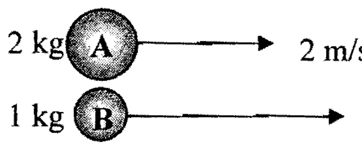
# Physics Semester 2 Final Review

Name Key

## IMPULSE-MOMENTUM

1. Compare the momentum of ball A to ball B.
   [✓ a.] A > B
   b. A < B
   c. A = B
   d. insufficient information for a comparison



$2(2)=4$

$3(1)=3$

2. Compare the momentum of ball A to ball B.
   a. A > B
   [✓ b.] A < B
   c. A = B
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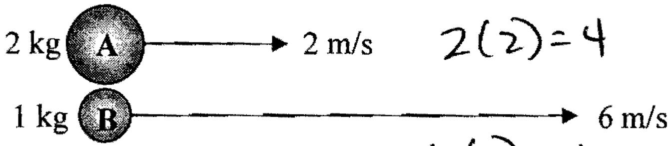
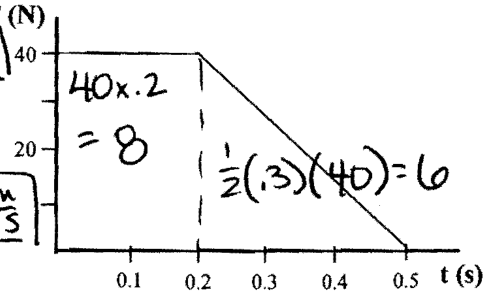


$2(2)=4$

$6(1)=6$

3. A force is applied to a ball according to the graph shown.
   a. What impulse is delivered to the ball? $8+6=\boxed{14 N.s}$ (Area)
   b. The above ball has a mass of 500g and was traveling at -20 m/s before it got hit. What will be the ball's change in momentum?



$40 \times .2 = 8$

$\frac{1}{2}(.3)(40)=6$

$I=\Delta p \rightarrow \Delta p = m\Delta v$ $\quad 14=(.500kg)\Delta v$ $\quad \boxed{\Delta v = 28 \frac{m}{s}}$

$\boxed{\Delta p = 14 kgm/s}$

   c. What will be the ball's change in velocity?

$\Delta v = V_f - V_i$

   d. What will be its new velocity?

$\Delta V = V_f - V_i$ $\quad 28 = V_f - -20$ $\quad 28 = V_f + 20$ $\quad \boxed{V_f = 8 m/s}$

   e. Based upon the graph, if an object starts from rest and has a mass of 5 kg, what will be its final velocity? $\Delta p = m\Delta v$

$14=(5kg)(V_f - V_i)$ $\quad \frac{14}{5} = V_f - 0$ $\quad \boxed{V_f = 2.8 m/s}$

4. Objects A and B collide. How does the force from Object A on Object B compare to the force of Object B on Object A? Explain.

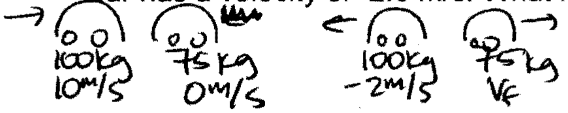
The force between objects is equal & opposite (Newton's 3rd Law)

5. Using what you know about impulse and momentum, how can you change the amount of force applied to an object in a collision?

Increase or decrease the time for the collision $\quad I = F\Delta t$

6. A bumper car with Mickey as the driver (total mass = 100 kg), moving at 10.0 m/s, collides with a stationary bumper car with Minnie as the driver (total mass = 75 kg). After the collision, Mickey's car has a velocity of -2.0 m/s. What is the velocity of Minnie's car after the collision?

(elastic)



$100(10)+75(0)=(100)(-2)+75V_f$

$1000 = -200 + 75V_f$

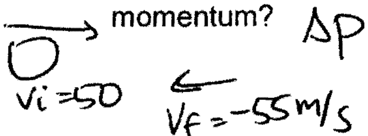
$+200 \quad +200$

$\rightarrow 1200 = 75V_f$ $\quad \boxed{V_f = 16 m/s}$

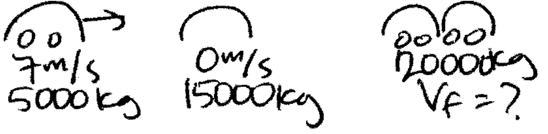
5. A 0.058 kg tennis ball is hit at 50 m/s and hit back at 55 m/s. What is the tennis ball's change in momentum?

$\Delta p = m\Delta v = (.058kg)(-55-50) = \boxed{-6.09 kgm/s}$

$(V_f - V_i)$



6. An empty train car, coasting at 7 m/s, strikes a loaded car that is stationary and the cars link together. Each of the cars has a mass of 5000 kg when empty, and the loaded car contains 10,000 kg of cargo. With what speed does the combination of the two cars start to move?



$7(5000)+0=20000V_f$ (inelastic)

$\boxed{V_f = 1.75 m/s}$

## ENERGY

7. What question would you ask to determine if you have the following type of energy?
   - Elastic (Eel) $\frac{1}{2}kx^2$
   - Kinetic (Ek) $\frac{1}{2}mv^2$
   - Gravitational (Eg) $mg\Delta y$
   - Thermal (Eth) $F_f \Delta x$

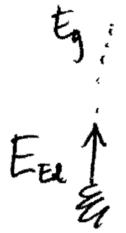
8. Be able to use the equations to determine energy changes.
   - Ex: If you quadruple the height an object is lifted, by what factor will the energy change? x4
     $E_g = mg(4)$
   - If you are moving at half the speed, by what factor will that change the energy? $\times \frac{1}{4}$
     $E_k = \frac{1}{2}m(\frac{1}{2})^2$
   - If you stretch a spring 3 times as far, by what factor will that change the energy? x9
     $E_{el} = \frac{1}{2}kx^2$   $\frac{1}{2}k(3)^2$

9. A 1.5 kg cat jumps down from a 2.0 meter high fence.
   a. What is the cat's gravitational energy at the top of the fence?
   $E_g = (1.5)(9.8)(2) =$ $\boxed{29.4\ J}$
   b. What will be the speed with which the cat lands on the ground?
   $E_g = E_k = \frac{1}{2}mv^2$   $29.4 = \frac{1}{2}(1.5)v^2$   $\boxed{V = 6.26\ m/s}$

10. A 25 g dart rests against a spring that has been compressed 0.050 meters.

$\Delta x = 0.050m$

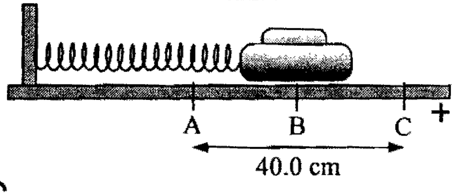
   c. If 1.25 J of energy was transferred to the spring as it was compressed, what is its spring constant?
   $E_{el} = \frac{1}{2}kx^2$
   $1.25J = \frac{1}{2}k(.050m)^2$
   $2.5 = k(0.0025)$
   $\boxed{k = 1000\ N/m}$



   d. What is the maximum velocity of the dart after the spring has transferred its energy to it?
   $E_{el} = E_k$   $1.25 = \frac{1}{2}mv^2 \rightarrow 1.25 = \frac{1}{2}(.025kg)v^2$
   $\sqrt{100} = \sqrt{v^2}$   $\boxed{V = 10\ m/s}$
   e. If the dart is fired vertically, how high will it go?
   $E_{el} = E_g$   $1.25J = mg\Delta y$
   $1.25 = (.025kg)(9.8)\Delta y$   $\boxed{\Delta y = 5.1m}$

## OSCILLATING PARTICLE

Use the diagram to the right to answer the following questions:



11. What is the hovercraft's amplitude of oscillation? 20.0cm

12. If the period of oscillation is 1 second, and the spring constant is quadrupled, what will be the new period? $T \propto \sqrt{\frac{1}{4}}$   $\sqrt{\frac{1}{4}} \times 1sec = \boxed{\frac{1}{2} \text{ or } .5sec}$   $T \propto \sqrt{m}$   $T \propto \sqrt{\frac{1}{k}}$
   ...what if the mass had been quadrupled?
   $T \propto \sqrt{m}$   $T \propto \sqrt{4}$   $\sqrt{4} \times 1sec = \boxed{2sec}$

13. When is the velocity of the hovercraft a maximum? When is it a minimum?
   B   A & C

14. When is the elastic energy at a maximum? When is it a minimum? (compressed or stretched spring)
   A & C   B

15. When is the kinetic energy at a maximum? When is it a minimum? (moving)
   B   A & C

16. If a mass completes 30 oscillations in 15 seconds, what is the frequency?
   30 oscill/15sec = $\boxed{2Hz}$

   What is the period?
   $T = \frac{1}{f} = \frac{1}{2} = \boxed{0.5sec}$

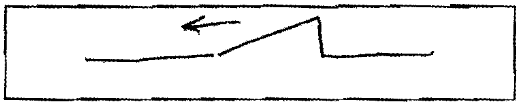
## WAVES

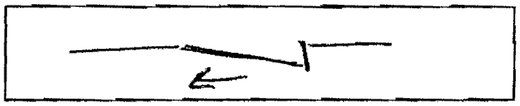
17. How do the following factors affect wave speed?
    - Wavelength? No effect
    - Frequency? No effect
    - Tension? ↑ tension = faster wave
    - Linear Density? ↑ Linear density = slower wave
    - Amplitude? No effect

18. Describe the principle of superposition and difference between constructive and destructive interference. Superposition is when waves add together.
    Constructive = creates a larger wave
    Destructive = cancels out waves.

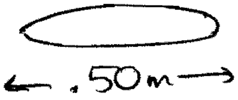
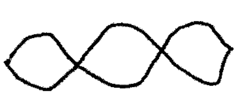
19.

- Draw the pulse as it returns after reflecting from a free end (left box) and a fixed end (right box).



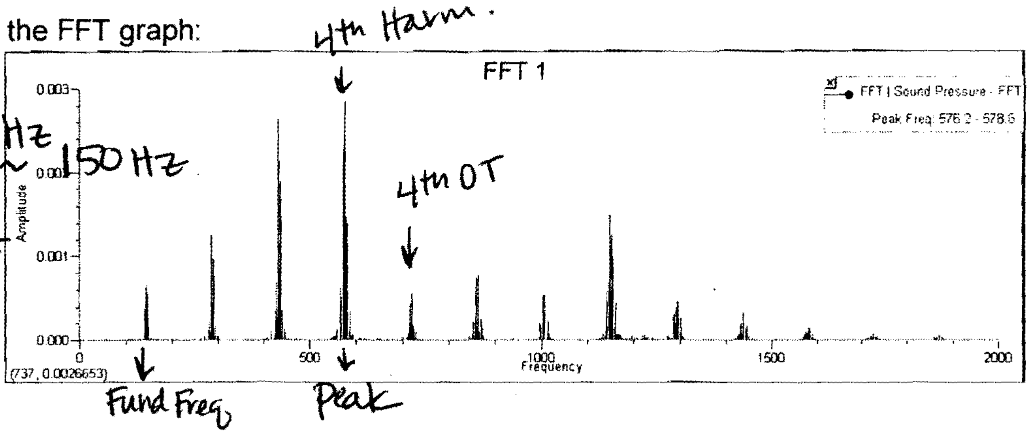


20. Draw the first three modes for a wave on a string that is 50 cm long and fill in the chart below.

| | Diagram | # of Nodes | # of Antinodes | Wavelength, λ | Resonant Frequency, $f$ | Wave Speed, v |
|---|---|---|---|---|---|---|
| 1 |  | 2 | 1 | $\frac{.50\text{ m}}{.5\text{ waves}} = \boxed{1\text{m}}$ | $f = \frac{v}{\lambda} = \frac{50\text{ m/s}}{1\text{m}}$<br>$f = \boxed{50\text{Hz}}$ | $\boxed{49.99\text{ m/s}}$ |
| 2 |  | 3 | 2 | $\frac{.5\text{m}}{1\text{wave}} = \boxed{.5\text{m}}$ | $f = \frac{v}{\lambda} = \frac{50\text{ m/s}}{.5\text{m}}$<br>$f = \boxed{100\text{Hz}}$ | $\boxed{49.99\text{m/s}}$ |
| 3 |  | 4 | 3 | $\frac{.5\text{m}}{1.5\text{ waves}} = \boxed{0.33\text{ m}}$ | 150 Hz | $V = f\lambda$<br>$= (150)(.33)$<br>$= \boxed{49.99\text{ m/s}}$ |

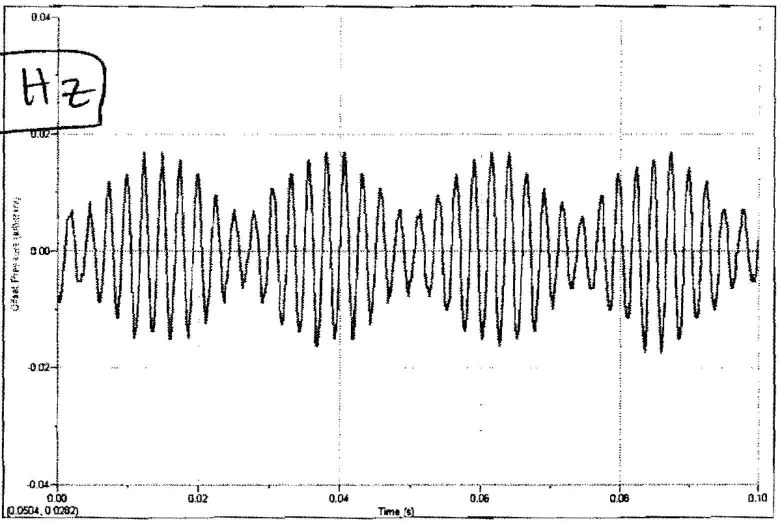
## Sound

24. Determine the following about the FFT graph:



- Tuning fork or [✓ voice]?
- Peak frequency? ~580 Hz
- Fundamental Frequency? ~150 Hz
- 4th overtone? ~720 Hz
- 4th harmonic? ~580Hz

25. Calculate the beat frequency for the graph to the right: $\frac{4 \text{ beats}}{0.10 \text{sec}} = \boxed{40 \text{ Hz}}$

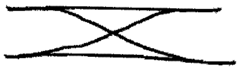
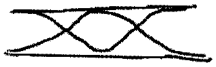


26. Describe the relationship between frequency and wavelength. inverse

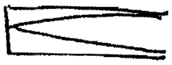
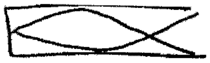
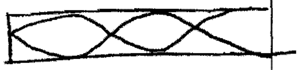
$f \propto \frac{1}{\lambda}$ $\lambda \propto \frac{1}{f}$

27. How are sound waves different from a fan blowing air? Sound waves transport energy but not air particles.

28. Draw the first three modes for a tube open at each end. Label the nodes and antinodes.

| | 1st Mode | 2nd Mode | 3rd Mode |
|---|---|---|---|
| **Diagram** |  |  |  |
| **# of Waves** | 1/2 | 1 | 1 1/2 |

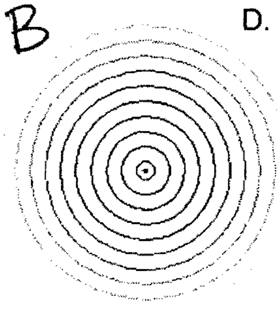
29. Draw the first three modes for a tube closed at one end (as in the Speed of Sound in air lab – tuning forks and tubes in water)

| | 1st Mode | 2nd Mode | 3rd Mode |
|---|---|---|---|
| **Diagram** |  |  |  |
| **# of Waves** | 1/4 | 3/4 | 1 1/4 |

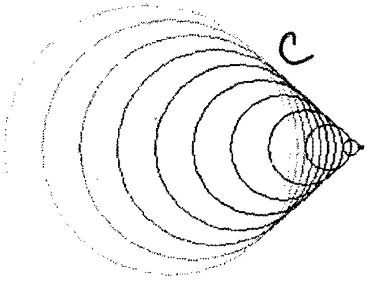
30. Label the following Doppler effect wave simulations using the following choices (use each once):

A. The object is moving slower than the speed of the waves
B. The object is not moving
C. The object is moving faster than the speed of the waves
D. The object is moving at the same speed as the waves

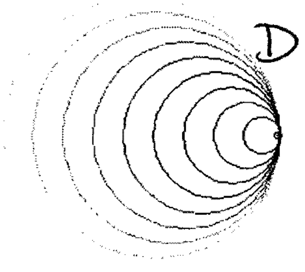
B



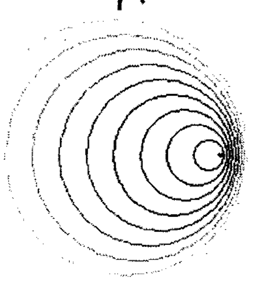
C



D

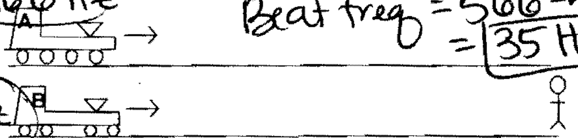


A



$V_{sound} = 345$ m/s

31. Two trains carry identical whistles that emit a sound with a frequency of $\overset{f}{500}$.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?



$f' = f\left(\frac{V + V_o}{V - V_s}\right)$

$f'_A = (500)\left(\frac{345+0}{345-40}\right) = 566 \text{ Hz}$

$f'_B = 500\left(\frac{345+0}{345-20}\right) = 531 \text{ Hz}$

Beat freq $= 566 - 531 = \boxed{35 \text{ Hz}}$

$f'_{A\ Away} = (500)\left(\frac{345+0}{345+40}\right) = \underline{448 \text{Hz}}$

New beat freq. $= 531 - 448 = \boxed{83 \text{Hz}}$