GRAVITATION

Problem Number 1

A space traveler weighs 'W' on planet Earth. What will the traveler weight on another planet whose radius is 3 times that of the Earth and whose mass is also 9 times that of the Earth. State your answer in terms of W.

$$W = F_G = \frac{GMm}{r^2}$$

9x M ⇒ 9x weight

3x r ⇒ $\left(\frac{1}{3}\right)^2 = \frac{1}{9}$ weight

9x with $\frac{1}{9}$ ⇒ SAME WEIGHT

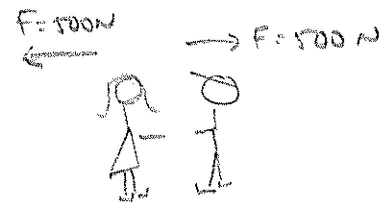
$\boxed{W}$

Do not write in this box: | Points Given = /10

IMPULSE

Problem Number 2

Two skaters, a man and a woman, are standing on ice. The mass of the man is 100 kg and the mass of the woman is 50 kg. The woman pushes against the man with a force of 500 N in the +x direction at time $t_0 = 0$ and at position $x_o = 0$. Determine the velocity (magnitude and direction) of the woman at t = 0.5 seconds as she just loses contact with the man. Neglect any friction between the skate blades and the ice.



$$\text{Impulse} = F(\Delta t) = 500(.5) = 250\ N\cdot s$$

$$\text{Impulse} = \Delta\vec{p} = mV_f - mV_0$$

$$250 = 50(V_f) - 0$$

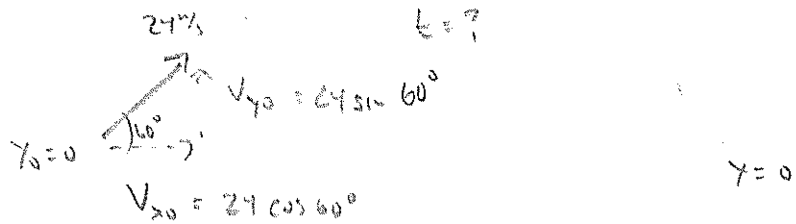
$$\boxed{V_f = 5\ m/s}$$

Do not write in this box: | Points Given = /10

PROJECTILES

Problem Number 3

The punter on a football team tries to kick a football so that it stays in the air for a long 'hang time.' If the ball is kicked with an initial velocity of 24 m/s at an angle of 60 degrees above the ground, what is the 'hang time' of the ball? Ignore any effects of air resistance.



X	Y
$X_0 = 0$	$Y_0 = 0$
$X = ?$	$Y = 0$
$V_x = 24 \cos 60°$	$V_{y0} = 24 \sin 60°$
$a = 0$	$V_y = ?$
$t = ?$	$a = -9.8\ m/s^2$
	$t = ?$

* USE Y-PART

$Y = Y_0 + V_{0y} t + \frac{1}{2} a t^2$

$0 = 0 + (24 \sin 60)t + \frac{1}{2}(-9.8)t^2$

$\boxed{t = 4.24\ sec}$

Do not write in this box: Points Given = / 10

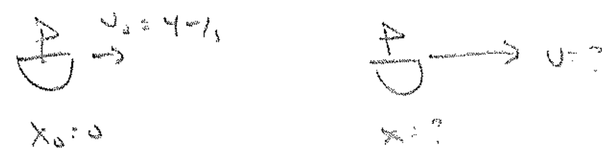
* Alternatively you could split this into an ↑ and a ↓ problem.

KINEMATICS

Problem Number 4

A boat is traveling at 4.0 m/s as it passes the starting line of a race. If the boat accelerates at 1.0 m/s^2 for 6.0 seconds, what is the <u>average</u> velocity of the boat during the 6 second interval?

$V_{avg} = \frac{d}{t}$



$a = 1\ m/s^2$ $t = 6\ sec$

$X = X_0 + V_0 t + \frac{1}{2} a t^2$

$X = 0 + 4(6) + \frac{1}{2}(1)(6)^2$

$X = 42\ m$

$V_{avg} = \frac{42}{6} = \boxed{7\ m/s}$

OR

$V_{avg} = \frac{V_f + V_0}{2} = \frac{10 + 4}{2} = 7\ m/s$

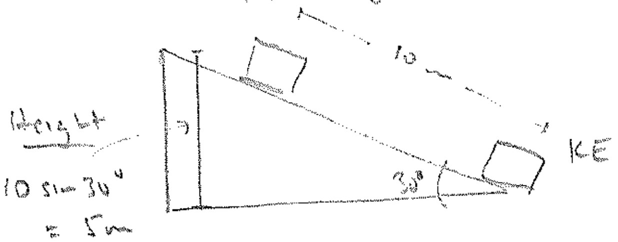
Do not write in this box: Points Given = / 10

FORCES OR ENERGY

Problem Number 5

A 10 kg box is sliding down a 30 degree slope at constant velocity. If the box is displaced 10 m from its initial position, determine the work done by the kinetic friction force as the box slid.

ENERGY



$E_0 - W = E_f$

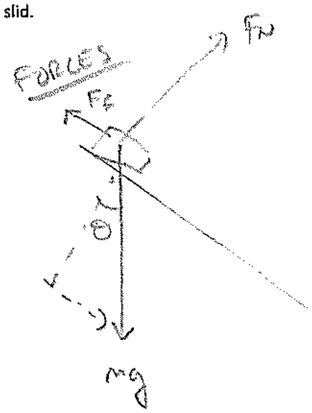
$KE + PE_G - W = KE$

$PE_G = W_{friction}$

$mgh = W_{friction}$

$10(10)(5) = \boxed{500\ J}$

FORCES



$F_f = mg\sin\theta$ b/c constant $\vec{v}$

$W_f = F_f \cdot d$

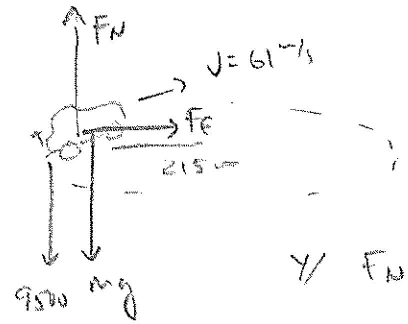
$= [10(10)(\sin 30°)] \times 10$

$\boxed{W_f = 500\ J}$

CIRCULAR MOTION

Problem Number 6

A 750 kg racecar can drive around an unbanked turn at a maximum speed of 61 m/s without slipping. The turn has a radius of 215 m. Air flowing over the car's wing exerts a downward pointing force (called the 'downforce') of 9500 N on the car. Under these conditions, calculate the coefficient of static friction between the track and the car's tires.



∗ Friction is centripetal

Y/ $F_N = 9500 + mg$

$= 9500 + 750(10)$

$= 17{,}000\ N$

CIRCLE

$F_c = \frac{mv^2}{r}$

$F_N \cdot \mu = \frac{mv^2}{r}$

$(17{,}000)(\mu) = \frac{(750)(61)^2}{215}$

$\boxed{\mu = 0.76}$

Do not write in this box: Points Given = / 10

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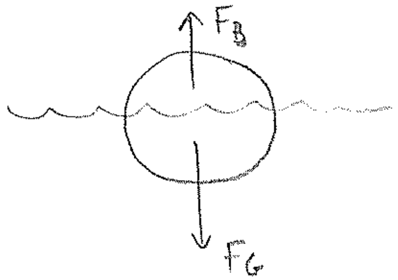
FLUIDS / BUOYANCY

Problem Number 7

A 3.5 kg ball is floating in water. What volume of water is displaced by the ball? (Water has a density of 1000 kg / m^3).



$F_B = F_G$

$(\rho_{fluid})(V_{disp})\cancel{g} = m\cancel{g}$

$(1000)(V_{disp}) = 3.5$

$\boxed{V_{disp} = 0.0035\ m^3}$

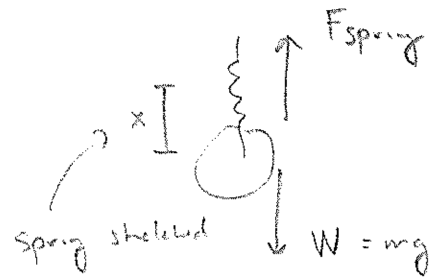
Do not write in this box: | Points Given = / 10

FORCES

Problem Number 8

You are buying grapefruits at the store and you weigh them by hooking them to a vertical spring with spring constant k = 367 N/m. The spring stretches 3.2 cm while the grapefruits are attached.

Determine the weight of the grapefruits.



$F_{spring} = W$

$kx = W$

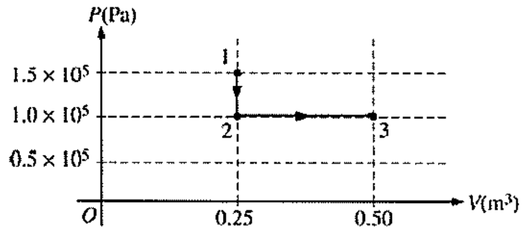
$(367)(.032) = \boxed{W = 11.7\ N}$

* DO NOT USE ENERGY CONS. HERE B/C YOU WOULD HAVE TO CONSIDER THE WORK YOU DO TO LOWER THE GRAPEFRUIT AT A CONSTANT SPEED.

Do not write in this box: | Points Given = / 10

THERMODYNAMICS

Problem Number 9



The graph above describes the pressure and volume of a 7.5 mol sample of an ideal gas at different times, 1, 2, and 3 respectively. The initial temperature of the gas in state 1 is 600 K.

a) Determine the net work done to/by the gas as it transitions from state 1 to state 3 as shown above.

$1 \to 2 \Rightarrow W = \text{ZERO}$

$2 \to 3 \quad W = P(\Delta V) = (100{,}000)(.25)$

$W = 25{,}000\ J$ DONE BY GAS (−)

b) Determine the change in total internal energy as the gas transitions from state 1 to state 3.

$\Delta U = \frac{3}{2} nR(\Delta T) \to$ Need T_3

$\frac{P_1V_1}{T_1} = \frac{P_3V_3}{T_3} \Rightarrow \frac{(1.5)(.25)}{600} = \frac{(1)(.5)}{T_3} \quad T_3 = 800\ K$

$\Delta U = \frac{3}{2}(7.5)(8.31)(800 - 600) = +18{,}700\ J$

c) Was heat added to or removed from the gas as it went from state 1 to state 3. Justify your answer.

ADDED

GAS DID WORK WHILE STILL SEEING AN INCREASE TO ITS TOTAL ENERGY

Do not write in this box: | Points Given = / 10

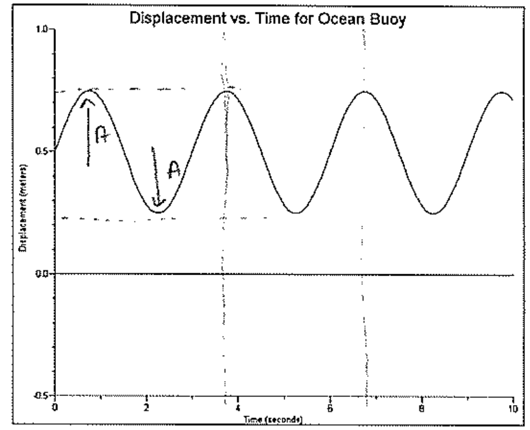
OR

$\Delta U = Q - W$

& SOLVE FOR Q

HARMONIC MOTION / GRAPHING

Problem Number 10



The following graph represents the position vs. time for a tsunami warning buoy floating somewhere in the Pacific Ocean, as periodic waves pass by the buoy over time. Answer the questions below based on the data displayed in the graph.

a) Determine the amplitude of the buoy's oscillation.

$2A = (.75 - .25)$

$A = 0.25\ m$

b) Determine the period of oscillation. (time until pattern repeats)

$T = (6.8\ sec - 3.8\ sec) = 3\ sec$

Do not write in this box: | Points Given = / 10