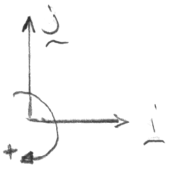
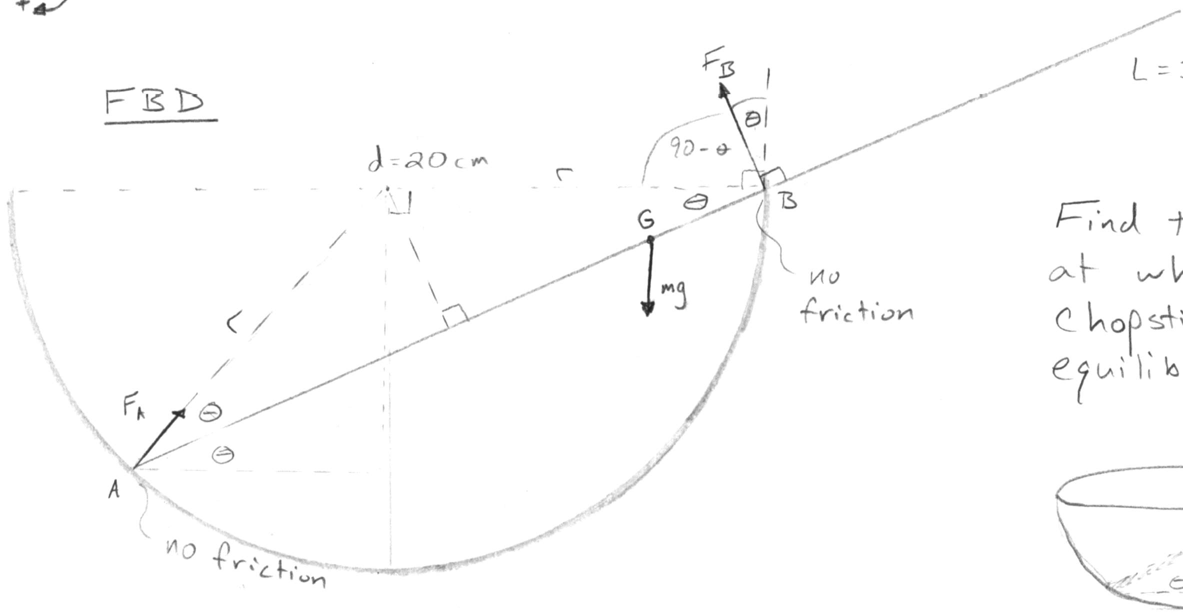
MAE 325, Fall 1999
Assignment 1 : Due Wed. 9/1/99

– No Solution Given to P2

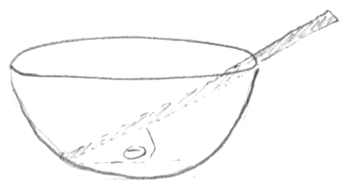
(3)



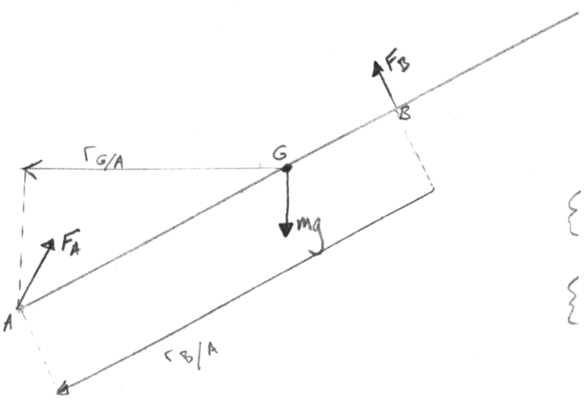
FBD



Find the angle at which the chopstick is in equilibrium



FBD of chopstick
-w/ less clutter



LMB: $\Sigma \underset{\sim}{F} = \underset{\sim}{0}$

$$\Big\{ -mg\,\underset{\sim}{j} + F_A\cos 2\theta\,\underset{\sim}{i} + F_A\sin 2\theta\,\underset{\sim}{j} - F_B\sin\theta\,\underset{\sim}{i} + F_B\cos\theta\,\underset{\sim}{j} = \underset{\sim}{0} \Big\}$$

$$\{\ \}\cdot\underset{\sim}{i} \Rightarrow \quad F_A\cos 2\theta - F_B\sin\theta = 0 \qquad (1)$$

$$\{\ \}\cdot\underset{\sim}{j} \Rightarrow \quad -mg + F_A\sin 2\theta + F_B\cos\theta = 0 \qquad (2)$$

AMB: $\sum \underset{\sim}{r}_{i/o} \times \underset{\sim}{F}_i = \underset{\sim}{0}$

$$\left\{ \underset{\sim}{r}_{B/A} \times \underset{\sim}{F}_B + \underset{\sim}{r}_{G/A} \times m\underset{\sim}{g} = \underset{\sim}{0} \right\}$$

$$\{ \quad \} \cdot \underset{\sim}{k} \Rightarrow \quad -r_{B/A} F_B + r_{G/A} mg = 0$$

$$r_{B/A} = r\cos\theta + r\cos\theta$$
$$= 2r\cos\theta$$

$$r_{G/A} = \frac{L}{2}\cos\theta$$

$$-2r\cos\theta \, F_B + \frac{L}{2}\cos\theta \, mg = 0 \qquad (3)$$

$r = 10\text{ cm}$ $\qquad L = 30\text{ cm}$

since $\cos\theta \neq 90, 270, \ldots$ divide by $\cos\theta$

$$20 F_B = 15 mg \quad \Rightarrow \quad F_B = \frac{3}{4} mg \qquad (4)$$

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MAE 325 HW1
MATLAB solution

```
» eq1 = 'Fa*cos(2*th)-Fb*sin(th)=0.0';
» eq2 = '-mg+Fa*sin(2*th)+Fb*cos(th)=0.0';
» eq4 = 'Fb = 0.75*mg';
» solve(eq4,eq2,eq1,'Fa,Fb,th')
```

eq1, eq2, eq4 from previous pages

⇒ solving 3 eqs. for Fa, Fb, th

```
ans =

   Fa: [4x1 sym]
   Fb: [4x1 sym]
   th: [4x1 sym]
```

4 possible solutions for each variable

```
» ans.th

ans =

[ 2.1460453407562160993173040494085]
[ -2.1460453407562160993173040494085]
[ -.40514883191467585005401963560765]
[ .40514883191467585005401963560765]
```

sol 1, sol 2: mathematically correct but physically impossible solutions

sol 3, sol 4: physically realistic solutions

```
» theta = .40514883191467585005401963560765*(180/pi)
```

→ convert from radians to degrees

```
theta =
```

$\boxed{23.2133 \text{ degrees}}$

```
»
```