Department of Mechanical and Aerospace Engineering
Midterm 1 for Dynamics (MAE, CEE and E 80)
Winter 2003

Duration: 45 minutes

Please make sure you turn in this exam, your blue book (if loose sheets, please staple) AND the one sheet of notes you used for this exam.

It would be better to leave symbols instead of their values: for example, while in all problems you can use $g = 10 \text{ m/s}^2$, it would be best to keep $g$ instead of 10, as long as possible.

Name: ________________________________

Problem 1: __________

Problem 2: __________

Problem 3: __________

Total: __________
1 (40 pt). Two slabs (bricks, whatever!) C, and D, with masses $m_C$ and $m_D$ are placed on top of one another in two different arrangements, as shown below. A force $P$ is applied to C in the arrangement on the LEFT and to D on the arrangement on the RIGHT. ALL surfaces have the same coefficient of friction $\mu_k = \mu_s = \mu$.

a. (10) For the RIGHT set up: Solve for accelerations of C and D- if you are told there is sliding on one surface only. Answer in terms of $\mu, g, P, m_C$ and $m_C$.

b. (10) For the RIGHT set up: Draw free body diagrams and solve for accelerations- if you are told there is sliding on both surfaces. Answer in terms of $\mu, g, P, m_C$ and $m_D$.

c. (10) For the RIGHT set up: What is the value of $P$ that separates the two cases (i.e., the largest force such that slipping on the second surface is ready to start). Answer in terms of $\mu, g, m_C$ and $m_D$.

d. (10) For the LEFT set up: Can you have both blocks move together? Explain briefly.

Figure 1: Schematic of Problem 1
2 (30 pt). In the figure below, a ball of mass $m$ is connected to a cable of length $l$, tied at the right end to a wall. The ball is released from position $C$ with an initial (horizontal) velocity $v_o = v_C$. The cable is supported by pin (or peg) at $O$ initially - ie was hanging from it - and the distance from $C$ to $O$ is $R$ (naturally $R < l$).

a. Determine the minimum value for the initial velocity $v_C$ so that it reaches point $A$ (answer in terms of $g$, $R$ and $l$).

b. What is the corresponding tension at $B$, just before becoming horizontal (answer in terms of $m$, $R$, $l$ and $g$).

Figure 2: Schematic of Problem 2
3 (30 pt). Two cable of length $l$ restrain ball $A$ (which has mass $m$) as shown below. The lower cable is attached to collar $B$, which is a slider that is free to move up and down the frictionless shaft CD. Mass of $B$ is 2m.

The shaft is rotating about its vertical axis CD with an angular velocity of $w$. It is observed that the mass $A$ is rotating in a horizontal plane (i.e., each cable is rotating making a cone shaped motion), resulting in angles $\beta_1 = \beta_2 = \beta = 40$.

a. Using slider $B$, find the tension in cable $AB$

b. What is the tension in cable $DA$?

c. What is angular velocity, $w$, with which the shaft is rotating?

Write the answers in terms of $m$, $g$, $l$, and $\beta$ (i.e., $\cos 40$, $\cos \beta$, $\sin 40$, $\tan 40$, etc )

![Figure 3: Schematic of Problem 3](image-url)