Irondale Physics S2 Review

Name ____*Key*____ **Date** ________ **Pd** ____

Newton's Laws of Motion

1.) ***An object in motion stays in motion, an object at rest stays at rest; inertia***

2.) ***ΣF = m · a***

3.) ***For every force, there is an equal and opposite force; forces always occur in equal and opposite pairs.***

Impulse-Momentum

Sample Problem 1: Based upon the graph at right, if an object starts from rest and has a mass of 5 kg, what will be its final velocity?

Impulse (I) = area on ΣF vs. t graph

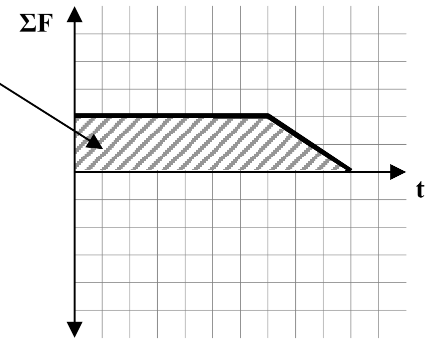
$I = 2N \cdot 7s + \frac{1}{2} \cdot 2N \cdot 3s$

$I = 14\ N{\cdot}s + 3\ N{\cdot}s = 17\ N{\cdot}s$

Since I causes Δp, $I = m \cdot \Delta v$

$17\ N{\cdot}s = (5\ kg) \cdot \Delta v \rightarrow \Delta v = 3.4\ m/s$

Since $v_i = 0$, $\mathbf{v_f = 3.4\ m/s}$



Sample Problem 2: If you (65 kg) jump at -2 m/s off a raft (120 kg) that is flowing at +1 m/s, what will be the raft's final velocity?

Mass and velocity info provided, no info about force or time → use Conserv. of Mom.

$p_{i\text{-system}} = p_{f\text{-system}}$

$p_{i\text{-you}} + p_{i\text{-raft}} = p_{f\text{-you}} + p_{f\text{-raft}}$

$m_y \cdot v_{i\text{-you}} + m_r \cdot v_{i\text{-raft}} = m_y \cdot v_{f\text{-you}} + m_r \cdot v_{f\text{-raft}}$

$(65\ kg)\cdot(1\ m/s) + (120\ kg)\cdot(1\ m/s) = (65\ kg)\cdot(-2\ m/s) + (120\ kg)\cdot(v_{f\text{-raft}})$

$185\ kg{\cdot}m/s = -130\ kg{\cdot}m/s + (120\ kg)\cdot(v_{f\text{-raft}}) \rightarrow$ $\mathbf{v_{f\text{-raft}} = +2.625\ m/s}$

Energy

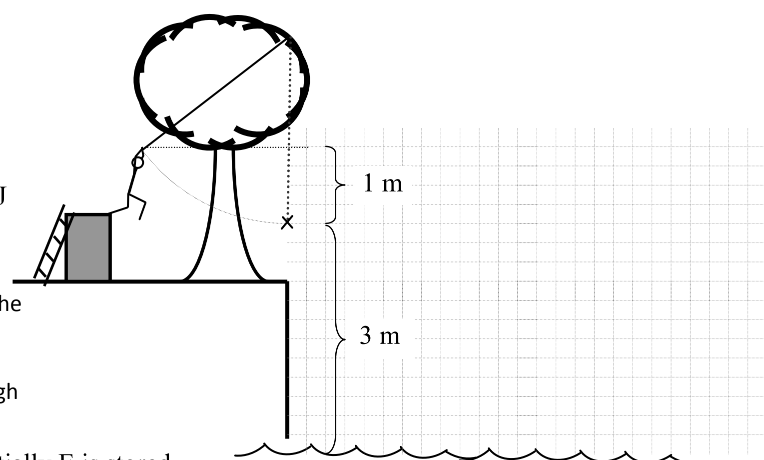
Sample Problem 1: If you (65 kg) swing from the rope from rest, what will be your velocity at the "x"?

$E_{i\text{-system}} = E_{f\text{-system}}$; at highest point of swing, E is stored entirely E_g, at bottom of swing E is stored entirely E_k .

$E_g = m \cdot g \cdot \Delta y = (65\ kg)\cdot(9.8\ N/kg)\cdot(1\ m) = 637\ N{\cdot}m = 637\ J$

Since in *this situation* $E_g = E_k$, $E_k = 637\ J = \frac{1}{2} \cdot m \cdot v^2$

→ $\mathbf{v = 4.427\ m/s}$



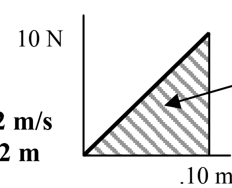
Sample Problem 2: A spring dart gun is loaded with a 50 g dart. The spring, is compressed by 10 cm as the dart is loaded and this requires 10 N of force. How much energy is stored elastically? How fast will the dart be moving when it leaves the gun? How high will the dart go (if it's launched straight up)?

$E_{i\text{-system}} = E_{f\text{-system}}$; total E in system is constant value. Initially E is stored entirely E_{el}, when leaves gun all E_k, at highest point all E_g.

E_{el} = area on ΣF vs. t graph = 0.5 J → $\mathbf{E_{el} = 0.5\ J}$

All this energy is then stored E_k, therefore $E_k = \frac{1}{2} \cdot m \cdot v^2 = 0.5\ J$ → $\mathbf{v = 4.472\ m/s}$

All this energy is then stored E_g, therefore $E_g = m \cdot g \cdot \Delta y = 0.5\ J$ → $\mathbf{\Delta y = 1.02\ m}$

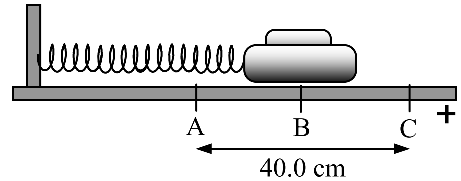


Energy = area = $\frac{1}{2} \cdot (10\ N) \cdot (.10\ m)$

$E_{el} = 0.5\ J$

Oscillating Particle | Wave Fundamentals

Sample Problems: What is the hovercraft's amplitude of oscillation? If the period of oscillation is 1 second, and the spring constant is quadrupled, what will be the new period? …what if the mass had been quadrupled?



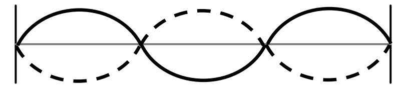
A = 20 cm = 0.20 m

T depends on square root of the inverse of spring constant, so changing the spring constant by a factor of 4 will change the period by a factor of square root of ¼, which is **½**.

T depends on square root of mass, so changing the mass by a factor of 4 will change the period by a factor of square root 4, which is **2**.

Matter Waves

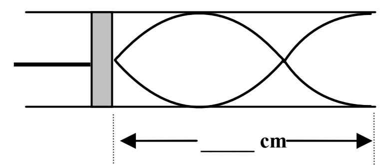
<u>Sample Problems</u>: How many nodes are in the standing wave pattern? How many antinodes? How much of a wave is present? If the end-to-end distance is 6 meters, then what is the wavelength? If the resonant frequency for this situation was doubled, what would be the new wavelength? If a standing wave pattern with a wavelength of 3 meters was produced by a resonant frequency of 4 Hz, what is the speed of the waves through the string?



4 nodes, 3 antinodes, 3/2 of a wave. In this situation, $L = 3/2 \cdot \lambda \rightarrow \lambda = 2/3 \cdot L = 2/3 \cdot 6\text{ m} \rightarrow$ **λ = 4 m**
Doubling frequency causes wavelength to be half, since they are inversely proportional.
Using the wave equation, $v = f \cdot \lambda = (4\text{ Hz}) \cdot (3\text{ m}) \rightarrow v = 12\text{ Hz} \cdot \text{m} \rightarrow$ **v = 12 m/s**

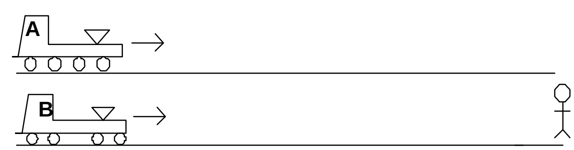
Sound Waves

<u>Sample Problem 1</u>: What mode is represented in this tube? If the wavelength is 92.0 cm and the resonant frequency is 388 Hz, what is the speed of sound in this tube? What is the end-to-end length of the tube?



Mode 2.
Since $v = f \cdot \lambda = (388\text{ Hz}) \cdot (.920\text{ m}) \rightarrow$ **v = 356.96 m/s**
Since this represents ¾ of a wave, $L = ¾ \cdot \lambda = ¾ \cdot (.92\text{ m}) \rightarrow$ **L = .69 m**

<u>Sample Problem 2</u>: Two trains carry identical whistles that emit a sound with a frequency of 500 Hz when measured at rest. The trains approach an observer standing between two sets of tracks (see sketch) at velocities V_A = 40 m/s and V_B = 20 m/s. What are the frequencies that the observer will hear? What will be the beat frequency? Train A then passes the observer and is moving away while Train B is still approaching. What will be the beat frequency heard by the observer?



Doppler shift: $f' = f\,[\,(v_{waves} + v_{observer}) / (v_{waves} - v_{source})]$
From Train A: f'_A = 500 Hz [(345 m/s + 0) / (345 m/s – +40 m/s)] = **565.57 Hz**
From Train B: f'_B = 500 Hz [(345 m/s + 0) / (345 m/s – +20 m/s)] = **530.77 Hz**
$f_{beats} = |\,f_1 - f_2| = |565.57\text{ Hz} - 530.77\text{ Hz}| \rightarrow$ **f_{beats} = 34.8 Hz**

Once Train A passes the observer, its frequency will be heard as 500 Hz [(345 m/s + 0) / (345 m/s – -40 m/s)] = 448.05 Hz
$f_{beats} = |448.05\text{ Hz} - 530.77\text{ Hz}| = |-82.72\text{ Hz}| \rightarrow$ **f_{beats} = 82.72 Hz**