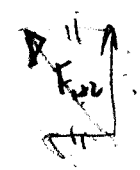


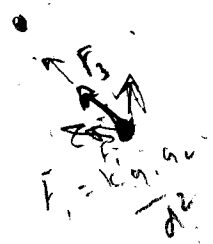
Spring Final Review 2

- An aluminum sphere is heated from 11 C to 580 C. If the volume of the sphere were 1.78 cm³ at 11 C, what is the increase in volume of the sphere at 580 c?
- A 250 kg cast-iron car engine contains water as a coolant. Suppose the engine's temperature is 35 C when it is shut off. The air temperature is 10 C. The heat given off by the engine and water in it as they cool to air temperature is 4.4 x 10⁶ J. What mass of water is used to cool the engine?
- In a solid-waste recycling plant, the small piston of a hydraulic press has radius of 2 cm and the larger piston has radius of 7 cm. If a 500 g weight applies force on the small piston, how much force can be applied to a load of used metal cans?
- The hydrogen atom contains a proton, mass 1.67 x 10⁻²⁷ kg, and an electron, mass 9.11 x 10⁻³¹ kg. The average distance between them is 5.3 x 10⁻¹¹ m. The charge of the proton is the same size, opposite sign of an electron.
 - What is the magnitude of the average electrostatic attraction between them?
 - What is the magnitude of the average gravitational attraction between them?
- A .5 kg sample of unknown material, at a temperature of 100 is dropped into a calorimeter containing 0.2 kg of methanol initially at 20 . The calorimeter absorbs no energy. The final temperature is is 23.2 °C. What is the specific heat capacity of the sample?
- Point charges of 3 x 10⁻⁹ C are situated at each of three corners of a square whose side is 0.2 m. What are the magnitude and direction of the resultant force on a point charge of -1 x 10⁻⁹ C if it is placed at the vacant corner of the square?
- A 100 m pendulum shaft of a clock is made of iron. What is the change in length of the shaft when it is cooled from 50 °C to 1 °C.
 - What is the change in PE of the 20 g weight at the end of the shaft if its maximum angle is 30°?



Handwritten notes and diagrams:

- A diagram showing a force vector F pointing upwards and to the right, with a horizontal component F_x and a vertical component F_y .
- A handwritten equation: $F = \frac{mg}{\sin \theta}$



Material	Specific Heat	Material	Specific Heat	Material	Specific Heat
Aluminum	903	Glass	664	Methanol	2450
Brass	376	Ice	2060	Zinc	388
Carbon	710	Iron	450	Steam	2020
Copper	385	Lead	130	Water	4180

Specific Heat of Common Substances (J/kg*K)

Material	Coefficient of linear expansion α	Coefficient of volume expansion β	Material	Coefficient of linear expansion α	Coefficient of volume expansion β
Aluminum	25×10^{-6}	75×10^{-6}	Platinum	9×10^{-6}	
Iron	12×10^{-6}	35×10^{-6}	Copper	16×10^{-6}	48×10^{-6}
Glass	9×10^{-6}	27×10^{-6}	Water		210×10^{-6}
concrete	12×10^{-6}	36×10^{-6}	Methanol		1100×10^{-6}

Coefficients of Thermal Expansion ($^{\circ}\text{C}^{-1}$)

FINAL REVIEW 2

1

$$T_i = 11^\circ\text{C}$$

$$T_f = 580^\circ\text{C}$$

$$V_i = 1.78 \text{ cm}^3$$

$$V_f = ?$$

$$\beta = 75 \times 10^{-6}$$

$$\Delta V = V \beta \Delta T$$

$$= (1.78 \text{ cm}^3) (75 \times 10^{-6}) (580 - 11)$$

$$\Delta V = 0.0760 \text{ cm}^3$$

$$\Delta V = 7.60 \times 10^{-2} \text{ cm}^3$$

2. $\Delta E_E - \Delta E_W = 0$

$$q = m sh \Delta T$$

$$4.4 \times 10^6 \text{ J} = m_{\text{H}_2\text{O}} (4180 \text{ J/kg}^\circ\text{C}) (10^\circ\text{C} - 35^\circ\text{C})$$

$$= \boxed{4.21 \text{ kg}}$$

3.

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

$$\frac{4.9 \text{ N}}{0.00126 \text{ m}^2} = \frac{F_2}{0.0154 \text{ m}^2}$$

$$= \boxed{9.66 \times 10^1 \text{ N}}$$

$$F_1 = 1.5 \text{ kg} (9.8) = 4.9 \text{ N}$$

$$A_1 = (3.14)(0.02)^2 = 0.00126 \text{ m}^2$$

$$F_2 = ?$$

$$A_2 = (3.14)(1.07)^2 = 0.0154 \text{ m}^2$$

4. $m_p = 1.67 \times 10^{-27} \text{ kg}$

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$d = 5.3 \times 10^{-11} \text{ m}$$

$$q_p = 1.6 \times 10^{-19} \text{ C}$$

$$q_e = 1.6 \times 10^{-19} \text{ C}$$

$$a) F_e = \frac{k q_1 q_2}{d^2} = \frac{(9 \times 10^9) (1.6 \times 10^{-19})^2}{(5.3 \times 10^{-11})^2}$$

$$= \boxed{8.2 \times 10^{-8} \text{ N}}$$

$$b) F_g = \frac{q m_{emp}}{d^2} = \frac{(9.1 \times 10^{-31})(1.67 \times 10^{-27})(9.11 \times 10^{-31})}{(5.3 \times 10^{-11})^2}$$

$$= \boxed{4.03 \times 10^{-67} \text{ N}}$$

5. $m_u = 0.5 \text{ kg}$ $T_i = 100^\circ \text{C}$ $T_f = 23.2^\circ \text{C}$ $sh =$

$m_m = 0.2 \text{ kg}$ $T_i = 20^\circ \text{C}$ $T_f = 23.2^\circ \text{C}$ $sh = \frac{2450 \text{ J}}{\text{kg} \cdot \text{K}} \frac{11 \text{ K}}{273^\circ \text{C}}$

$$= 8.94 \frac{\text{J}}{\text{kg} \cdot ^\circ \text{C}}$$

$$\Delta E_u = \Delta E_m$$

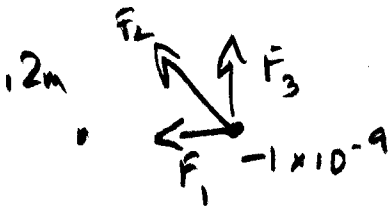
$$(0.5)(sh)(23.2 - 100) = (0.2)(8.94)(23.2 - 20)$$

$$sh \cdot -38.4 = -5.72$$

$$sh = -\frac{5.72}{38.4}$$

$$= \boxed{1.49 \times 10^{-1} \frac{\text{J}}{\text{kg} \cdot ^\circ \text{C}}}$$

6. 3×10^{-9}



$$F_1 = \frac{(9 \times 10^9)(3 \times 10^{-9})(1 \times 10^{-9})}{(1.2)^2} = 6.75 \times 10^{-7}$$

$$F_1 = F_3$$

$$(F_{1+3})^2 = 2(6.75 \times 10^{-7})^2$$

$$= 4.77 \times 10^{-7} \text{ N}$$

$$F_2 = \frac{9 \times 10^9(-1 \times 10^{-9})(3 \times 10^{-9})}{(1.283 \text{ m})^2}$$

$$F_2 = 3.37 \times 10^{-7} \text{ N}$$

$$F_T = F_2 + F_{1+3}$$

$$= 4.77 \times 10^{-7} \text{ N} + 3.37 \times 10^{-7} \text{ N}$$

$$= \boxed{8.14 \times 10^{-7} \text{ N}}$$

$$d^2 = 2(1.2)^2$$

$$d = 0.283 \text{ m}$$

7.

$$L = 100 \text{ m}$$

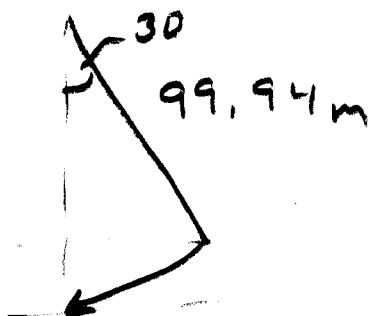
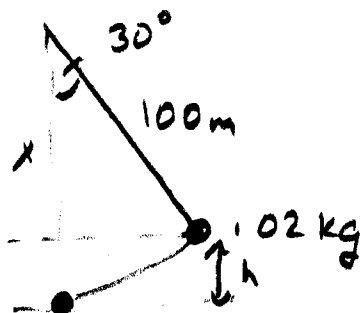
$$T_f = 1^\circ \text{C}$$

$$T_i = 50^\circ \text{C}$$

$$\Delta L = L \alpha \Delta T$$

$$= 100 \text{ m} (12 \times 10^{-6}) (1 - 50)$$

$$\Delta L = -0.0588 \text{ m}$$



$$\cos 30 = \frac{x}{100 \text{ m}}$$

$$x = 86.6 \text{ m}$$

$$h = 100 \text{ m} - 86.6 \text{ m} = 13.4 \text{ m}$$

$$\begin{aligned} PE &= m g h \\ &= (0.02)(9.8)(13.4) \\ &= 2.63 \text{ J} \end{aligned}$$

$$\cos 30 = \frac{x}{99.94 \text{ m}}$$

$$x = 86.55$$

$$\begin{aligned} h &= 100 - 86.55 \\ &= 13.45 \text{ m} \end{aligned}$$

$$\begin{aligned} PE &= 0.02(9.8)(13.45) \\ &= 2.64 \text{ J} \end{aligned}$$

$$\Delta PE = 2.63 - 2.64 = -1 \times 10^{-2} \text{ J}$$