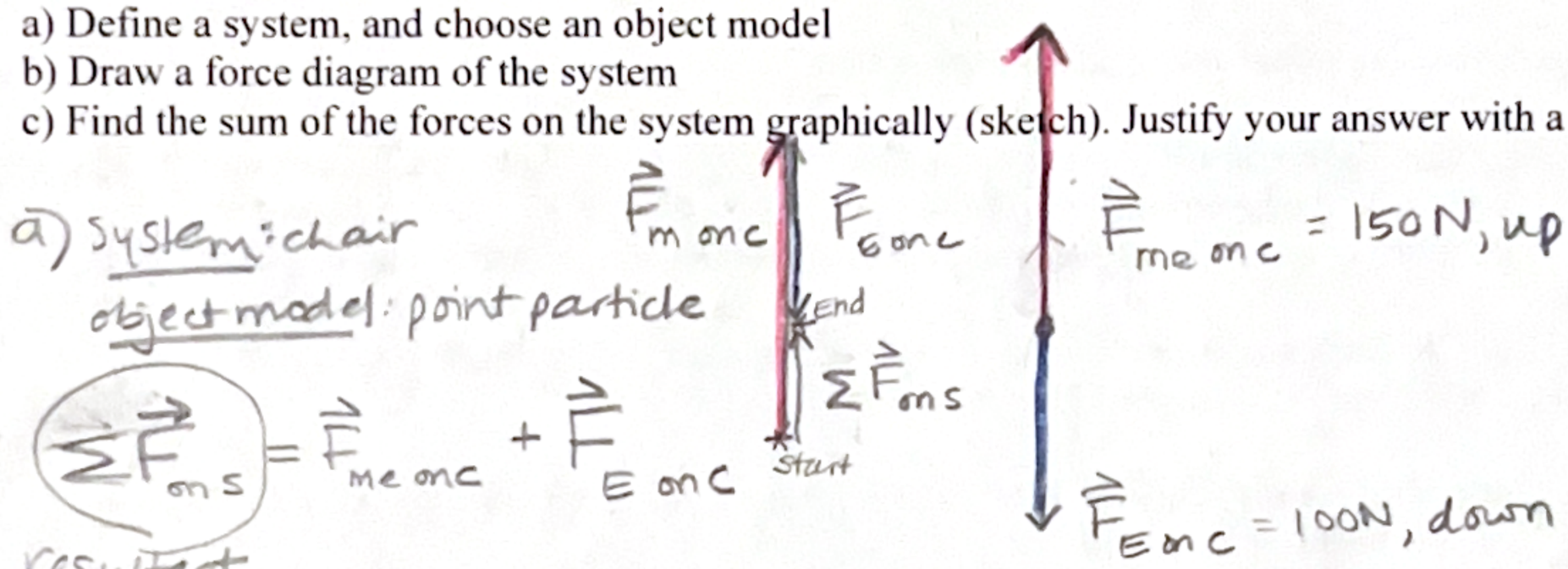
Finding the Sum of the Forces on a System: Graphically

Materials: Whiteboard, markers, meterstick, ruler, protractor

1. You are lifting a chair straight up. The forces resulting from the gravitational interaction of the chair with Earth have a magnitude of 100 N, and the forces resulting from the interaction between you and the chair have a magnitude of 150 N.
a) Define a system, and choose an object model
b) Draw a force diagram of the system
c) Find the sum of the forces on the system graphically (sketch). Justify your answer with a fact.



On your group whiteboard:

2. Complete the following steps for these problems on *Diagramming Objects and Interactions*. Justify each answer with a fact.

B
a) Will the sum of the forces on this system be equal to zero?
b) Find the sum of the forces on the system graphically (sketch).

D
a) Will the sum of the forces on this system be equal to zero?
b) Find the sum of the forces on the system graphically (sketch).

E
a) Will the sum of the forces on this system be equal to zero?
b) Find the sum of the forces on the system graphically (sketch).

G
a) Will the sum of the forces on this system be equal to zero?
b) Find the sum of the forces on the system graphically (sketch).

You have now leveled up to finding the sum of the forces graphically using scale diagrams!

3. Suppose a sled on the ice is pushed horizontally by Abraham and Isaac. The force of Abraham's push on the sled is 35 N, due west. The force of Isaac's push on the sled is 60 N, 20° west of north. We will ignore the vertical forces in this analysis.

a) **Define a system and choose an object model**

b) **Sketch a force diagram** for the system, showing only horizontal forces.

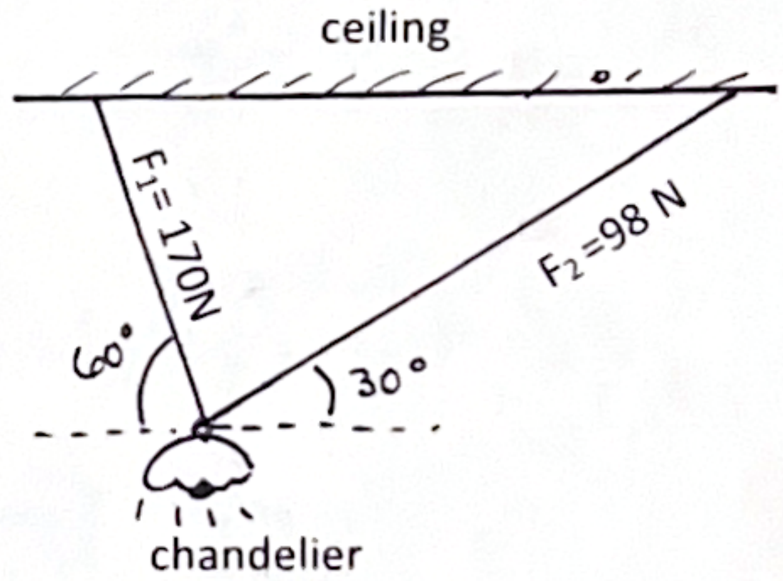
c) **List all the forces** on the system (Ex: F_ on_ = ____ N at ____°) The angle of a vector is measured counterclockwise from the + x-axis, so you will first need to draw x-y coordinate system on your force diagram and then determine the angle of each force.

d) **Choose a scale** for drawing the force vectors so they will make a large diagram on your whiteboard. Record the scale. (1 cm = ___ N).

e) **Calculate the scaled length** of each force vector and record it in your list using a double arrow. (⇒____cm)

f) **Add the force vectors** graphically to find the sum of the forces on the system.

4. A 20.0 kg chandelier is suspended from two ropes as shown in Fig.2. The tension in each rope and angles are labeled. Find the sum of the forces on the chandelier by following the steps in the previous problem. Refer to details in the previous problem for help. (The given diagram is not to scale, so don't try to measure it!)



- Should the sum of the forces on the chandelier be equal to zero? yes, because it is at rest.
- Find the sum of the forces on the system graphically (scale diagram) by following steps (a) to (f) above.

(see graph paper)

(4) ⓐ System: chandelier
object model: point particle

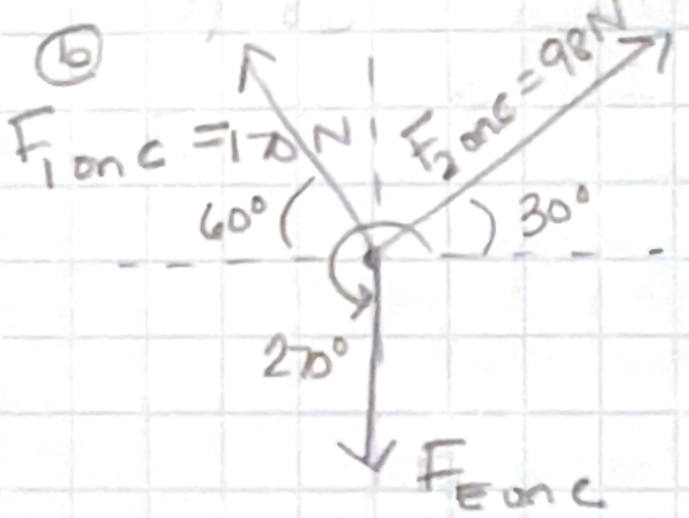
ⓒ LIST

$F_{1\,on\,C}$ = 170N at 120° ⇒ 11.3 cm
$F_{2\,on\,C}$ = 98N at 30° ⇒ 6.5 cm
$F_{E\,on\,C}$ = 196.6N at 270° ⇒ 13.1 cm

ⓓ SCALE: 1cm = 15N

ⓔ ↑

ⓑ



Calculate: $F_{E\,on\,C} = \frac{G M_E m_C}{R_E^2}$

$= \frac{(6.67\times10^{-11}\,\frac{N m^2}{kg^2})(5.98\times10^{24}\,kg)(20.0\,kg)}{(6.37\times10^{6}\,m)^2}$

$= \boxed{196.6\,N}$

f) I'm going to start with $F_{E\,on\,C}$

d) The end is almost exactly at the start.
To be exact, I got

F_{net} = 1mm = 1.5N,
which is quite small.

It should be 0 because the object is at rest!