

Atmospheric Forces

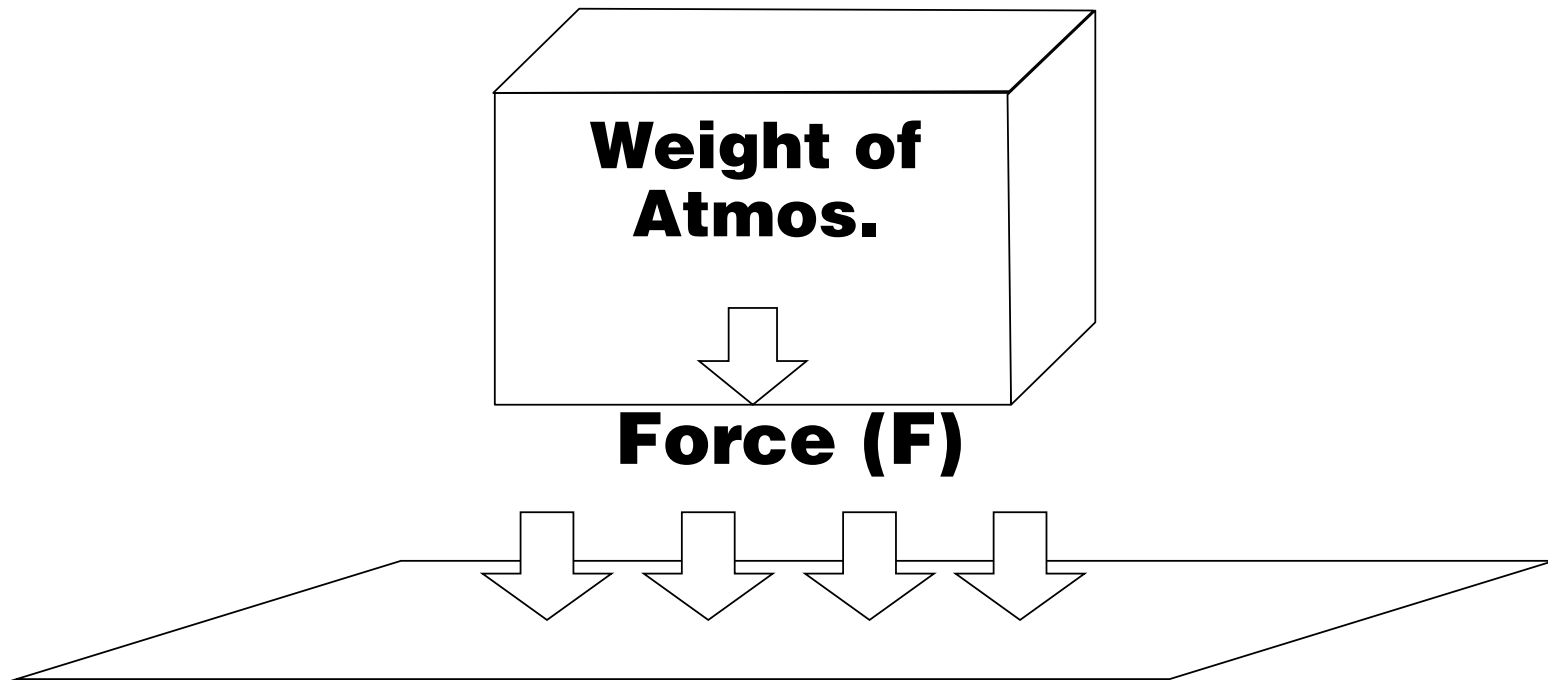
Makin' the wind go 'round

Ch. 4: Atmospheric Pressure

- **Vertical Pressure Profile**
- **Barometers**
- **Maps of Pressure Fields**
 - **Isobars**
 - **Heights of Pressure Surfaces vs. Temperature**
 - **Height Contours**

Ch. 4: Forces and Wind

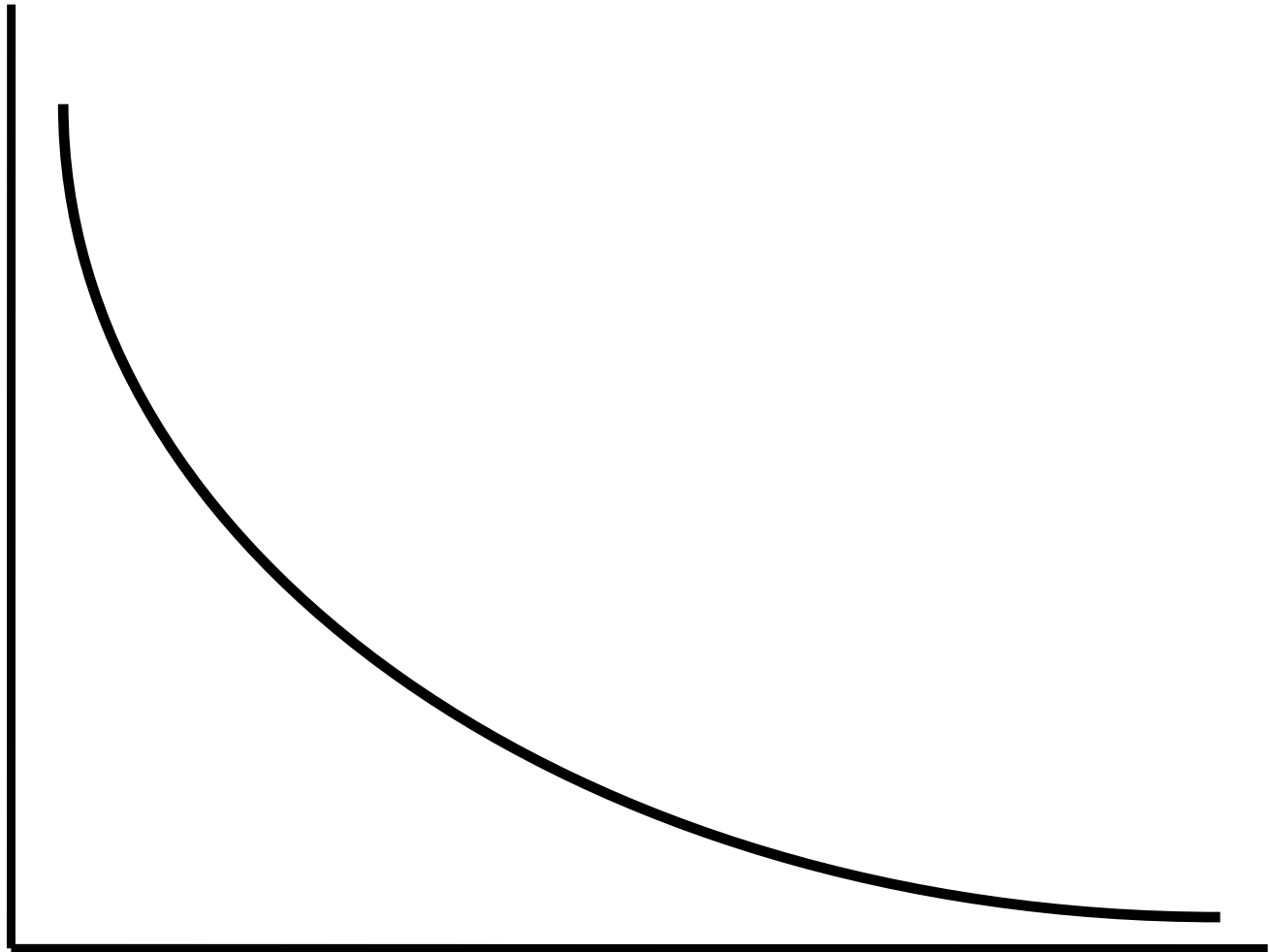
- **Atmospheric Forces**
 - **Pressure Gradient Force**
 - **Coriolis Force**
 - **Friction**
- **Winds and Balance of Forces**
 - **Hydrostatic Balance**
 - **Winds Aloft—Geostrophic Balance**
 - **Surface Winds**
- **Wind Measurement**



Sea level pressures:

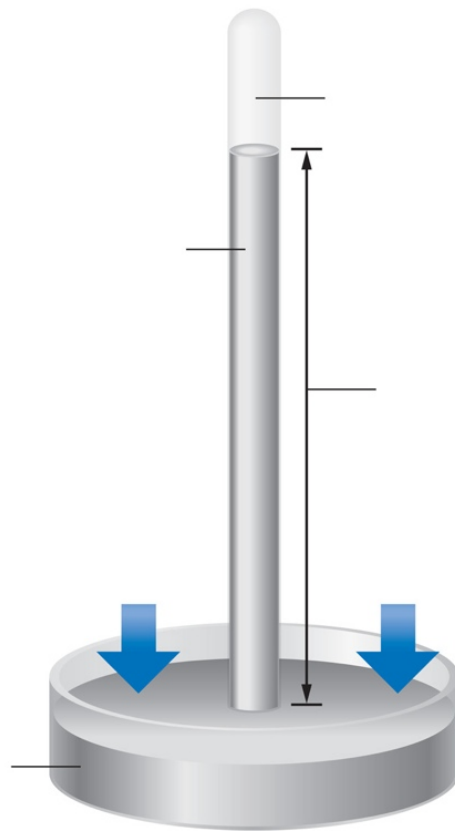
- **1 atmosphere (atm)**
- **1013.2 millibars (mb)**
- **14.7 lb./sq. in. (psi)**

Z



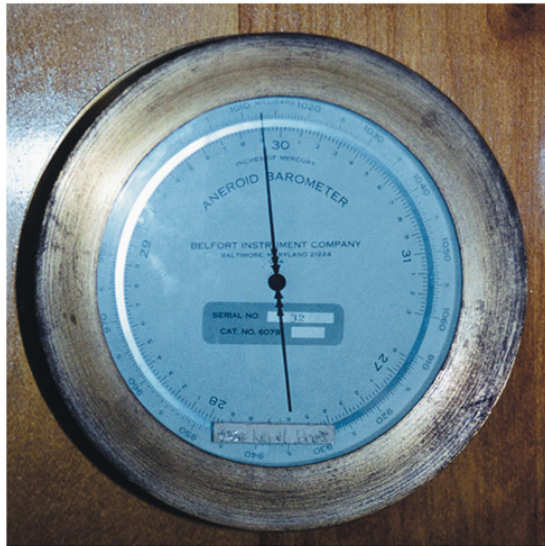
P

Measurement: Barometers

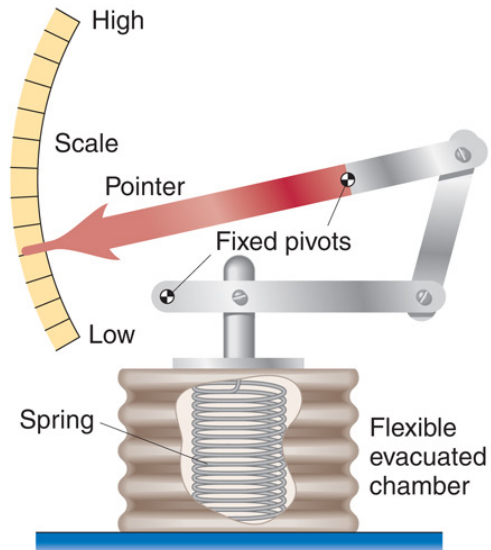


© 2010 Pearson Education, Inc.

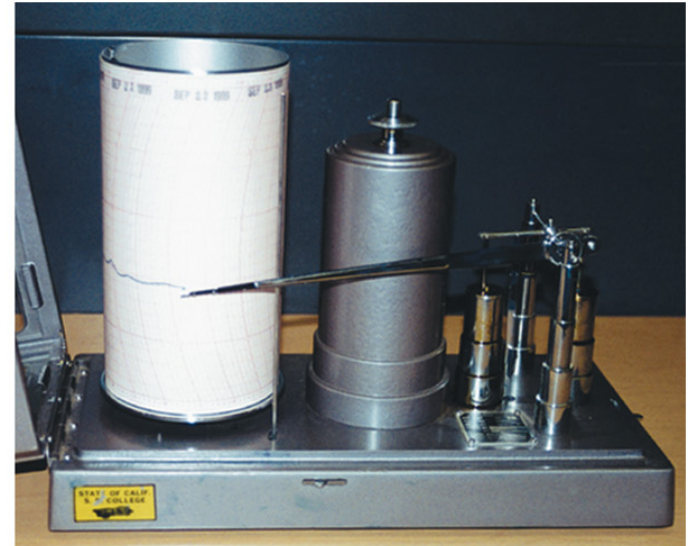
Mercury Barometer



(a)



(b)

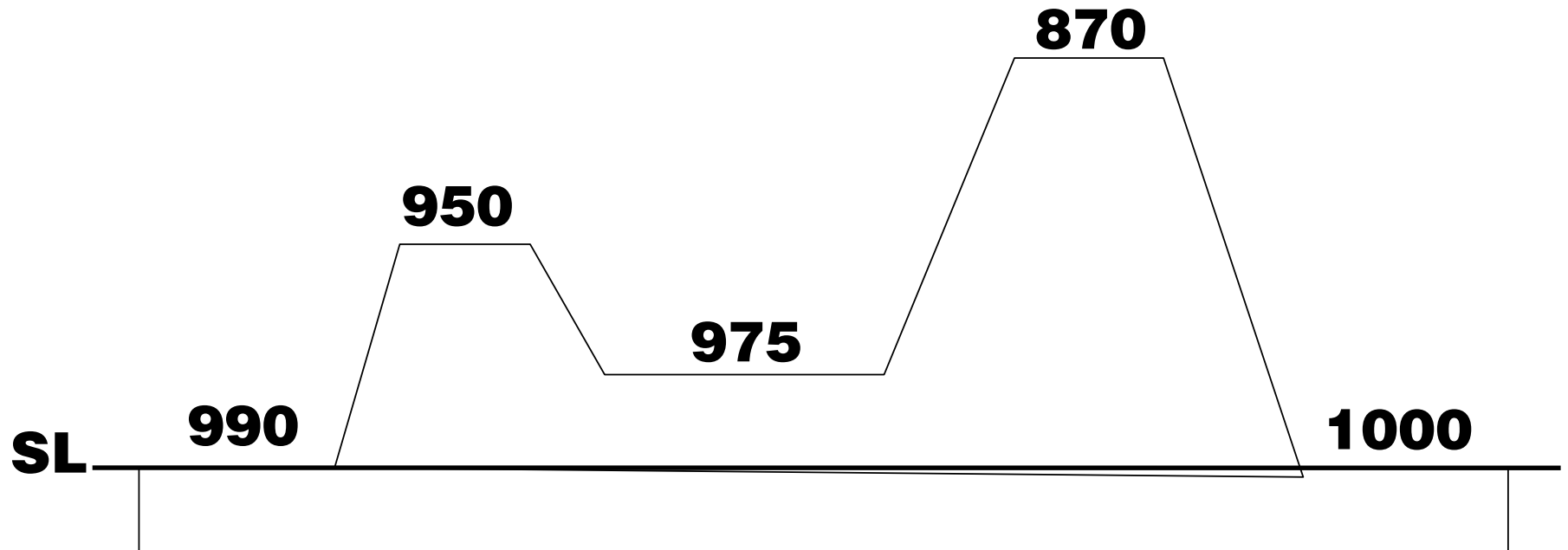


(c)

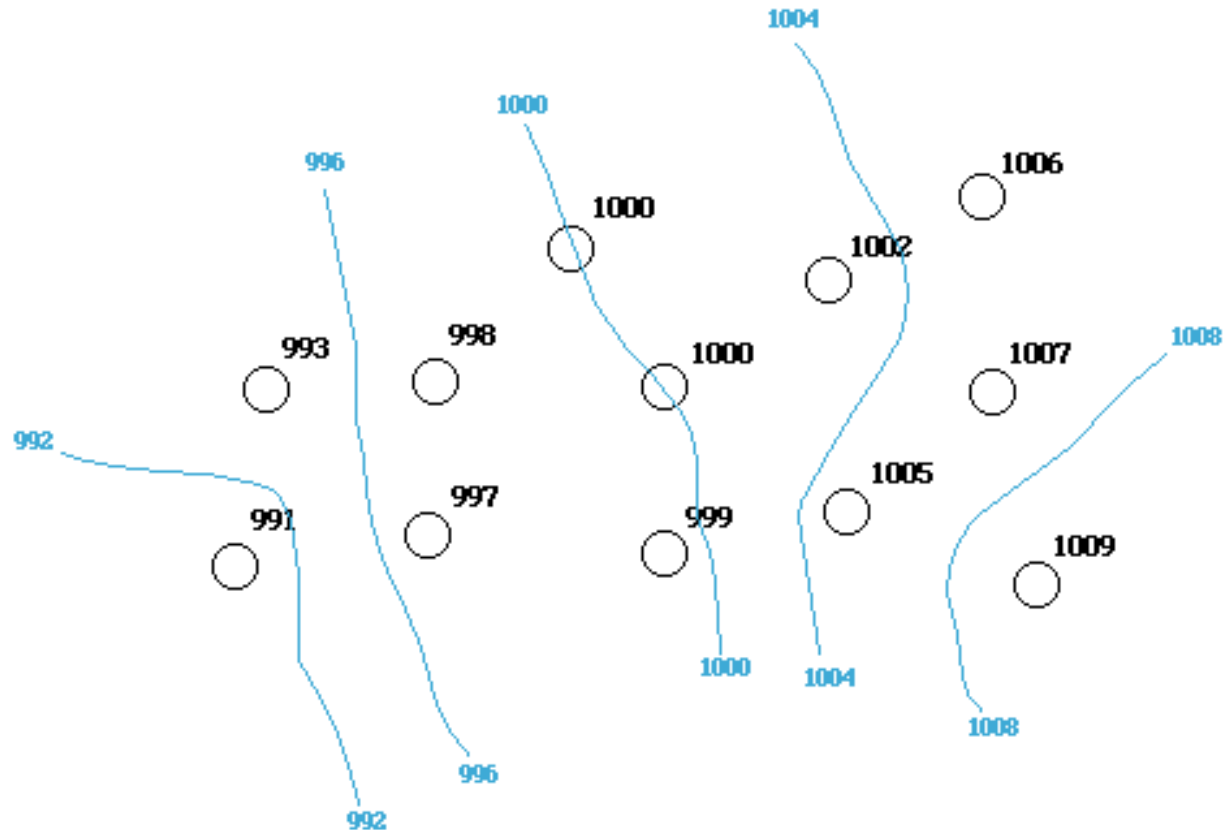
© 2010 Pearson Education, Inc.

Aneroid Barometer

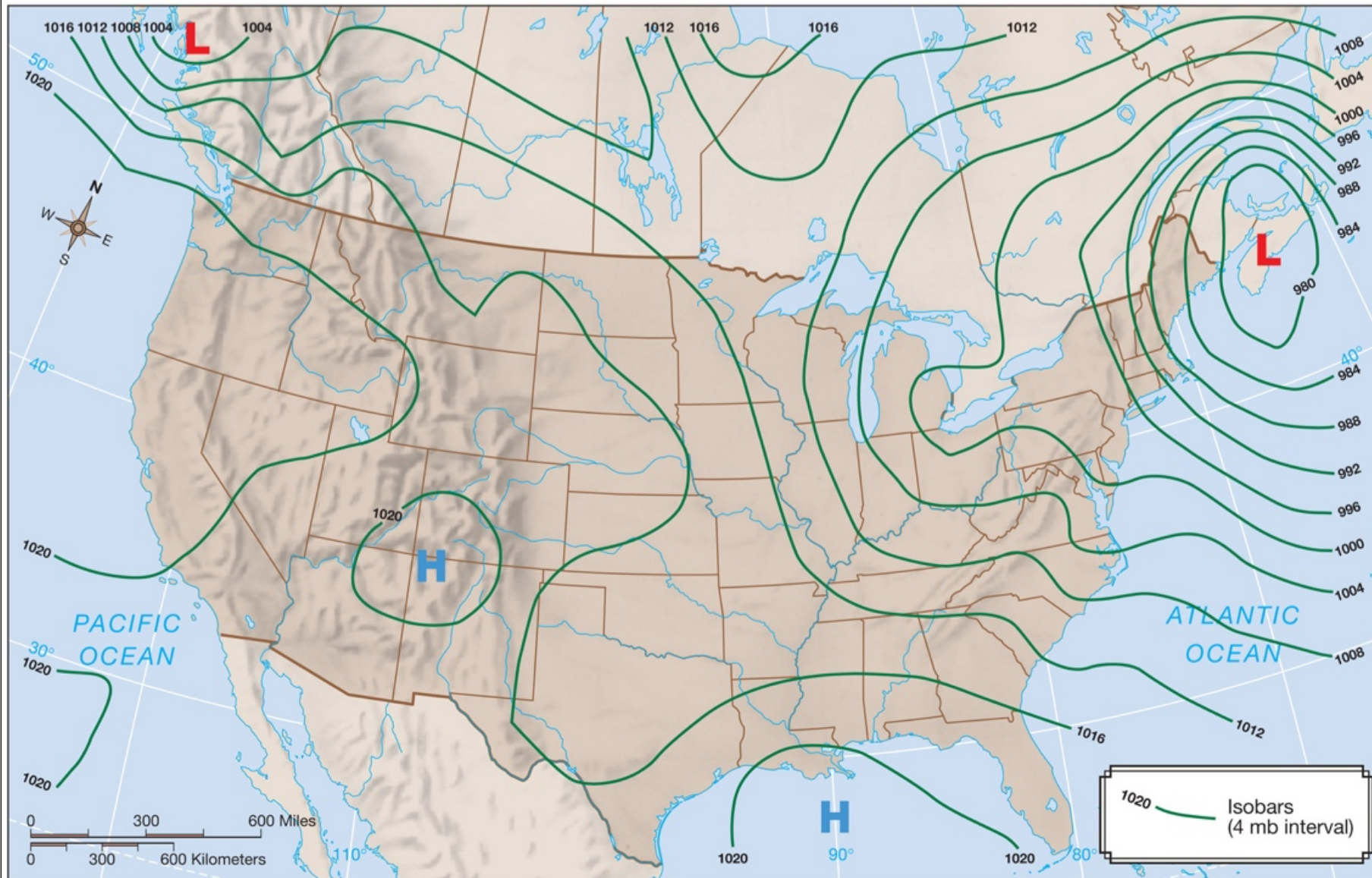
Reduction of Pressure to Sea Level



Charting Pressure



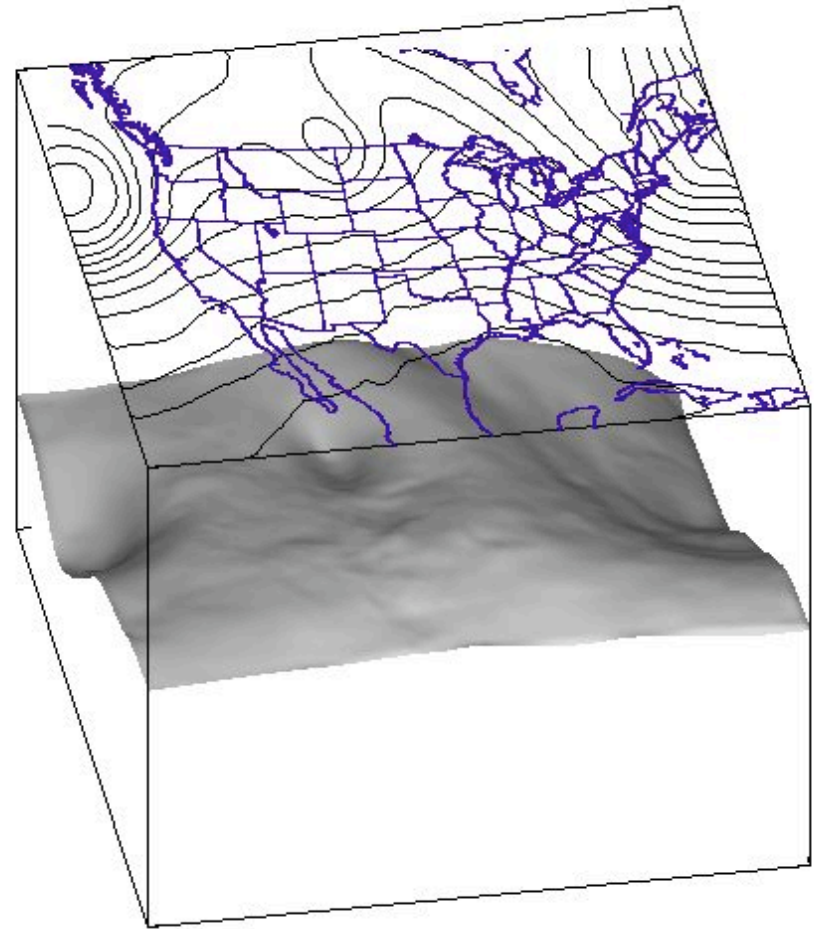
- **Isobars: lines connecting points of equal pressure**

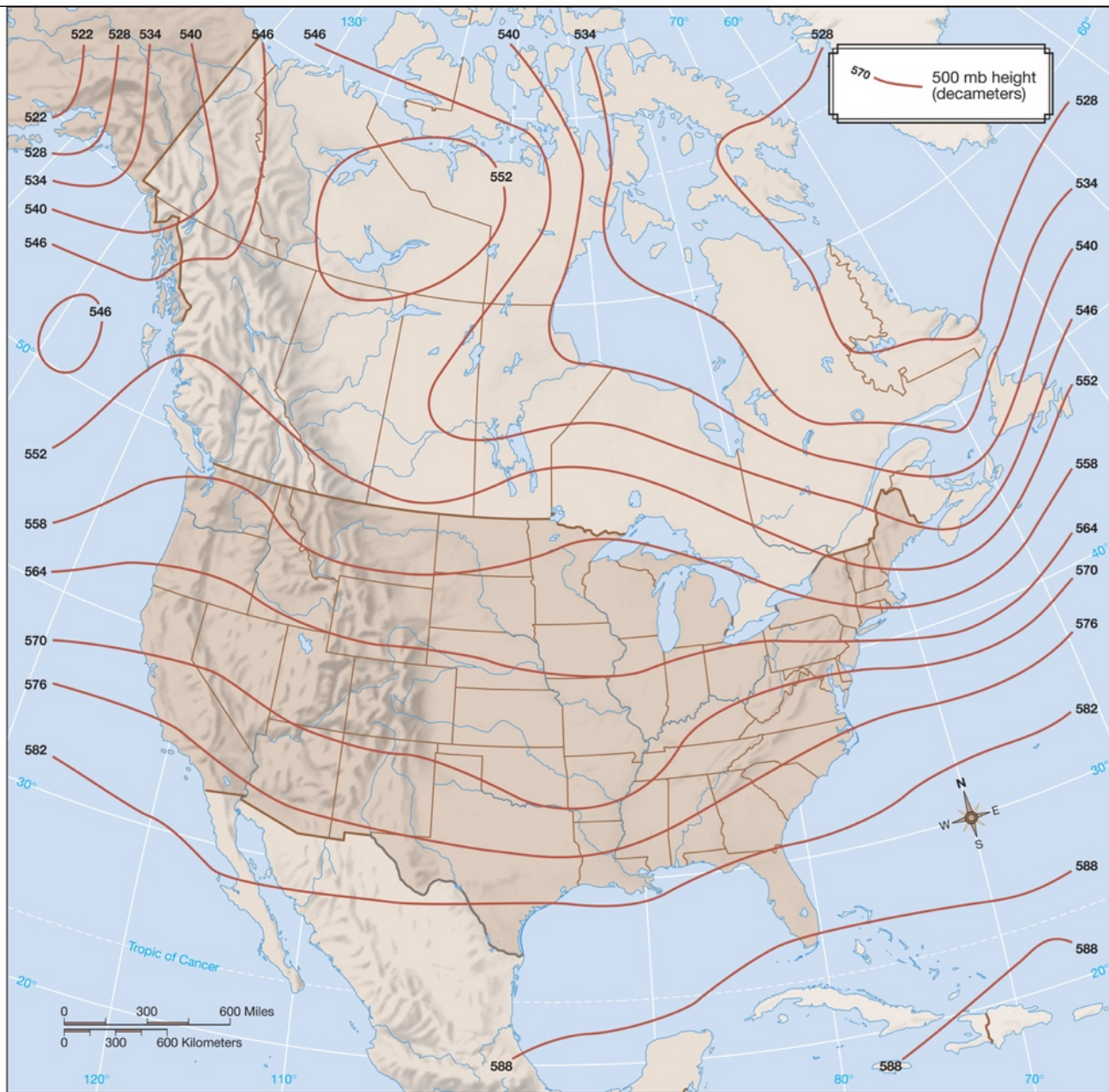


© 2010 Pearson Education, Inc.

Heights of Pressure Surfaces

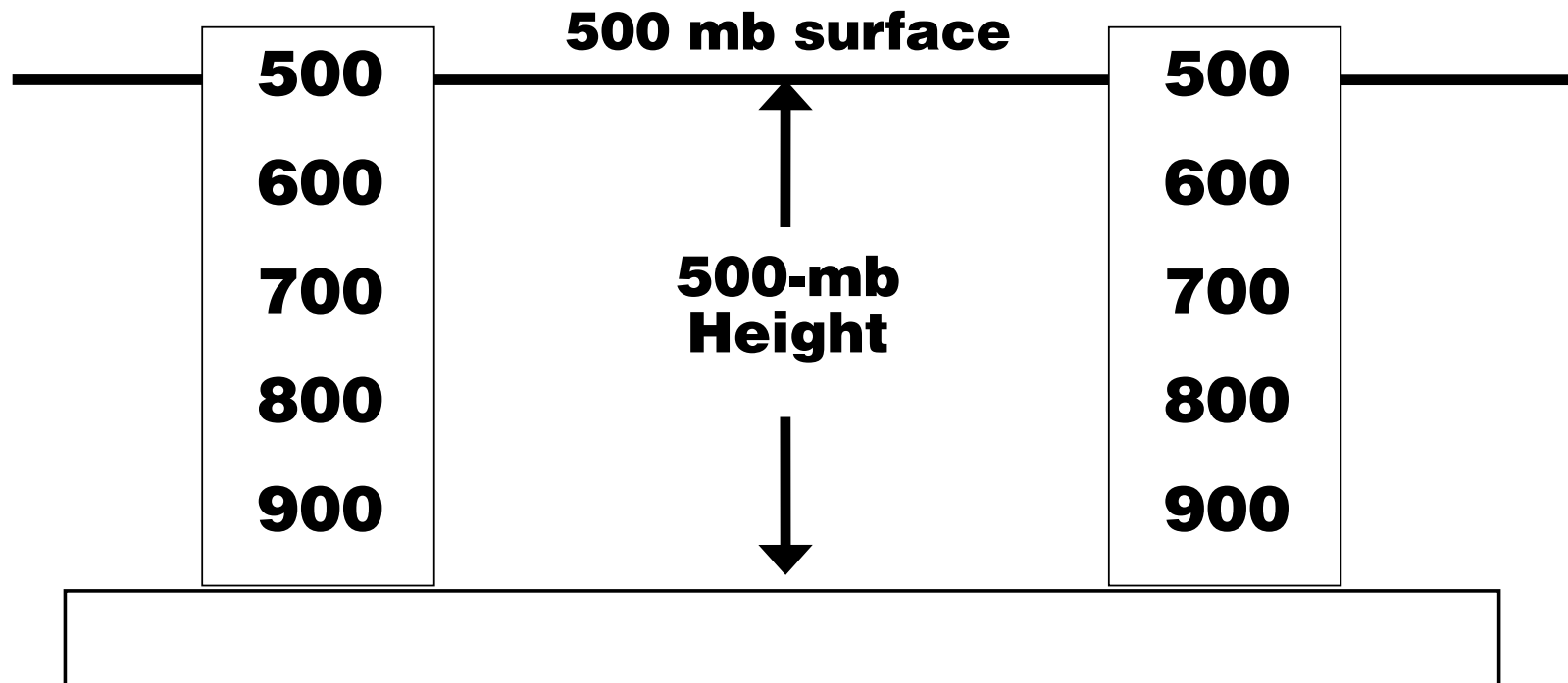
- **Pressure surface:** a surface where the atmospheric pressure is the same everywhere
- **Height contours:** lines connecting points of equal heights of some pressure surface



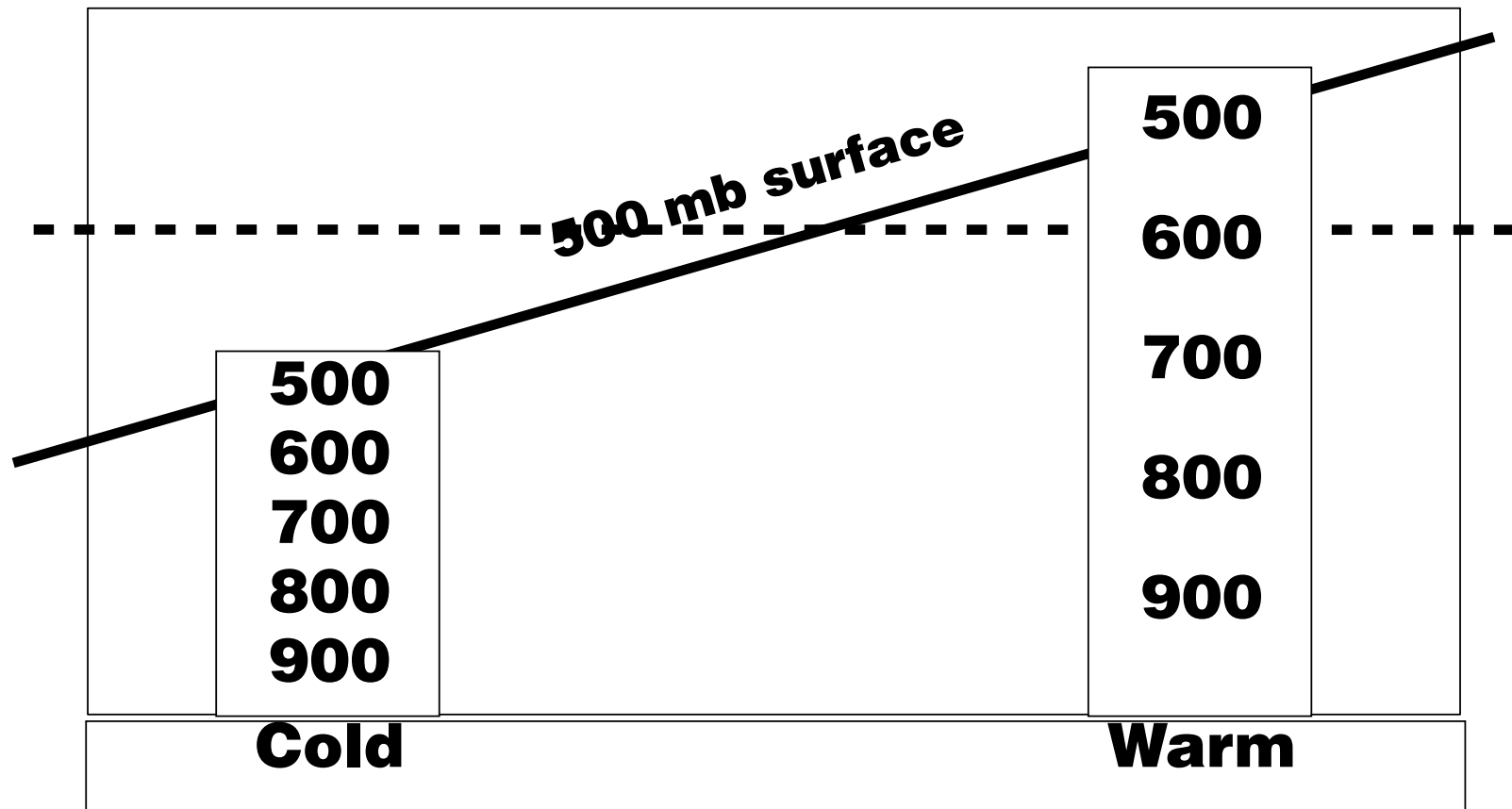


© 2010 Pearson Education, Inc.

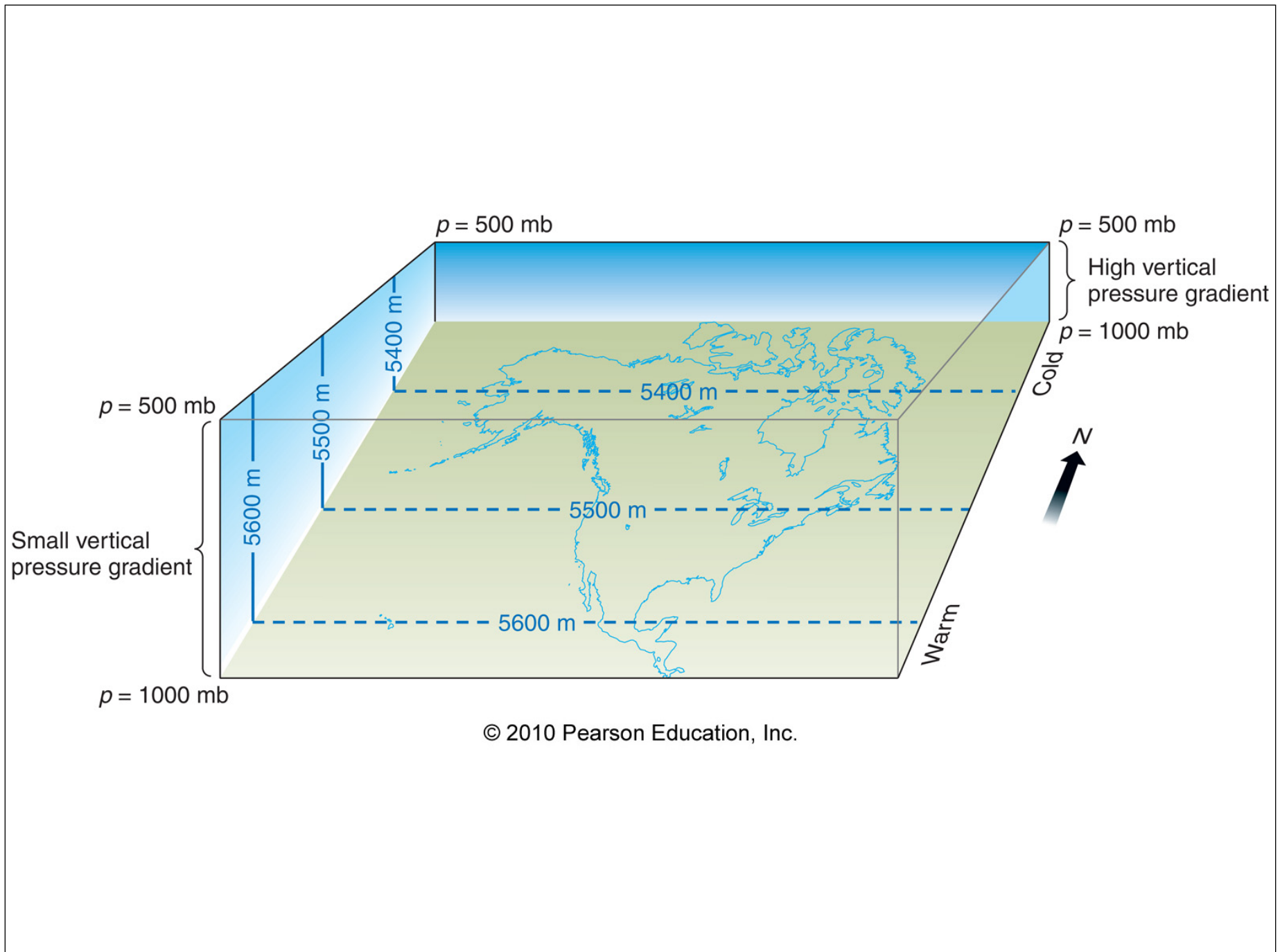
Pressures and Heights



Pressures and Heights

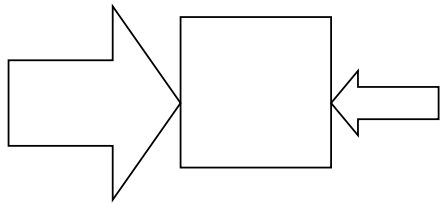
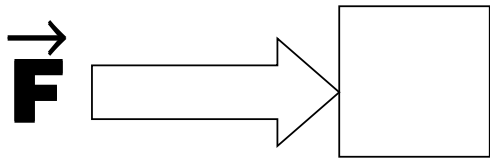


Heights of pressure surfaces aloft are higher when the air is warmer.



© 2010 Pearson Education, Inc.

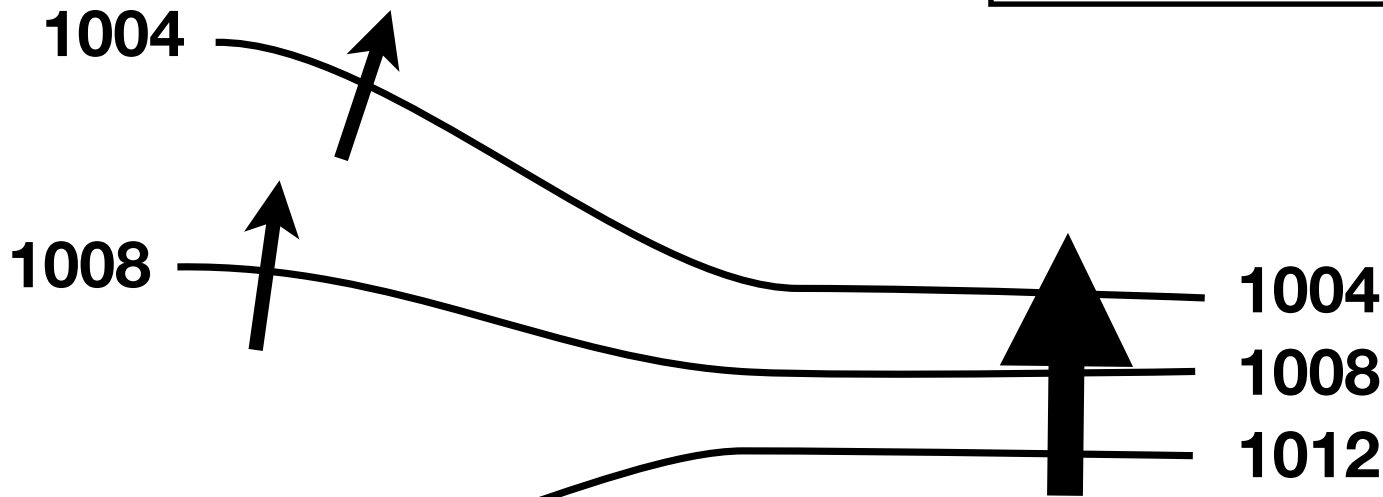
Forces



Pressure Gradient Force

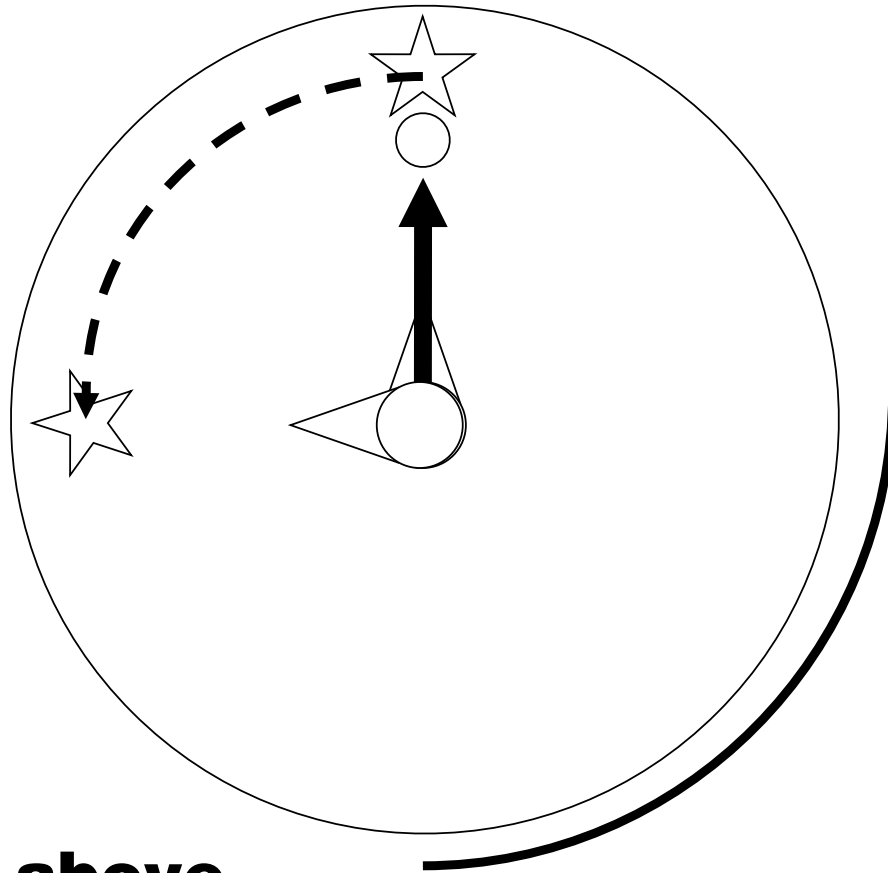
Pressure force is proportional to the difference in pressures

$$\text{PGF} \propto \frac{\Delta p}{d}$$



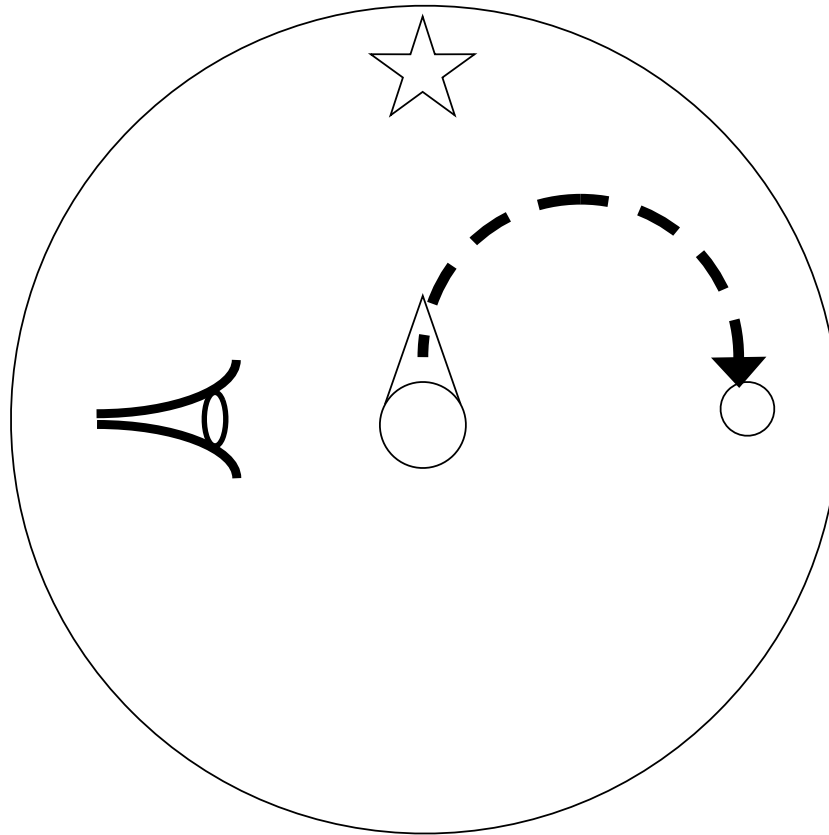
More closely spaced pressure contour lines: higher pressure gradient force

Coriolis Force



View from above

Coriolis Force



View on turntable



Coriolis Force

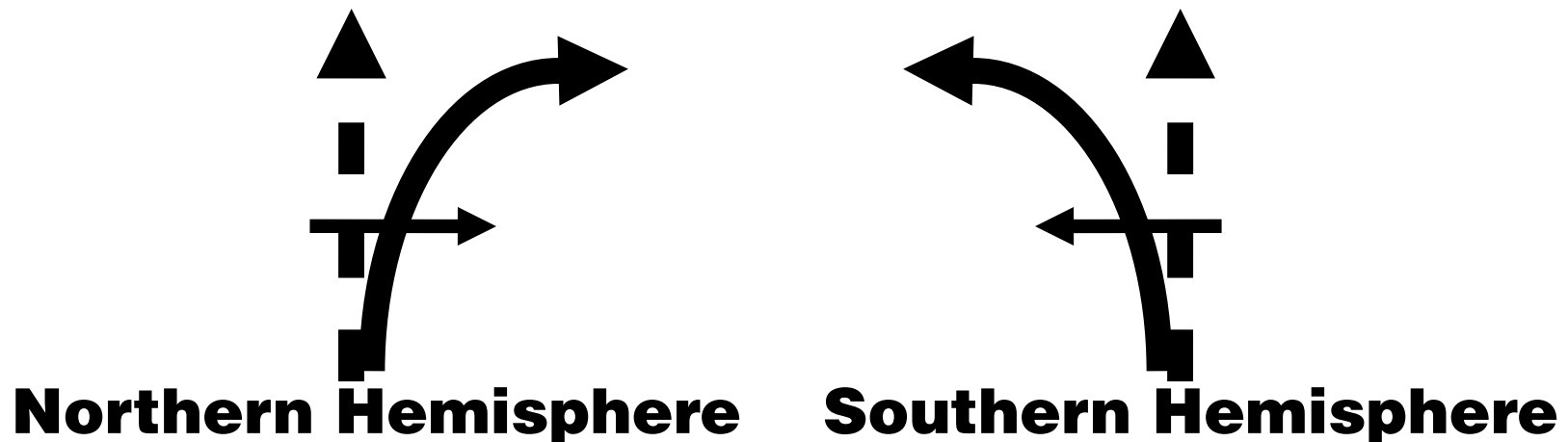
Coriolis force magnitude $F_{\text{cor}} \propto$

Object's speed

Earth's rotation speed

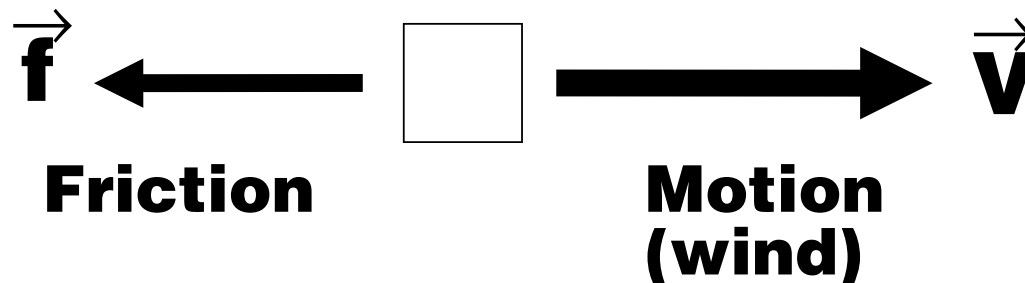
Latitude

Direction: right angle (90°) to direction of motion



Friction

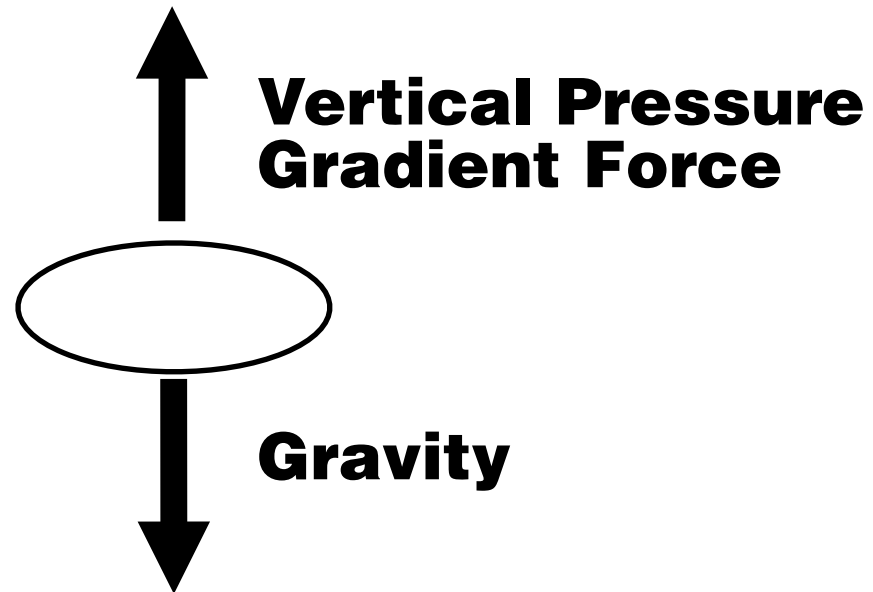
- **Frictional force opposes motion**
- **Magnitude directly proportional to object's speed**



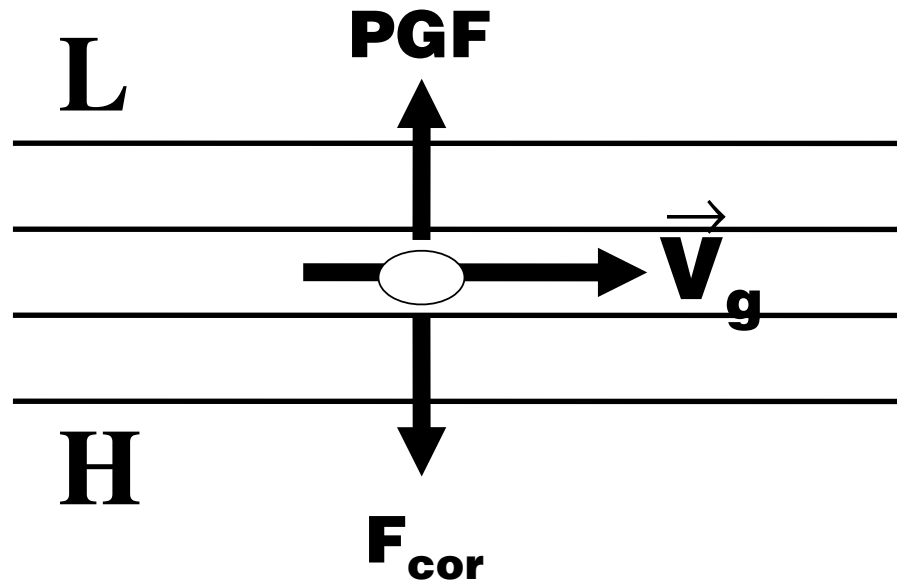
$$\mathbf{f} \propto -\mathbf{v}$$

Hydrostatic Balance

Balance of forces in the vertical direction



Geostrophic Balance



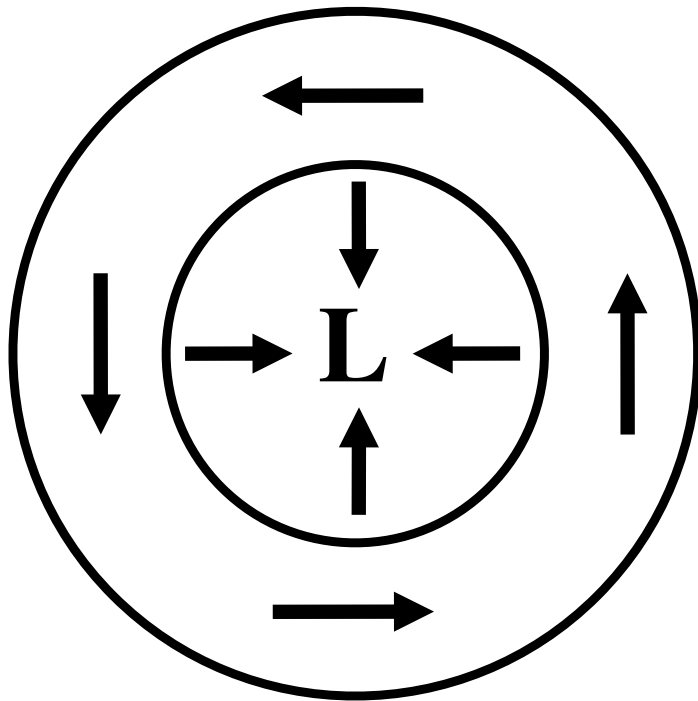
**Geostrophic wind
blows parallel to
isobars or height
contours**

**Geostrophic balance: steady-state wind
where the PGF is exactly balanced by the
Coriolis force**

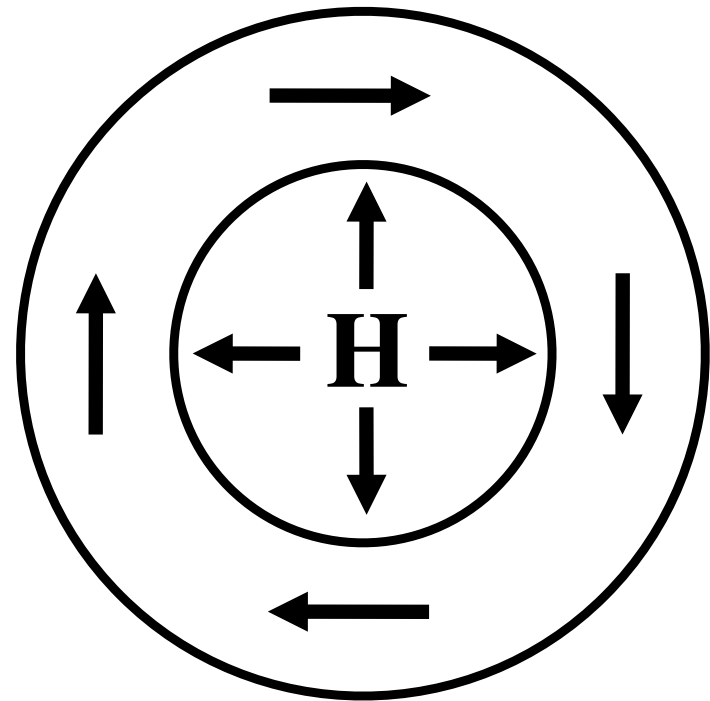
**Northern Hemisphere: lower pressure is to
the left of the wind motion**

Circulation Around Highs and Lows

Northern Hemisphere



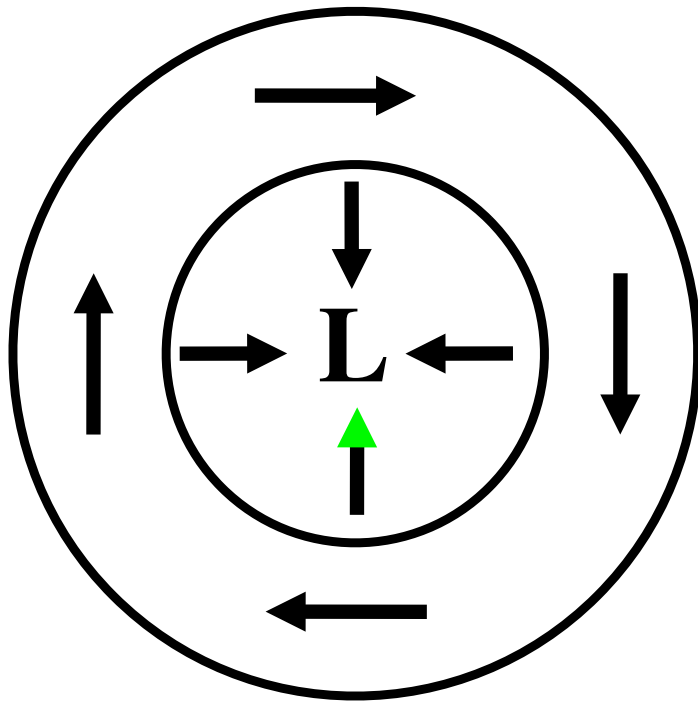
Counterclockwise



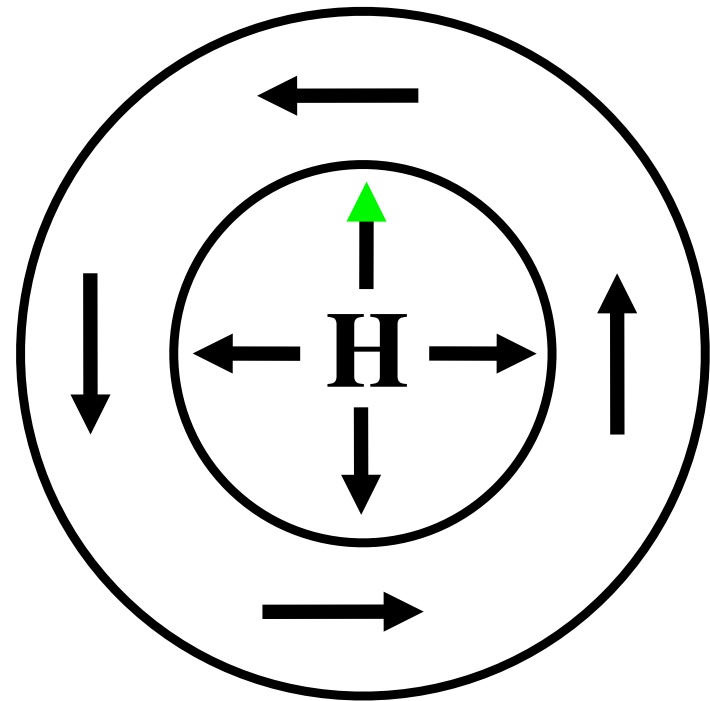
Clockwise

Circulation Around Highs and Lows

Southern Hemisphere



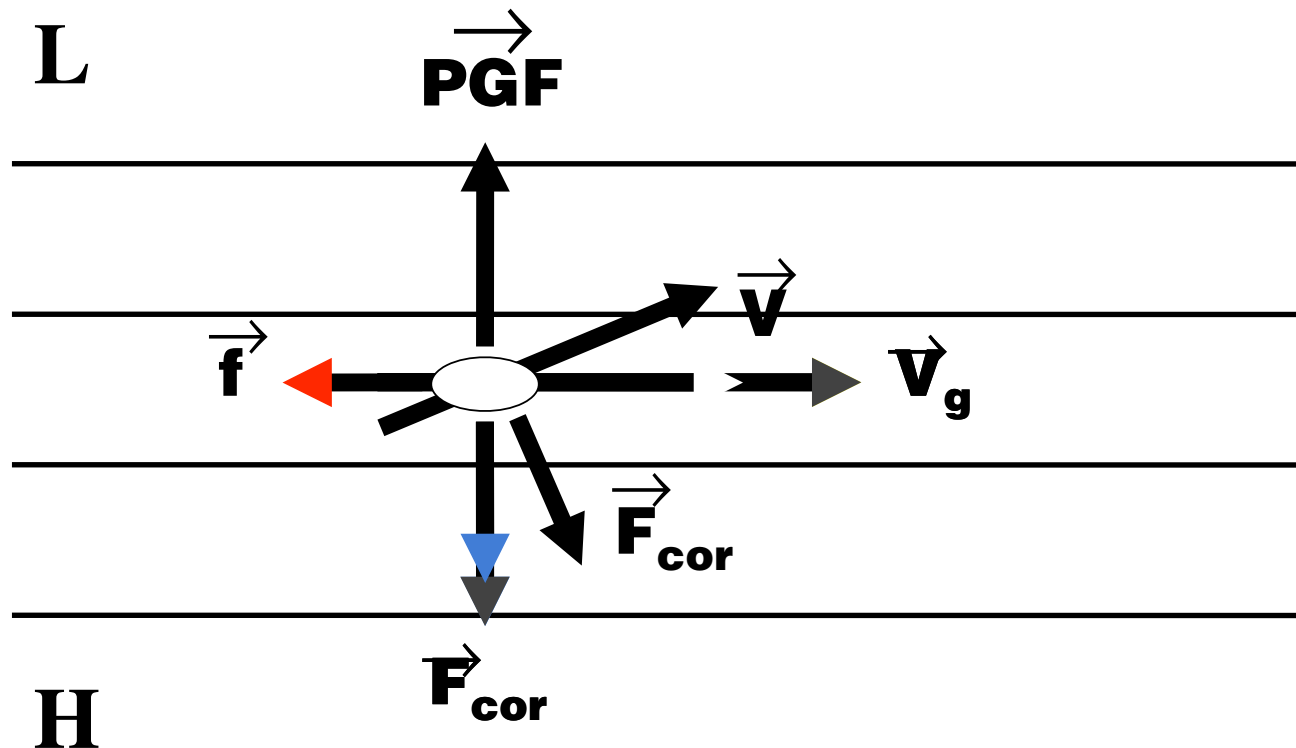
Clockwise



Counterclockwise

Surface Winds

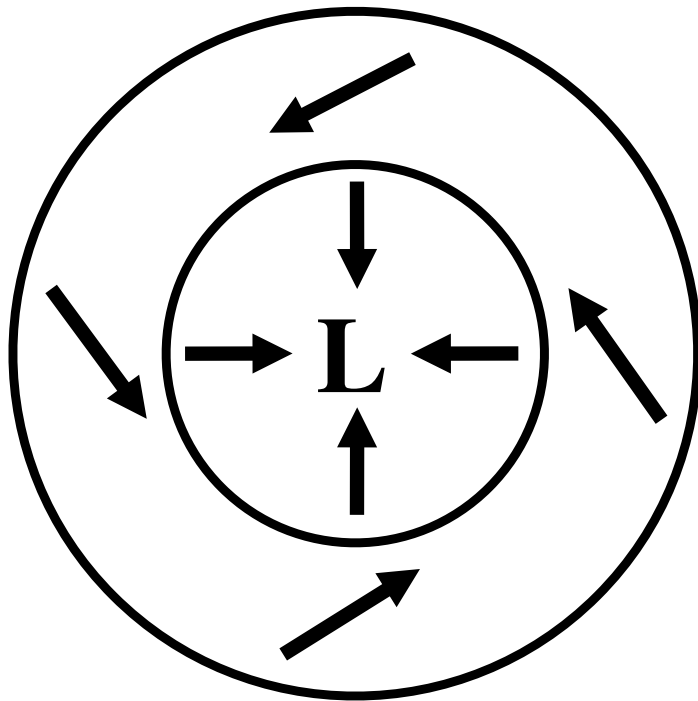
—Add friction



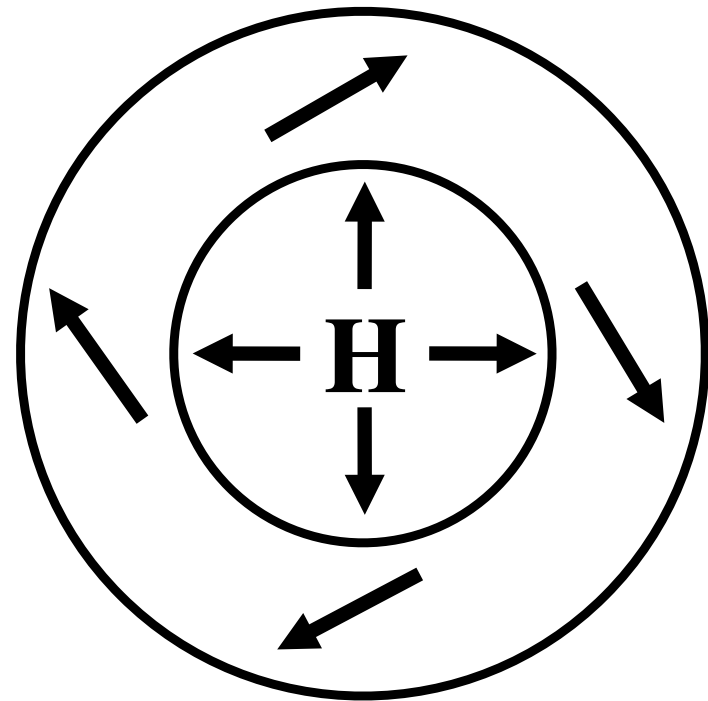
Surface winds blow at an angle to the isobars, turned slightly toward lower pressure

Circulation at the Surface

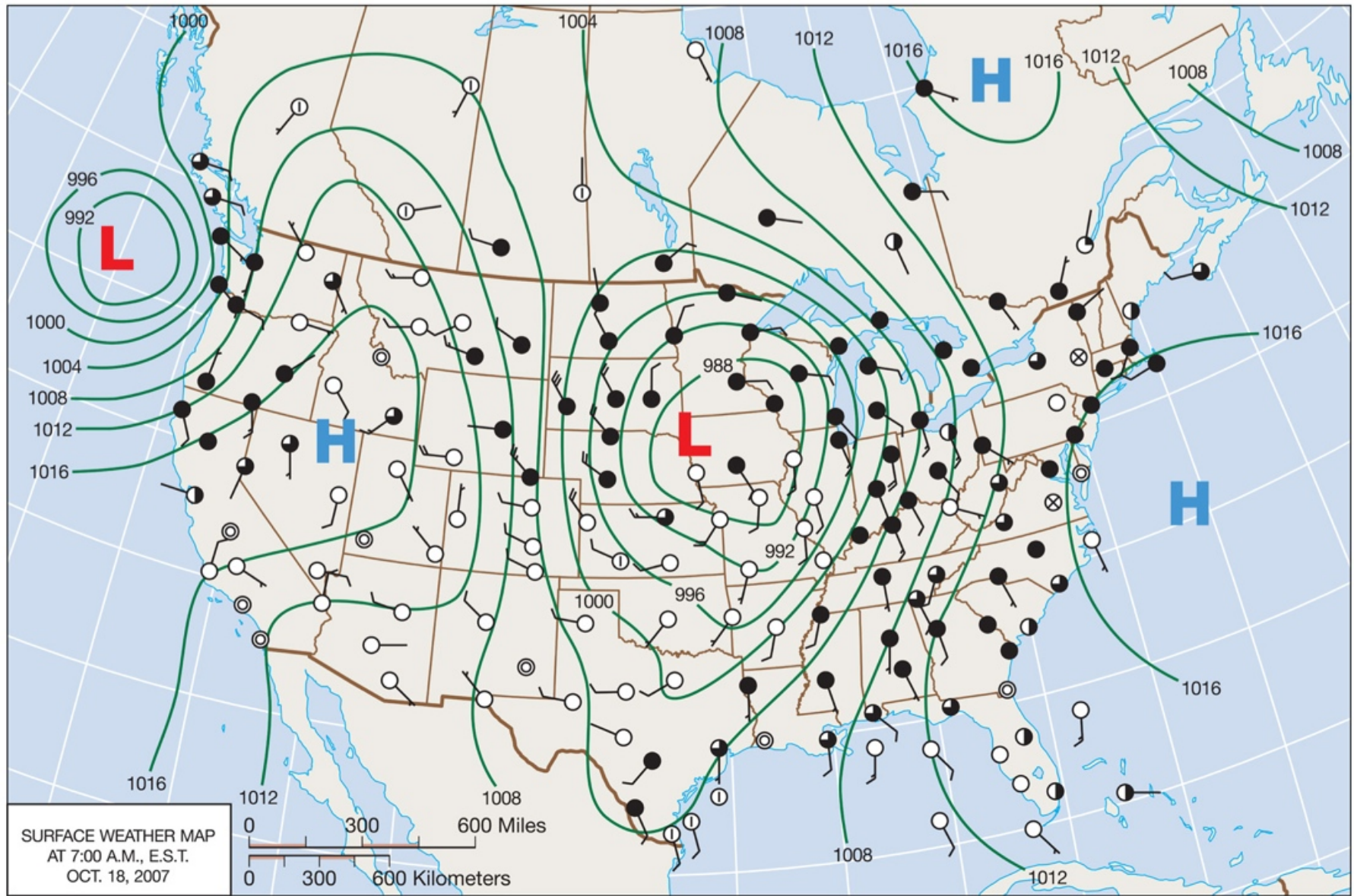
Northern Hemisphere



**Counterclockwise,
spiral inward**

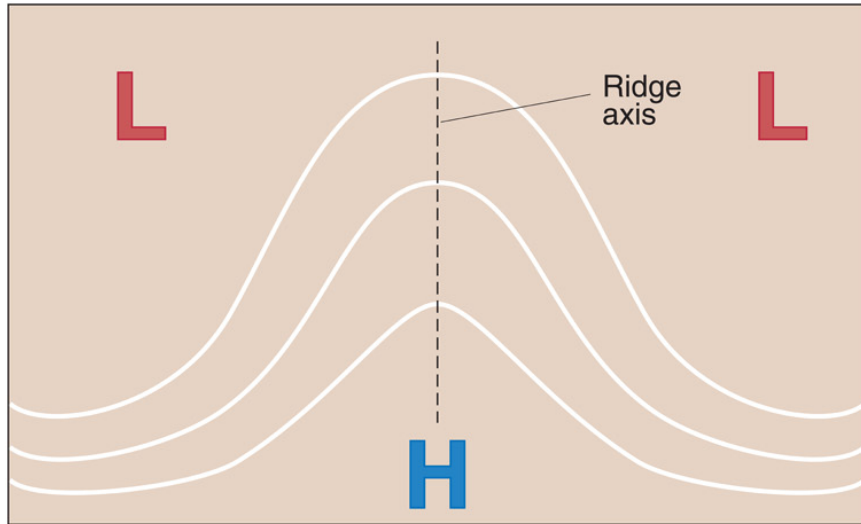


**Clockwise,
spiral outward**

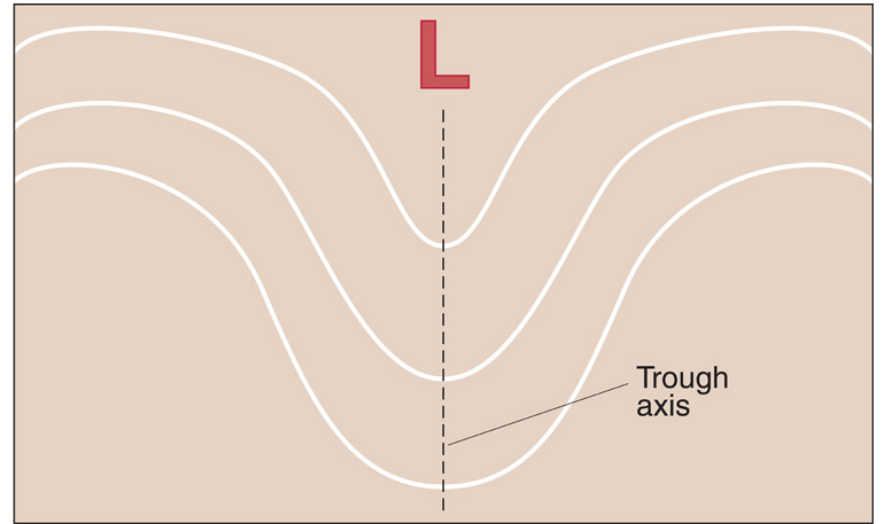


© 2010 Pearson Education, Inc.

Ridges and Troughs

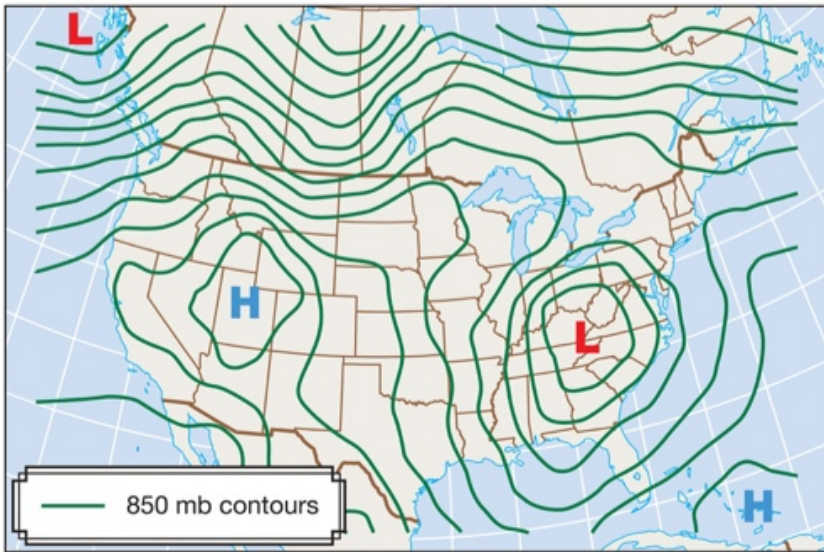


(a)

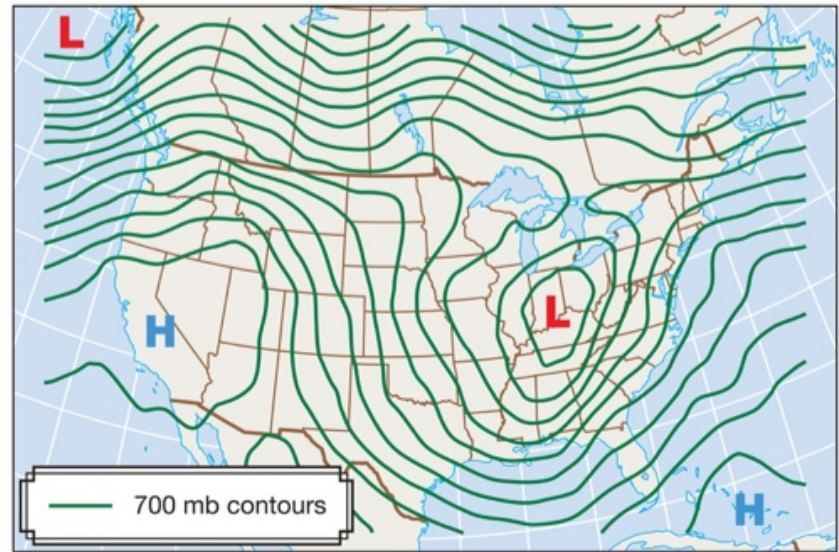


(b)

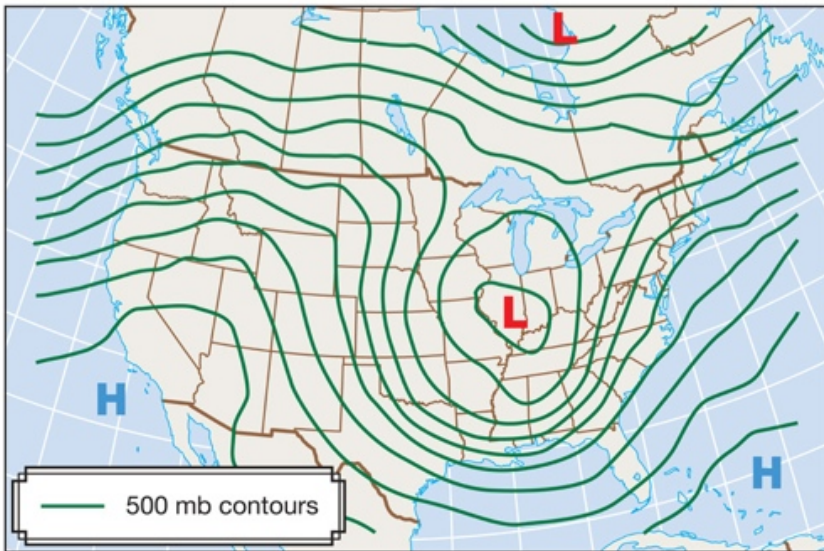
© 2010 Pearson Education, Inc.



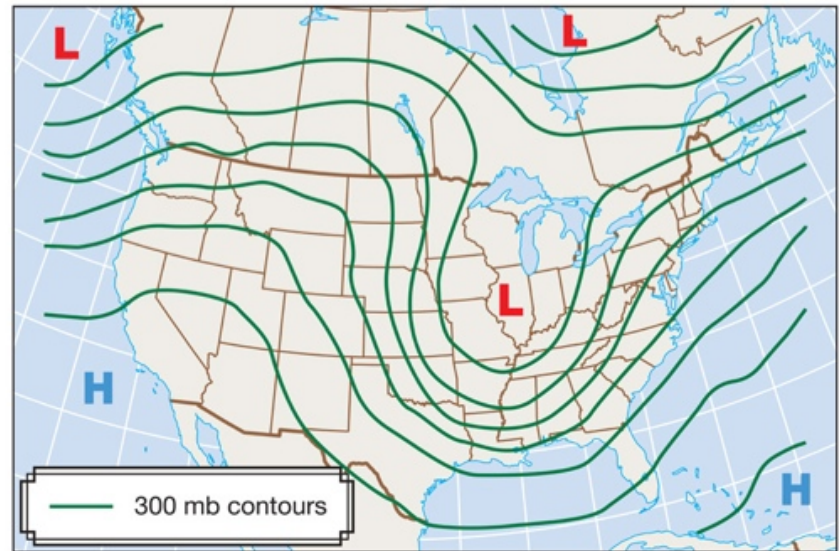
(a)



(b)



(c)

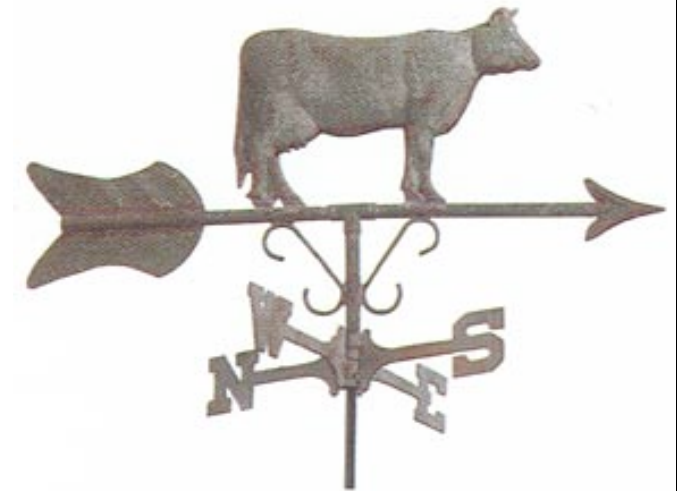
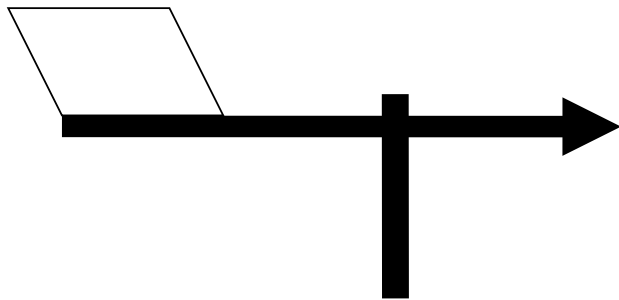


(d)

© 2010 Pearson Education, Inc.

Wind Instruments

- **Direction: Wind Vane**



- **Speed: Anemometer**

