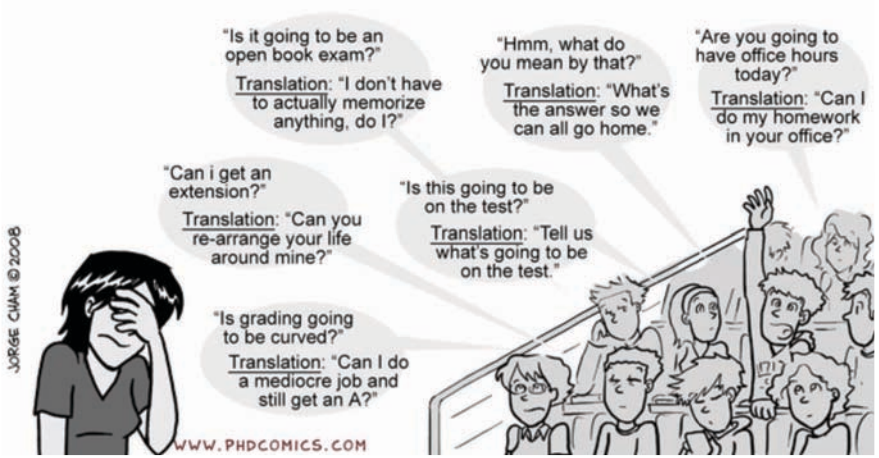
e14 - applied mechanics: statics

what e14 students ask vs. what they are **really** asking



mon/wed/fri, 12:50-2:05pm, 370-370

e14 - applied mechanics: statics

first homework due

day	date		topic	chapter
	w01		force week	ch 1-2
mon	mar	28	what's statics?	1.1-1.5
wed	mar	30	what's a force?	2.1-2.4
fri	apr	01	what's a force resultant?	2.5-2.9
	w02		particle week	ch 3
mon	apr	04	what's a free body diagram at a point?	3.1-3.2
wed	apr	06	what's force equilibrium at a point?	3.3-3.4
fri	apr	08	problem session 1	
	w03		moment week	ch 4
mon	apr	11	what's a moment?	4.1-4.4
wed	apr	13	what's a couple? what's distributed loading?	4.5-4.7
fri	apr	15	problem session 2	
	w04		practice week	ch 1-4
mon	apr	18	problems, problem, problems ...	
wed	apr	20	midterm 1, in class, closed book, 1 cheat sheet	
fri	apr	22	recover-from-midterm friday / no problem session	
	w05		2d equilibrium week	ch 5
mon	apr	25	what's a free body diagram of a 2d system?	5.1-5.2
wed	apr	27	what force and moment equilibrium in 2d?	5.3-5.4
fri	apr	29	problem session 3	

syllabus

e14 - applied mechanics: statics

Homework I - Chapters 1 and 2

due Friday, 08/04/11, 12:50pm, 370-370

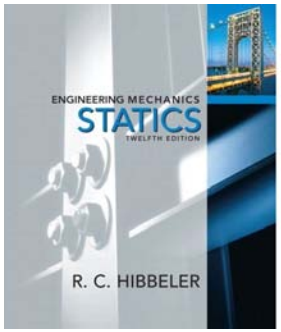
For late homework, you are responsible to arrange drop off with our grader Kaushik Mani, kmani@stanford.edu. Once you have used up your three late days, you will no longer receive points for your homework. Here are our office hours and emails.

when	when	where	who	email
Tuesdays	06:00 - 07:30pm	Durand 247	Charbel	ceid@stanford.edu
Wednesdays	02:30 - 04:00pm	Durand 217	Ellen	ekuhl@stanford.edu
Wednesdays	05:00 - 06:30pm	Durand 393	Chris	cploch@stanford.edu
Thursdays	10:00 - 11:30am	Durand 203	Joules	jmgould@stanford.edu
Thursdays	01:00 - 02:30pm	Durand 393	Estevan	estevanm@stanford.edu

For this homework, you need to be familiar with chapters 1 and 2 of your book! You may skip pages 22-31.

homework #01

e14 - applied mechanics: statics

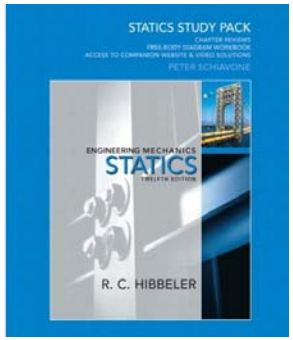


textbook.

russell c. hibbeler
prentice hall, 12th edition

engineering mechanics
statics

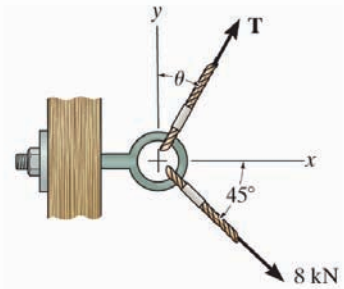
read chapters 1 and 2 for homework #1



homework #01

e14 - applied mechanics: statics

Problem 1



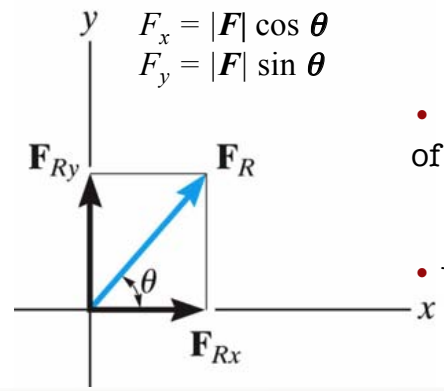
1.1 If $\theta = 60^o$ and $T = 6$kN, determine the magnitude of the resultant force acting on the eyebolt and its direction measured clockwise from the positive x-axis.

1.2 If the magnitude of the resultant force is to be 9 kN, and the resultant force is to be directed along the positive x-axis, determine the magnitude of the force **T** acting on the eyebolt and its angle θ.

force resultant in cartesian coordinates

$$\boldsymbol{F} = \begin{bmatrix} F_x \\ F_y \end{bmatrix}$$

$$F_x = |\boldsymbol{F}| \cos \boldsymbol{\theta}$$
$$F_y = |\boldsymbol{F}| \sin \boldsymbol{\theta}$$



- we can easily add and subtract forces using a Cartesian coordinate system

$$\boldsymbol{F}_R = \begin{bmatrix} F_{Rx} \\ F_{Ry} \end{bmatrix} \qquad \begin{aligned} F_{Rx} &= \square F_x \quad (1) \\ F_{Ry} &= \square F_y \quad (2) \end{aligned}$$

- we can determine the magnitude of a force using Pythagoras (2d)

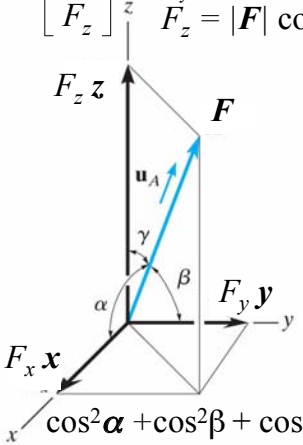
$$F_R = \square \; [\, F_{Rx}^2 + F_{Ry}^2 \,]$$

- we can determine the direction of a force using trigonometry

$$\boldsymbol{\theta} = \tan^{-1}[\, F_{Ry} / F_{Rx} \,]$$

force resultant in cartesian coordinates

$$\boldsymbol{F} = \begin{bmatrix} F_x \\ F_y \\ F_z \end{bmatrix} \qquad \begin{aligned} F_x &= |\boldsymbol{F}| \cos \boldsymbol{\alpha} \\ F_y &= |\boldsymbol{F}| \cos \beta \\ F_z &= |\boldsymbol{F}| \cos \gamma \end{aligned}$$



$\cos^2\boldsymbol{\alpha} + \cos^2\beta + \cos^2\gamma = 1$

- we can easily add and subtract forces using a Cartesian coordinate system

$$\boldsymbol{F}_R = \begin{bmatrix} F_{Rx} \\ F_{Ry} \\ F_{Rz} \end{bmatrix} \qquad \begin{aligned} F_{Rx} &= \square F_x \quad (1) \\ F_{Ry} &= \square F_y \quad (2) \\ F_{Rz} &= \square F_z \quad (3) \end{aligned}$$

- we can determine the magnitude of a force using Pythagoras (3d)

$$F_R = \square \; [\, F_{Rx}^2 + F_{Ry}^2 + F_{Rz}^2 \,]$$

- we can determine the direction of a force using trigonometry

$$\boldsymbol{\alpha} = \cos^{-1}[\, F_{Rx} / F \,]$$

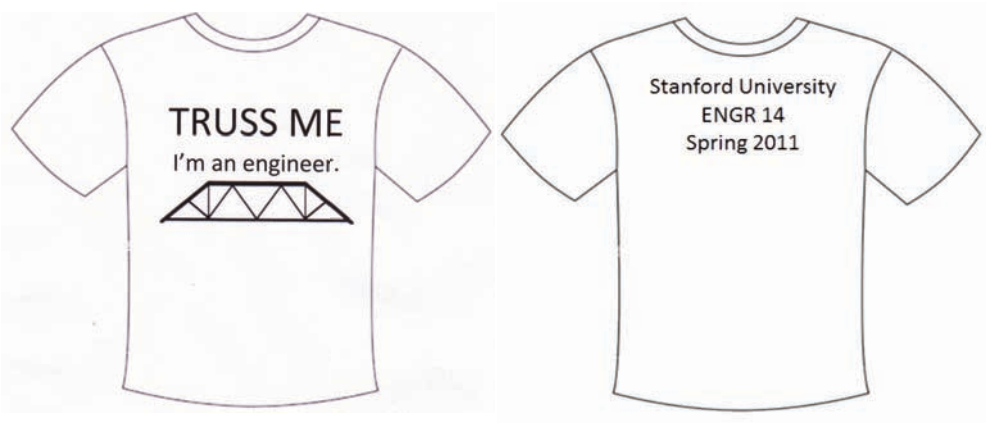
e14 - applied mechanics: statics

design your own E14 statics t-shirt!

- designs can only be single color.
- designs can cover both front and back, but could also be single sided
- everybody who uploads one or more designs into the drop box will receive 5 extra bonus points for this homework
- the top three designs will receive another 5 extra bonus points
- the best design will be elected as our E14 shirt
- everybody in class will receive a free shirt

upload your design into the drop box on coursework!

design your own e14 t-shirt!

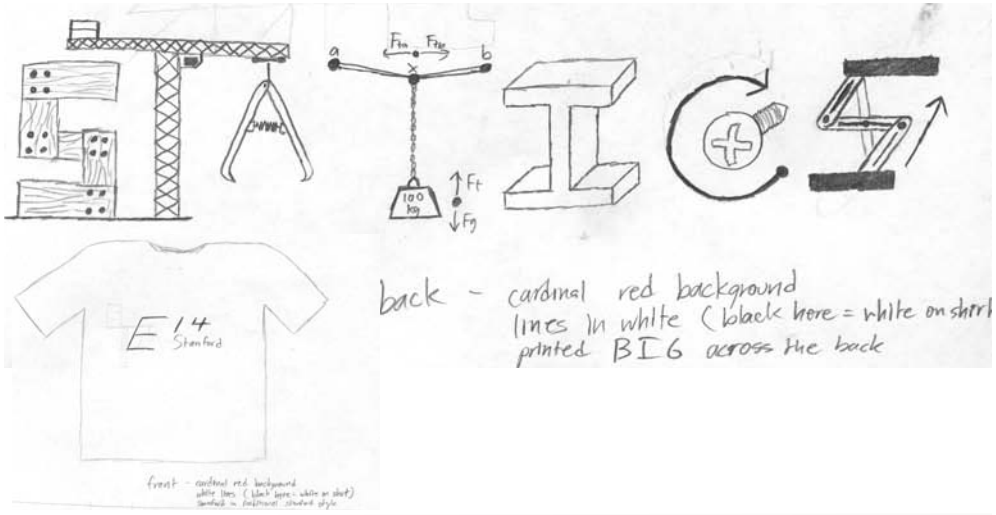


©maisy wieman

design your own e14 t-shirt!

©blake crowe

design your own e14 t-shirt!



@brandon skerda

design your own e14 t-shirt!

©julie mai

e14 - applied mechanics: statics

as part of the following homework sets, we will ask you to upload photos of yourself or yourself with some of your class mates, wearing your statics t-shirts and illustrating forces. towards the end of this class, we will make a music video from the best photos.

- list the **size of your t-shirt** order, i.e., **men or women**, and **small, medium, large, or extra large**
- list your **favorite song for the E14 video**. it can be a "force"-related song, or just any song you like
- if you would like to be part of the **E14 video team**, and participate in photo selection, song selection or song composition, and video making, **send us an email** or talk to us for details after class

e14 t-shirt design context

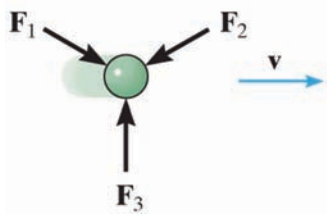
today's objectives

- to introduce the concept of the free-body diagram for a particle
- to show how to solve particle equilibrium problems using the equations of equilibrium
- when cables are used for hoisting loads, the must be selected so that they do not fail. today, we will show how to calculate cable forces for such cases

3. equilibrium of a particle

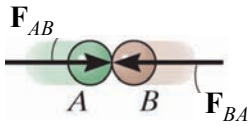
newton's three laws of motion

- first law
  equilibrium
  if $\sum \boldsymbol{F} = \boldsymbol{0}$ then $\boldsymbol{v}$ = const.



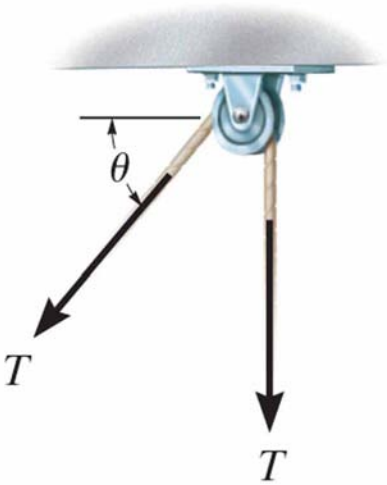
- second law
  accelerated motion
  $\boldsymbol{F} = m \cdot \boldsymbol{a}^{=0}$

- third law
  actio = reactio
  $\boldsymbol{F}_{AB} = -\boldsymbol{F}_{BA}$



3.1 equilibrium condition of a particle

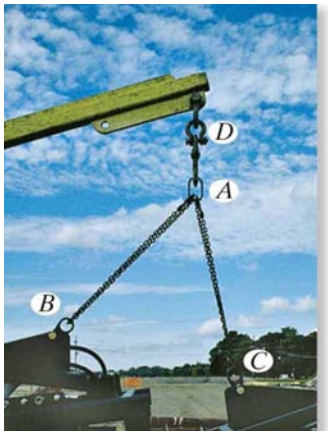
assumptions - cables and pulleys

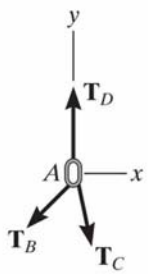


- **cables.** unless otherwise stated, we will assume that all cables have a **negligible weight** and **cannot stretch**. they can only support **tension** along their axis.
- **pulleys.** for now, we assume that pulleys are **frictionless**, i.e., the tension force of a cable that passes over a pulley may change its direction but not its magnitude.

3.2 free body diagram

procedure for drawing a FBD





I. **isolate the particle of interest** - easy ;-)
here shown for particle A

II. **show all forces** - tricky!
3 cables, 3 tension forces
assume directions

III. **label each force** - easy ;-)

example 3.2

determine the tension in cables BA and BC to support the 60kg cylinder!