

Name: _____

ID: _____

Physics 202

Midterm 2

2/19/2025

Collaboration is not allowed. Allowed on your desk are: ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating graphing scientific calculator, a page of scratch paper, writing utensils, and the exam. Show work for full credit on non-multiple choice questions. You will have 80 minutes to complete this exam.

Constants

$$k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$R = 8.31 \text{ J/mol}\cdot\text{K}$$

$$p_{\text{atm}} = 101,300 \text{ Pa}$$

$$1 \text{ cal} = 4.19 \text{ J}$$

$$1 \text{ liter} = 1 \times 10^{-3} \text{ m}^3$$

$$c_{\text{water}} = 4190 \text{ J/kg}\cdot\text{K}$$

$$c_{\text{ice}} = 2090 \text{ J/kg}\cdot\text{K}$$

$$\rho_w = 1000 \text{ kg/m}^3$$

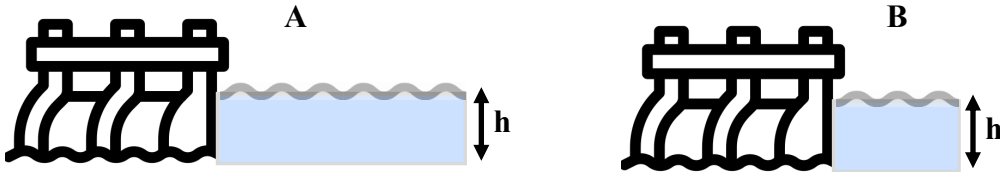
$$L_{f,\text{water}} = 3.33 \times 10^5 \text{ J/kg}$$

$$L_{v,\text{water}} = 22.6 \times 10^5 \text{ J/kg}$$

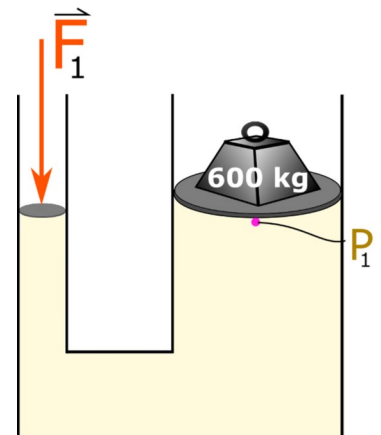
$$\sigma = 5.67 \times 10^{-8} \text{ W/m}^2\cdot\text{K}^4$$

For questions 1 through 2 select all correct answers. A given problem may have more than one correct answer. Each correctly selected answer will receive two points. There are **2** correct answers in this section and only the first **2** selected answers will be graded. There is no partial credit.

1. Two dams are identical with the exception that the water reservoir behind dam **A** extends twice the horizontal distance behind it as that of dam **B**. Which of the following statements regarding these dams are correct.



- (a) The force exerted by the water on dam **A** is greater than that on dam **B**.
 - (b) The force exerted by the water on dam **B** is greater than that on dam **A**.
 - (c) Dam **A** is more likely to collapse than dam **B** if the water level rises.
 - (d) Dam **B** is more likely to collapse than dam **A** if the water level rises.
 - (e) The horizontal distance of the water behind the two dams does not determine the force on them.
2. Consider the hydraulic system in the figure filled with an incompressible fluid like oil. The large piston has a mass of 600 kg, while the small piston is massless. The radius of the larger piston is 6 times the smaller one. What force F_1 must be applied to keep the system in equilibrium?

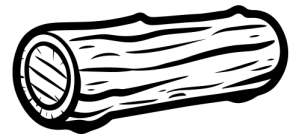


- (a) 35,280 N
- (b) 21,600 N
- (c) 980 N
- (d) 600 N
- (e) 163 N
- (f) 100 N
- (g) 21 N
- (h) 10 N

3. (8 points) To prepare for class every morning, your faithful instructor makes a latte. He starts by steaming milk. To do this, a machine puts water vapor (steam) through a tube into the milk. The 0.24 kg of milk is initially at 20 °C (room temperature) and has a specific heat of 3930 J/kg K. The water vapor is added at a temperature of 100 °C. Assume all of the water stays in the milk, making a homogeneous mixture. What mass of water vapor must be added to the milk in order for the mixture to reach the ideal equilibrium serving temperature of 60 °C? Note: there is a table of constants on the first page of the exam.



4. (8 points) A uniform log with a radius of 20.0 cm and a length of 6.00 m is found in the woods. The log is made of Balsa wood, which has a low density of 160 kg/m³ that makes it ideal to float yourself and some goods across a lake. What is the maximum amount of mass you can float on the log before it will be fully submerged? Assume none of the mass on the log is in the water. Note: the volume of a cylinder is the circular cross sectional area times the length.



5. (10 points) Consider a system consisting of a fixed number of mols of an ideal gas. The initial pressure is 8 kPa and the initial volume is 3 m^3 . Suppose the ideal gas undergoes the following process:

Process 1 – The pressure is changed to 4 kPa and the volume is changed to 6 m^3 .

- (a) Determine whether each of the following quantities is positive, negative, or zero. Explain your reasoning in each case.

(i) The change in temperature of the gas

(ii) The work done on the gas

(iii) The heat transferred to the gas

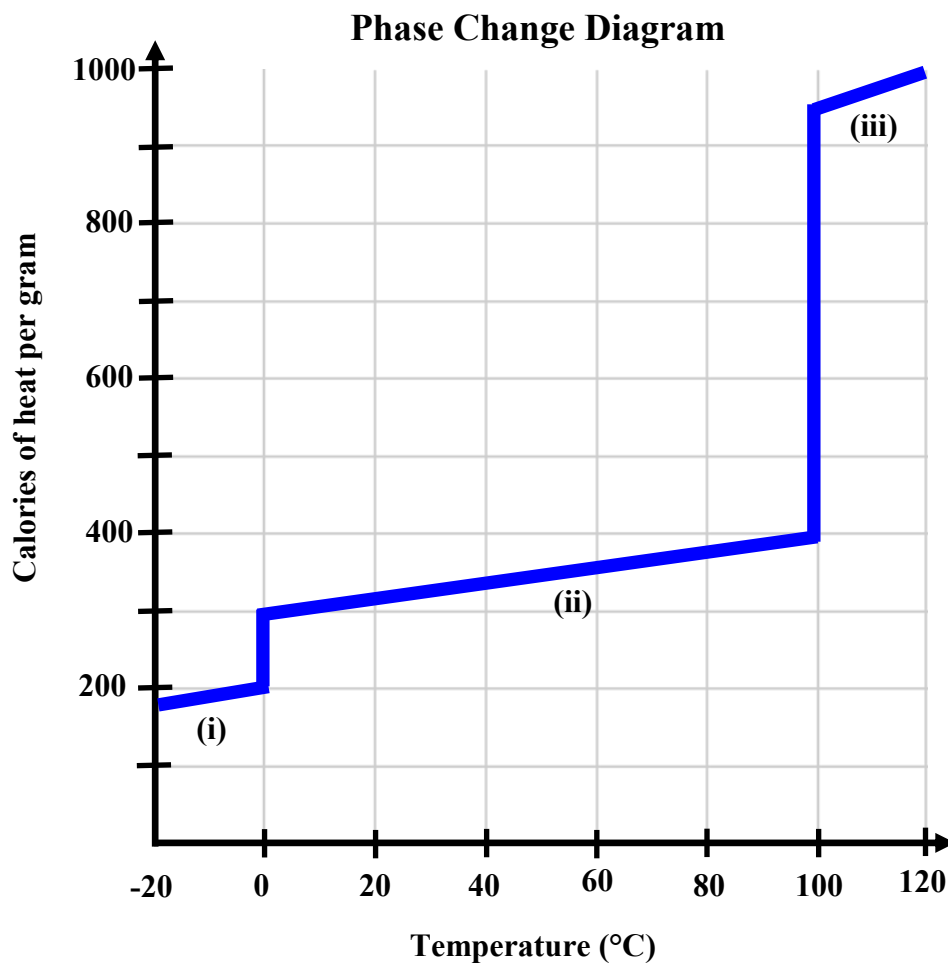
Now consider an alternative process performed on the initial state of the gas ($P = 8 \text{ kPa}$ and $V = 3 \text{ m}^3$).

Process 2 – The pressure is changed to 5 kPa and the volume is changed to 5 m^3 in such a way that the work done on the gas is exactly the same (value and sign) as in process 1.

- (b) Is the amount of heat transferred to the gas during process 2 greater than, less than, or equal to the amount of heat transferred to the gas during process 1? Explain your reasoning.

6. (8 points) A phase change diagram for a particular substance is shown in the figure.

(a) Sections (i), (ii), and (iii) represent the three major phases of matter. Identify which phase goes with which section.



(b) How much latent heat in Calories would it take to change 2.50 kg of this substance from a solid to a liquid?

(c) What is the specific heat of this material in section (ii)? Show how you came to this answer and use the units provided on the figure, Cal/g·°C?

(d) What substance might this represent? What evidence are you using for your claim?