2

Analysis Problem 6 – Part 1

Name: Solution
Date: ___________

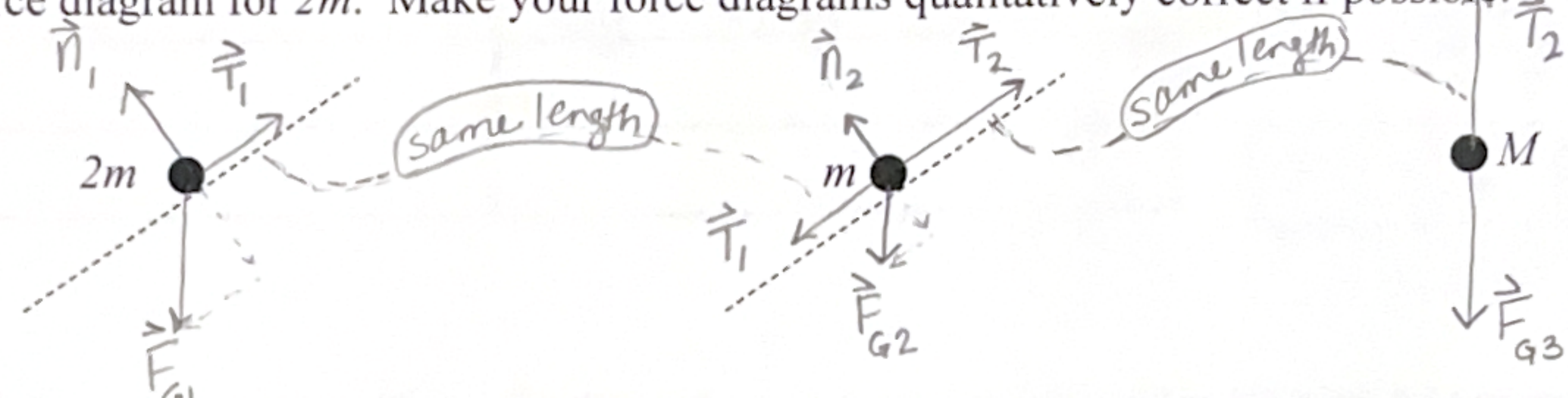
Step 1: Read *Analysis Problem 6*, parts *1(a)* and *1(b)*. Today we are going to do *1(a)*, and some preparatory work for *1(b)*.

Step 2: Read these notes:

- String 1 is connecting blocks $2m$ and m. A *light* string means that its mass is negligible, which tells us that String 1 exerts the same magnitude of tension force at all points along the string, including at its ends. Therefore, the tension forces exerted by String 1 on $2m$ and m can be drawn as arrows of equal length and represented by the same symbol T_1!

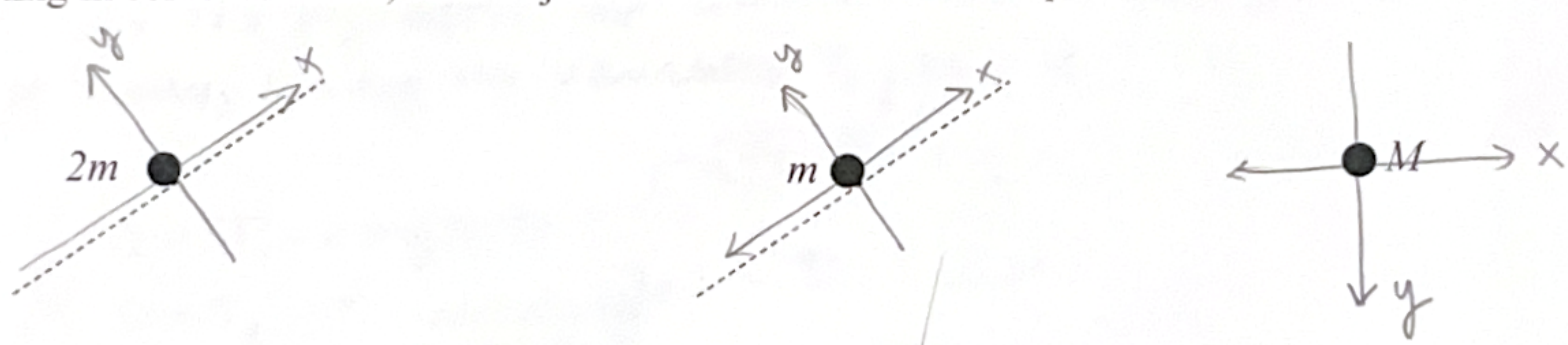
- String 2 is connecting blocks m and M. It is a *light* string, and it passes over a pulley of *negligible mass* and *negligible friction*. All this tells us that String 2 exerts the same magnitude of tension force at all points along the string, including at its ends. Therefore, the tension forces exerted by String 2 on m and M can be drawn as arrows of equal length and represented by the same symbol T_2!

Step 3: Read the question prompt for 1(a) again. Write your answers below, including the additional force diagram for $2m$. Make your force diagrams qualitatively correct if possible.



Step 4: In the space below, sketch a coordinate system for each object. such that *IF* everything was accelerating in some direction, each object's acceleration would be positive.

I assumed an accel up the incline, so I chose up the incline as + for m and 2m, and down as + for M. If you chose an accel down the incline, it's fine, just realize your coord. system will be opposite mine, as well as your force organizers. But, the equations will work out to be the same as mine.



Step 5: Make a force organizer for $2m$ and apply Newton's second law in the x-direction for this object:

$\vec{F}$	F_x	F_y
$\vec{n}_1$	$n_{1x} = 0$	$n_{1y} = +n_1$
$\vec{T}_1$	$T_{1x} = +T_1$	$T_{1y} = 0$
$\vec{F}_{G1}$	$F_{G1x} = -(2m)g\sin\theta$	$F_{G1y} = -2mg\cos\theta$

$$a_{1x} = \frac{\Sigma F_{m_1 x}}{m_1}$$

$$0 = \frac{T_1 + (-2mg)\sin\theta}{2m}$$

$$\boxed{0 = T_1 - 2mg\sin\theta}$$

Step 6: Make a force organizer for *m*, and apply Newton's second law in the x-direction for this object:

$\vec{F}$	F_x	F_y
$\vec{n}_2$	$n_{2x} = 0$	$n_{2y} = +n_2$
$\vec{T}_2$	$T_{2x} = +T_2$	$T_{2y} = 0$
$\vec{T}_1$	$T_{1x} = -T_1$	$T_{1y} = 0$
$\vec{F}_{G2}$	$F_{G2x} = -mg\sin\theta$	$F_{Gy} = -mg\cos\theta$

$$a_{2x} = \frac{\Sigma F_{on\,2x}}{m_2}$$

$$0 = \frac{+T_2 + (-T_1) + (-mg\sin\theta)}{m}$$

$$\boxed{0 = T_2 - T_1 - mg\sin\theta}$$

Step 7: Make a force organizer for *M*, and apply Newton's second law in the y-direction for this object:

$\vec{F}$	F_x	F_y
$\vec{T}_2$	$T_{2x} = 0$	$T_{2y} = -T_2$ (because my + direction is down)
$\vec{F}_{G3}$	$F_{G3x} = 0$	$F_{G3y} = +Mg$

$$a_{3y} = \frac{\Sigma F_{on\,3y}}{m_3}$$

$$0 = \frac{-T_2 + Mg}{M}$$

$$\boxed{0 = -T_2 + Mg}$$

Step 8: Which two equations could be added together to obtain an answer for 1(b)(i)? Add them together and box your answer.

If I add the equations for 2m and m, I see that T_1 will go away, leaving the variables T_2, m, g, θ.

add these equations

Eqn for 2m

$0 = T_1 - 2mg\sin\theta$

Eqn for m

$+[\,0 = T_2 - T_1 - mg\sin\theta\,]$

$0 + 0 = T_1 - 2mg\sin\theta + T_2 - T_1 - mg\sin\theta$

$0 = -3mg\sin\theta + T_2$

$$\boxed{3mg\sin\theta = T_2}$$