

NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 210 – Mechanics & Heat

Spring 2022

Problem Set #4

Problem Set Due: Thurs., Feb. 17, 2022

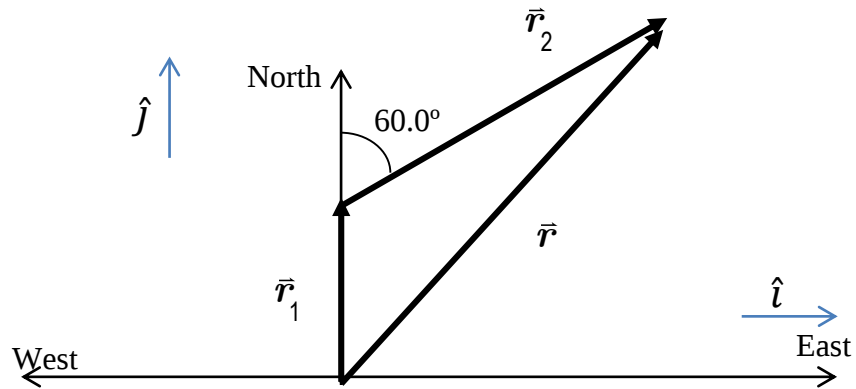
Read OpenStax: Chapter 4, Chapter 5.1, Lecture Notes #3 & #4

**Show explicitly all your work for full credit.**

- |                                |                                   |
|--------------------------------|-----------------------------------|
| 1. Expert TA: <b>c2.2.6</b>    | <i>conceptual problem—explain</i> |
| 2. Expert TA: <b>2.3.1-alt</b> | <i>math problem—explain</i>       |
| 3. Expert TA: <b>2.4.17</b>    | show calculation and figure       |
| 4. Expert TA: <b>5.3.5</b>     | show calculation and figure       |
| 5. Expert TA: <b>5.3.12</b>    | show calculation and figure       |
| 6. Expert TA: <b>5.6.45</b>    | show calculation and figure       |
| 7. Expert TA: <b>5.7.4</b>     | show calculation and figure       |
| 8. Expert TA: <b>5.7.34</b>    | show calculation and figure       |
| 9. Expert TA: <b>5.8.0</b>     | show figure                       |
| 10. Expert TA: <b>5.9.12</b>   | show figure                       |

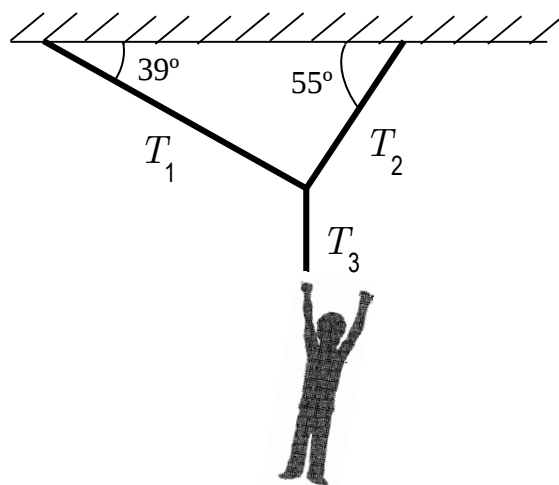
Staple (Problems #11 & #12) together separately from (Expert TA problems)

**Problem # 11 & 12 are on the next pages**



11. An NIU student walks due north towards the campus for 30.0 km (displacement  $\vec{r}_1$ ) and then walks 50.0 km in a direction  $60.0^\circ$  east of north (displacement  $\vec{r}_2$ ) as shown in the figure above.

- Find the magnitude and direction of her resultant displacement  $\vec{r}$ .  
(70,51.7867893)
- Express her displacement  $\vec{r}$  in terms of the unit vectors  $\hat{i}$  and  $\hat{j}$  shown in the figure above.



12. A 160 lb NIU student doing some rock climbing hangs from a rope tied to two other ropes fastened to supports as shown above. The upper ropes make angles of  $39^\circ$  and  $55^\circ$  with the horizontal. These upper ropes are not as strong as the vertical rope and will break if the tension in them exceeds 500 N.

- (a) Draw the free-body diagram for the student.
- (b) Draw the free-body diagram for the knot where the three ropes are joined.
- (c) Write down Newton's 2<sup>nd</sup> law for the student.
- (d) Write down Newton's 2<sup>nd</sup> law for the knot (assume it is massless).
- (e) By finding the tension in the 3 cables, determine whether the student remains hanging in this precarious situation or one of the ropes break.
- (f) Suppose the two angles are equal. What would be the relationship between  $T_1$  and  $T_2$ ? Would this improve the student's situation?