

$$U_2 = \frac{3}{2} R \cdot 400$$

$$5T_f = 4T_B + T_A = 2100$$

$$T_f = 420 \text{ K}$$

$$\text{ADIABATIC: } Q = 0$$

$$\text{From } U_f = U_i + Q + W_{\text{on}}$$

$$W_{\text{on}} = \frac{3}{2} R \cdot 200 = 300R$$