Physics 2211 BCD Test form 433 Name ____________________________

Spring 2015

Test 3 Recitation Section (see back of test):__________

A

1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".

2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.

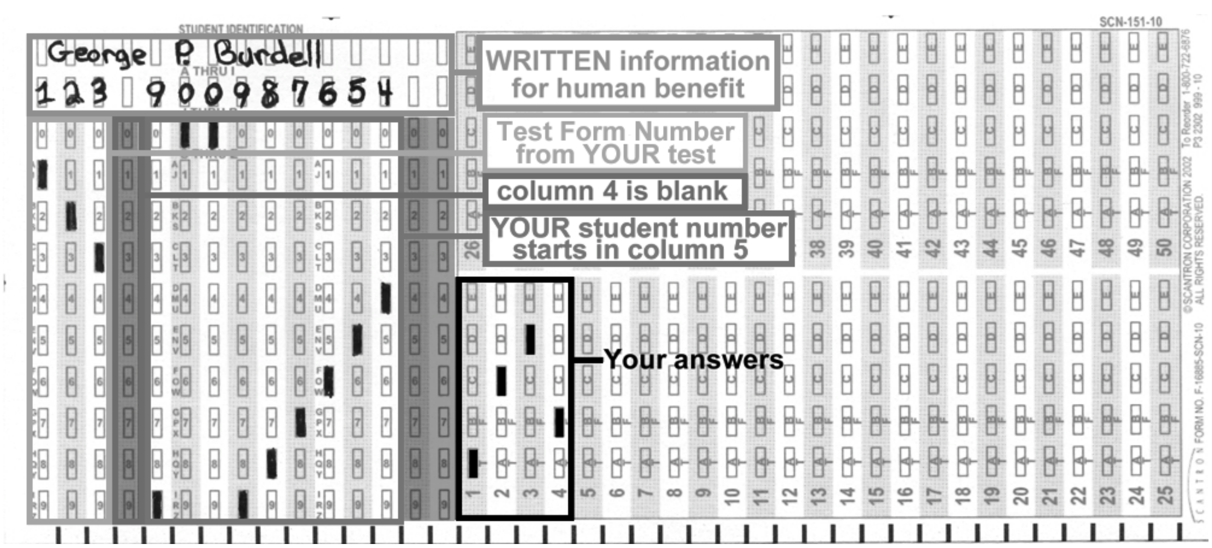
3) For each free-response question, show all relevant work supporting your answer. **Clearly box or underline your final answer.** "Correct" answers which are not supported by adequate calculations and/or reasoning will be counted wrong.

4) For each multiple-choice question, select the answer most nearly correct, **circle this answer on your test**, and bubble it in on your answer card. **Show all relevant work on your quiz.**

5) Be prepared to present your Buzzcard as you turn in your test. Scores will be posted to WebAssign after they have been been graded. **Quiz grades become final when the next quiz is given.**

6) You may use a simple scientific calculator capable of logarithms, exponentials, and trigonometric functions. **Programmable engineering calculators with text or graphical capabilities are not allowed. Wireless devices are prohibited.**

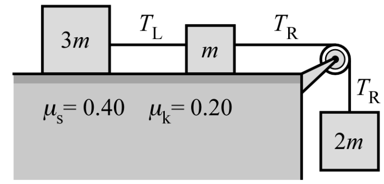
Your test form is: $\boxed{433}$



Our next test will be on Monday, April 6!

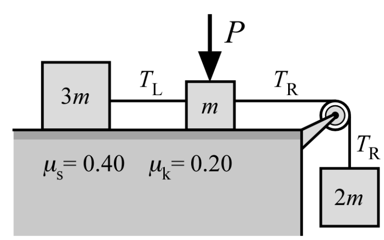
The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

[I] A block of mass $2m$ is suspended by an ideal cord that passes over a massless, frictionless pulley and is attached to a block of mass m lying on a rough horizontal surface. A second ideal cord attaches the second block to a third block, of mass $3m$. The friction coefficients between the two blocks and the surface are $\mu_s = 0.40$ and $\mu_k = 0.20$.



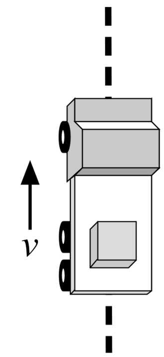
(A) *(10 points)* Static friction will not hold the blocks at rest; if released, they will slip along the surface. What will be the tensions in the two cords—T_L connecting m to $3m$ and T_R connecting $2m$ to m—after they are released? Express each tension as a multiple of mg.

(B) *(10 points)* By pushing straight down on block m, it is possible to hold all three blocks at rest, without slipping. What minimum downward push P will maintain the equilibrium of the blocks? Express your answer as a multiple (or fraction) of mg.



The following problem will be hand-graded. *Show all your work for this problem.* *Make no marks and leave no space on your answer card for it.*

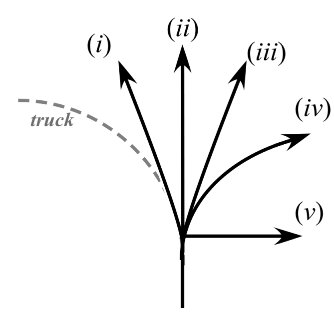
[II] At right is a top-down view of a flatbed truck driving at constant speed *v* along a straight section of roadway. A crate lies on the truckbed, with coefficients of friction μ_k and μ_s between the crate and bed. The truck driver suddenly veers left (maintaining his speed *v*) to avoid a unicorn in the road ahead.



(15 points) Draw a free body diagram for the crate, *as seen from behind*, and determine the smallest possible turn radius the the truck can have without allowing the crate to slip off the truckbed. Express your answer in therms of *v*, μ_k, and/or μ_s, as well as *g*.

Question value 5 points — mark your answer in space #1 on the answer card.

(1) Suppose that the driver veers too sharply, and the crate slips off the bed. Which of the trajectories at right best depicts the path of the crate after it slides of the truckbed. (Assume the truck itself has continued its turn, following the dotted-line trajectory.)



(a) The crate follows path (*iv*).

(b) The crate follows path (*ii*).

(c) The crate follows path (*v*).

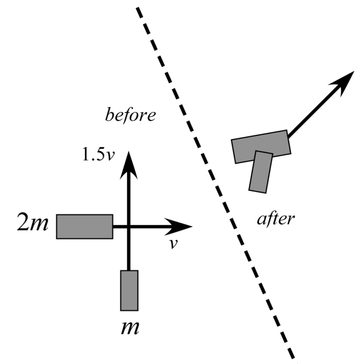
(d) The crate follows path (*i*).

(e) The crate follows path (*iii*).

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

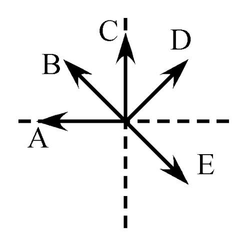
[III] A UPS truck is travelling eastward through an intersection with speed v, when it is struck in the side by a station wagon travelling northward with a speed $1.5v$. As a result of the collision, the two vehicles become stuck, and skid together along the pavement.

(15 points) Assuming that the mass of the UPS truck is precisely twice that of the station wagon, what will be the velocity of the two vehicles immediately after the collision? Express your answer as a speed v_f that is a multiple (or fraction) of v, and a direction angle θ measured north of east.



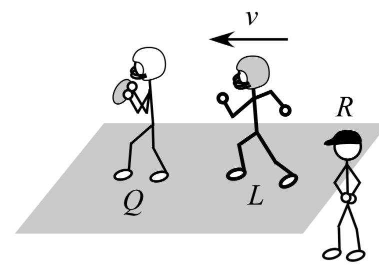
Question value 5 points — mark your answer in space #2 on the answer card.

(2) Which of the arrows in the diagram at right *best* characterizes the direction of the impulse delivered to the UPS truck by the station wagon?



(a) Direction B
(b) Direction D
(c) Direction A
(d) Direction E
(e) Direction C

A football Quarterback is tackled from behind by a rushing defensive Lineman. The Quarterback (mass m) is stationary at the moment of impact, while the Lineman (mass $1.5m$) is moving with a speed v. Nearby, a stationary Referee observes the collision.



Question value 5 points

(3) Which of the three observers will see that the total momentum of the Quarterback and Lineman is a conserved quantity—as measured *in that observer's frame of reference*?

(a) For Q and L only.
(b) For all three observers.
(c) For R and Q only.
(d) For none of the three observers.
(e) For R only.

Question value 5 points

(4) Assuming a coordinate system where L's initial velocity is in the <u>negative</u> direction, what is the vector impulse delivered **<u>to</u>** the L **<u>by</u>** Q, during the collision?

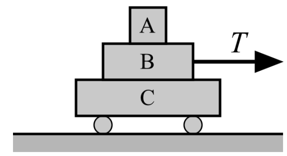
(a) $\vec{J} = \langle -2mv/3 \rangle$
(b) $\vec{J} = \langle -2mv/5 \rangle$
(c) $\vec{J} = \langle +mv/3 \rangle$
(d) $\vec{J} = \langle +3mv/5 \rangle$
(e) $\vec{J} = \langle -mv/2 \rangle$

Question value 5 points

(5) Which statement below properly characterizes the forces acting on the players *during* the collision?

(a) Q experienced a greater magnitude of collision force, because L had a greater mass.
(b) L experienced a greater magnitude of collision force, because he experienced a larger velocity change.
(c) Q experienced a greater magnitude of collision force, because L was moving faster than Q at the moment of impact.
(d) The net force on Q and the net force on L are both zero because the total momentum of the system does not change.
(e) Both players experienced collision forces of equal magnitude.

Block A rests on block B, which rests on block C, which in turn rests on frictionless rollers. The masses of the blocks are, in order, $m_A = M$, $m_B = 2M$, and $m_C = 4M$. The blocks are pulled together, by a cord attached to block B, having tension T.



Question value 5 points

(6) How many total Third Law force pairs are acting between the three blocks? (You may assume that mutual gravitational attractions *to each other* are negligible.)

(a) two
(b) three
(c) five
(d) none
(e) four

Question value 5 points

(7) According to the Third Law, what force is paired with the upward normal force exerted by block C on block B?

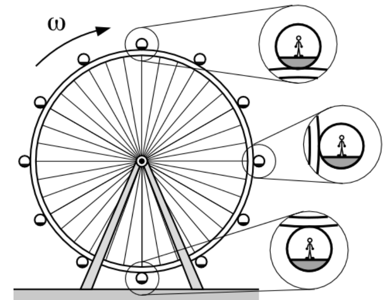
(a) The weight of both blocks A and B, down on block C.
(b) The downward normal force by block B on block C.
(c) The weight of just block A, down on block B
(d) The downward normal force by block A on block B.
(e) The weight of just block B, downward.

Question value 5 points

(8) The coefficient of static friction between blocks A and B is $\mu_{AB} = 0.34$, and the coefficient of static friction between blocks B and C is $\mu_{BC} = 0.40$. What maximum acceleration can be imparted to all three blocks (by pulling the cord with some tension $T_{\max}$), without anything slipping?

(a) $0.37g$
(b) $0.40g$
(c) $0.34g$
(d) $0.30g$
(e) $0.74g$

The London Eye is a huge Ferris wheel suspended overover the river Thames. Note that the passenger capsules on the Eye are designed so that the floor remains directly under one's feet at all times—the capsules do *not* "invert" as the Eye rotates. Assume the Eye has radius R and rotates at a fixed angular speed ω.



Question value 5 points

(9) What are the directions of: the net force on a passenger at the top of the loop, $\left(\sum \vec{F}\right)_T$; and the net force on a passenger at the bottom of the loop, $\left(\sum \vec{F}\right)_B$?

(a) $\left(\sum \vec{F}\right)_T$ is upward and $\left(\sum \vec{F}\right)_B$ is downward.

(b) $\left(\sum \vec{F}\right)_T$ is upward and $\left(\sum \vec{F}\right)_B$ is upward.

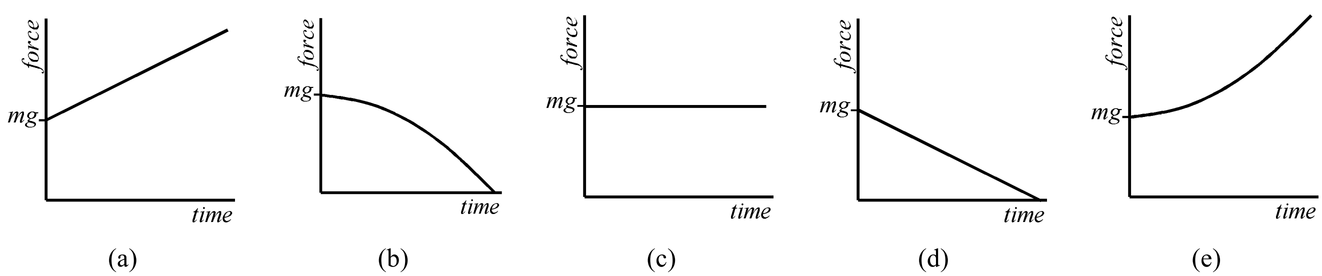
(c) $\left(\sum \vec{F}\right)_T$ is downward and $\left(\sum \vec{F}\right)_B$ is upward.

(d) $\left(\sum \vec{F}\right)_T$ and $\left(\sum \vec{F}\right)_B$ are both zero, so direction is irrelevant.

(e) $\left(\sum \vec{F}\right)_T$ is downward and $\left(\sum \vec{F}\right)_B$ is downward.

Question value 5 points

(10) Suppose that a deranged engineer sabotages the Eye so that its angular speed ω steadily increases. Which of the graphs below best characterizes the normal force by the floor on a passenger <u>at the top of the loop</u>, as a function of the Eye's rotational speed?



PHYS 2211 BCD Recitation TA and Room Assignments

Tests will be returned in recitation, in the week *after* the test. In order to ensure that you receive your test back as soon as possible, please enter your recitation section from the table above on the front of this test.

	Clough 123	Clough 125	Clough 127	Clough 131	Clough 325
Monday					
2:05 – 2:55 pm				B01 Greenway, Lucas	B05 Baker, Caitlin
3:05 – 3:55 pm				B02 Greenway, Lucas	C02 Eswar, Aditya
4:05 – 4:55 pm	C01 Eswar, Aditya			B06 Greenway, Lucas	
Tuesday					
1:05 – 1:55 pm					C04 Liberi, Brandon
2:05 – 2:55 pm		D02 Zhou, Jiarun		C03 Baker, Caitlin	
3:05 – 3:55 pm					B04 Strauss, Hunter
4:05 – 4:55 pm					B03 Strauss, Hunter
5:05 – 5:55 pm	C09 Eswar, Aditya			D04 Strauss, Hunter	
Wednesday					
1:05 – 1:55 pm		B09 Ravipati, Akshay			
2:05 – 2:55 pm		D01/D05 Liberi, Brandon			
3:05 – 3:55 pm			C05 Ravipati, Akshay		
4:05 – 4:55 pm			C06/D06 Eswar, Aditya		
Thursday					
2:05 – 2:55 pm				B08 Zhou, Jiarun	C07 Baker, Caitlin
3:05 – 3:55 pm			B07 Tao, Liangyu		D07 Baker, Caitlin
4:05 – 4:55 pm			C08/D03 Tao, Liangyu		
5:05 – 5:55 pm					
6:05 – 6:55 pm			C10/D09 Tao, Liangyu		