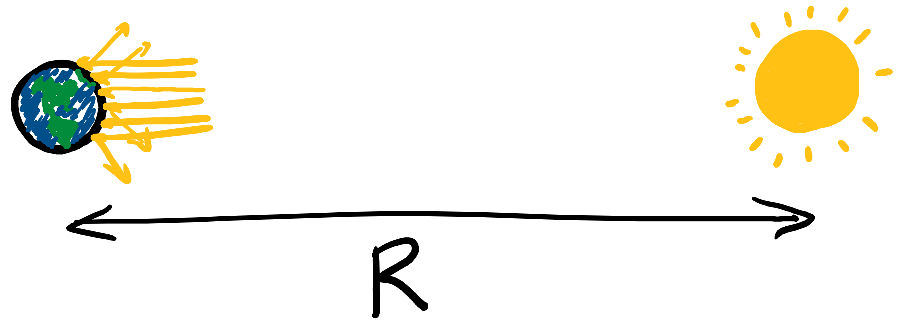
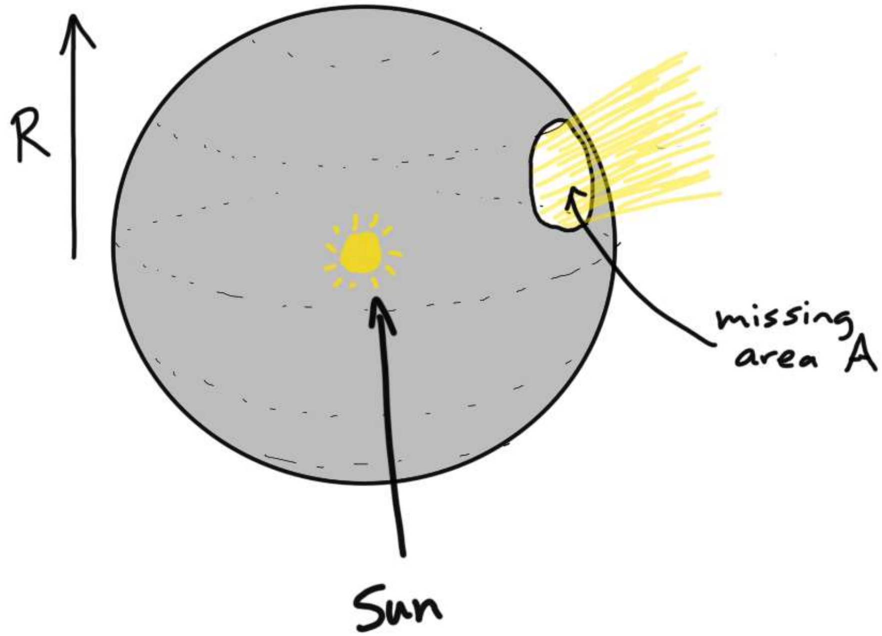
extra office hours: 11 - 12:30 today, Hennings 420



If we moved the Earth twice as far away from the Sun, the power of solar radiation hitting the Earth would be

A) twice as much as before.
B) the same as before.
C) half as much as before
D) one quarter as much as before.
E) one eighth as much as before.



Power through hole is

$$H_{sun} \cdot \frac{A}{4\pi R^2}$$

INTENSITY of sunlight (power per area) is

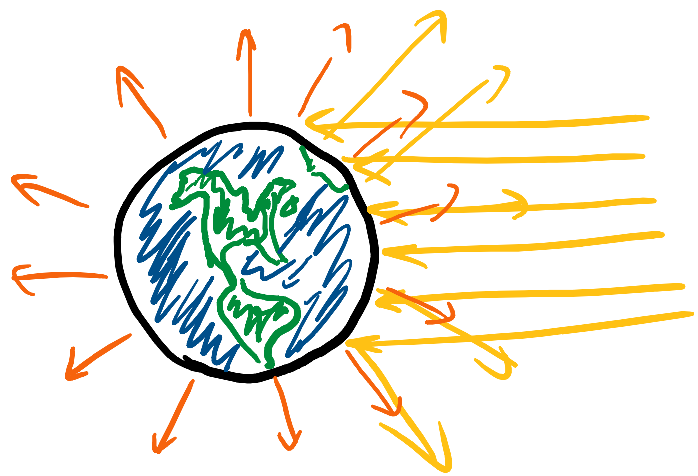
$$I = \frac{H_{sun}}{4\pi R^2} \longrightarrow \text{double } R \Rightarrow \frac{1}{4} I$$

At distance of Earth, $I = I_{sc} = 1367\ W/m^2$

Key relation for steady-state heat flow:

$$H_{in} = H_{out}$$

Our problem:



H_{out}: IR radiation (thermal)

$$= (4\pi r^2) e \sigma T^4$$

$(4\pi r^2)$ = $A_{surface}$

H_{in}: absorbed sunlight

$$I_{sc} \cdot \pi r^2 \cdot (1 - a)$$

a = albedo = fraction reflected

★ set equal & solve for T ★

Result:

$$T = \left(\frac{I_{sc} \cdot (1 - a)}{4 e \sigma} \right)^{\frac{1}{4}}$$

2. Mars albedo, the reflection coefficient for sunlight from Mars, is 0.250. The radius of Mars is 3397 km. The Solar constant at Earth is 1367 W/m^2 and the distance from Mars to the Sun is 1.52 times the Earth to Sun distance.

a) Find the temperature of Mars.

power of absorbed sunlight ↓

Q: Write an expression for H_{in} in terms of the information provided

(you don't need to evaluate it)

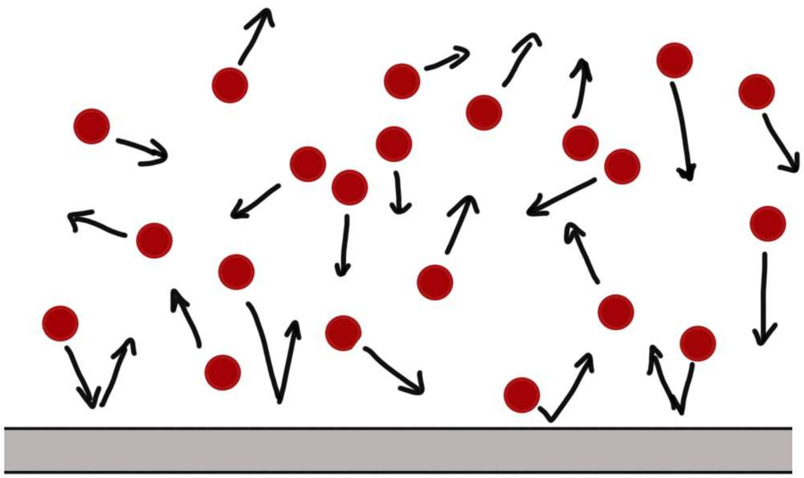
2. Mars albedo, the reflection coefficient for sunlight from Mars, is 0.250. The radius of Mars is 3397 km. The Solar constant at Earth is 1367 W/m^2 and the distance from Mars to the Sun is 1.52 times the Earth to Sun distance.

a) Find the temperature of Mars.

Q: Write an expression for H_{in} in terms of the information provided

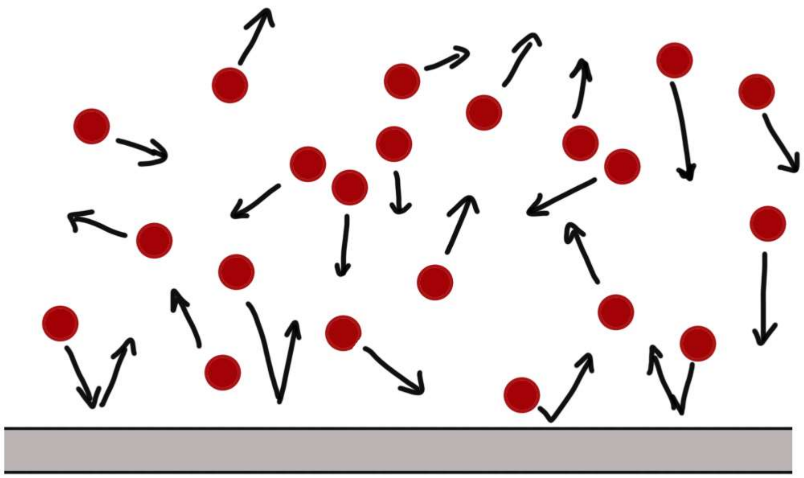
New topic: First Law of Thermodynamics (Chapter 19)

$$\Delta E = Q - W$$



The picture shows molecules of an ideal gas near the wall of a container. What properties of these molecules does the pressure on the wall (force per unit area) depend on?

EXTRA: for each quantity you identify, what would happen to the pressure if you double that quantity?



The picture shows molecules of an ideal gas near the wall of a container. What properties of these molecules does the pressure on the wall (force per unit area) depend on?

double density → double P

double mass → double P

double velocity → quadruple P

(twice as many collisions
twice as much impact)

$$P = \text{const} \cdot \underbrace{\frac{n}{V}}_{\text{density}} \cdot \overbrace{m \cdot v_{avg}^2}^{\text{2x kinetic energy per molecule}}$$

Temperature & Kinetic Energy

For constant n and V, molecular model gives

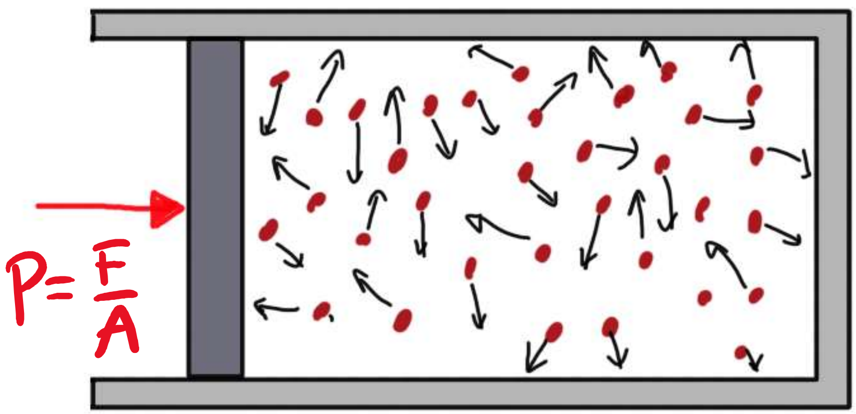
$$P \propto E_{kin}^{avg}$$

We previously observed $P \propto T$

Consistent if $T = \text{const} \cdot E_{kin}^{avg}$

Temperature measures the average kinetic energy of the molecules!

Ideal Gas Law



molecular density → $\frac{N}{V}$; avg. kinetic energy per molecule → E^{kin}_{avg}

$$P = const \cdot \frac{N}{V} \cdot E^{kin}_{avg}$$

⇓

$$PV = n \cdot R \cdot T$$

n: # moles; R: $8.31 \frac{J}{mol \cdot K}$

Tells us how much force a gas exerts on the wall

Thirsty cup demo:

https://www.youtube.com/watch?v=3EGfqU_zBec