Grading Details and Notes

- End semester exam – 42 %
- Mid semester exam – 28 %
- Quizzes (1) – 15 % (before mid sem)
- Quiz 2/Group Presentation – 15 % (after mid sem)

- Only the registered students will be evaluated for each courses.
- Mode of examination: Closed Book
- Any unfair means adopted during the mid-semester and/or end-semester examination 'F' Grade will be awarded

Table 7: For class strength > 30

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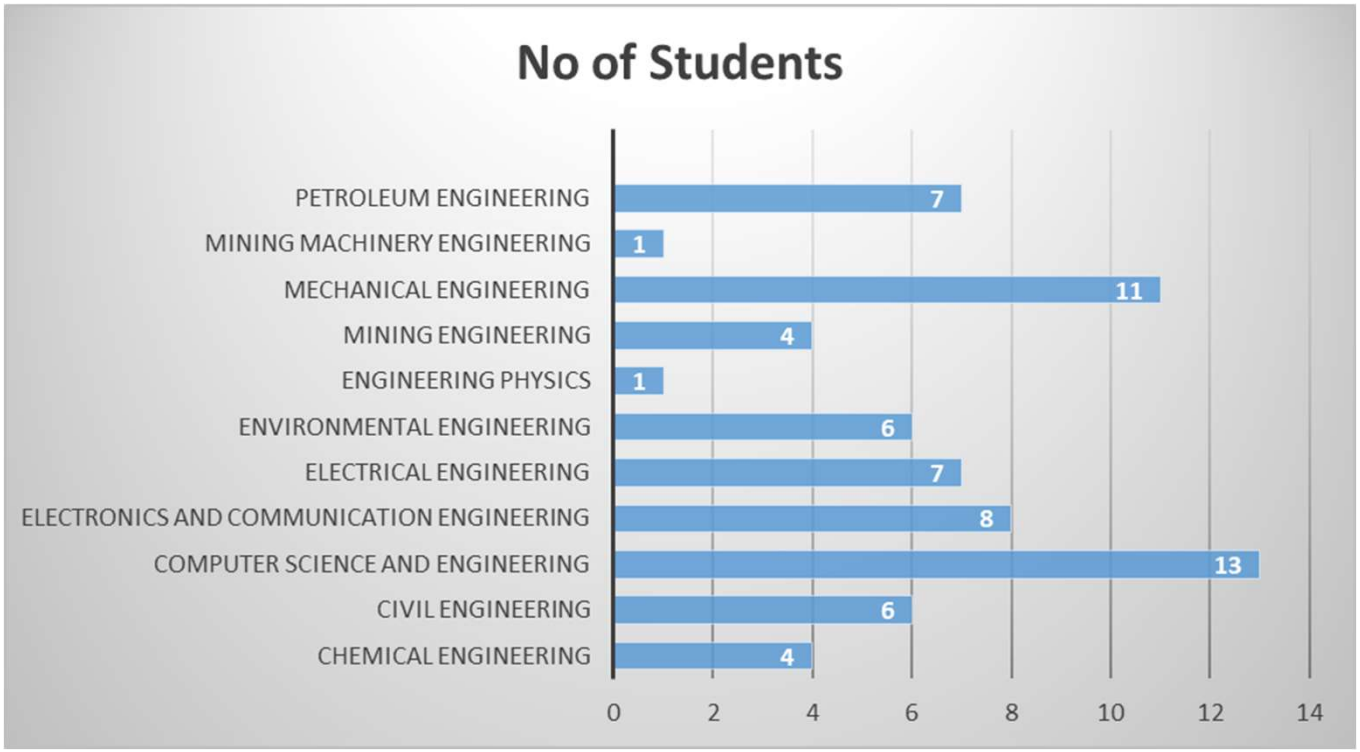
Grades	**% of Students**
A+, A, B+	Top (45 ± 5)%
B, C+, C	Next (45 ± 5)%
D, F	Next (10 ± 5)%

What made you decide to opt this course?



ESD 511: Aerosol in the Atmosphere

L1: **Origin, structure and composition of atmosphere**

Course Instructor

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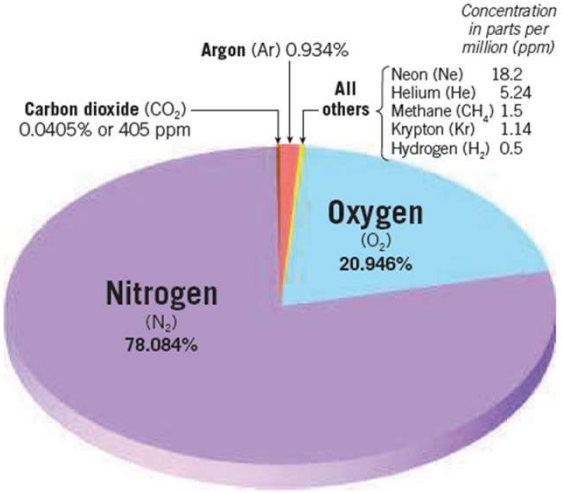
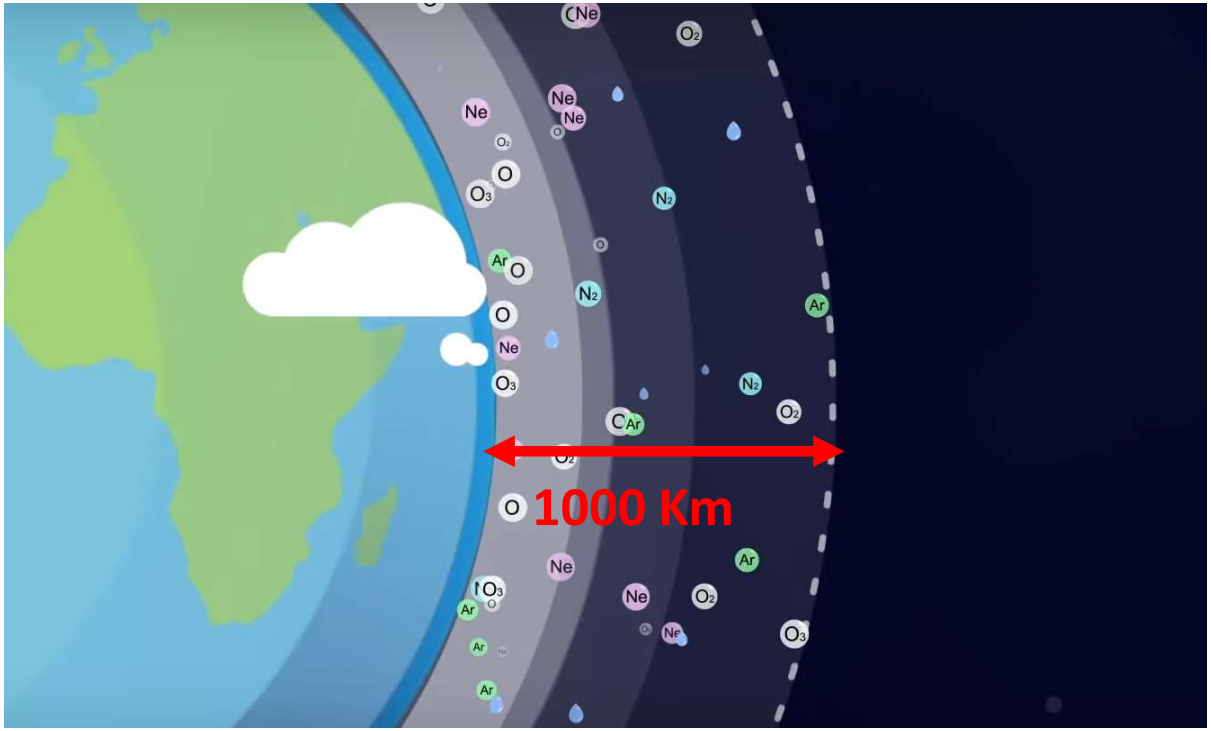
The Atmosphere

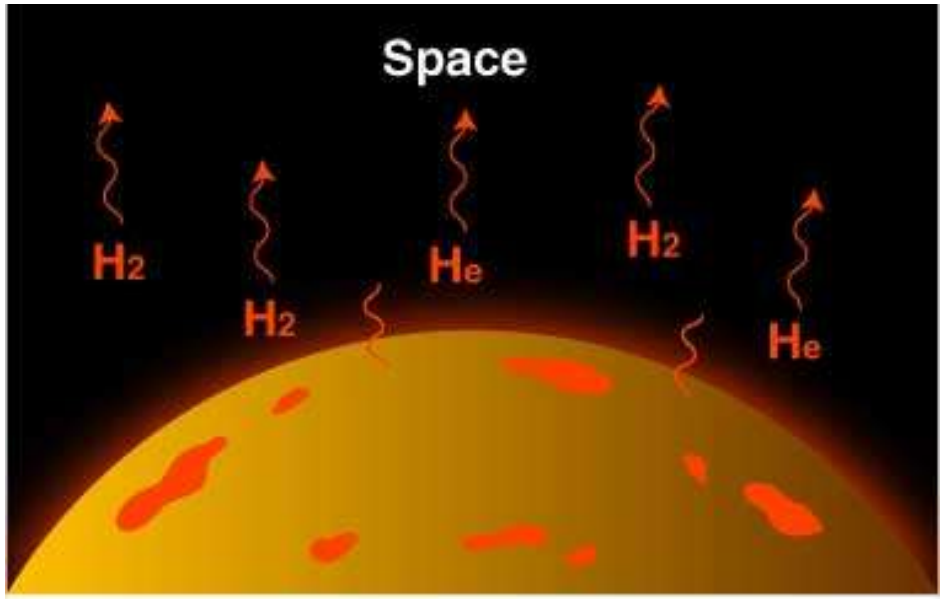
- The atmosphere surrounds the Earth and holds the air we breathe
- It protects us from outer space and holds moisture (clouds), gases, and tiny particles.





Origin of the atmosphere

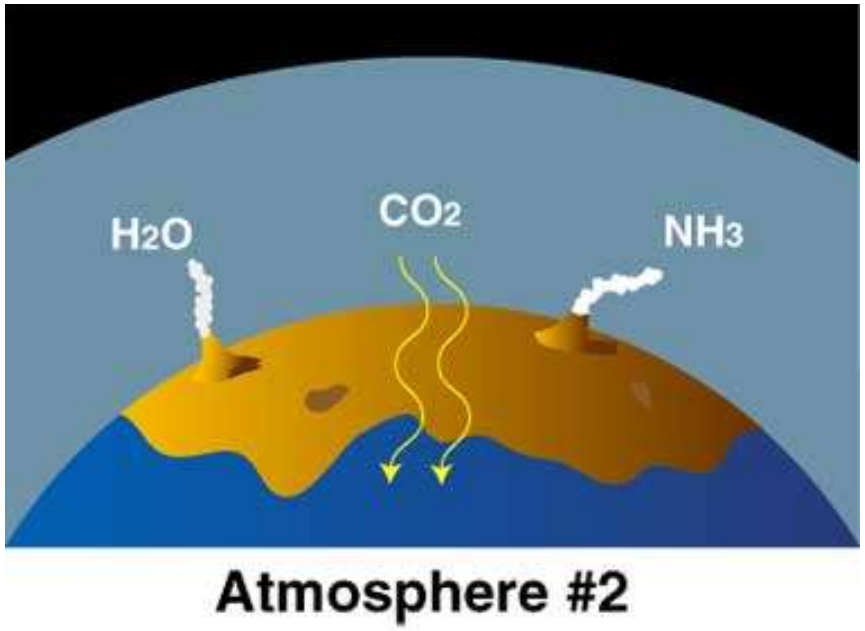
The First or Original Atmosphere



Atmosphere #1

- When Earth formed 4.6 billion years ago from a hot mix of gases and solids, it had almost no atmosphere. The surface was molten.
- Earth's original atmosphere was probably just hydrogen and helium, because these were the main gases in the dusty, gassy disk around the Sun from which the planets formed. The Earth and its atmosphere were very hot.
- Hydrogen and helium have the smallest atoms by mass and moved very fast, so they escaped into space due to weaker Earth gravity which could not hold them that time

The Secondary Atmosphere



Atmosphere #2

- Earth's "second atmosphere" came from Earth itself.
- There were lots of volcanoes, many more than today, because Earth's crust was still forming.
- Outgassing of volcanoes released gases trapped in the planet's interior
- Gasses emitted probably similar to the gasses emitted by volcanoes today.
  - ✓ H_2O (water),
  - ✓ CO_2 (carbon dioxide)
  - ✓ NH_3 (ammonia)
  - ✓ SO_2 (sulfur dioxide),
- No free molecular oxygen

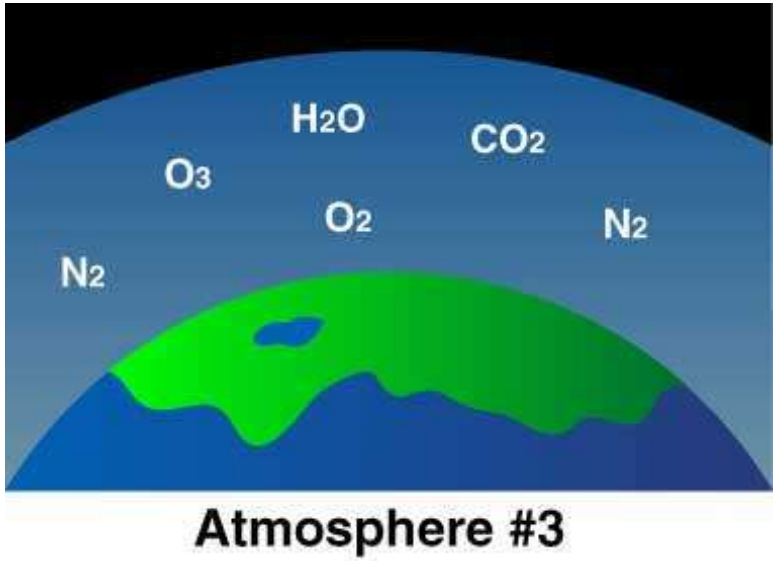
Free Oxygen in the Atmosphere

- As Earth's surface cooled, water vapor condensed to form clouds, and torrential rains began to fill low-lying areas that eventually became the oceans.
- CO_2 in ocean due to dissolution of atmospheric CO_2 resulted in photosynthesis process.
- In these oceans Primitive bacteria (cyanobacteria) results in the production of oxygen (O_2) via Photosynthesis process.

$$\mathbf{CO_2 + H_2O + sunlight = organic\ compounds + O_2}$$

- The excess free oxygen started to appear in the atmosphere, which led to production of Aerobic organisms.
- Another significant benefit of this "oxygen explosion" is that O_2 readily absorb ultraviolet radiation and rearrange themselves to form ozone (O3) (Stratosphere- that protects from UV light penetration).
- For the first time, Earth's surface was protected from this type of solar radiation, which is particularly harmful to DNA. Marine organisms had always been shielded from ultraviolet radiation by the oceans, but the development of the atmosphere's protective ozone layer made the continents more hospitable.

The Modern atmosphere



Atmosphere #3

Meanwhile, the ammonia molecules in the atmosphere were broken apart by sunlight, leaving nitrogen and hydrogen. The hydrogen, being the lightest element, rose to the top of the atmosphere and much of it eventually drifted off into space.

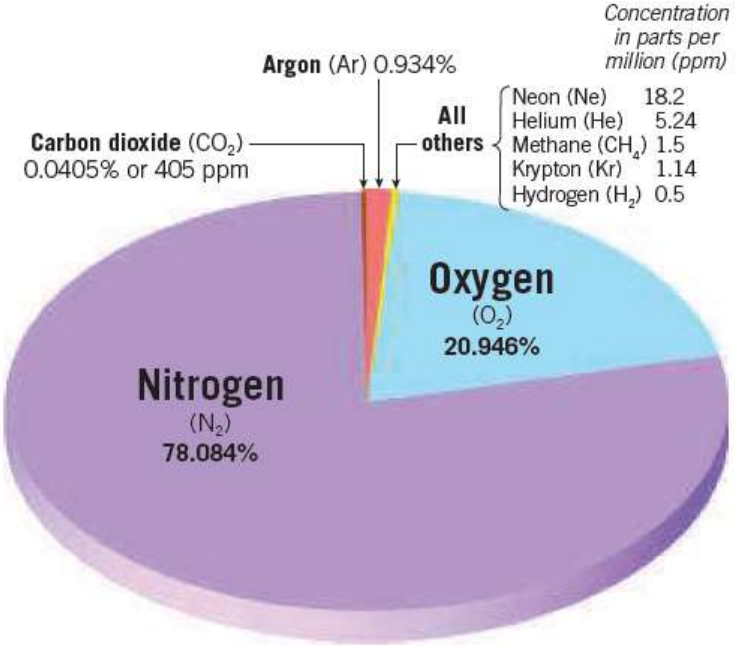


Figure: Composition of the atmosphere (Proportional volume of gases composing dry air)

- The remaining gaseous constituents, the trace gases, represent less than 1% of the atmosphere.
- These trace gases play a crucial role in the Earth's radiative balance and in the chemical properties of the atmosphere.
- The trace gas abundances have changed rapidly and remarkably over the last two centuries.

Dry vs. Moist air

- The atmosphere is rarely, if ever, dry. Water vapor (water in a 'gas' state) is nearly always present up to about 4% of the total volume.
- The amount of water vapour in the air at saturation is strongly dependent on temperature

Chemical makeup of the atmosphere INCLUDING water vapor

Water Vapor	Nitrogen	Oxygen	Argon
0%	78.084%	20.947%	0.934%
1%	77.30%	20.70%	0.92%
2%	76.52%	20.53%	0.91%
3%	75.74%	20.32%	0.90%
4%	74.96%	20.11%	0.89%

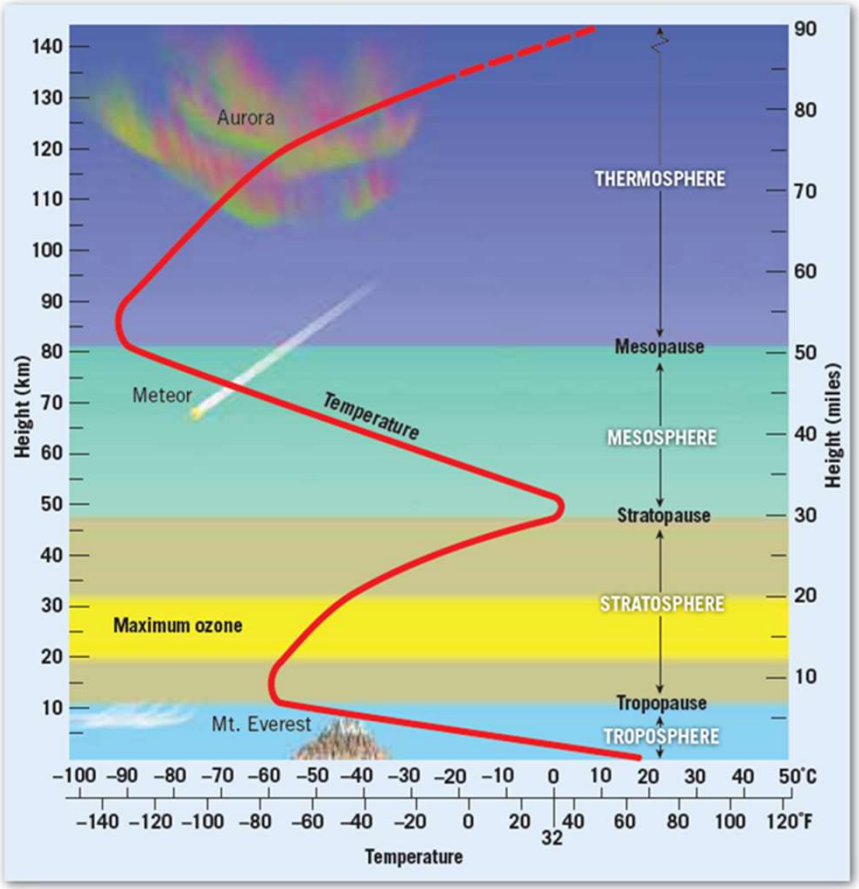
Which is more heavier ? dry air or moist air ? WHY

Which will rise and descend?

Dry air is heavier because molecular weight of O2 is more than H2O.

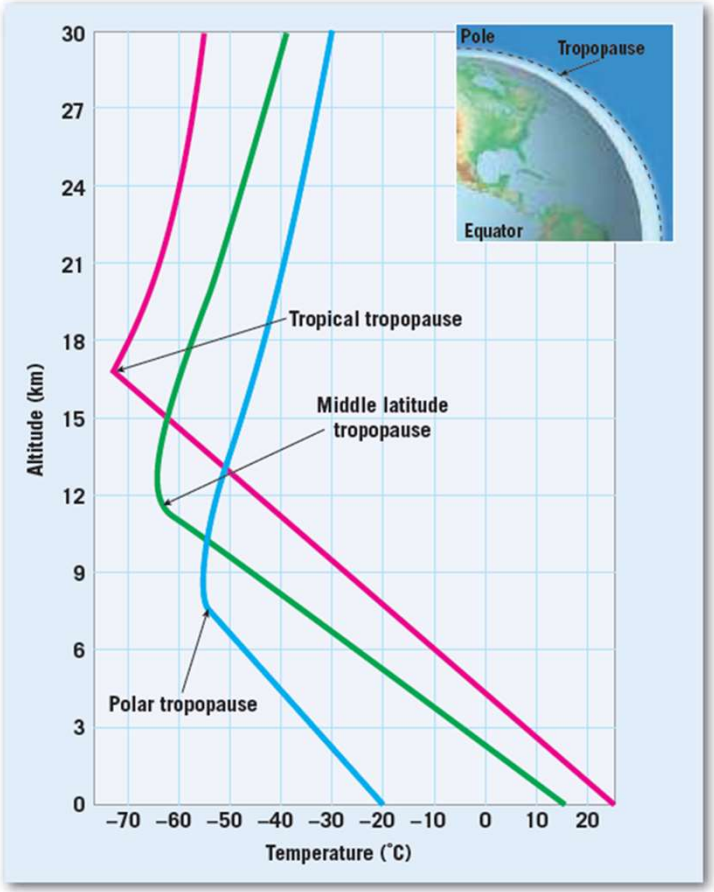
Vertical Structure of the atmosphere

- Relative to size of the earth, the atmosphere is extremely thin
- 90% of mass below 16 km.
- Balloons and rocket-sounding techniques used for measuring the temperature structure of the atmosphere up to great heights.
- The atmosphere is divided into four layers, based on temperature:
  - Troposphere – Temperature decrease
  - Stratosphere – Temperature increase
  - Mesosphere – Temperature decrease
  - Thermosphere – Temperature increase



Troposphere

- The lowest region of the atmosphere (0 to 15 Km altitude), where life & all weather phenomenon occur.
- Although the troposphere accounts for only a small fraction of the atmosphere's total height, it contains about 80% of its total mass.
- Temperature declines due to decrease in pressure causing decrease in the average kinetic energy. This decrease is termed "environmental lapse rate or normal lapse rate". Its average value is 6.5°C per km
- Top of the troposphere is known as the tropopause
- The thickness of the troposphere is not the same everywhere. In the tropics, the tropopause reaches heights in excess of 16 km, whereas in polar regions it is lower, varying from about 7 to 8 km (due to heterogeneous solar intensity distribution).
- Warm surface temperatures and highly developed thermal mixing causes warm rise more upward of the troposphere near the equator. **Air particles absorbs more energy at equator compared to pole due which they rise at higher height due to which troposphere height is more at equator.**



Source of HEAT

Solar Energy- source of HEAT for our planet