

Physics I - Final Exam

Equations

$$X = R \cos(\theta)$$

$$R^2 = X^2 + Y^2$$

$$Y = R \sin(\theta)$$

$$\theta = \tan^{-1}\left(\frac{Y}{X}\right)$$

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

$$\vec{p} = m\vec{v}$$

for constant a:

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

$$\bar{v} = \frac{1}{2}(v_0 + v)$$

$$\sum \vec{F} = m\vec{a} = \frac{\Delta \vec{p}}{\Delta t}$$

$$F_{fr} = \mu_s F_N \text{ or } \mu_k F_N$$

$$\vec{F}_{ab} = -\vec{F}_{ba}$$

$$\vec{F}_s = -k\vec{x}$$

$$\vec{F}_g = G \frac{m_1 m_2}{r^2}$$

$$a_R = \frac{v^2}{R}$$

$$W = Fd \cos \theta$$

$$K.E. = \frac{1}{2}mv^2$$

$$PE_g = mgh$$

$$PE_s = \frac{1}{2}kx^2$$

$$\bar{P} = \frac{\Delta E}{\Delta t}$$

$$\vec{\tau} = RF \sin \theta$$

$$\sum \vec{\tau} = I\alpha = \frac{\Delta L}{\Delta t}$$

$$K.E. = \frac{1}{2}I\omega^2$$

$$\rho = \frac{M}{V}$$

$$P = \frac{F}{A}$$

$$F_b = \rho g V_d$$

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{const}$$

$$PV = NkT$$

$$v_{rms} = \sqrt{\frac{3k_B T}{m}}$$

$$\Delta L = \alpha L_0 \Delta T$$

$$Q = mc\Delta T$$

$$PV = Nk_B T$$

$$Q = mL$$

$$\Delta E_{int} = Q - W$$

$$\Delta S = \frac{Q}{T}$$

$$f = \frac{1}{T}$$

$$I = \frac{A^2}{2\rho v_w}$$

$$v_w = f\lambda$$

$$\beta(dB) = 10 \log_{10}\left(\frac{I}{I_0}\right)$$

Constants

$$g = 9.81 \text{ m/s}^2$$

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

$$1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$$

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

$$I_0 = 10^{-12} \text{ W/m}^2$$

$$G = 6.7 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

$$0^\circ\text{C} = 273.15\text{K}$$

$$\rho_{air} = 1.27 \text{ kg/m}^3$$

$$c_w = 4186 \text{ J}/(\text{kg}\cdot^\circ\text{C})$$

Metric System

$$\text{T} = 10^{12}$$

$$\text{k} = 10^3$$

$$\mu = 10^{-6}$$

$$\text{G} = 10^9$$

$$\text{c} = 10^{-2}$$

$$\text{n} = 10^{-9}$$

$$\text{M} = 10^6$$

$$\text{m} = 10^{-3}$$

$$\text{p} = 10^{-12}$$

Problems

1. How much 25°C water must you add to 1.0 kg of 100.0°C steam to completely condense it to liquid water (assuming no energy loss)? The specific heat of water is $c_{water} = 4.186 \text{ kJ}/(\text{kg } ^\circ\text{C})$ and the latent heat of evaporation for water is $L_f = 2256 \text{ kJ}/\text{kg}$. What will be the change of entropy for the water as it turns to ice?
2. A hand pump works by quickly reducing the volume of the air in a cylinder so that the pressure increases. If the volume in a pump goes from 90cm^3 to 15cm^3 what will be the corresponding increase in pressure if the temperature is unchanged? If instead the pressure remained unchanged what would be the final temperature of the gas if it started at 25°C
3. A treasure hunter finds an ancient treasure chest 2.00 km below the surface of the ocean. How much greater is the pressure at that depth than on the water's surface? He is able to pull the treasure up at constant velocity with a force of 5000N. When the treasure comes out of the water the force required to lift it increases to 6000N. What is the mass of the treasure? What is its volume?

4. A sailboat is moving at 1.0m/s and accelerating at 0.10m/s^2 . The size of the sail is 5.0m^2 and the mass of the boat plus crew is 400kg . The air in the back of the sail is moving at 1.0m/s , what must be its speed in front of the sail to cause this acceleration?

5. A 50kg girl dives off the end of 6.0m high diving board into a pool. What will be her velocity as she enters the pool? She comes to a stop in the pool, so all of her energy must be transferred to the water. If the pool has a volume of 10m^3 how much will this raise the temperature?

6. A person carries a plank of wood 1.50 m long with one hand pushing down on it at one end with a force F_1 and the other hand holding it up at 0.500 m from that end with force F_2 . If the plank has a mass of 15.0 kg and its center of gravity is at the middle of the plank, what are the magnitudes of the forces F_1 and F_2 ?