### Physics 211 Exam 2, Form C

Problem 1	Problem 2	Problem 3	Problem 4	Total
/25+5	/25+5	/25	/25	/100

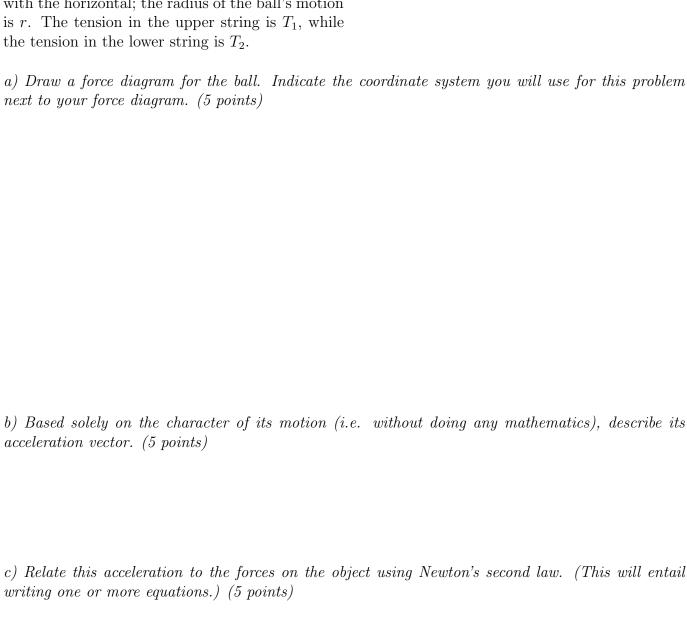
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Recitati	on section	numbe	r·	

- There are four questions worth a total of 100 points, with a possible 10 points extra credit.
- You must show your reasoning to receive credit. A numerical answer with no logic shown will be treated as no answer. An answer that doesn't follow from the logic shown will not be given credit, even if it is correct.
- You are highly encouraged to use both pictures and words to show your reasoning, not just algebra.
- Remember, show your reasoning as thoroughly as possible for partial credit.
- $\bullet\,$  You may use  $g=10\,\mathrm{m/s^2}$  throughout, except where indicated, to minimize arithmetic.

# RECITATION SCHEDULE

M003	8:25	-	9:20	Avinay	B129E
M011	8:25	-	9:20	Lindsay	106
M019	8:25	-	9:20	Francesco	HL205
M004	9:30	_	10:25	Avinay	B129E
M012	9:30	-	10:25	Julian	106
M020	9:30	_	10:25	Tie	Sims 437
M025	9:30	_	10:25	Francesco	HL205
M005	10:35	-	11:30	Avinay	B129E
M013	10:35	-	11:30	Lindsay	106
M021	10:35	-	11:30	Tie	Sims 437
M023	10:35	-	11:30	Francesco	HL205
M006	11:40	_	12:35	Andrew	B129E
M014	11:40	-	12:35	Lindsay	106
M022	11:40	-	12:35	Tie	Sims 437
M007	12:45	-	1:40	Andrew	B129E
M015	12:45	-	1:40	Kyle	106
800M	2:15	-	3:10	Andrew	B129E
M016	2:15	-	3:10	Harris	106
M009	3:45	-	4:40	Harris	B129E
M017	3:45	-	4:40	Kyle	106
M010	5:15	-	6:10	Harris	B129E
M018	5:15	-	6:10	Kyle	106

A ball of mass m is connected by two strings to a pole, as shown, and made to rotate around it at angular velocity  $\omega$ . Each string makes an angle  $\theta$  with the horizontal; the radius of the ball's motion is r. The tension in the upper string is  $T_1$ , while the tension in the lower string is  $T_2$ .



# QUESTION 1, CONTINUED

d) Calculate $T_1$ and $T_2$ in terms of $\theta$ , $r$ , $m$ , and $g$ . (5 points)
e) If $\omega$ is reduced below a certain minimum value, the ball will be unable to move as described – i
will fall, with the lower string becoming slack. Find this minimum value of $\omega$ , based on your answer to part (d). (5 points extra credit)

Two boxes sit on a table. The bottom box has mass M, and the top box has mass m. The coefficient of kinetic friction between the table and the bottom box, and between the bottom box and the top box, is  $\mu_k$ .

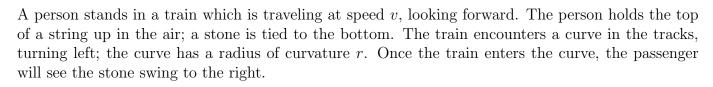
A rope is tied to the bottom box, and a large tension T is applied horizontally. This is large enough to pull the bottom box out from under the top box.

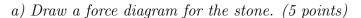
a) Draw a force diagram for the top box and for the bottom box. (10 points each)

b) Newton's third law says that  $\vec{F}_{AB} = -\vec{F}_{BA}$ . Are there any pairs of forces in your diagram which form Newton's-third-law pairs? If so, list those pairs. You should ensure that your force diagrams are consistent with Newton's third law. (5 points)

#### QUESTION 2, CONTINUED

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d)	Calculate	the acceleratio	$n \ a_1 \ of \ the$	e top box.	(5 points)	
e)	Calculate	the acceleratio	$n \ a_2 \ of \ the$	bottom b	ox. (5 points	extra credit)





b) Calculate the angle  $\theta$  that the string makes with the vertical in terms of g, v, and r. (10 points)

## QUESTION 3, CONTINUED

c) According to your force diagram, is there a force pushing the stone in the direction given by part (a)? If so, what is that force? If not, how do you explain the fact that the stone will swing to the passenger's right? (10 points)

A large boulder of mass 300 kg sits on the surface of a frozen lake. An engineer, whose desire to see things go boom exceeds his common sense, wants to remove the boulder. He drills a hole in it, inserts a stick of dynamite, and lights the fuse. After the explosion the boulder splits into two pieces, which move in opposite directions after the collision. The larger piece has a mass M = 200 kg; the smaller piece has a mass m = 100 kg. The coefficient of kinetic friction is  $\mu_k$  between both pieces and the ice; this friction eventually brings both of them to rest.

The large piece travels a distance of 20 meters after the collision before coming to rest. How far does the small piece travel? (25 points)

Hints for solving this problem:

- Calculate the relationship between the velocity of the large piece and the velocity of the small piece after the explosion. Introduce variables for these velocities.
- Calculate the relationship between the velocity of each piece after the collision and how far it travels.
- Combine the results of the preceding to figure out how far the small piece travels.