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

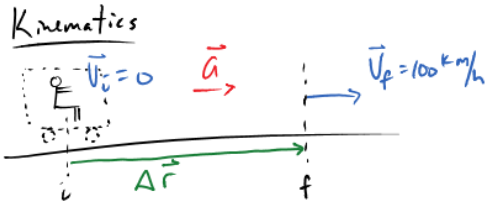
Physics 201

Midterm Exam 2

11/12/2014

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 80 minutes to complete this exam.

1. (6 points) A Ferrari accelerates from 0 to 100.0 km/h in 4.80 s. What net force (in Newtons) does a passenger of mass 68.0 kg experience during acceleration?



ID | K | uK
$v_i = 0$ | Δx
$v_f = 27.7\ m/s$ | a_x
$\Delta t = 4.8\ s$

Conversion: $\frac{100\ km}{h} \left| \frac{1\ h}{60\ m} \right| \frac{1\ m}{60\ s} \left| \frac{1000\ m}{1\ km} \right. = 27.7\ m/s$

Solve: $v_f = \cancel{v_i}^{0} + a_x \Delta t$

$a_x = \frac{v_f}{\Delta t} = 5.787\ m/s^2$

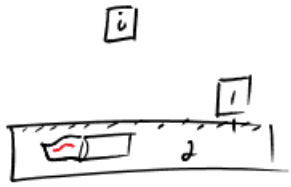
Mechanics: $\sum \vec{F} = m\vec{a}$ $\xrightarrow{ID}$ $\sum F_x = m a_x = 393.5\ N$

$\approx \boxed{394\ N}$

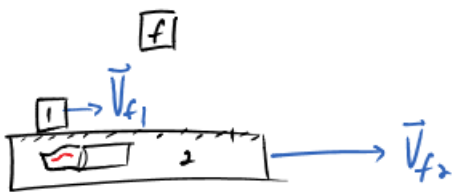
2. (2 points) On page 145 of our textbook it says, in a highlighted box, that *kinetic friction* is in the *direction opposite the motion*. This is not always a true statement. Provide an example where this is not true.

[1] Sliding a table cloth out from the dinner ware.

[2]



$v_{i_1} = v_{i_2} = 0$



$v_{f_1} < v_{f_2}$

For questions 3 through 6 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.

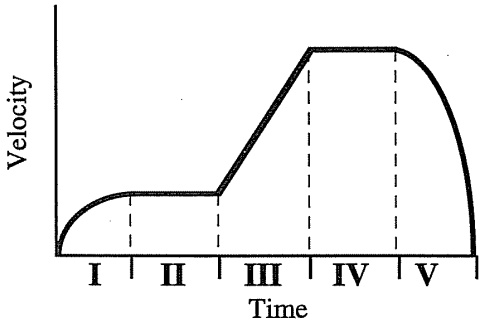
3. Initially a 2-kg object has the acceleration vector described on the right. What additional force must be applied to the object to put it in equilibrium? $\vec{a} = \left\langle \frac{1}{2}, 1, \frac{3}{2} \right\rangle \frac{m}{s^2}$

(a) $\langle 1,2,3 \rangle N$ (b) $\langle 3,2,1 \rangle N$ (c) $\langle -1,-2,-3 \rangle N$ (d) $\left\langle \frac{1}{2}, 1, \frac{3}{2} \right\rangle N$ (e) $\left\langle -\frac{1}{2}, -1, -\frac{3}{2} \right\rangle N$

4. Which of the following situations does the car have a eastward net force?

[F] (a) The car travels eastward at constant speed.
[T] (b) The car travels eastward and speeds up.
[T] (c) The car travels westward and slows down.
[F] (d) The car travels eastward and slows down.
[F] (e) The car is traveling at constant speed around a circular track and is located at the most eastern point of the track.
[F] (f) The car is traveling at constant speed around a circular track and is located at the most northern point of the track.
[T] (g) The car is traveling at constant speed around a circular track and is located at the most western point of the track.
[F] (h) The car is traveling at constant speed around a circular track and is located at the most southern point of the track.

5. A 2.0-kg object, starting from rest, moves in a straight line and the graph shows the velocity of the object as a function of time. The various equal time intervals are labeled using Roman numerals: I, II, III, IV, and V. The net force on the object always acts along the line of motion of the object. Which of the following statements about the object during these time intervals are false.



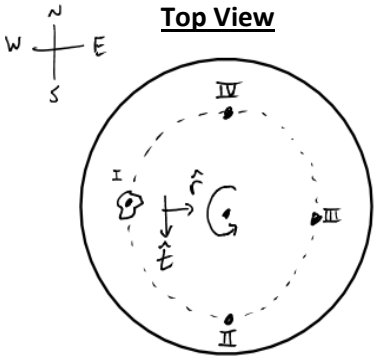
[T] (a) The object is in equilibrium in regions **II** and **IV**.
[F] (b) The object is in equilibrium in regions **I** and **V**.
[T] (c) The object experiences its maximum *average* magnitude net force in region **V**.
[F] (d) The object reaches its maximum positive position in region **IV**.
[T] (e) The only region the object has a constant non-zero net force is region **III**.
[T] (f) The net force is decreasing in time interval **I**.

6. A rock is suspended from a string and has an acceleration vector pointing downward. Which of the following statements concerning this situation are *necessarily* true?

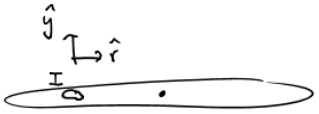
[F] (a) The tension points downward.
[T] (b) The tension is less than the weight of the rock.
[F] (c) The tension is equal to the weight of the rock.
[F] (d) The tension is greater than the weight of the rock.
[F] (e) The tension is independent of the magnitude of the rock's acceleration.
[?] (f) The rock is traveling downward and speeding up.
[T] (g) The rock's velocity could be zero, or point up or down.

7. (10 points) A 0.5-kg stone is located at point **I** on a rotating horizontal disk as shown in the figures. (a) What does the symbol labeled with a **t** on the top view figure represent? (b) What from the figure would indicate that the symbol **t** cannot represent time? Now assume the stone is not sliding and is half a meter away from the center of the disk. The coefficient of static friction between the disk and the stone is 0.5. Draw free-body-diagrams using the provided grids for the stone when it is located at point **I** (west) and traveling with a speed of (c) 1.0 m/s and (d) 1.5 m/s. Be careful to scale the vectors appropriate to the grid spacing and label the vectors. (e) If a wind blows towards the East, at which point (I, II, III, IV) will the stone be most likely to start to slide? Explain.

Top View



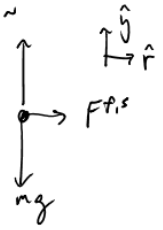
Side View



(a) tangential

(b) Vector symbol implies vector not scalar quantity

In general



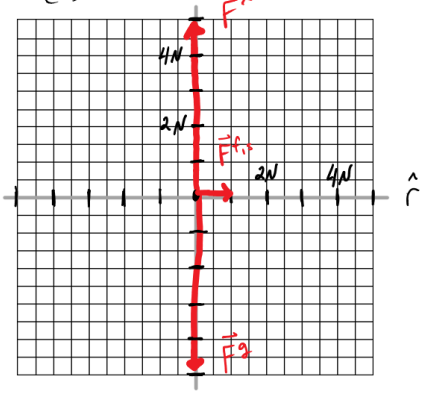
$\Sigma F_y \Rightarrow F^N - mg = m\cancel{a_y}^{0} \Rightarrow F^N = mg$

$\Sigma F_r \Rightarrow F^{f,s} = \frac{mv^2}{r}$

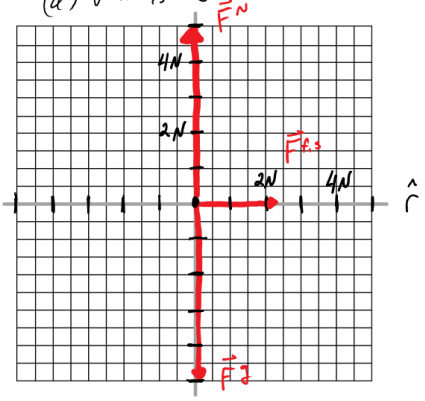
w/ $m = 0.5kg$, $r = 0.5m$, $F^N = 4.9N$

(c) $F^{f,s} = 1N$ (d) $F^{f,s} = 2.25N$

(c) $v = 1 m/s$



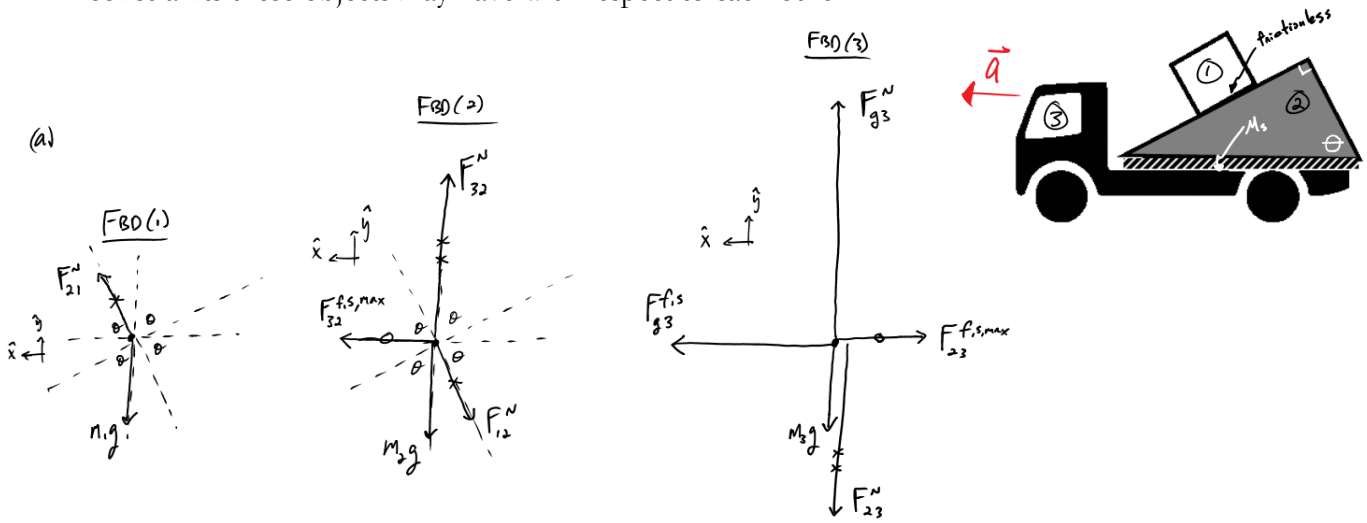
(d) $v = 1.5 m/s$



(e) Point III b/c that is when the wind is opposite the direction of the friction.

Think of it this way: at point I the wind is in the same direction as the friction & is "helping" the friction w/ a net radial force.

8. (20 points) A square block ($\mathbf{m_1}$) sits atop a triangular wedge ($\mathbf{m_2}$) that sits on the horizontal bed of a truck ($\mathbf{m_3}$). One of the angles of the wedge is $\boldsymbol{\theta}$, as shown in the figure. There is no friction between the wedge and the block but there is friction ($\boldsymbol{\mu_s}$) between the truck and the wedge. When the truck accelerates as much as it can ($\mathbf{a_{max}}$) and not have the wedge + block system slide relative to the truck, it is noticed that the block does not slide relative to the wedge. (a) For this max acceleration situation draw a free-body diagram for the square, wedge, and truck separately. (b) Identify all Newton's third law force pairs. (c) When analyzing these objects what coordinate system orientation would best be suited? Explain. (d) Create a set of Newton's 2nd law equations for each mass using the variables given, and **g**, the acceleration of gravity. Identify any quantities that are zero. (you do not have to solve for anything) (e) Identify any constraints these objects may have with respect to each other.



(b) $\vec{F}^N_{21} = -\vec{F}^N_{12}$, $\vec{F}^N_{32} = -\vec{F}^N_{23}$, $\vec{F}^{f,s,max}_{32} = -\vec{F}^{f,s,max}_{23}$

(c) Since all objects are accelerating to left the coordinate system should be oriented towards the left. So, $\hat{x} \leftarrow \uparrow \hat{y}$ is a good option for all three.

(d) [1] $\sum F_x \Rightarrow F^N_{21}\cos\theta = m_1 a_{x_1}$

$\sum F_y \Rightarrow F^N_{21}\sin\theta - m_1 g = m_1 \cancel{a_{y_1}}^{\,0}$

[2] $\sum F_x \Rightarrow \underbrace{\mu_s F^N_{32}}_{F^{f,s,max}_{32}} - F^N_{12}\cos\theta = m_2 a_{x_2}$

$\sum F_y \Rightarrow F^N_{32} - F^N_{12}\sin\theta - m_2 g = m_2 \cancel{a_{y_2}}^{\,0}$

[3] $\sum F_x \Rightarrow F^{f,s}_{g3} - \underbrace{\mu_s F^N_{23}}_{F^{f,s,max}_{23}} = m_3 a_{x_3}$

$\sum F_y \Rightarrow F^N_{g3} - F^N_{23} - m_3 g = m_3 \cancel{a_{y_3}}^{\,0}$

(e) Constraints

$\vec{a}_1 = \vec{a}_2 = \vec{a}_3 = \vec{a}_{12} = \vec{a}_{13} = \vec{a}_{23} = \vec{a}_{123} \equiv \vec{a}$

also some kinematic constraints

$\Delta\vec{r}_1 = \Delta\vec{r}_2 = \Delta\vec{r}_3 \equiv \Delta\vec{r}$

$\vec{v}_1 = \vec{v}_2 = \vec{v}_3 \equiv \vec{v}$

extra space

Scores:

Problems

1	2	3-6	7	8

Exam Total
