

**Today, we will:**

- Continue discussing EFs: **Tank filling**, and do some example problems
- Begin to discuss some basics of meteorology: **Coriolis effect, global wind patterns, atmospheric stability**

Continuation of the gasoline-tank-filling problem from last lecture:

We estimated that approximately 0.057 kg of gasoline vapors are emitted into the atmosphere for each 15-gallon fill-up of gasoline at a gas station.

Bias in the media: Which sounds more alarming to the average person on the street?

1. You emit 0.057 kg of gasoline vapors into the atmosphere every time you fill up your car.
2. You emit 57 g of gasoline vapors into the atmosphere every time you fill up your car.
3. You emit 57,000 mg of gasoline vapors into the atmosphere every time you fill up your car.
4. You pollute the air by emitting 57,000 mg of toxic gasoline vapors into the atmosphere every time you fill up your car!

Gas costs \$2.50/gal

$$1 \text{ m}^3 = 264.17 \text{ gal}$$

How much money (in cents) do you waste by emitting this gasoline vapor?

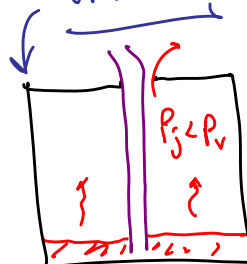
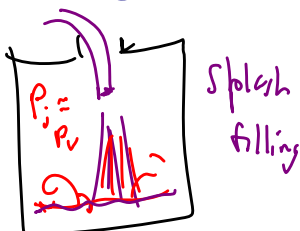
Density of gasoline  $\rightarrow$  S.G. = 0.75  $\rightarrow \rho = 0.75 (1000 \frac{\text{kg}}{\text{m}^3}) = 750 \frac{\text{kg}}{\text{m}^3}$   
*Specific gravity*

$$\$ = \frac{\$2.50}{\text{gal}} (0.057 \text{ kg}) \left( \frac{\text{m}^3}{750 \text{ kg}} \right) \left( \frac{264.17 \text{ gal}}{\text{m}^3} \right) = \$0.05019$$

$$\approx \boxed{5.0 \text{ ¢}}$$

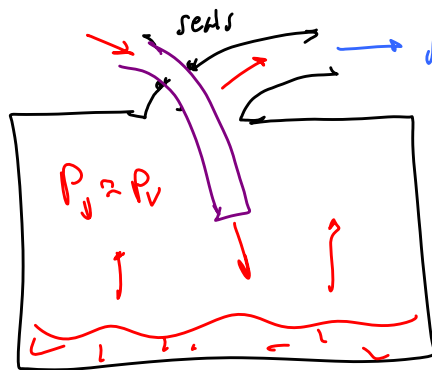
• How can we reduce  $m_j$  from filling tanks?

• For empty tanks — we can bottom fill instead of top or splash fill



Typ. we can save  
 $\approx$  factor of 2  
 for most VOCs

For gas tanks, etc — partially filled already, we can add a  
Vapor recovery system



e.g. condense the vapor back  
 to liquid & re-use

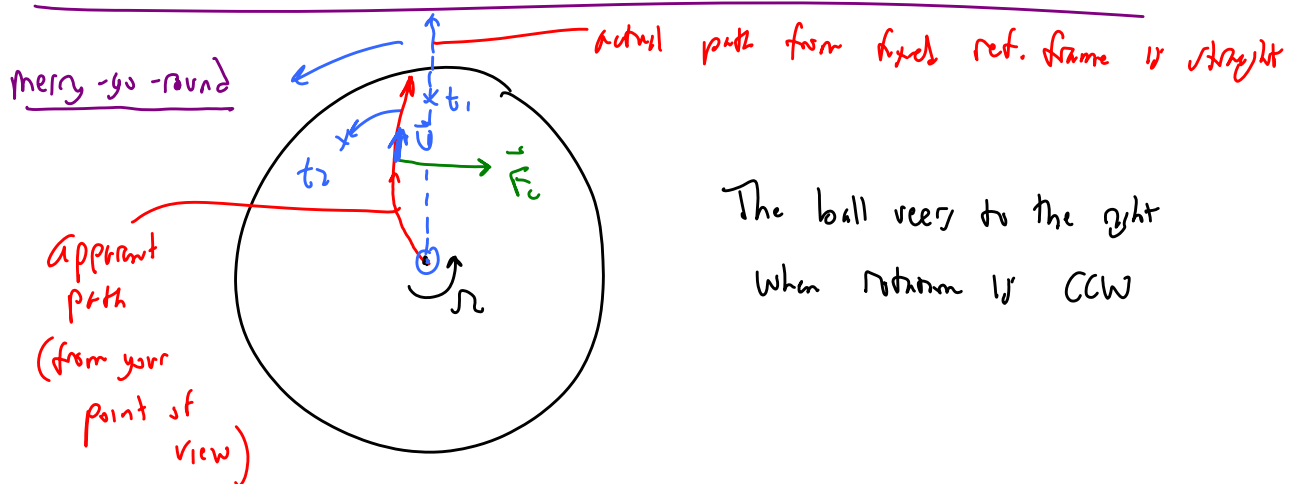
Prevent vapor from entering  
 the atmosphere

## METEOROLOGY BASICS

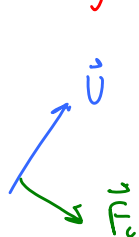
### 1) Coriolis effect

Coriolis force = an apparent force (fake force) that a  
 particle "feels" when moving in a rotating reference frame

Simple example is a merry-go-round



The ball veers to the right  
 when rotation is CCW



$\vec{F}_c$  = Coriolis force is  $\perp$  to  $\vec{U}$

[Note →  $\vec{U}$  is relative to the rotating reference frame]

Mathematically,

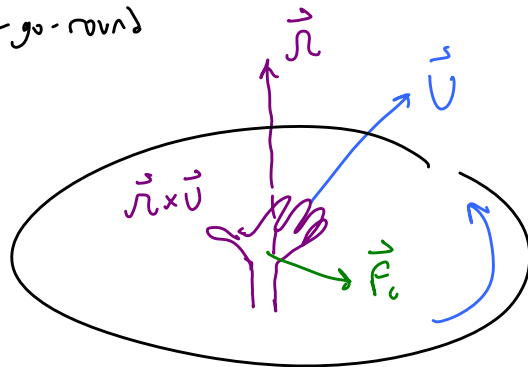
$$\vec{F}_c = m \vec{a}_c = -2m (\vec{\omega} \times \vec{U})$$

↑ Coriolis force     ↑ Coriolis accel

This  $\vec{U}$  is relative to the rotating reference frame

Cross product - use right hand rule

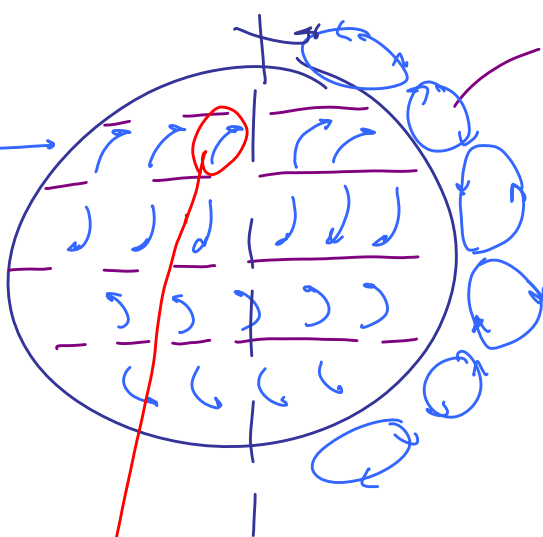
Eg Merry-go-round



Earth:

We live here  
Wind is predominantly from west to east i.e. south to north on average

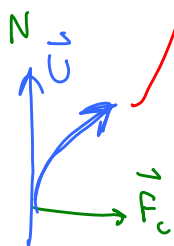
“Prevailing Westerlies”



HADLEY CELLS (like convection cells)

air rises at equator (warm air rises)

This leads to formation of the Hadley cells



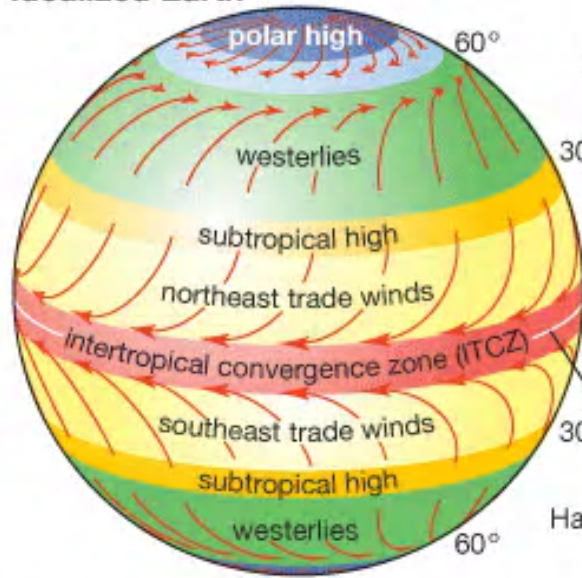
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→ In our area of the world (Pennsylvania), we have northward wind from the Hadley cells. Then the Coriolis force causes the air to drift to the right, or eastward as sketched.

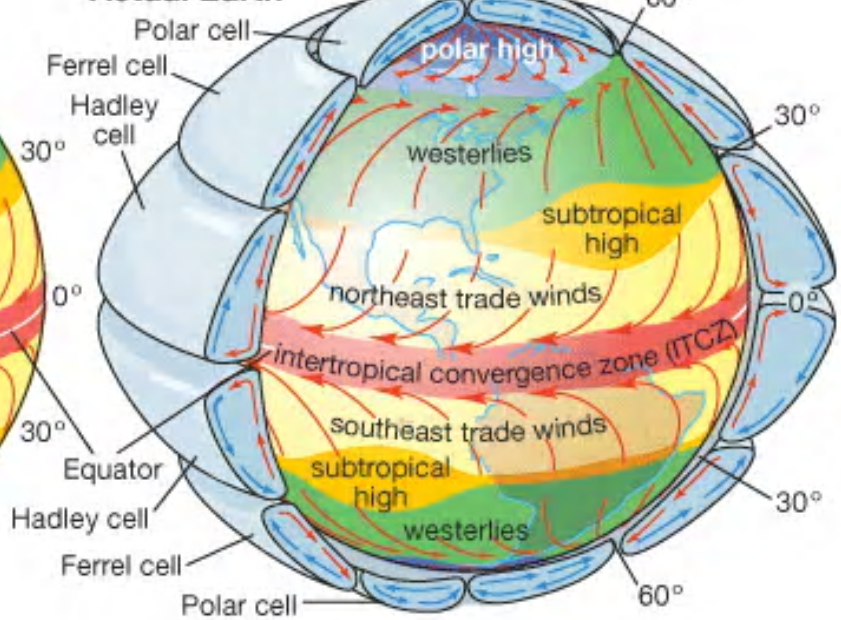
SEE PICTURES ON NEXT PAGE →

## Global Wind Patterns

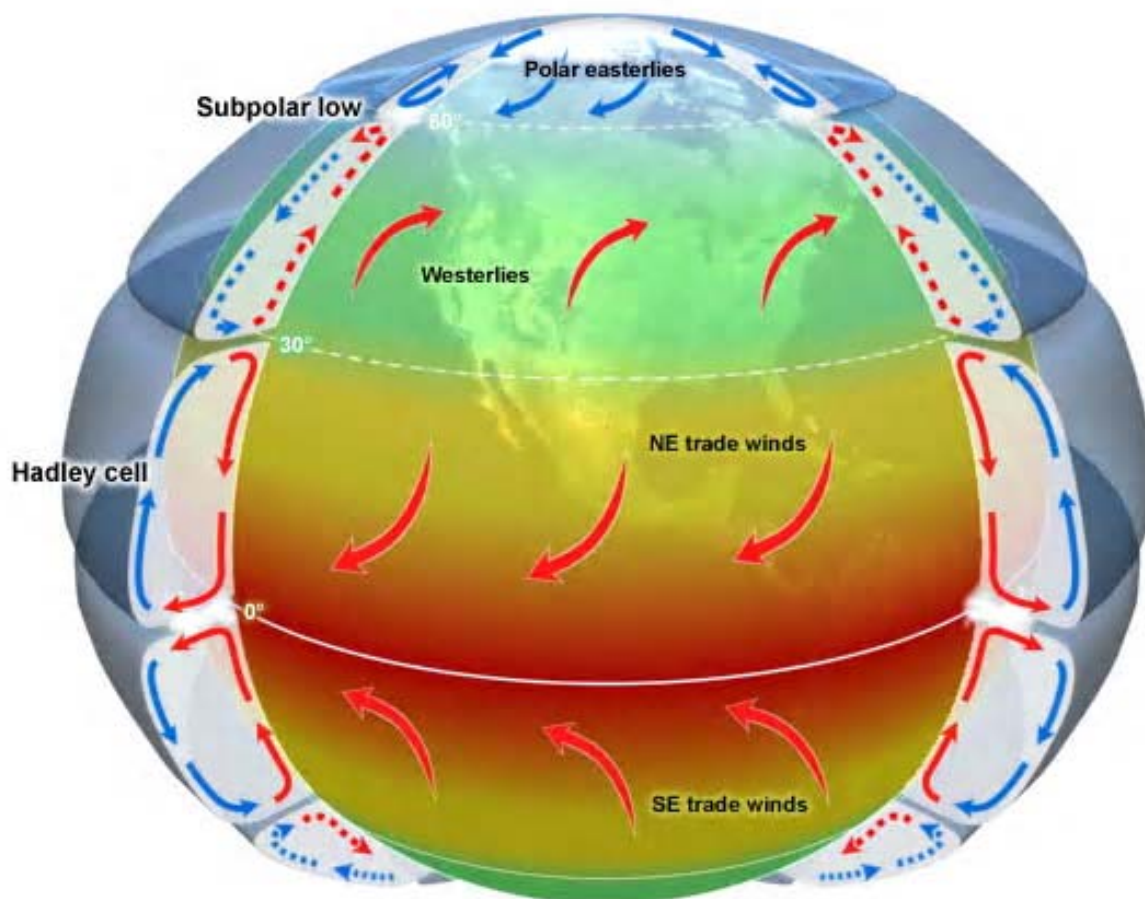
### Idealized Earth



### Actual Earth



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