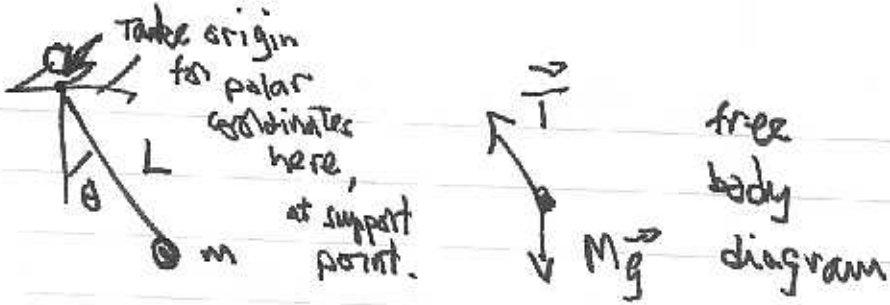
5.



Eq'n of motion from angular momentum point of view:

$$\frac{d}{dt}(ML^2\dot{\theta}) = -MgL\sin\theta$$

i.e. $$\ddot{\theta} = -\frac{g}{L}\sin\theta$$

Now the actual acceleration of M in this motion is

$$\vec{a} = L\ddot{\theta}\hat{\theta} - L\dot{\theta}^2\hat{r}$$ where (r,θ) are polar coordinates

also, the forces are $\vec{T} = -T\hat{r}$

and $M\vec{g} = +Mg\cos\theta\,\hat{r} - Mg\sin\theta\,\hat{\theta}$

So from $\vec{F}_{net} = M\vec{a}$, i.e. $\vec{T} + M\vec{g} = M\vec{a}$,

$$-T\hat{r} + Mg\cos\theta\,\hat{r} - Mg\sin\theta\,\hat{\theta} = L\ddot{\theta}\hat{\theta} - L\dot{\theta}^2\hat{r}$$