Name:________________ ID:_______________ Lab (day/time)___________

Physics 201

Final Exam

12/7/2016

Collaboration is not allowed. Allowed on your desk are: up to ten 8.5 x 11 inch doubled sided sheets of notes that are bound together, non-communicating/graphing scientific calculator, 1 page of scratch paper, writing utensils, and the exam. You will have 110 minutes to complete this exam.

1. (3 points) You are a passenger on a jetliner that is flying at a constant velocity. You get up from your seat and walk toward the front of the plane. Because of this action, your forward momentum increases. What, if anything, happens to the forward momentum of the plane? Give your reasoning.

> Assuming the net force acting on the plane + occupants system is zero, the impulse acting on the system is also zero, and momentum is conserved. Since you moving forward increases your momentum it must decrease the planes momentum.

2. (5 points) You stretch a slingshot, then shoot a rock vertically into the air, it rises to a peak, then falls, and finally hits the ground and stops without bouncing. Describe the energy transfers that take place throughout this scenario.

> Chemical energy in your muscles is transformed into elastic potential energy as you stretch the slingshot; the elastic potential energy changes to kinetic energy of the rock as the sling is released; the rock's kinetic energy gradually changes to gravitational potential energy as it rises and stops at its peak; the gravitational potential energy is transformed back into kinetic energy as the rock falls; the rock's kinetic energy changes to heat in the ground and the rock itself, once the rock hits the ground and stops.

For questions 3 through 7 circle all correct answers, a given problem may have more than one correct answer. Each correctly circled answer will receive two points. There are **9** correct answers in this section and only the first **9** circled answers will be graded. There is no partial credit.

3. The period of a pendulum is the time it takes the pendulum to swing back and forth once. If the only dimensional quantities that the period depends on are the acceleration of gravity, **g**, and the length of the pendulum, **ℓ**, what combination of **g** and **ℓ** must the period be proportional to?
   (a) g/ℓ
   (b) $g\ell^2$
   (c) $g\ell$
   (d) $(g\ell)^{0.5}$
   (e) $(\ell/g)^{0.5}$

4. You are standing in the back of a moving bus, wearing roller-skates, facing forward. Suddenly the bus comes to a quick stop and you move towards the front of the bus. Which one of the following forces acted on you to causes you to move forward relative to the back of the bus?
[F] (a) The force of gravity.
[F] (b) The normal force from the floor of the bus.
[F] (c) The force of friction between you and the floor of the bus.
[T] (d) No forces were acting on you that caused you to move forward relative to the bus.
[F] (e) The force of inertia.

5. Which of the following statements regarding momentum and kinetic energy are true.
[F] (a) If a force acts perpendicular to an object's velocity it cannot change its momentum.
[T] (b) If a force acts perpendicular to an object's velocity it cannot change its kinetic energy.
[F] (c) If a force acts on two different mass objects for equal amounts of time, it will change their momentum by different amounts.
[T] (d) If a force acts on two different mass objects for equal amounts of time, it will change their momentum by the same amount.
[F] (e) If a force acts on two different mass objects for equal distances, it will change their kinetic energy by different amounts.
[T] (f) If a force acts on two different mass objects for equal distances, it will change their kinetic energy by the same amount.

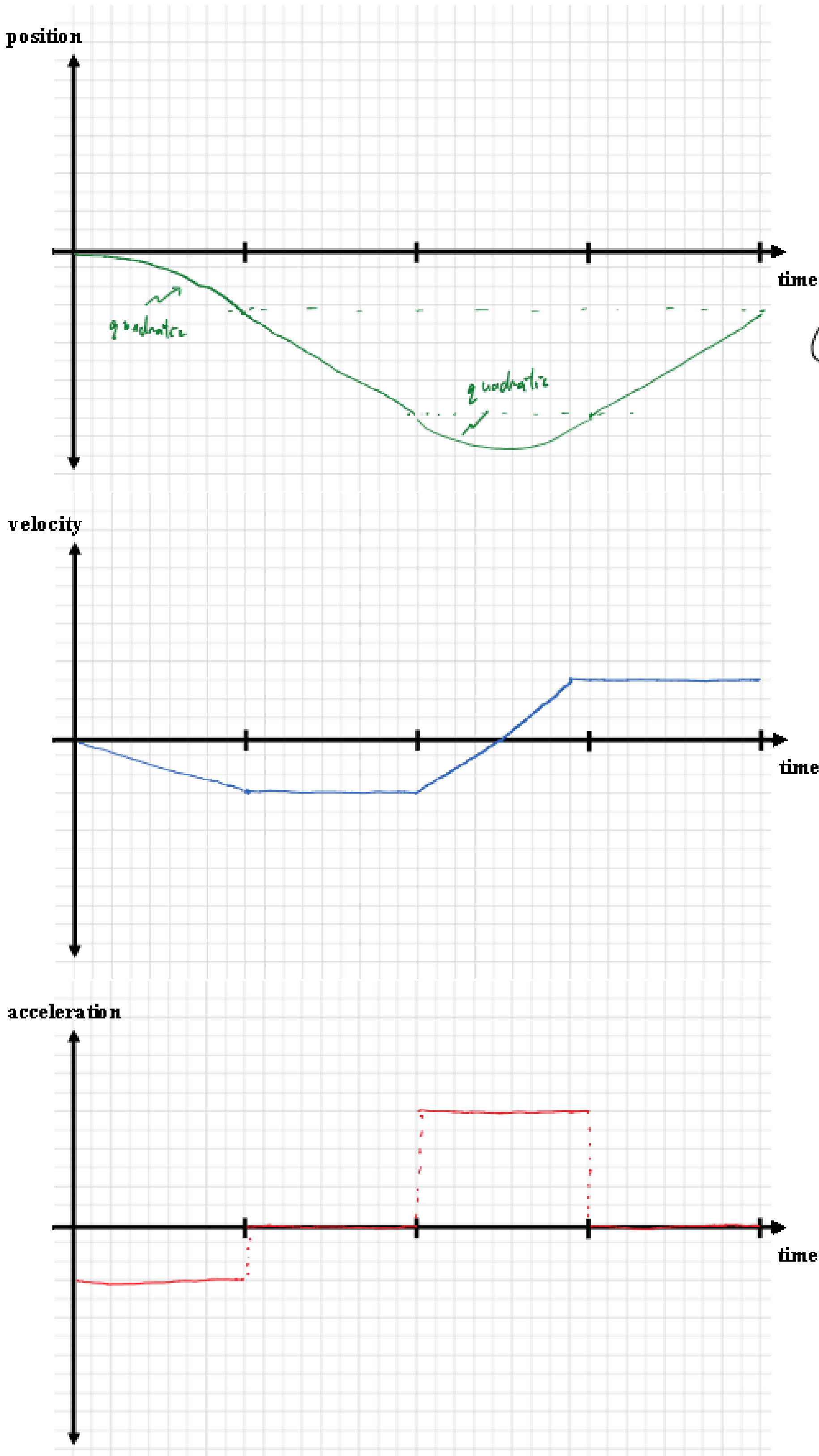
6. A block is sliding at constant speed on a rough horizontal surface while wind is blowing on it at an angle θ, down from the horizontal. Which of the following statements are *necessarily* false in regards to the block system.
[T] (a) The distance the block travels increases linearly with respect to time.
[F] (b) The block will eventually come to rest.
[T] (c) Wind is doing positive work on the block.
[T] (d) Friction is doing negative work on the block.
[F] (e) The wind is in the opposite direction of the blocks motion.

7. Which of the following are a vector quantities?
[NV] (a) the age of the earth
[NV] (b) the mass of a football
[V] (c) the earth's pull on your body
[NV] (d) the temperature of an iron bar
[NV] (e) the number of people attending a baseball game
[NV] (f) the work done on a tennis ball hitting a racquet
[V] (g) the impulse given to a baseball by a bat

8. (10 points) An object is confined along a straight line. It begins from rest at the origin and undergoes the following net forces during four equal time interval stages.

(1) A net force in the negative direction.
(2) Zero net force.
(3) A net force twice as large but in the opposite direction as the first stage.
(4) Zero net force.

(a) Sketch the position, velocity, and acceleration as a function of time for all four stages. Be sure to scale the vertical axis of your plots so that changes during each interval are comparable. If the line you're drawing is not linear, please indicate it on the plot. (b) After all stages does the object end up in the positive or negative region?



(b) ends up in still in neg. region

Rubric

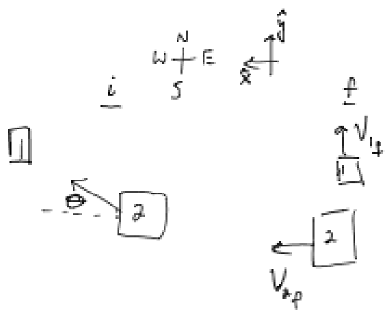
+2 pt accel

+3 pt Vel.

+4 pt position

+1 pt Answer (b)

9. (8 points) One yak, (m_1) with a mass 500 kg is sitting still on a frictionless surface when a smaller yak (m_2) charges into it at a velocity of 15 m/s in a direction 30° north of west. After the two collide the smaller yak is traveling due west while the larger yak is traveling due north. The smaller yak's final speed is twice that of the larger yak. What is (a) the mass and (b) the final speed of the smaller yak?



$$\sum \vec{P}_i = \sum \vec{P}_f, \quad V_{2ix} = |\vec{V}_{2i}|\cos\theta, \quad V_{2iy} = |\vec{V}_{2i}|\sin\theta$$

$\boxed{x}$ $$m_1 \cancel{V_{1ix}}^{0} + m_2 V_{2ix} = m_1 \cancel{V_{1fx}}^{0} + m_2 V_{2fx}$$

$\boxed{y}$ $$m_1 \cancel{V_{1iy}}^{0} + m_2 V_{2iy} = m_1 V_{1fy} + m_2 \cancel{V_{2fy}}^{0}$$

$$V_{2fx} = 2 V_{1fy} \equiv V_f$$

So,

x: $$\cancel{m_2} V_{2ix} = \cancel{m_2} V_f$$

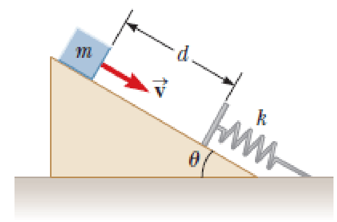
y: $$m_2 V_{2iy} = m_1 \frac{V_f}{2}$$

$$m_2 = \frac{m_1 V_{2ix}}{2 V_{2iy}} = 433 \text{ kg}$$

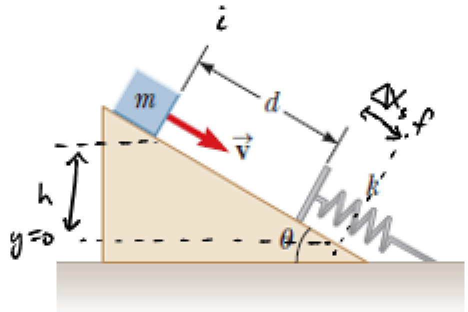
Rubric

+ 1.5pt - components of $\vec{V}_i$
+ 2pt - Identifying con. of $\vec{P}$
+ 2pt - Apply $\sum \vec{P}_i = \sum \vec{P}_f$
+ 1pt - Constraint $V_{2fx} = 2 V_{1fy}$
+ 1 - Combine x & y
0.5 - Answer w/ units

10. (10 points) A 3-kg-mass is sliding down a frictionless inclined plane ($\theta = 22°$) towards a spring of force constant 450 N/m. The mass is initially a meter from the spring and is traveling with a speed of 0.8 m/s. How much is the spring compressed when the mass is momentarily stationary? Assume the mass of the spring is negligible.



$$\Sigma E_i + \cancel{W_{nc}}^{0} = \Sigma E_f$$



$$K_i + U_i^g + \cancel{U_i^s}^{0} = \cancel{K_f}^{0} + \cancel{U_f^g}^{0} + U_f^s$$

$$\frac{1}{2}mv^2 + mgh = \frac{1}{2}k\Delta X_s^2$$

Geometry $h = (d + \Delta X_s)\sin\theta$

$$\frac{1}{2}mv^2 + mg(d + \Delta X_s)\sin\theta = \frac{1}{2}k\Delta X_s^2$$

quadratic

$$\underbrace{\frac{1}{2}k}_{\text{"A"}}\Delta X_s^2 \underbrace{- mg\sin\theta}_{\text{"B"}}\Delta X_s \underbrace{-\left[\frac{1}{2}mv^2 + mgd\sin\theta\right]}_{\text{"C"}} = 0$$

$\Delta X_s = 0.256$ m

Rubric

+2 - Identifying con. of E

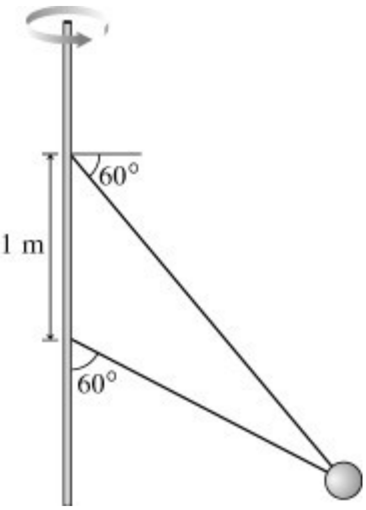
+4 - Application of $\Sigma E_i = \Sigma E_f$

+2 - Geometry for h

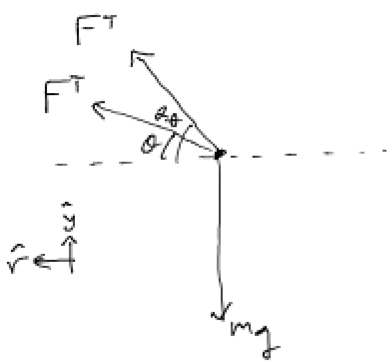
+1 - Identifying quadratic

+1 - Answer + units

11. (10 points) The figure shows two wires tied to a 3.3 kg sphere that revolves in a horizontal circle at constant speed. At this particular speed the tension is the same in both wires. What is the tension?



FBD



$$\Sigma F_y \Rightarrow F^T \sin\theta + F^T \sin(2\theta) - mg = m\cancel{a_y}^{\,0}$$

$$F^T = \frac{mg}{\sin\theta + \sin(2\theta)} = 23.7\ N$$

$$\Sigma F_r \Rightarrow F^T \cos\theta + F^T \cos(2\theta) = m\frac{V^2}{r}$$

Rubric

+1.5 pt - FBD

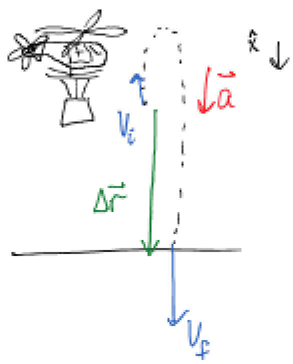
+2 pt - F^T components

+4 pt - ΣF_y

+1.5 pt - Realizing don't need ΣF_r

+1 - Answer + units

12. (6 points) A package is dropped from a helicopter moving upward at 15 m/s. If it takes 16.0 s before the package strikes the ground, how high above the ground was the package when it was released? Ignore air resistance.



$\boxed{10}$

K	UK
$V_i = -15\ m/s$	V_f
$\Delta t = 16\ s$	Δx
$a = 9.8\ m/s$	

$\Delta x = V_{ix}\Delta t + \frac{1}{2}a\Delta t^2$

$\underline{\Delta x = 1014\ m} \equiv h$

Rubric

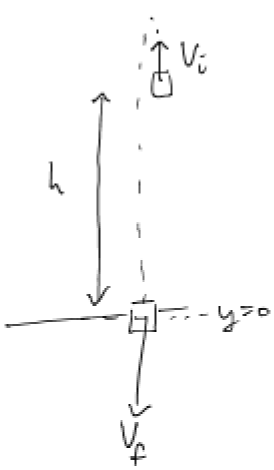
+1.5 physical Rep

+1.5 K + UK

+2 $\Delta x = V_i\Delta t + \frac{1}{2}a\Delta t^2$ eq.

+1 Answer + units

13. (6 points) If the package in the previous problem has an actual weight of 58.8 N, use conservation of energy to determine it's kinetic energy right before hitting the ground?



$\Sigma E_i + \cancel{W_{nc}}^{0} = \Sigma E_f \Rightarrow K_i + U_i^g = K_f + \cancel{U_f^g}^{0}$ b/c w/ y=0

$\frac{1}{2}\underset{w/g}{m}V_i^2 + \underbrace{mg}_{w}\underset{h}{y_i} = K_f = \underline{60{,}322\ J}$

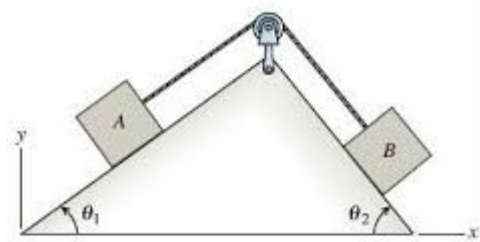
Rubric

+4 Applying con. of E

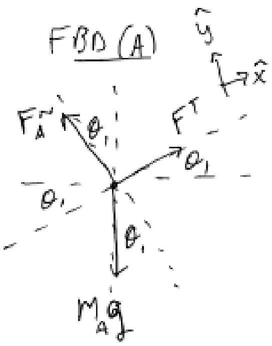
+1 Dealing w/ W=mg

+1 Answer + units

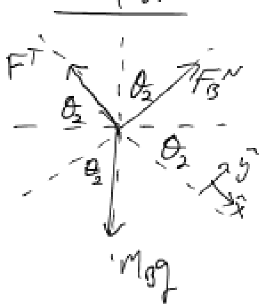
14. (12 points) Two masses, **A** and **B**, are on different incline planes and are connected via a light string and pulley, as shown in the figure. The mass of **A** is 2 kg, and angles θ_1 and θ_2 are 30° and 50° respectively. All surfaces are frictionless. The mass of **B** is such that **A** slides up the incline at a constant speed. (a) If **A** slides up the incline for 3 s, how much has its momentum changed? (b) If **A** slides along the inline a distance of 3 m, how much work has tension done on **A**? (c) What is the mass of **B**?



FBD (A)



FBD (B)



$|\vec{V}_A| = |\vec{V}_B| = \text{constant}$, $\sum \vec{F}_{ext} = 0$

(a) $\Delta \vec{P} = \cancel{\sum \vec{F}_{ext}}^{\,0} \Delta t = 0$, zero change

(b) $\sum E_i + W_{nc} = \sum E_f$

$\boxed{A}$ $\cancel{K_i} + U_i^g + W^T = \cancel{K_f} + U_f^g$

$W^T = \Delta U^g = mgh$

$= mgl\sin\theta = 29.4\text{ J}$

(c) A $\sum F_x \Rightarrow F^T - M_A g \sin\theta_1 = M_A \cancel{a_{Ax}}^{\,0}$

B $\sum F_y \Rightarrow M_B g \sin\theta_2 - F^T = M_B \cancel{a_{Bx}}^{\,0}$

$\Rightarrow M_B = M_A \dfrac{\sin\theta_1}{\sin\theta_2} = 1.31\text{ kg}$

Rubric

(a) 2pts

(b) 3pts - finding W, either w/ $W = \Delta U^g$ or w/ finding F^T

0.5pts - Answer + units

(c) 2pts - FBD's

1.5pts - axis + components

2.5pt - $\sum F$'s

0.5pts - Answer + units

extra space if needed

Scores:

<u>Problems</u>

1	2	3-7	8	9	10	11	12	13	14

<u>Exam Total</u>