Name:_____ ID:_____ Lab (day/time)_____

Physics 201

Final Exam

7/16/2015

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. (4 points) Suppose there is a wind blowing parallel to the ground and toward the kicker in a football game. Would you expect the time of flight of the ball to be greater than, less than, or equal to the case when the wind is not blowing? Explain.

The y-component of the acceleration is what determines the time of flight - it is what slows the ball down in the vertical direction and brings it back down to the ground. Adding an additional x-component to the acceleration will thus not affect the net y-component of the acceleration and **will not** change the time of flight.

2. (4 points) Two sharpshooters fire 0.30-caliber rifles using identical shells. Assume a constant force exerted by the expanding gas in the barrels, accelerates the bullets. The barrel of rifle A is 2.00 cm longer than the barrel of rifle B. If friction is ignored, which rifle will have the higher muzzle (exit) speed? Justify your answer with both an energy and mechanics/kinematics answer.

Energy $W = \Delta K = K_f - \cancel{K_i}^{0} = \vec{F} \cdot \Delta \vec{r}$ $\quad m = \text{const},\ |\vec{F}| = \text{const}$

so $\frac{1}{2} m v_f^2 = |\vec{F}|\,|\Delta \vec{r}| \cancel{\cos\theta}^{1}$, w/ $|\Delta \vec{r}_A| > |\Delta \vec{r}_B|$, $v_{fA} > v_{fB}$

Mech/Km. $\Sigma \vec{F} = m\vec{a}$, so $\vec{a}_A = \vec{a}_B$,

ID $a_{Ax} = a_{Bx}$

w/ $v_{fx}^2 = \cancel{v_{ix}^2}^{0} + a\Delta x$

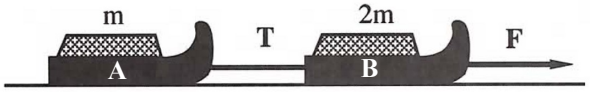
+ $\Delta x_A > \Delta x_B$, $v_{fA}^2 > v_{fB}^2$

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 **8** correct answers in this section and only the first **8** circled answers will be graded. There is no partial credit.

3. A satellite maintains a circular orbit around a planet of mass **m**, at a radius **r**, with a speed **v**. If the satellite is to instead orbit a planet that has twice the mass, at half the speed, what must the radius of the orbit be?

(a) 2**r** (b) **r**/2 (c) 4**r** (d) **r**/4 (e) 8**r** (f) **r**/8

4. Two sleds (**A** and **B**), connected by a rope with tension **T**, are pulled at a constant speed by a force **F**, as shown in the figure. Which of the following statements are false?

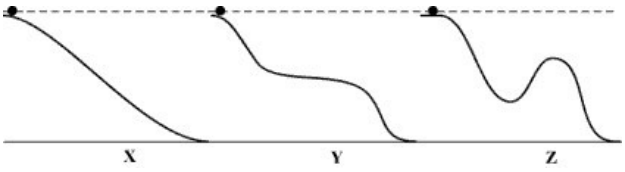


[F] (a) The work done by **T** on sled **A** is twice the work **F** does on **B**.
[T] (b) The work from friction on **B** is twice the work from friction on **A**.
[T] (c) The change in energy of the **A+B** system is zero.
[F] (d) The net impulse exerted on **A** is less than on **B**.
[T] (e) The net impulse exerted on both **A** and **B** is zero.
[F] (f) Both **A** and **B** experience positive net work.
[F] (g) Both **A** and **B** experience negative net work.
[T] (h) Both **A** and **B** experience zero net work.

5. Which one of the statements below completes the following statement?
The work done by friction is…

[F] (a) always negative.
[F] (b) always zero.
[F] (c) positive, or negative, but never zero.
[T] (d) positive, negative or zero.

6. A ball can be rolled down one of four different ramps, as shown below. The final elevation loss of each of the ramps is the same. Neglecting friction, for which ramp will the speed of the ball be the highest at the bottom?



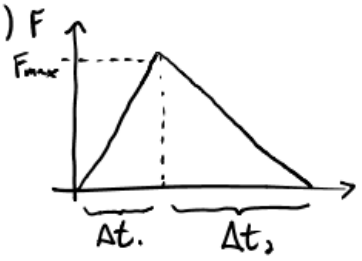
[T] (a) The speed of the ball will be the same for all ramps.
[F] (b) Ramp X
[F] (c) Ramp Y
[F] (d) Ramp Z

7. A man stands on a scale in a moving elevator and notices that the scale reading is 20% less than when he weighs himself in his bathroom. Which of the following statements are true?

[F] (a) The tension in the elevator's supporting cable must exceed the weight of the elevator and its contents.
[F] (b) The tension in the elevator's supporting cable must equal the weight of the elevator and its contents.
[F] (c) The elevator could be moving upward with increasing speed.
[T] (d) The elevator could be moving downward with increasing speed.
[F] (e) The elevator could be moving downward at constant speed.

8. (16 points) A golf ball of mass 0.050 kg is at rest on the tee and has a velocity of 102 m/s immediately after being struck by a club. Model the impact force, F(t), on the ball as a linearly increasing function, that reaches a max force, then linearly decreases until it is zero. The magnitude of the slope for the time the force is increasing is twice that of the time it's decreasing. (a) Sketch a plot of the impact force as a function of time. (b) Does the force spend more time increasing or decreasing? (c) What was the impulse delivered to the ball? (d) How much mechanical energy was imparted to the ball by the club? (e) If the club and ball were in contact for 0.81 ms, what was the maximum force exerted on the ball?

i: $v_i = 0$ f: $v_f = 102$ m/s

a) 

b) w/ slope $= \frac{\text{rise}}{\text{run}}$ &

$|\text{slope}|_1 = 2|\text{slope}|_2$

& rise the same

$\Delta t_2 = 2\Delta t_1$

c.) $|\vec{J}| = |\Delta \vec{p}| = |\vec{p}_f - \vec{p}_i|$ ($\vec{p}_i = 0$)

$= m v_f = 5.1 \frac{kg \cdot m}{s}$

d.) $W = \Delta K = K_f - K_i$ ($K_i = 0$)

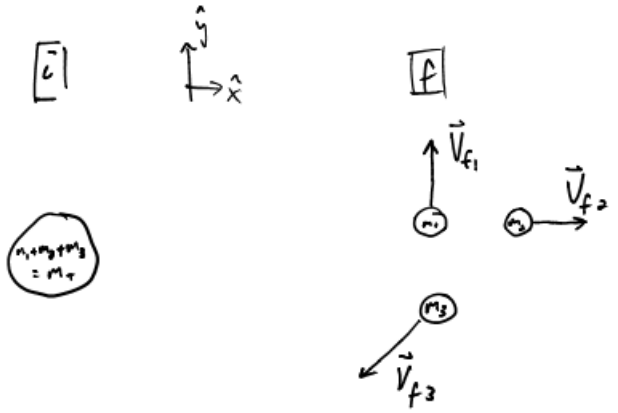
$= \frac{1}{2} m v_f^2 = 260.1$ J

e.) $|J|$ = Area under f(t) curve

so $|\vec{p}_f| = \frac{1}{2} F_{max}(\Delta t_1 + \Delta t_2)$, where $\Delta t = \Delta t_1 + \Delta t_2$

$F_{max} = \frac{2 m v_f}{\Delta t} = 12{,}593$ N

9. (10 points) An unstable nucleus of mass 17 x 10^{-27} kg, initially at rest, disintegrates into three particles. One of the particles, of mass 5.0 x 10^{-27} kg, moves along the y axis with a speed of 6.0 x 10^{6} m/s. Another particle, of mass 8.4 x 10^{-27} kg, moves along the x axis with a speed of 4.0 x 10^{6} m/s. Find (a) the velocity of the third particle and (b) the total energy given off in the process.



$m_3 = m_T - m_1 - m_2 = 3.6 \times 10^{-27}$ kg

a.) w/ $\Sigma \vec{F}_{ext} = 0$, $\Sigma \vec{P}_i = \Sigma \vec{P}_f$

[x] $m_T v_{ix}^{\,0} = m_1 v_{f1x}^{\,0} + m_2 v_{f2x} + m_3 v_{f3x}$

$v_{f3x} = -\frac{m_2 v_{f2x}}{m_3} = -9.33 \times 10^{6}$ m/s

[y] $m_T v_{iy}^{\,0} = m_1 v_{f1y} + m_2 v_{f2y}^{\,0} + m_3 v_{f3y}$

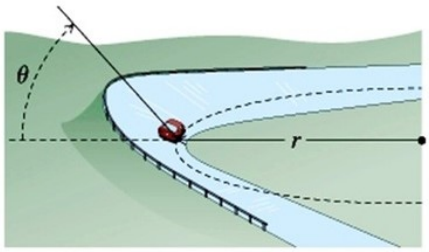
$v_{f3y} = -\frac{m_1 v_{f1y}}{m_3} = -8.33 \times 10^{6}$ m/s

So, $\vec{v}_{f3} = -\langle 9.33, 8.33 \rangle \times 10^{6}$ m/s

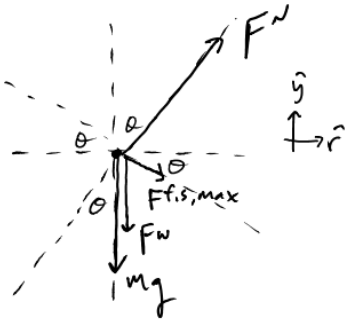
b.) $W = K_f - K_i^{\,0} =$ Energy Released

$= \frac{1}{2}\left(m_1 v_{1f}^2 + m_2 v_{2f}^2 + m_3 v_{3f}^2\right) = 4.39 \times 10^{-13}$ J

10. (10 points) What is the fastest an 800-kg-car can round a banked curve of radius 45 m and angle 15°, if the coefficient of static friction between the tires and the road is 0.66, and a wind is pushing downward on the car with a force of 1000 N.



FBD



$$\Sigma F_y \Rightarrow F^N\cos\theta - \mu_s F^N\sin\theta - F^w - mg = m\cancel{a_y}^{\,0}$$

$$F^N = \frac{F^w + mg}{(\cos\theta - \mu_s \sin\theta)}$$

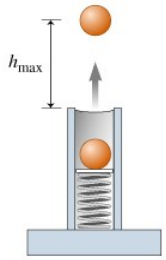
$$\Sigma F_r \Rightarrow F^N\sin\theta + \mu_s F^N\cos\theta = m\frac{V_{max}^2}{r}$$

$$\frac{F^w + mg}{(\cos\theta - \mu_s\sin\theta)}(\sin\theta + \mu_s\cos\theta) = m\frac{V_{max}^2}{r}$$

$$V_{max}^2 = \frac{r}{m}(F^w + mg)\frac{(\sin\theta + \mu_s\cos\theta)}{(\cos\theta - \mu_s\sin\theta)}$$

$$V_{max} = 23.7\ m/s$$

11. (10 points) A half-kg-ball is pressed against an ideal vertical spring, that is compressed a distance of 25 cm from it's relaxed position. When the ball is released from rest, it launches to a max height of 2.30 m above the relaxed position of the spring. What is the spring constant of the spring?



$$\Sigma E_i + W_{nc} = \Sigma E_f$$

$$K_i + U_i^g + U_i^s = K_f + U_f^g + U_f^s$$

$$\frac{1}{2} k \Delta x_s^2 = mg(\Delta x_s + h_{max})$$

$$k = \frac{2mg(\Delta x_s + h_{max})}{\Delta x_s^2} = 400 \text{ N/m}$$

Scores:

Problems

1	2	3-7	8	9	10	11

Exam Total
