1. (a) for the wave function traveling to the right

$y_1(x,t) = A\sin(kx - wt)$ to $+\vec{x}$ direction

$y_2(x,t) = A\sin(kx + wt)$

(b) If a standing wave is created. it is formed with y_1 and y_2. then the wavefunction will be

$Y = y_1 + y_2 = A\sin(kx - wt) + A\sin(kx + wt)$

Using the formula given

$\sin\alpha \pm \sin\beta = 2\sin\frac{1}{2}(\alpha \pm \beta) \cdot \cos\frac{1}{2}(\alpha \mp \beta)$

$Y = 2A\sin kx \cdot \cos wt$ ← this is not a traveling wave any more.

determine the node positions It is a standing wave

(c)

i. $\underset{y_1+y_2}{Y} = 2A\sin kx \cdot \cos wt$

oscillation with time t.

Oscillation with positions x.

To have nodes. $\sin kx = 0$

or $kx = n\pi$. but $k = \frac{2\pi}{\lambda}$

$\frac{2\pi}{\lambda} x = n\pi \rightarrow x = n\frac{\lambda}{2}$. $n = 1, 2, 3 \ldots$

→ We need to know which harmonic to determine the wave length λ

2.

Initial kinetic energy

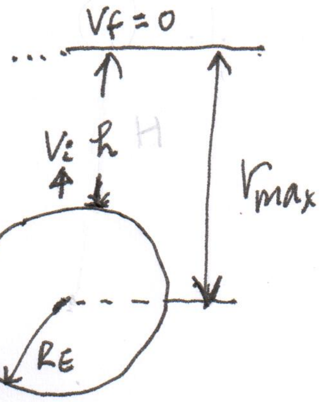
$$E_{ki} = \frac{1}{2} m v_i^2$$

(a)

Total energy =

$$\frac{1}{2} m v_i^2 - \frac{G M_E m}{R_E} = -\frac{G M_E m}{r_{max}}$$

$$\rightarrow v_i^2 = 2 G M_E \left(\frac{1}{R_E} - \frac{1}{r_{max}} \right)$$



(b) if $r_{max} = \infty \rightarrow \frac{1}{r_{max}} = 0$

then

$$v_i^2 = 2 G M_E \left(\frac{1}{R_E} \right)$$

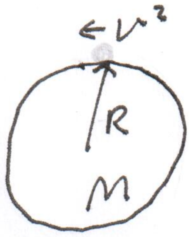
$$= V_{esc}^2$$

$$\therefore V_{esc} = \sqrt{\frac{2 G M_E}{R_E}}$$

If we plug in numbers

$V_{es} \approx 10$ km/sec

3, The magnitude of the gravitational force exerted by the planet on an object of mass m at the surface is $F = \frac{GMm}{R^2}$



let M = mass of the planet

m = mass of the object

R = Earth radius

$$= \frac{mv^2}{R} = \text{Centrifugal force}$$

(a) If the gravitational force is less than the centrifugal force, then the object will fly off.

(b) But $M = \frac{4}{3}\pi R^3 \rho$, ρ = the density

$v = \frac{2\pi R}{T}$, $T \equiv$ the period of the revolution

Plug in M and v into the equation

$$\frac{GMm}{R^2} = \frac{mv^2}{R}$$

$$\Rightarrow \frac{G\,\frac{4}{3}\pi R^3 \rho}{R^2} = \left(\frac{2\pi R}{T}\right)^2 \frac{1}{R}$$

$$\Rightarrow T = \sqrt{\frac{3\pi}{G\rho}}$$

(c) plug in numbers. $G = 6.67 \times 10^{-11}\, m^3/s^2 \cdot kg$

$\rho = 3 \times 10^3\, kg/m^3$

$T = \sqrt{\frac{3\pi}{G\rho}} = 6.86 \times 10^{+3}\, s = \underline{1.9\, hour}$ No planet is spinning so fast

4.

The internal energy change

$$\Delta E_{int} = \Delta(n C_v T) = C_v \Delta(nT) \quad -① $$

But $PV = nRT$

↑ when n = constant

$$\rightarrow nT = \frac{PV}{R} \quad -②$$

Put ② into ①

$$\Delta E_{int} = C_v \Delta\left(\frac{PV}{R}\right)$$

But here P. V. R are all constant

$\therefore \Delta E_{int} = 0$

There is no change in the internal energy.

But in this Cabin. Some air are leaving the cabin through openings. the n did not stay constant and the wood burning is lost through the air escaping the room

5 Consider an ideal gas goes $V_i T_i \rightarrow V_f T_f$

From the thermodynamic 1^{st} law

$$dE_{int} = dQ + dW \qquad dW \equiv \text{work done on the gas.}$$

$$= -pdV$$

$$dQ = dE_{int} - dW$$

$$= dE_{int} + PdV$$

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$dQ = nC_v dT + \frac{nRT}{V} dV$$

$$\therefore \frac{dQ}{T} = nC_v \frac{dT}{T} + \frac{nR \cdot dV}{V}$$

$$\therefore \int_i^f \frac{dQ}{T} = \text{total entropy change}$$

$$= \int_{T_i}^{T_f} nC_v \frac{dT}{T} + \int_{V_i}^{V_f} \frac{nR \cdot dV}{V}$$

$$= nC_v \ln\left(\frac{T_f}{T_i}\right) + nR \ln\left(\frac{V_f}{V_i}\right)$$