Exam 2 Review

Name: ____________________Group: __________

Directions: *Turn in what you have completed at the end of the period on Monday for credit.*

1. A person is pulling two big rocks in a wagon through the grass. The wagon and rocks have a mass of 75kg. The wagon is being pulled at a steady speed and the person is pulling so that the handle makes an angle of 30^o with the horizontal.
   a. Draw a free body diagram (FBD) for the wagon.
   b. Write the sum of forces for this FBD.
   c. Clearly show how using the sum of forces equations must be manipulated to get an expression for the tension of the wagon handle using the variables M, g, Θ and μ.

2. A semi's brakes fail as it heads down I-70. Luckily there's a runaway truck ramp near. The semi goes up the ramp and the deep gravel quickly brings the truck to a stop.
   a. Draw a diagram showing all the action reaction pairs of forces involved while the truck heads up the runaway truck ramp.
   b. Draw a free body diagram showing the forces on the truck separate from your action-reaction pair diagram from a.
   c. Explain how these two types of diagrams are different.

3. The back of your text says: Venus has a mass of 4.88×10^{24} kg, it is 1.08×10^{11} m from the sun, it has a radius of 6.06×10^{6} m and it takes Venus 0.615 years to orbit the sun.
   a. Find the time it takes for a rock to fall 2.0 meters on Venus.
   b. If the same rock were to be put into orbit around Venus at an altitude of 10,000 m, what would its speed be?

$\Sigma\vec{\boldsymbol{F}} = m\vec{\boldsymbol{a}}$ $\quad w = mg$ $\quad f = \mu n$ $\quad g = 9.8\text{m/s}^2$

$G = 6.67 \times 10^{-11}\ \text{Nm}^2/\text{kg}^2$ $\quad F_G = \frac{Gm_1m_2}{r^2}$ $\quad$ 1 radian = 57.3^o

$T^2 = \frac{4\pi^2}{GM} r^3$ $\quad v = \frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$ $\quad v = \omega r$

$a = \frac{v^2}{r} = \omega^2 r$ $\quad f = \frac{1}{T}$

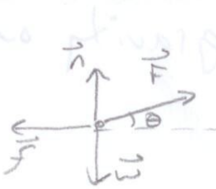
$v_x = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$ $\quad a_x = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{\Delta t}$

$x_f = x_i + v_{xi}\Delta t + ½\, a_x(\Delta t)^2$ $\quad v_{xf} = v_{xi} + a_x\Delta t$ $\quad v_{xf}^2 = v_{xi}^2 + 2a_x(\Delta x)$

sin θ = opp/hyp $\quad$ cos θ = adj/hyp $\quad$ tan θ = opp/adj

1.

a)



$\vec{a} = 0$ $\theta = 30°$, $m = 75\,kg$

b) $\Sigma F_x = F\cos\theta - f = 0$

$\Sigma F_y = n - w + F\sin\theta = 0$

c) From $\Sigma F_y \rightarrow n = w - F\sin\theta$

From ΣF_x $F\cos\theta - \mu n = 0$

Sub in $n = w - F\sin\theta$ $F\cos\theta - \mu(w - F\sin\theta) = 0$

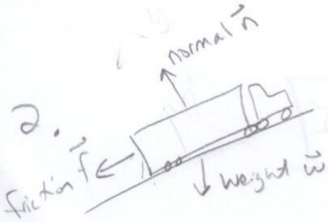
$F\cos\theta - \mu w + \mu F\sin\theta = 0$

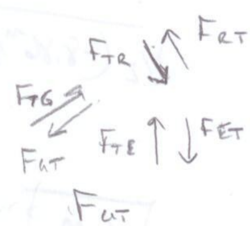
$F\cos\theta + \mu F\sin\theta = \mu w$

$F(\cos\theta + \mu\sin\theta) = \mu w$

$$F = \frac{\mu m g}{\cos\theta + \mu\sin\theta}$$

2.

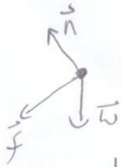




normal is force of road on the truck F_{RT}
pair is force of truck on road F_{TR}

Weight is force of Earth on truck F_{ET}
pair is force of truck on Earth F_{TE}

friction is force of Gravel on truck F_{GT}
pair is force of truck on Gravel F_{TG}



Free body diagram

c. FBD is good for determining the net force on an object
Action reaction pairs help you understand where forces are coming from. - What causes them.

3. Need acceleration due to gravity on Venus

a.

$F_g = mg$

$\frac{G m_1 m_2}{r^2} = m g$

$g = \frac{Gm}{r^2} = \frac{6.67 \times 10^{-11} Nm^2/kg^2 \; 4.88 \times 10^{24} kg}{(6.06 \times 10^6 m)^2}$

$= 8.86 m/s^2$

Now use $y_f = y_i + v_i \Delta t + \frac{1}{2} a \Delta t^2$ to find time to fall.

$0m = 2.0m + 0 m/s \Delta t + \frac{1}{2}(-8.86 m/s^2) \Delta t^2$

$-2.0m = \frac{1}{2}(-8.86 m/s^2) \Delta t^2$

$\frac{-2.0m}{\frac{1}{2}(-8.86 m/s^2)} = \Delta t^2$

$\boxed{\Delta t = 0.67s}$

b. $v = \sqrt{\frac{Gm}{r}}$ $r = 6.06 \times 10^6 m + 10{,}000m = 6.07 \times 10^6 m$

$v = \sqrt{\frac{6.67 \times 10^{-11} Nm^2/kg^2 \cdot 4.88 \times 10^{24} kg}{6.07 \times 10^6 m}} = \boxed{7323 m/s}$