PHYS 170 Section 101
Lecture 2
September 7, 2018

SEP 7—ANNOUNCEMENTS

- First online homework assignment for marks available today at 6 PM, due Monday, Sept. 17 at 11:59 PM (introductory, no-marks, assignment due Friday, Sept. 14 at 11:59 PM, available now)

- Tutorials (aka problem sessions) start next Tuesday, first session will involve in-tutorial solution of a problem, so be prepared!

- Lecture notes are being posted on Canvas in module "Lectures"
  - Will generally be differences between versions of notes posted before and after lectures
  - Version posted after will generally contain solutions of problems, version posted before will not necessarily

- Additional problems (with solutions) not covered in lectures will be posted on Canvas in "Additional Problems".

  NOTE: As with problems covered in lectures, these will often be taken from previous editions of the text.

INFORMATION ABOUT MASTERING ENGINEERING ASSIGNMENTS

1. Mastering Engineering Assignments count for a total of 5 marks towards your Final Grade.

2. The assignments are on https://www.pearson.com/mastering/engineering. You must sign on to this site and register using the course ID **MECHOPTUIK75090**. See the separate document "**Getting Started with Mastering Engineering**" for more details.

   Please note the following important point. If you purchase a standalone access code (i.e. your code was not bundled with a text or e-text), you must register at

   https://register.pearsoncmg.com/reg/register/reg1.jsp

   Once you have registered, you can access the assignments via https://www.pearson.com/mastering/engineering no matter how you acquired your access code.

3. Each online assignment consists of three problems from the text. The problems are the same for every student. The problem data are, in general, different for every student.

4. You enter your answers to these problems directly on the above web site. There is nothing to hand in. You get five attempts to answer each problem.

5. There are 12 numerically labelled assignments which will appear on the above web site at **6:00 PM every Friday**, starting September 7. Additionally there is 1 introductory assignment, which is available now.

6. You will usually have until **11:59 PM Friday the following week** to complete any given assignment. **Late work will not be accepted: no exceptions!** However, if you are unable to finish an assignment in time due to circumstances such as illness or a family emergency, e-mail me with the details and your final homework grade will be adjusted accordingly.

   There are several exceptions to this deadline structure, including for those assignments that would normally be due the week of a midterm, or when we require a little extra lecture time to cover the pertinent material for a homework. In these cases the deadline will usually be extended to the following Monday at 11:59 PM, as noted in the course overview handout. I will also make announcements in class to draw your attention to these exceptions.

7. Each and every assignment will count equally towards the 5 total marks available for the Mastering Engineering work, but **your lowest assignment grade will be discounted.** The introductory assignment will not count towards your final grade.

8. You can get help with these assignments from me (during office hours, or through an appointment made via e-mail). You can also get help from your TA during your scheduled tutorials once your tutorial problem is complete.

Pearson

Get Started with Pearson's Mastering Engineering & Computer Science

First, make sure you have these 3 things…

1. **Email:** You'll get some important emails from your instructor at this address.
2. **Course ID:** Ask your instructor for your Course ID!
3. **Access code or credit card:** An access code card may be packaged with your new book or may be sold by itself at your bookstore. Otherwise, you can buy instant access with a credit card or PayPal account during registration.

Next, get registered and join your course!

1. Go to **www.pearson.com/mastering/engineering**
2. Under Register Now, select **Student**.
3. Confirm you have the information needed, then select **OK! Register now.**
4. Enter your instructor's Course ID (**MECHOPTUIK75090**) and choose **Continue**.
5. Enter your existing Pearson account **username** and **password** and select **Sign in**.
   You have an account if you have ever used a Pearson MyLab & Mastering product, such as MyLab Math, MyLab IT, or Mastering Chemistry.
   - If you don't have an account, select **Create** and complete the required fields.
6. Select an access option.
   - Enter the access code that came with your textbook or was purchased from the bookstore.
   - Buy access using a credit card or PayPal account.
   - **NOTE:** Students who are purchasing "**without eText**" access are to go to the following customized URL: https://register.pearsoncmg.com/reg/register/reg1.jsp
7. From the "You're Done!" page, select **Go to My Courses**.
8. Select **Yes** and enter your Course ID to join your course. Click **Continue**.
9. If asked, enter your Student ID according to the instructions provided and click **Continue**.
   That's it! You should see the Course Home page for the course.

To sign in later:

1. Go to **www.pearson.com/mastering/engineering** and select **Sign In.**
2. Enter your Pearson account **username** and **password** from registration, and select **Sign In.**
   - If you forgot your username or password, select **Forgot your username or password?**

To join another course for the same textbook (no additional purchase needed):

1. **Sign in** with the **username** and **password** that you specified during registration.
2. Click **My Courses** in the upper left and then choose Join a Course.
3. Enter the Course ID from your instructor and click **Continue.**
4. If asked, enter your Student ID according to the instructions provided and click **Continue**.
5. To switch courses, select **My Courses** from the course menu (left side).
6. Select any active course link that appears below "Switch to another course".

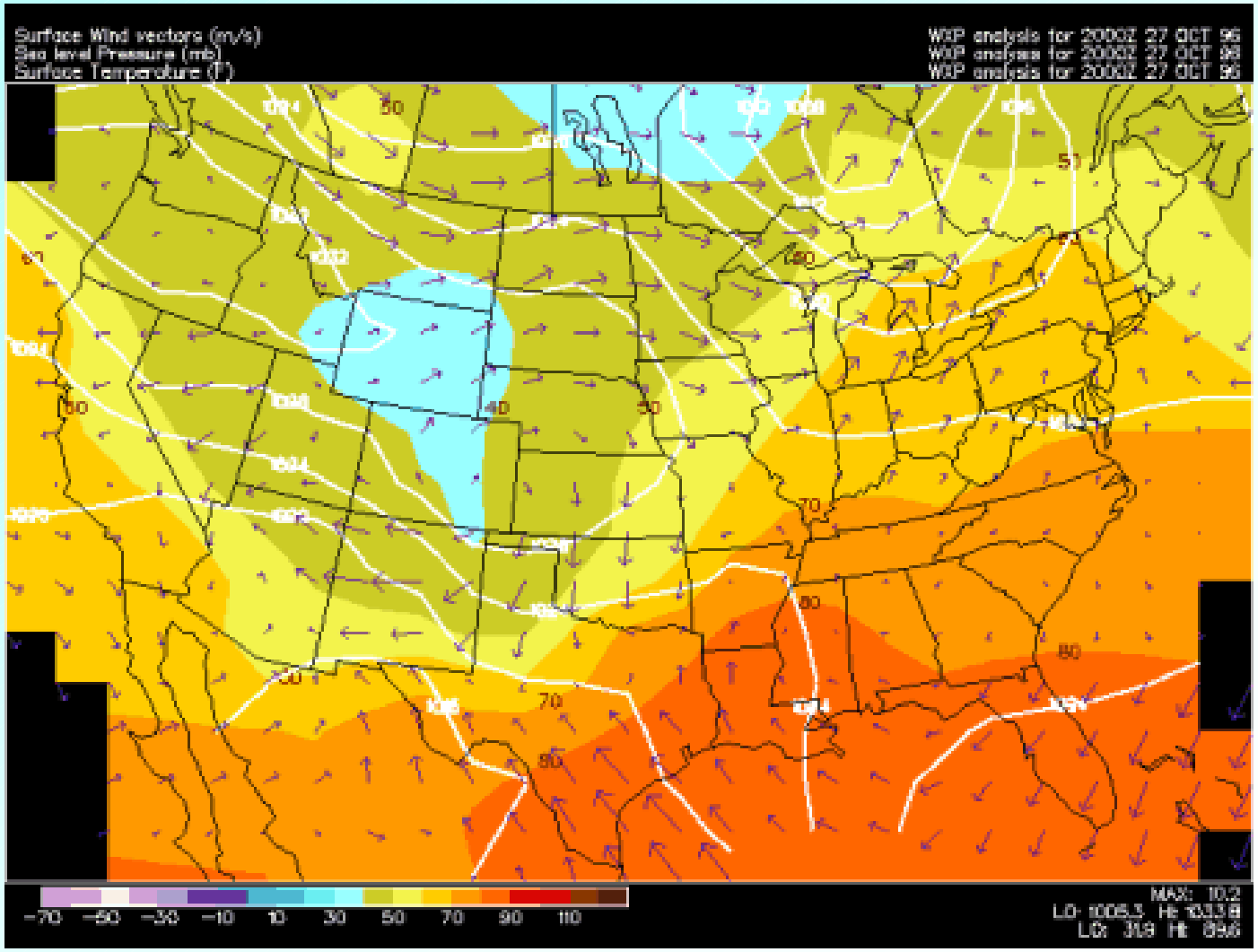
Need Help? Contact Pearson's 24/7 Support at https://support.pearson.com/getsupport

SCHEDULE

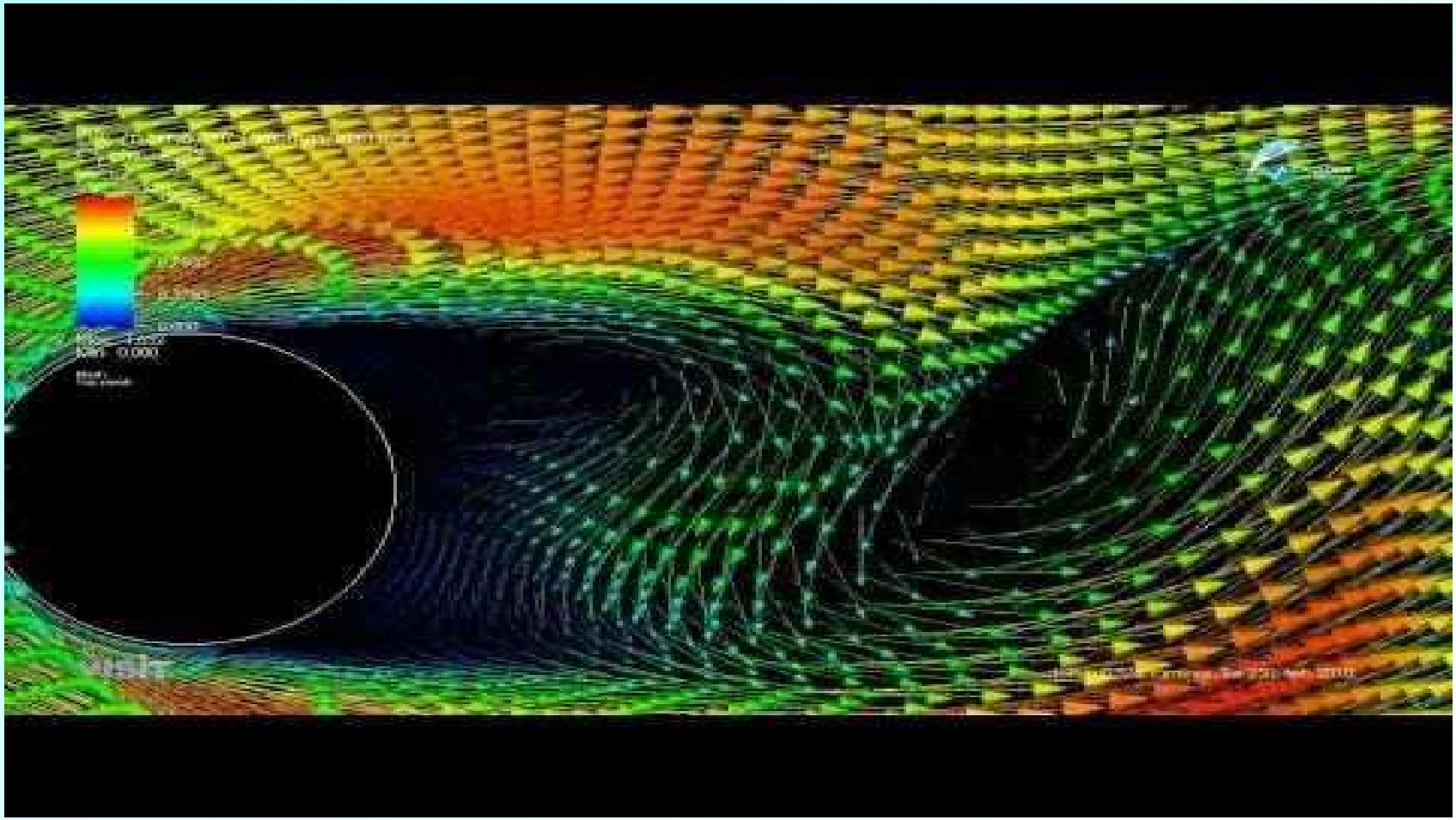
Homework assignments are due each Friday at 11:59 PM unless otherwise specified.

Week	Lectures	Text Sections	Homework due	Tutorial
1	Sep 5, 7	1.1-1.6, 2.1-2.4		
2	Sep 10, 12, 14	2.5-2.9	1 Mon Sep 17, 11:59 PM	1
3	Sep 17, 19, 21	3.1-3.4, 4.1-4.3	2	2
4	Sep 24, 26, 28	4.4-4.8	3	3
5	Oct 1, 3, 5	5.1-5.3, 5.5-5.7	4	4
6	Wed Oct 10 Fri Oct 12	8.1-8.2 October Exam: Chapters 1, 2, 3, 4	5 Mon Oct 15, 11:59 PM	
7	Oct 15, 17, 19	8.3, 12.1-12.7	6 Mon Oct 22, 11:59 PM	5
8	Oct 22, 24, 26	12.8-12.10	7	6
9	Oct 29, 31, Nov 2	13.1-13.5	8	7
10	Nov 5, 7 Fri Nov 9	13.6, 14.1-14.2 November Exam: Chapters 5, 8, 12	9 Tue Nov 13, 11:59 PM	
11	Nov 14, 16	14.3-14.6	10	8
12	Nov 19, 21, 23	15.1-15.4	11	9
13	Nov 26, 28, 30	15.5-15.7	12 Mon Dec 3, 11:59 PM	

Temperature Contours and Wind Vectors



Von Karman Vortex Street
(Flow behind a cylinder)



Lecture Outline/Learning Goals

- Vector Basics
  - Definition, graphical representation, planar vectors (2 dimensions)
  - Vector operations (negations, addition, subtraction, resolution)
- Addition of System of Coplanar Forces (vectors)
  - Scalar approach
  - Cartesian component approach
- Sample problems

CHAPTER 2: (FORCE) VECTORS

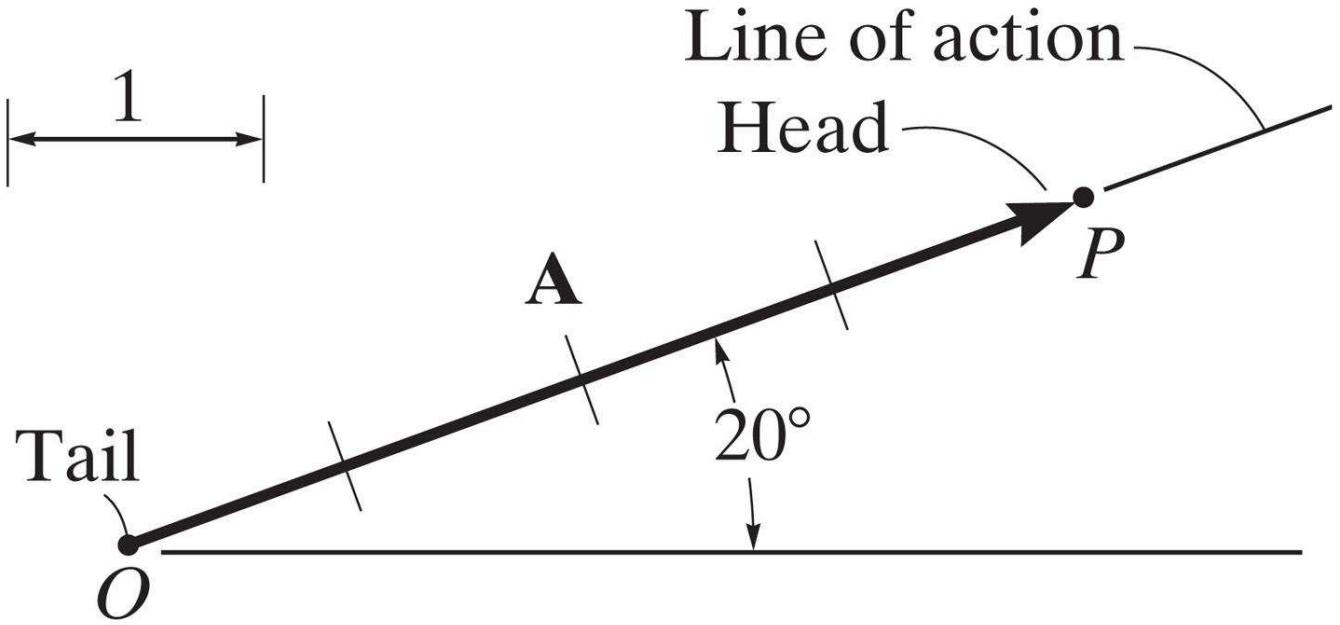
- Scalars
  - Quantities characterized by positive (and possibly negative) number
  - Examples: mass, volume, length …
- Vectors
  - Quantities that have both magnitude and direction
  - Examples: position, force, moment …
  - Notation for vectors (will use both)

$$\mathbf{A} \text{ or } \vec{A}$$

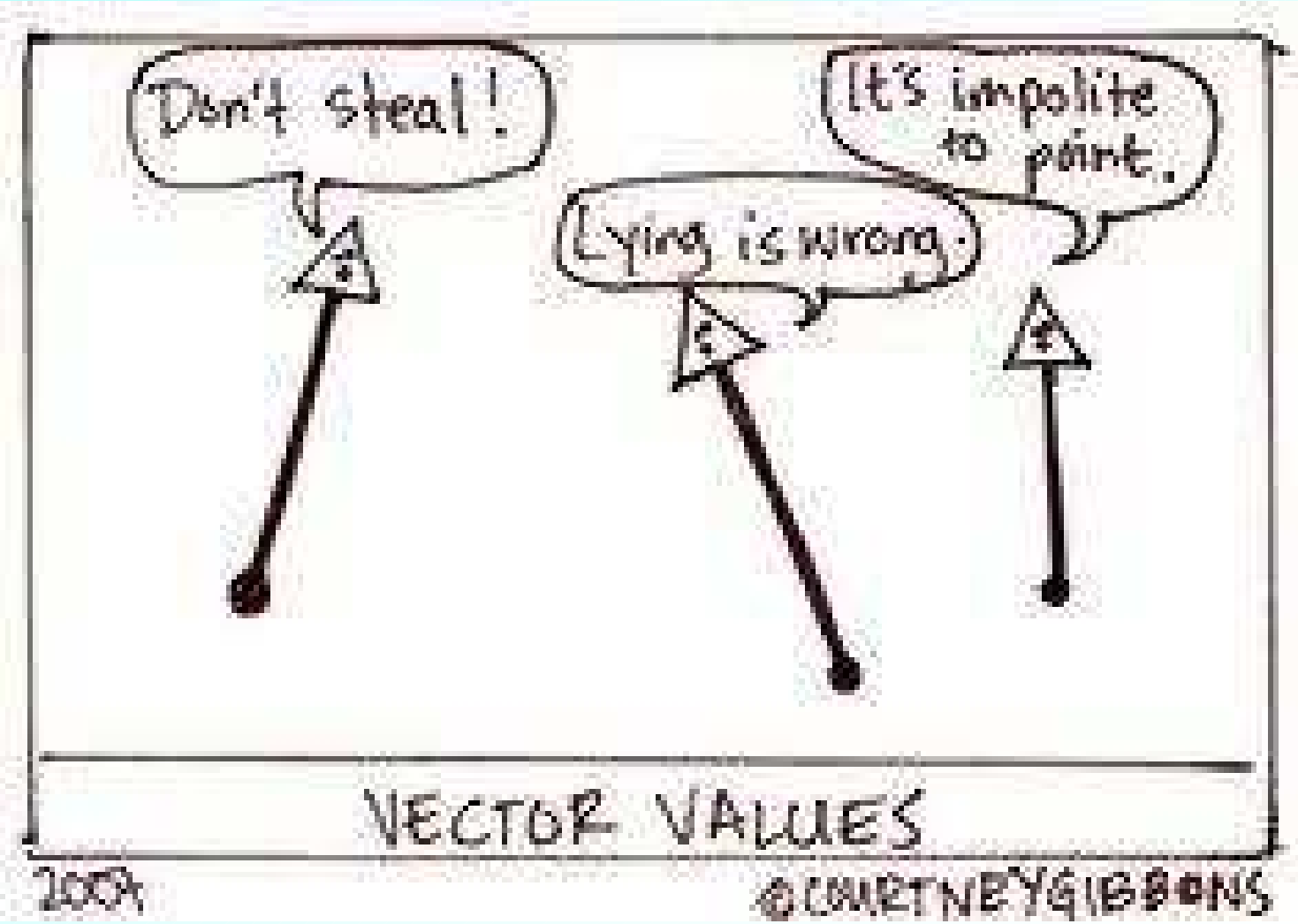
  - Notation for magnitude (length) of vector

$$A \text{ or } |\vec{A}|$$

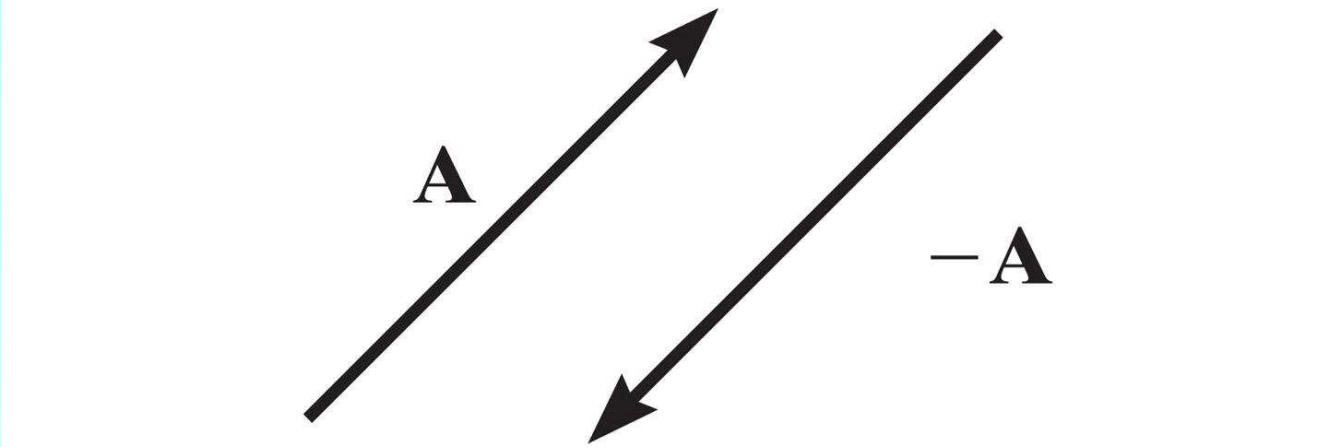
GRAPHICAL REPRESENTATION



VECTOR VALUES

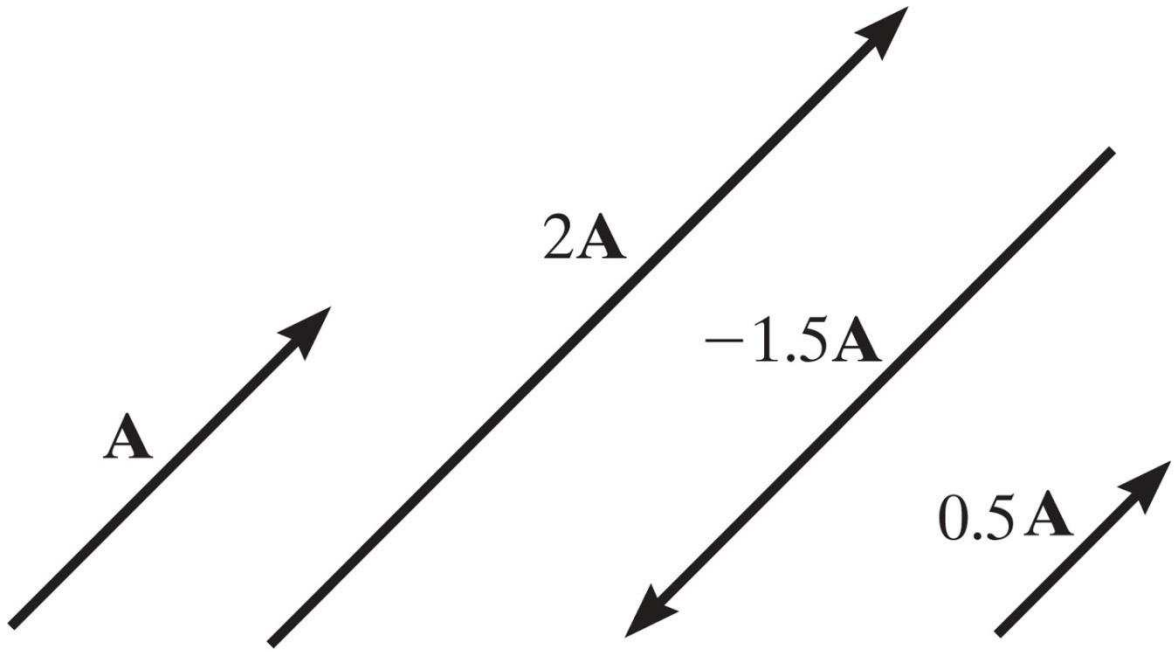


NEGATIVE OF VECTOR



Vector **A** and its negative counterpart

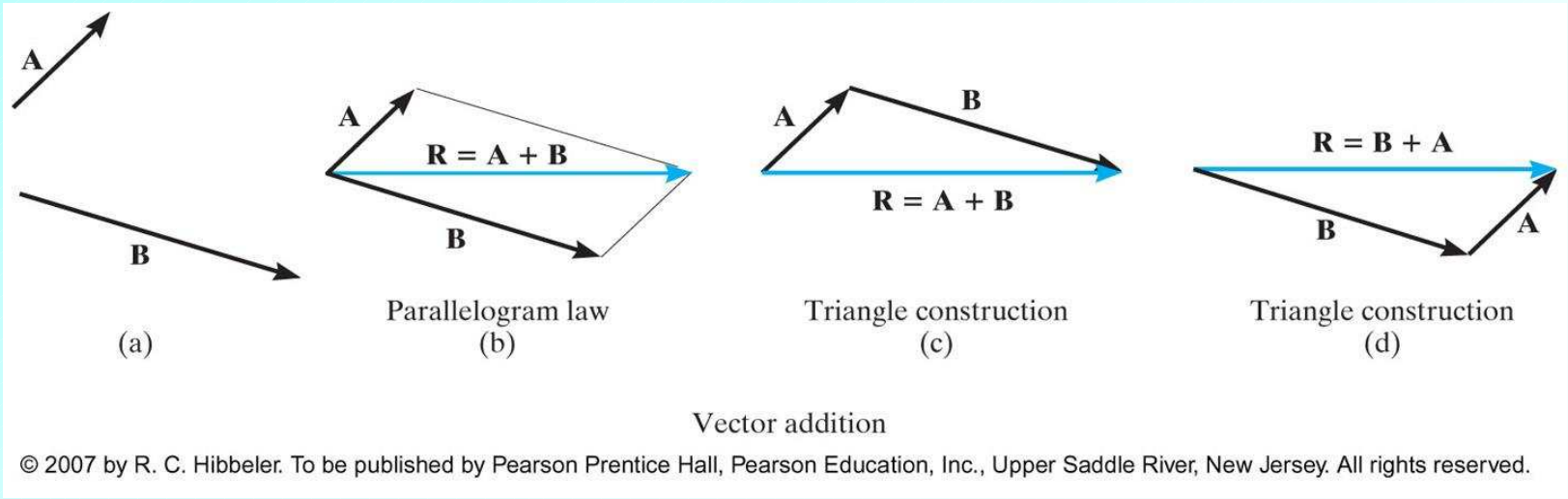
SCALAR MULTIPLICATION



Scalar multiplication and division

VECTOR ADDITION

- Three equivalent approaches

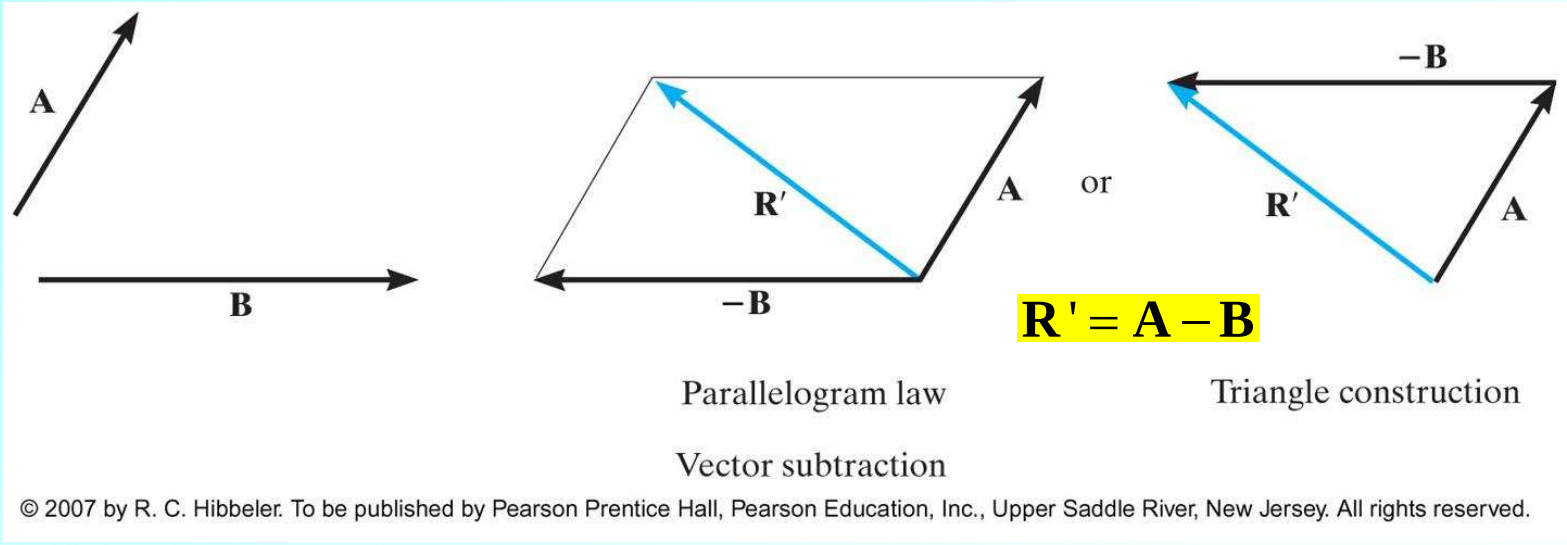


Vector addition

NOTE: “Tip to tail” (“Head to tail”) mnemonic for triangle constructions

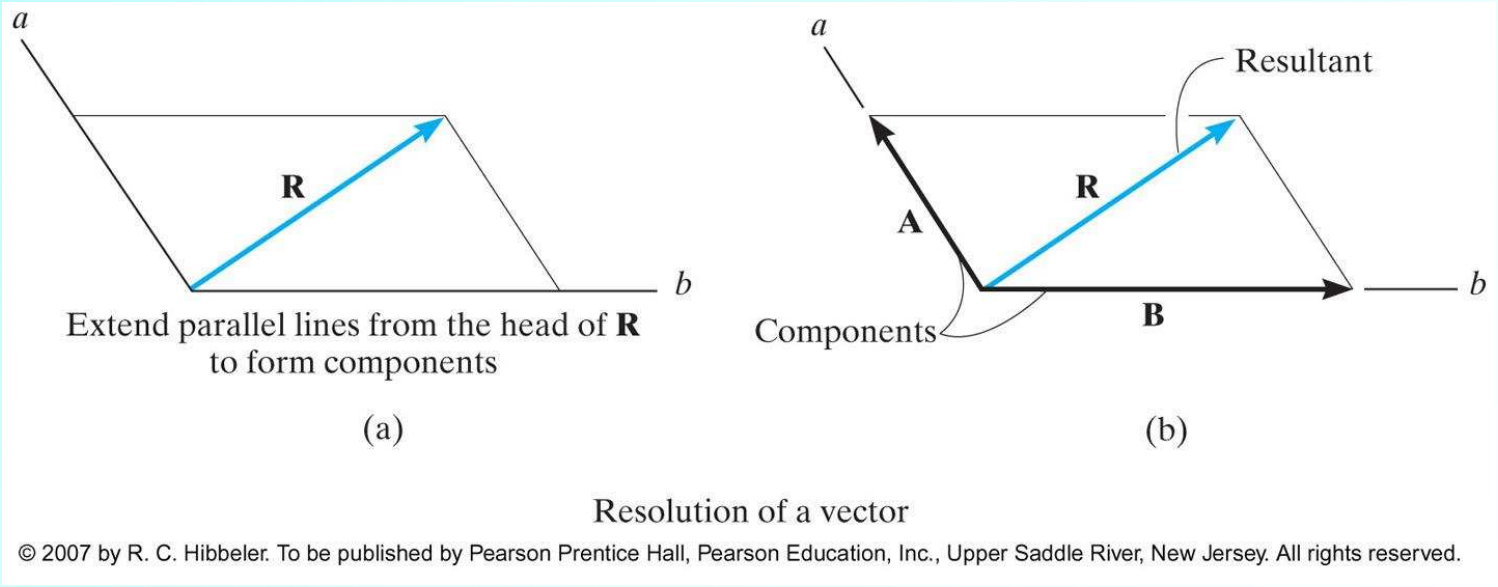
VECTOR SUBTRACTION

- RECALL: Vector negation reverses sense of vector



RESOLUTION OF VECTOR

- Express vector as sum of two “component” vectors (“inverse parallelogram law”)



Resolution of a vector

VECTOR ADDITION OF FORCES (EXAMPLE)

The screw eye in Fig. 2–10*a* is subjected to two forces, $\mathbf{F}_1$ and $\mathbf{F}_2$. Determine the magnitude and direction of the resultant force.

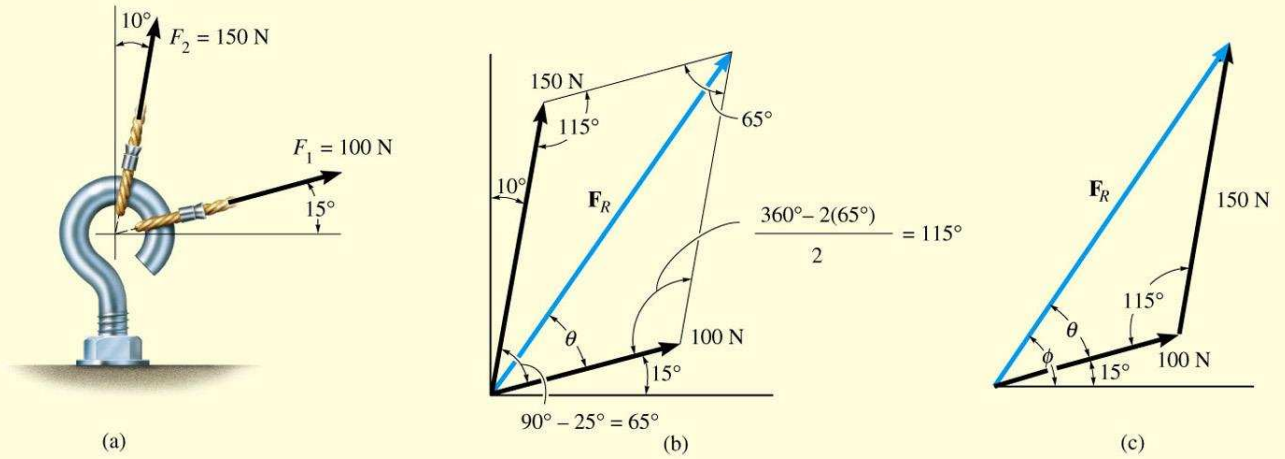


Fig. 2-10

- For 2 coplanar vectors, can generally use trigonometry to perform addition (cumbersome for more vectors)

Solution

Parallelogram Law. The parallelogram law of addition is shown in Fig. 2–10*b*. The two unknowns are the magnitude of $\mathbf{F}_R$ and the angle θ (theta).

Trigonometry. From Fig. 2–10*b*, the vector triangle, Fig. 2–10*c*, is constructed. F_R is determined by using the law of cosines:

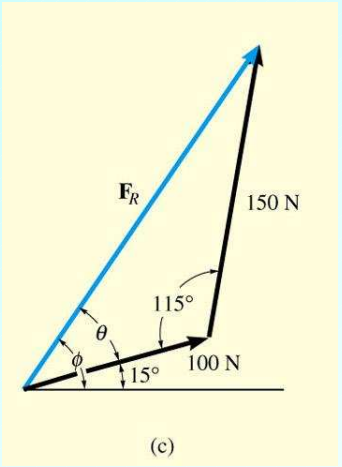
$$F_R = \sqrt{(100\text{ N})^2 + (150\text{ N})^2 - 2(100\text{ N})(150\text{ N})\cos 115°}$$
$$= \sqrt{10\,000 + 22\,500 - 30\,000(-0.4226)} = 212.6\text{ N}$$
$$= 213\text{ N} \qquad \textit{Ans.}$$

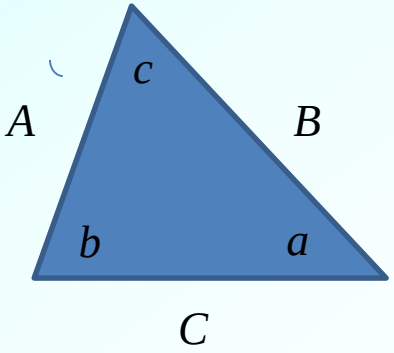
The angle θ is determined by applying the law of sines, using the computed value of F_R.

$$\frac{150\text{ N}}{\sin\theta} = \frac{212.6\text{ N}}{\sin 115°}$$
$$\sin\theta = \frac{150\text{ N}}{212.6\text{ N}}(0.9063)$$
$$\theta = 39.8°$$

Thus, the direction ϕ (phi) of $\mathbf{F}_R$, measured from the horizontal, is

$$\phi = 39.8° + 15.0° = 54.8° \measuredangle^{\phi} \qquad \textit{Ans.}$$





Sine law:

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

Cosine law:

$$C = \sqrt{A^2 + B^2 - 2AB\cos c}$$

2.4 Addition of a System of Coplanar (2D) Forces

- It is often convenient to resolve vectors into two components along the *x* and *y* axes: the resulting components are then called **rectangular components**

- Text discusses two approaches:
  - Scalar Notation
  - Cartesian Vector Notation

- Notation is similar in both cases, but in reading text have to be careful with signs due to the way text likes to define things (essentially wanting all quantities acting as labels in figures to be positive)

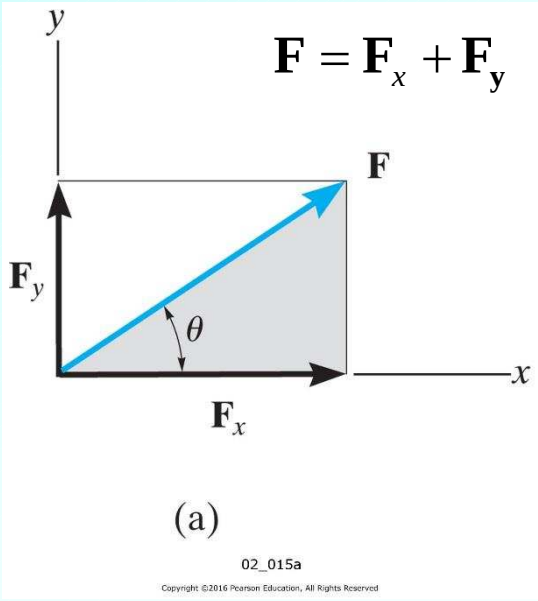
- In 3D case—which is our ultimate interest—we will adopt the Cartesian approach but will not insist that the components be positive (book doesn't either)

Scalar Notation

(a) Determine components, F_x and F_y from F and θ

$$F_x = F\cos\theta$$

$$F_y = F\sin\theta$$



(b) Determine components from "slope triangle"

$$\frac{F_x}{F} = \frac{a}{c}$$

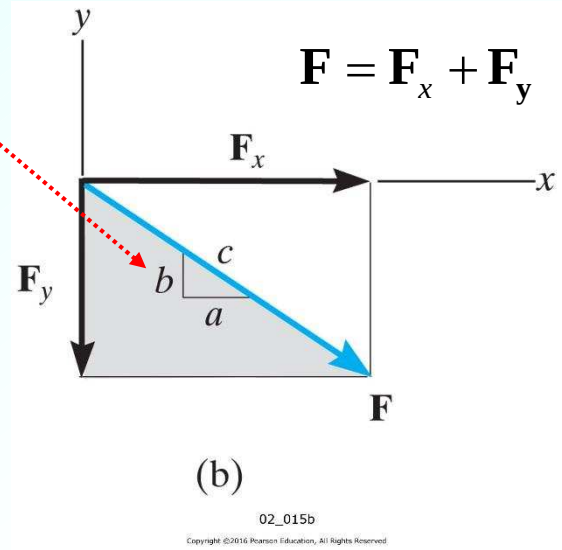
$$F_x = F\left(\frac{a}{c}\right)$$

and

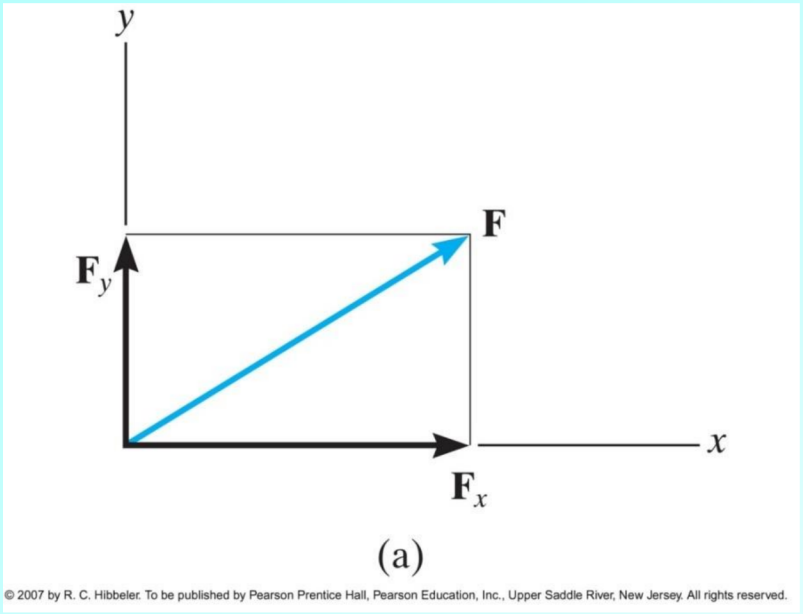
$$\frac{F_y}{F} = \frac{b}{c}$$

$$F_y = -F\left(\frac{b}{c}\right)$$

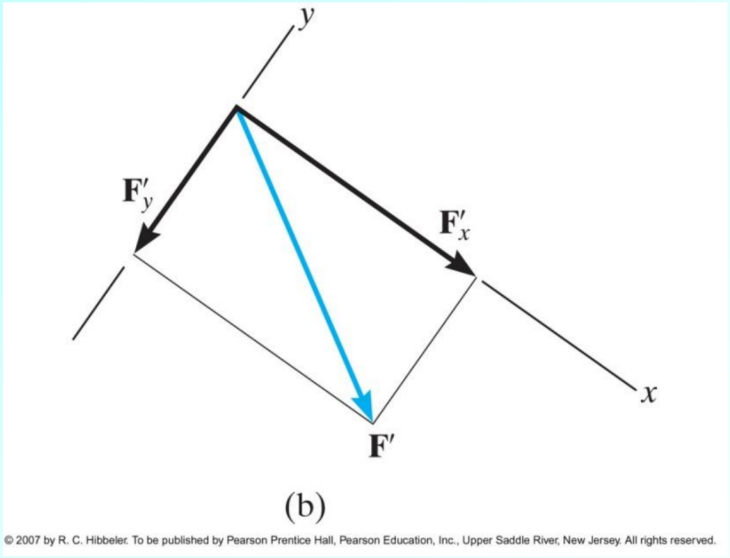
Components in scalar notation case can have negative as well as positive sign.



Cartesian Vector Notation



- Introduce x and y coordinate axes (orientation arbitrary)
- Define unit vectors in positive x and y directions



i and **j**

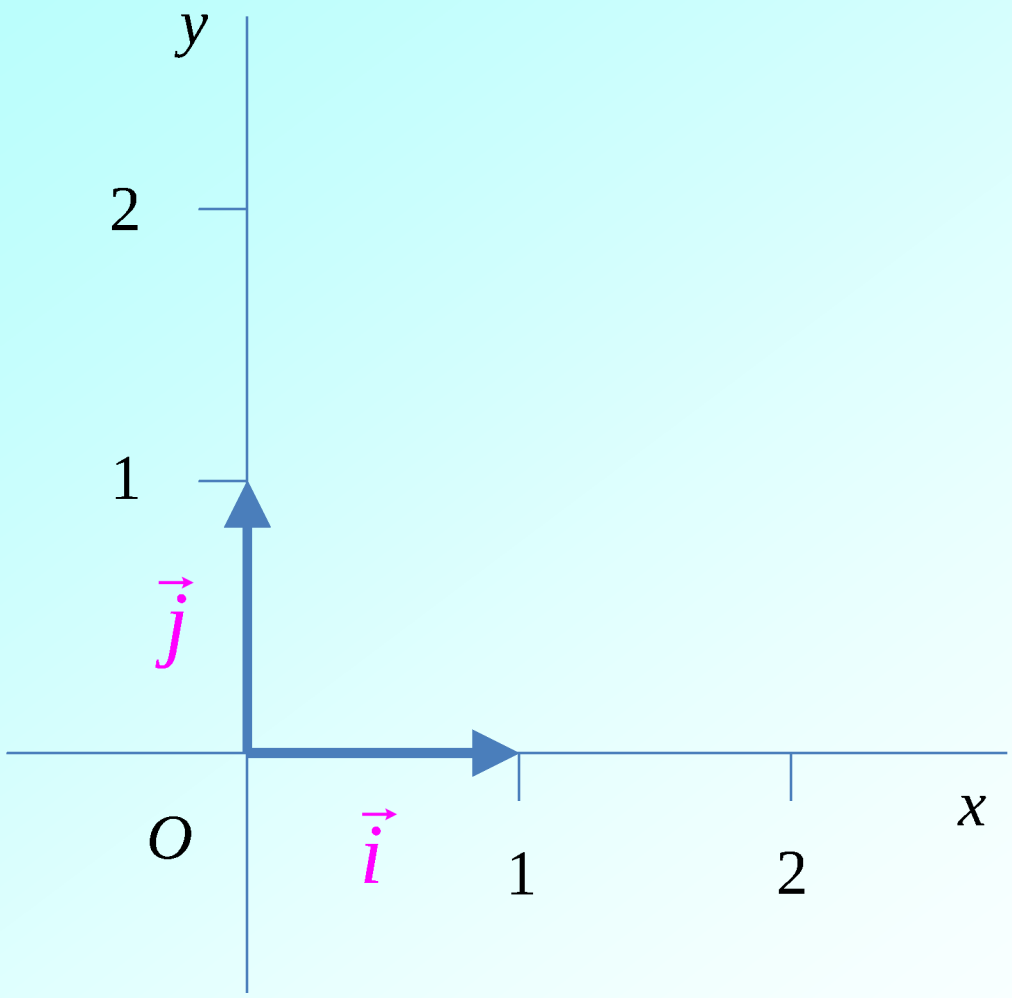
or

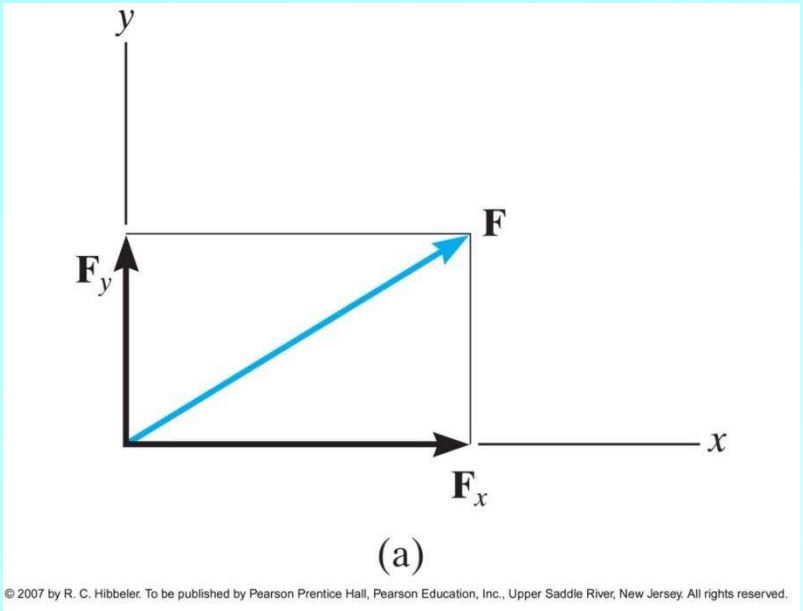
$\vec{i}$ and $\vec{j}$

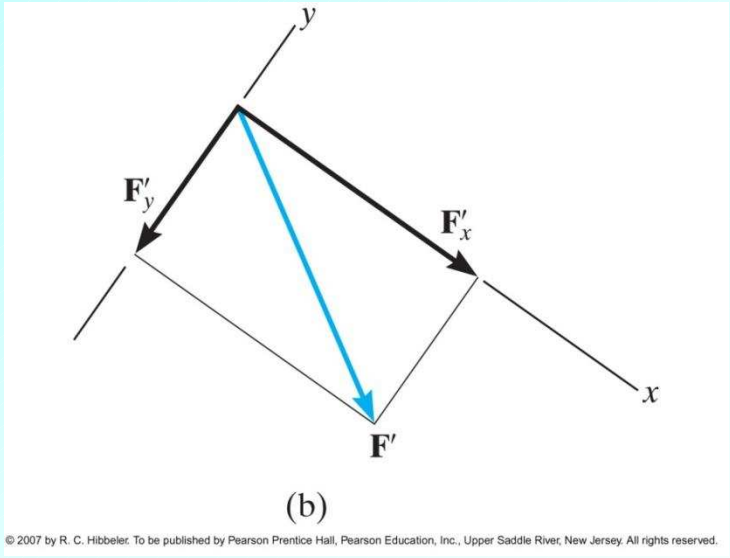
or

$\hat{i}$ and $\hat{j}$

UNIT VECTORS







$$\mathbf{F} = F_x\mathbf{i} + F_y\mathbf{j}$$

$$\mathbf{F}' = F'_x\mathbf{i} - F'_y\mathbf{j}$$

- IMPORTANT!

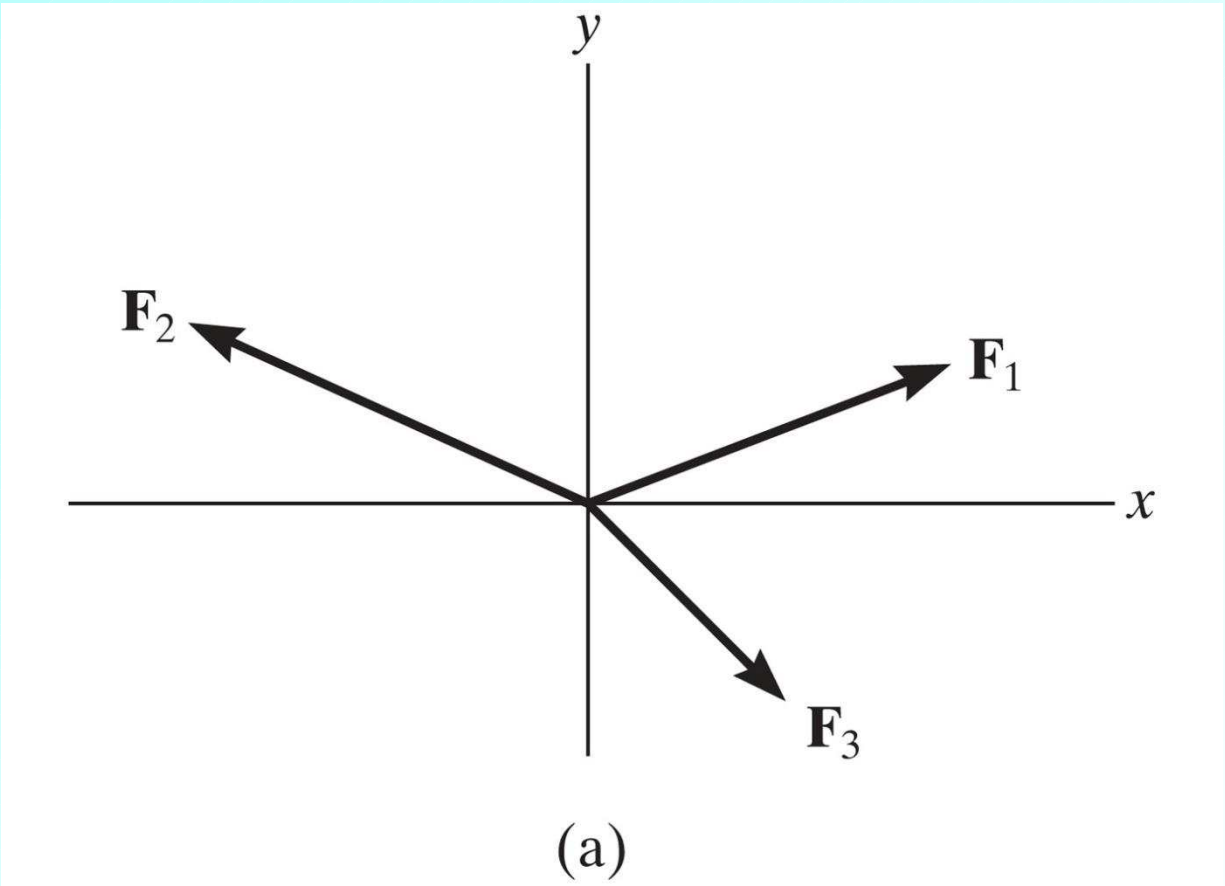
$$F_x, F_y, F'_x, F'_y \text{ ... etc.}$$

are *defined* as *magnitudes* of component *vectors*, and are therefore *positive* quantities: negative sign, if any, is associated with unit vector. Again, this is a peculiarity of the text which won't be as much of an issue when we deal with 3-dimensional vectors.

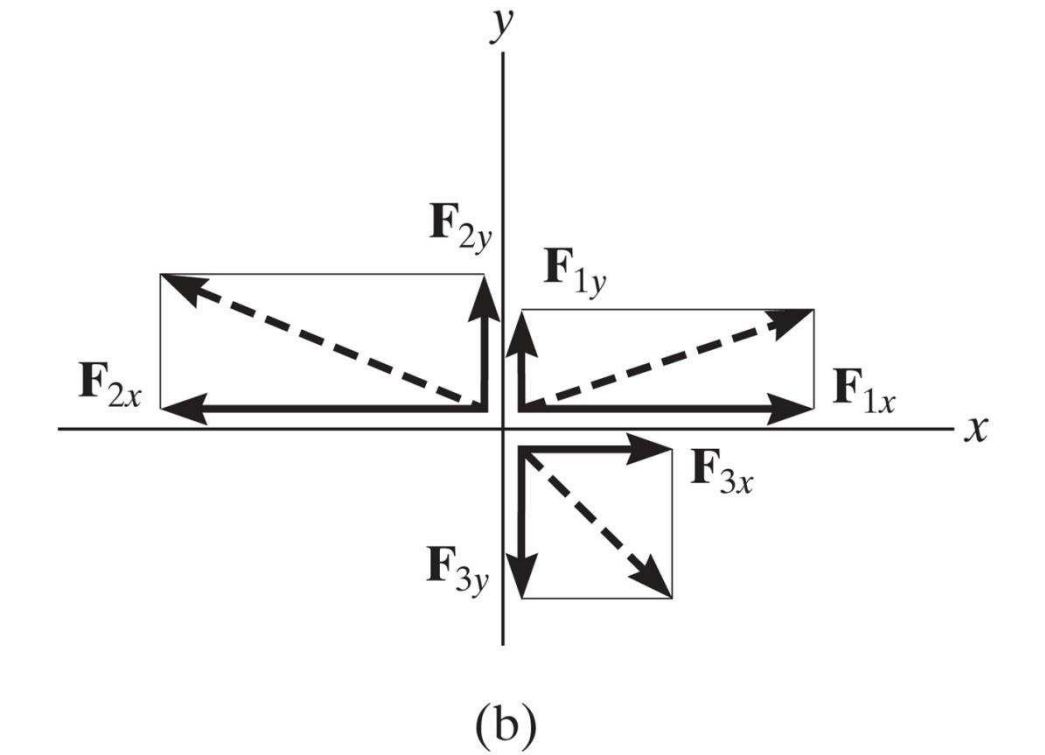
COPLANAR FORCE RESULTANTS

- We now wish to consider summing an arbitrary number of vectors in the *xy* plane. For example:

$$\mathbf{F}_R = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3$$



COPLANAR FORCE RESULTANTS



NOTE: Components of resultants, such as

$$F_{Rx},\ F_{Ry}$$

not necessarily positive! Signs will determine sense of components.

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 \\ &= F_{1x}\mathbf{i} + F_{1y}\mathbf{j} - F_{2x}\mathbf{i} + F_{2y}\mathbf{j} + F_{3x}\mathbf{i} - F_{3y}\mathbf{j} \\ &= (F_{1x} - F_{2x} + F_{3x})\mathbf{i} + (F_{1y} + F_{2y} - F_{3y})\mathbf{j} \\ &= (F_{Rx})\mathbf{i} + (F_{Ry})\mathbf{j}\end{aligned}$$