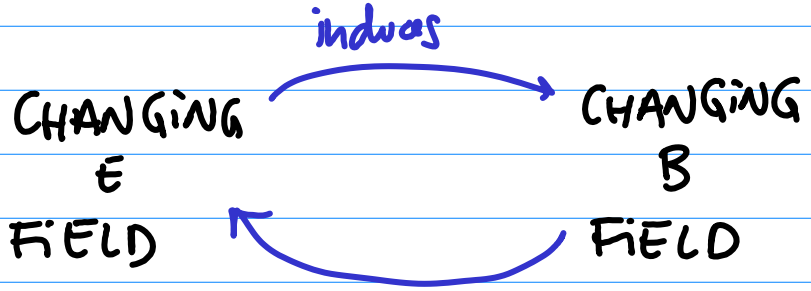
LECTURE 7
CHAPTERS 8,9

PHY 100: LIGHT, OPTICS

RECAP: MAXWELL'S EQNS: 4 EQNS THAT UNIFY ELECTRICITY AND MAGNETISM.

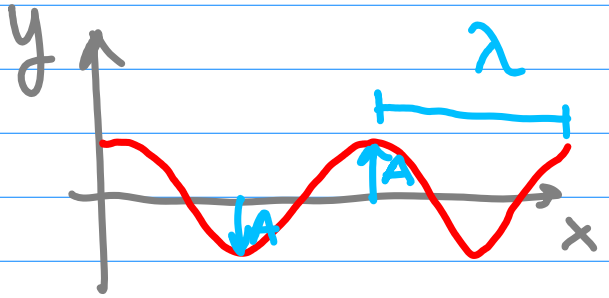


⇨ LIGHT IS A WAVE

ASIDE: WAVE EQUATION

$$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$$

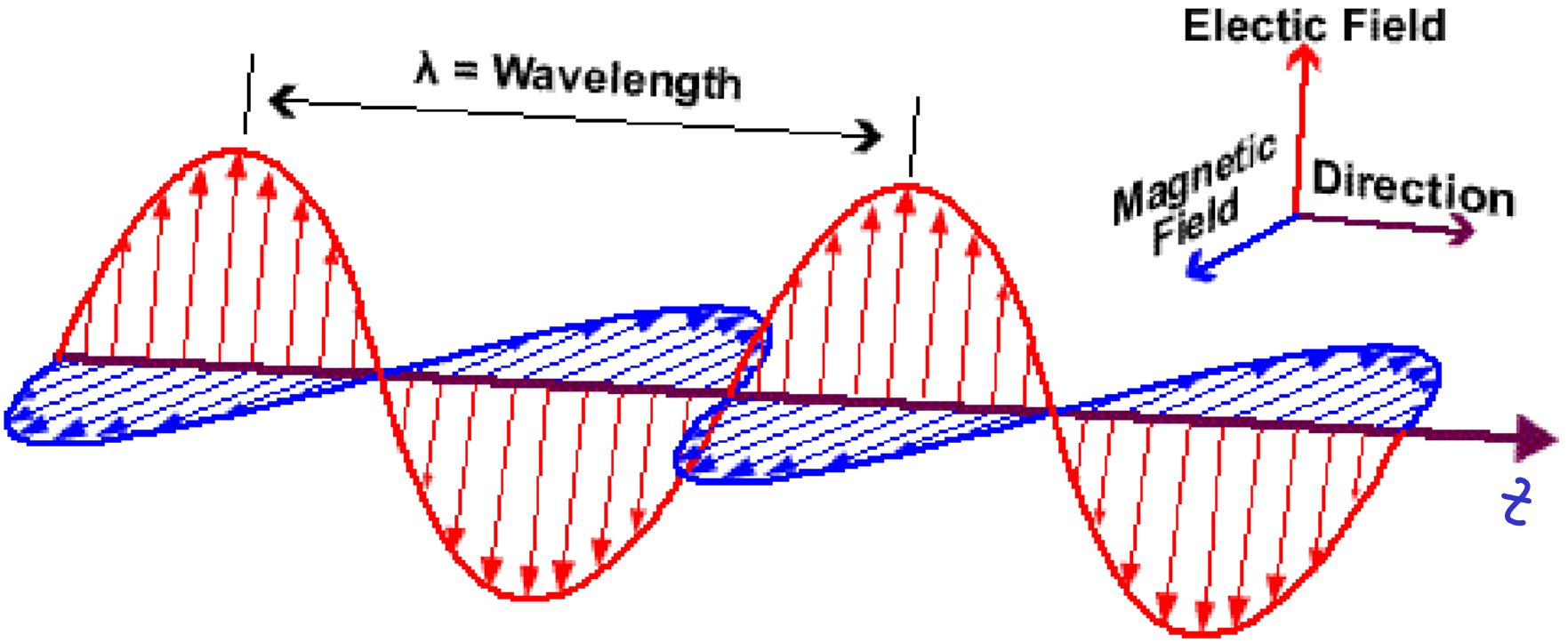
$$y(x,t) = A\cos(ct)\sin(x)$$



FREQ $= f = \frac{1}{T}$

$$c = \lambda f$$

http://www.falstad.com/ripple/



WAVE PROPAGATES IN z DIRECTION

↑ REPRESENTS DIRECTION AND MAGNITUDE OF E FIELD IN A PLANE TRANSVERSE TO MOTION

↙ REPRESENTS DIRECTION AND MAGNITUDE OF B FIELD IN A PLANE TRANSVERSE TO MOTION

E AND B FIELDS OSCILLATE TOGETHER BUT PERPENDICULAR TO EACH OTHER → THE EM WAVE PROPAGATES PERPENDICULARLY TO BOTH FIELDS.

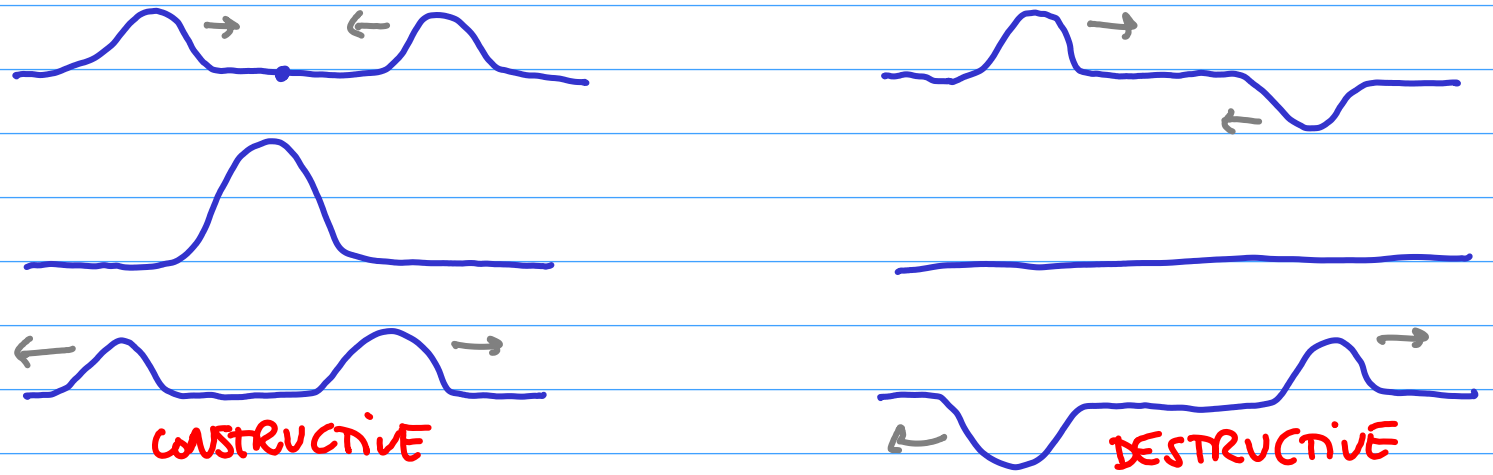
THE WAVE NATURE OF LIGHT.

DEBATE THAT SHAPED MUCH OF 18th & 19th CENTURIES.

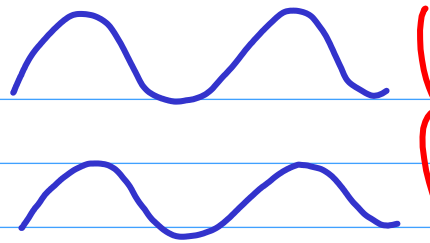
LIGHT AS PARTICLE (NEWTON)
LIGHT AS A WAVE (HOOKE)

WAVES OF ALL TYPES EXHIBIT : INTERFERENCE, DIFRACTION, REFRACTION

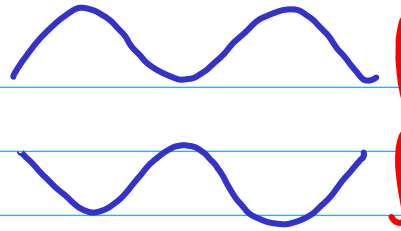
INTERFERENCE



http://id.mind.net/~zona/mstm/physics/waves/interference/waveInterference2/WaveInterference2.htm

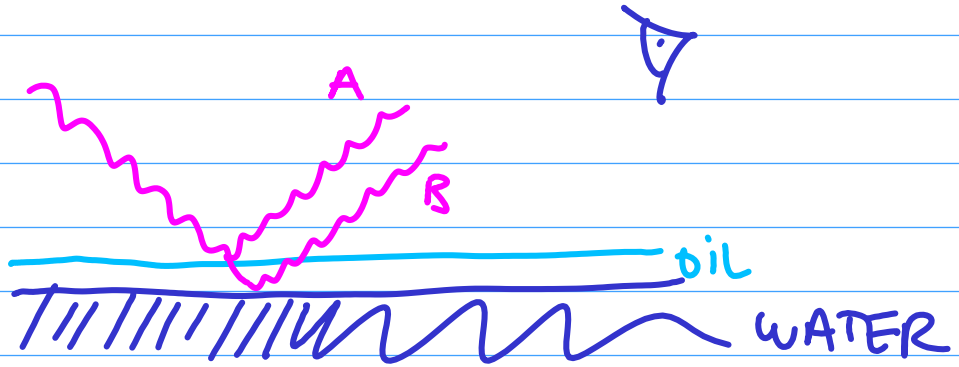


CONSTRUCTIVE



DESTRUCTIVE

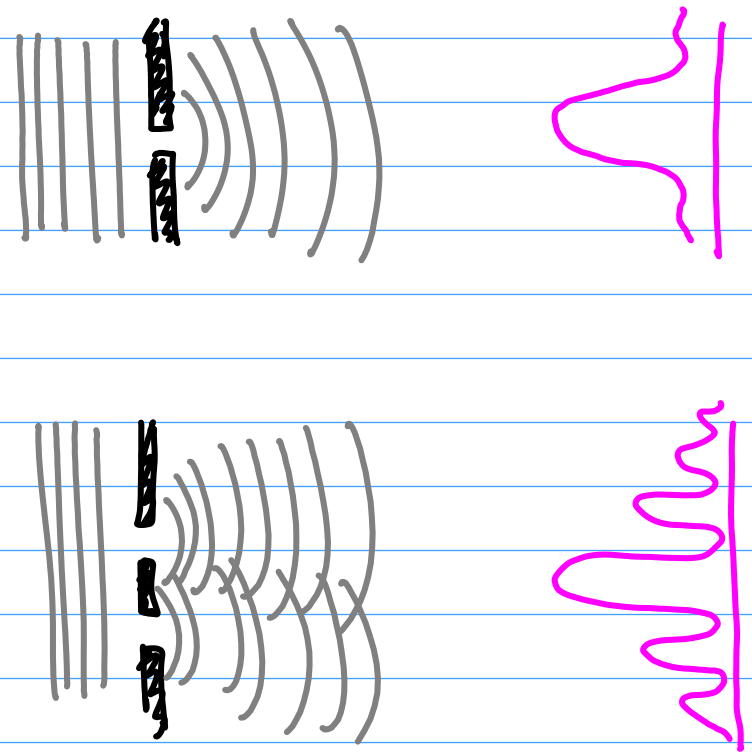
WAVES INTERFERE BUT PARTICLES DO NOT.



THE REFLECTED LIGHT INTERFERES CONST. OR DESTR. OR SOMEWHERE IN BETWEEN.

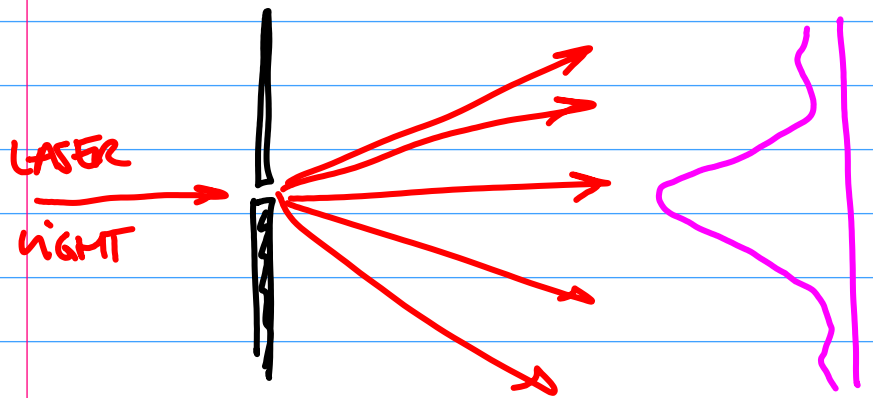
THE DIFFERENT COLORS ARE DUE TO THE DIFFERENT THICKNESS OF THE FILM OF OIL

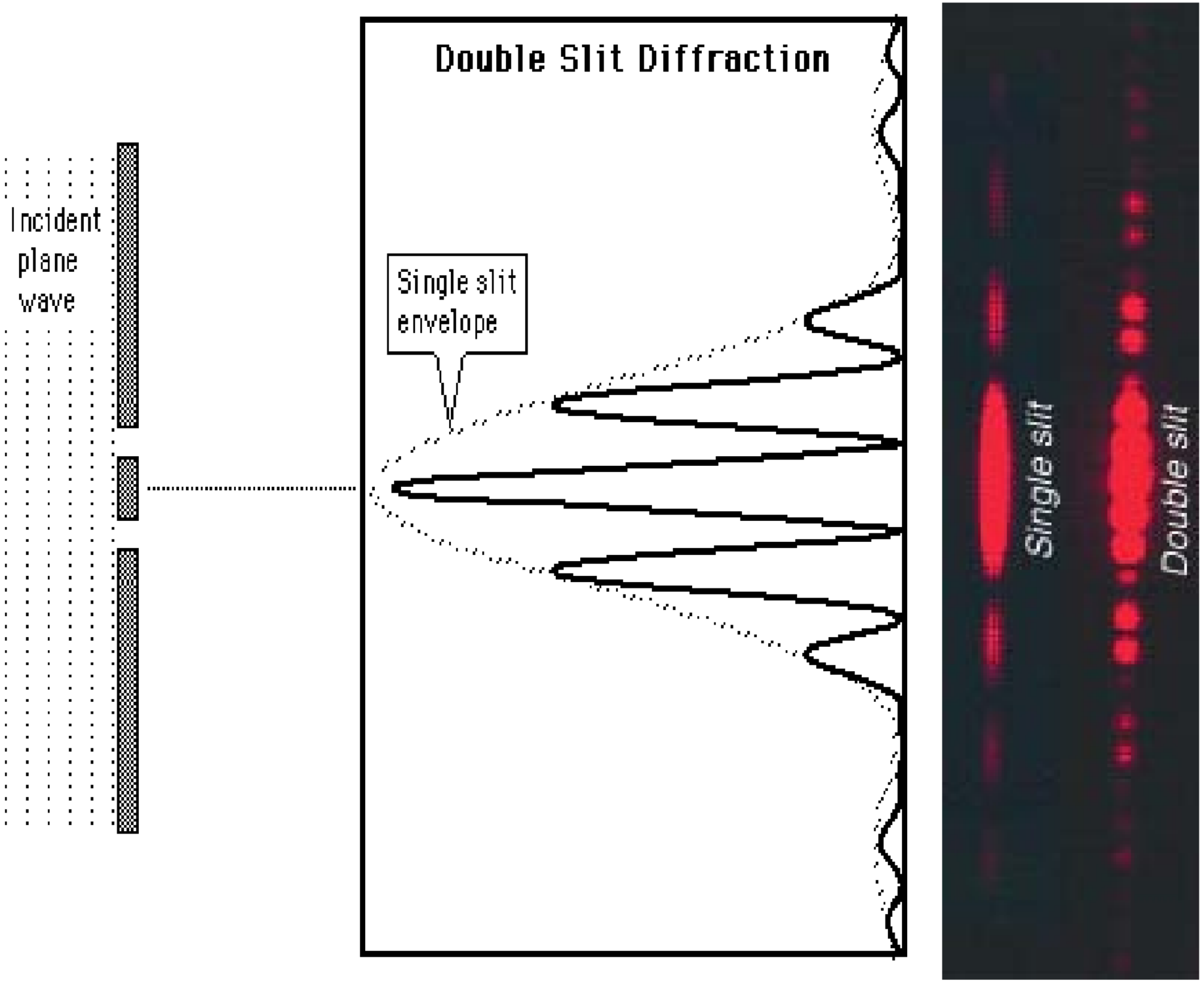
DIFFRACTION:



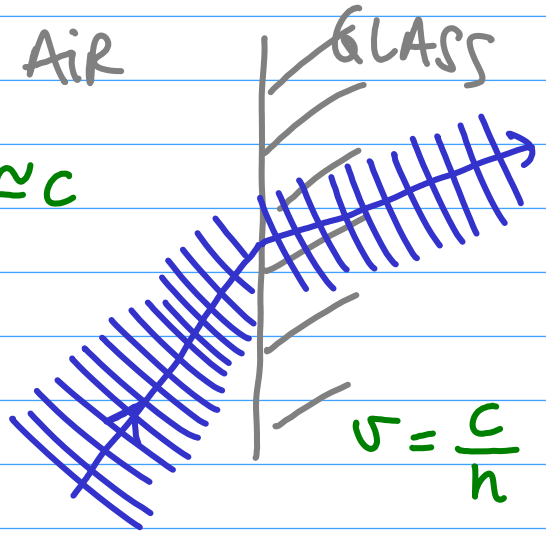
EXAMPLE: LIGHT DIFRACTION OF CLOUDS IN SUNSET (SILVER LINING)

- CD



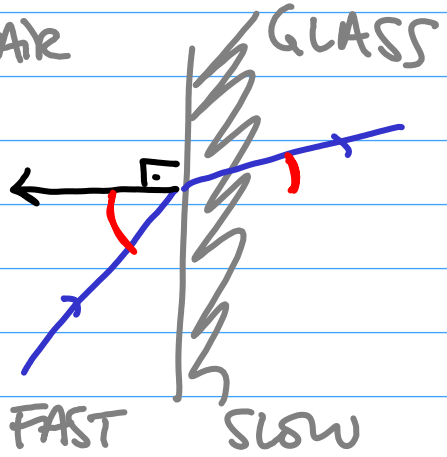

Double Slit Diffraction
Incident plane wave
Single slit envelope
Single slit
Double slit

REFRACTION

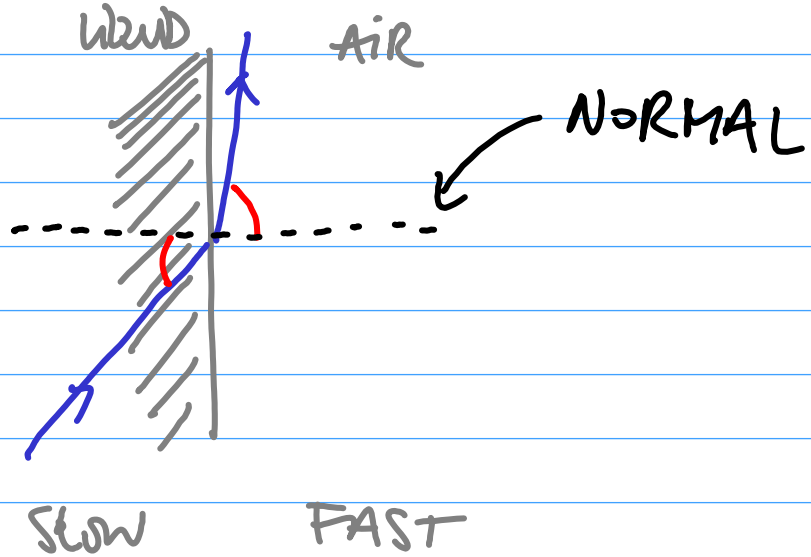


n = index of refraction

$n_{glass} \sim 1.3$



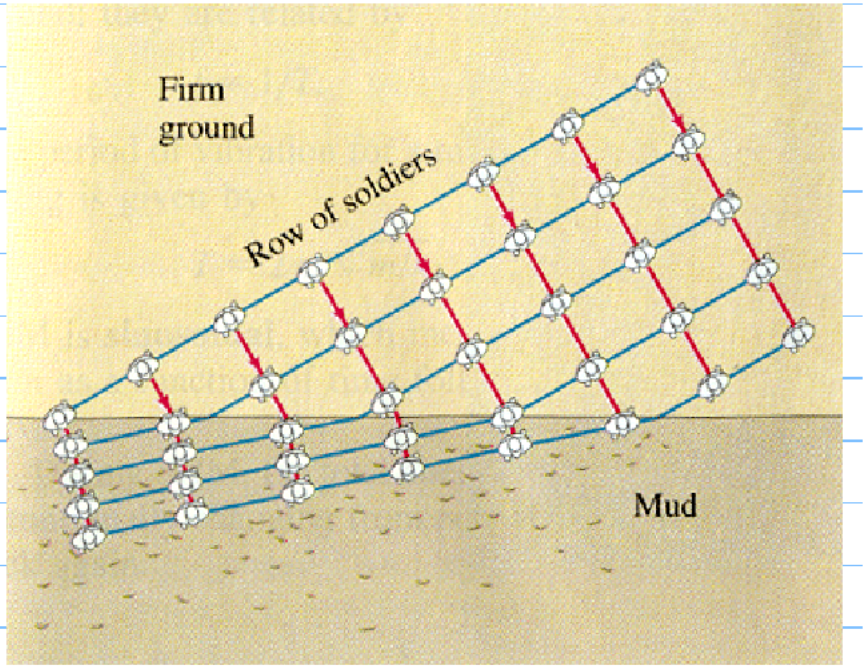
BENT TOWARDS NORMAL



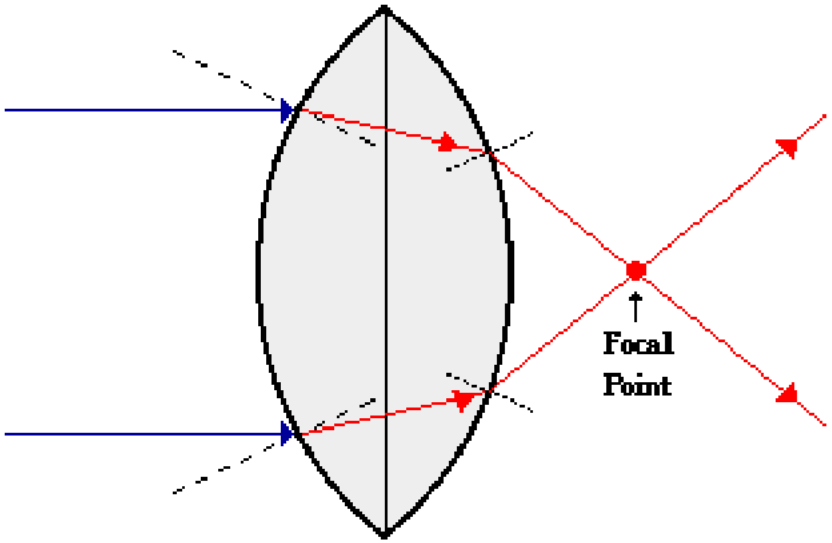
BENT AWAY FROM THE NORMAL.

REFRACTION

Imagine that the **fronts** are rows of soldiers and the **rays** are lines of soldiers. The soldiers move more slowly through mud. If they approach it at an angle, then the soldiers on the left will reach the mud first, and slow down first. This will cause the lines of soldiers (the **rays**) to bend.

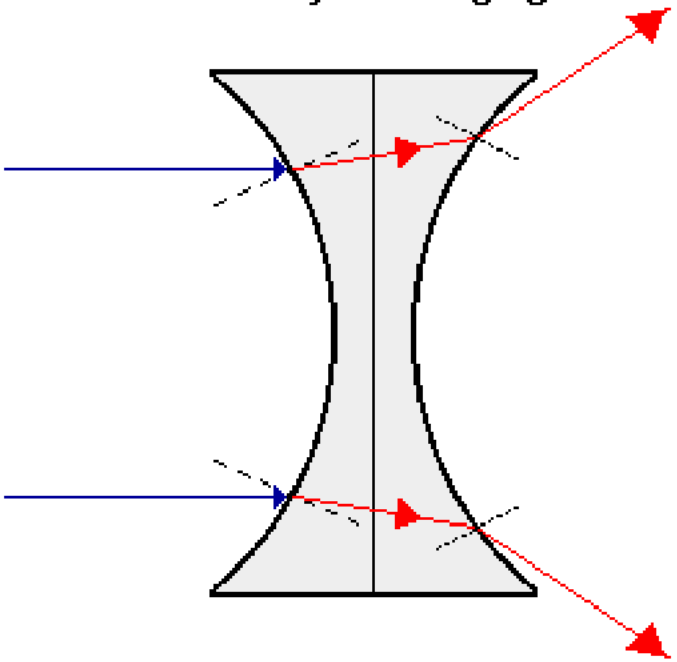


Refraction by a Converging Lens



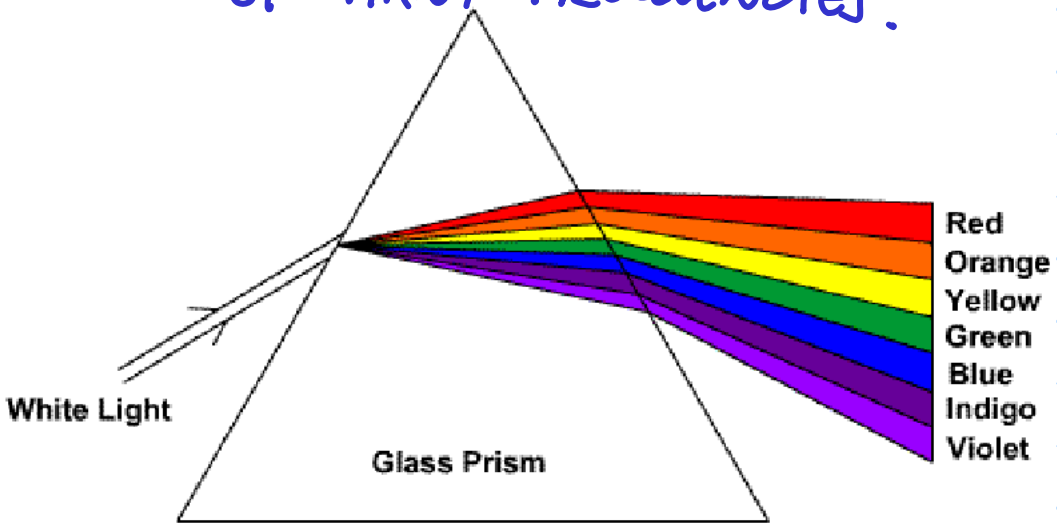
Incident rays which travel parallel to the principal axis will refract through the lens and converge to a point.

Refraction by a Diverging Lens

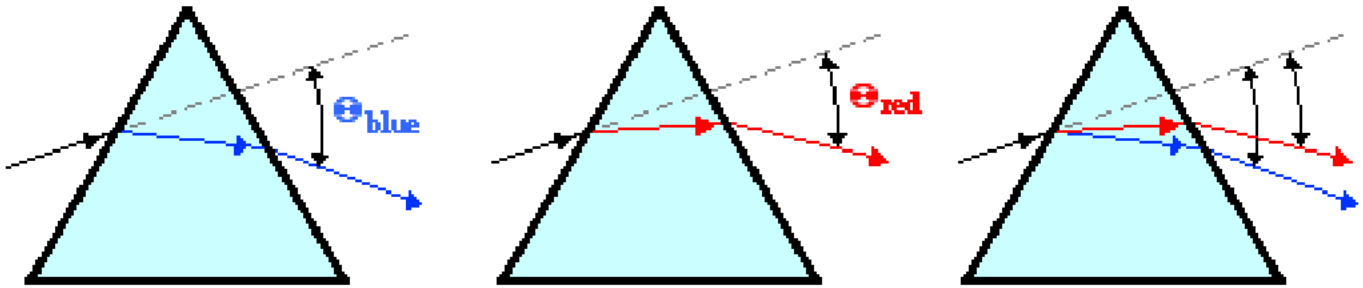


Incident rays traveling parallel to the principal axis will refract through the lens and diverge, never intersecting.

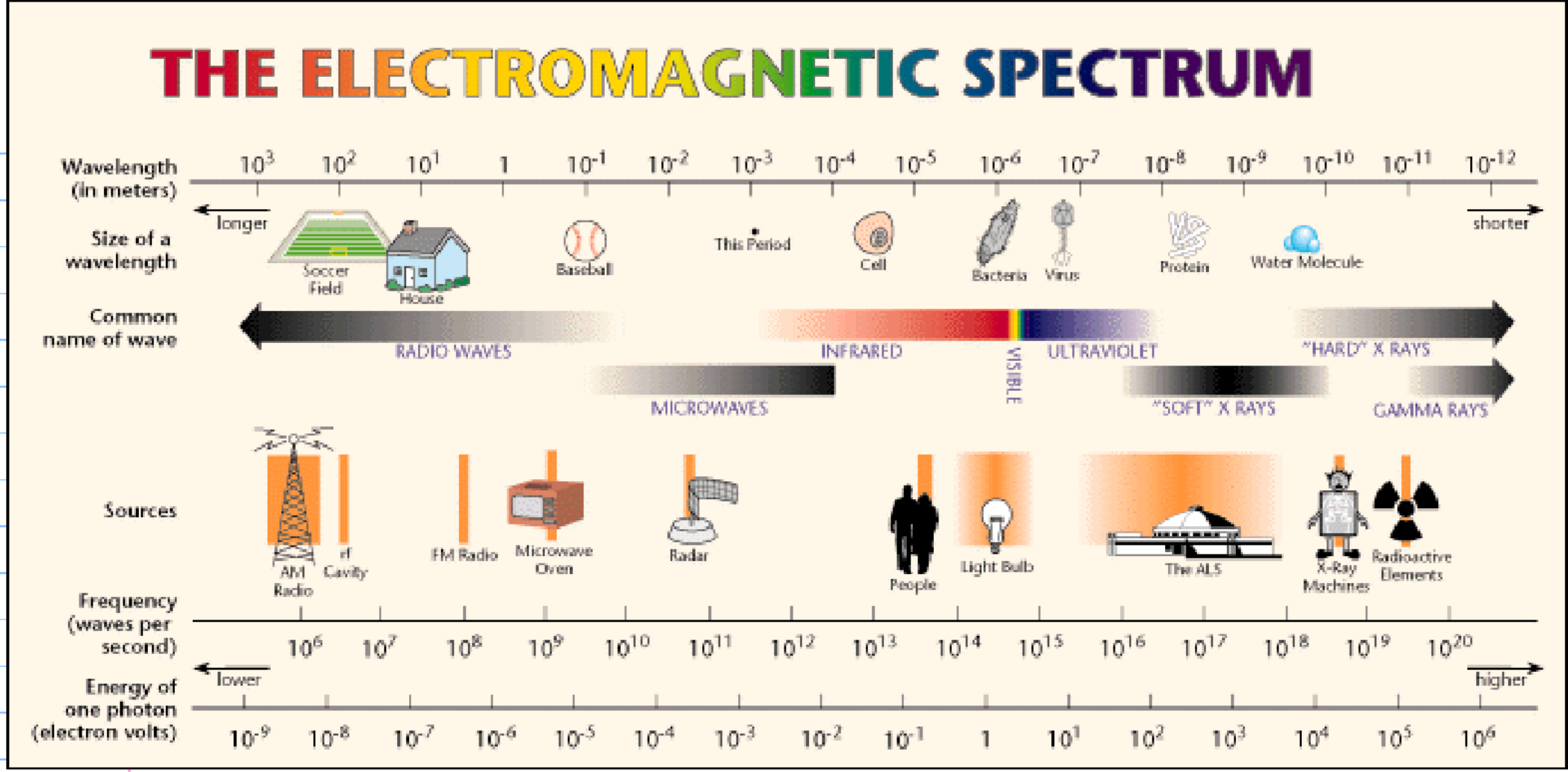
DISPERSION : NORMAL LIGHT IS A COLLECTION OF MANY FREQUENCIES.



DEGREE BY WHICH LIGHT IS BENT DEPENDS ON FREQUENCY



Blue light refracts more than red light due to the difference in wavelength. This causes blue light to deviate from its original path by a greater angle than the red light.



RADIO: WIDE (1 - 1000 m) OSCILLATIONS OF CHARGE

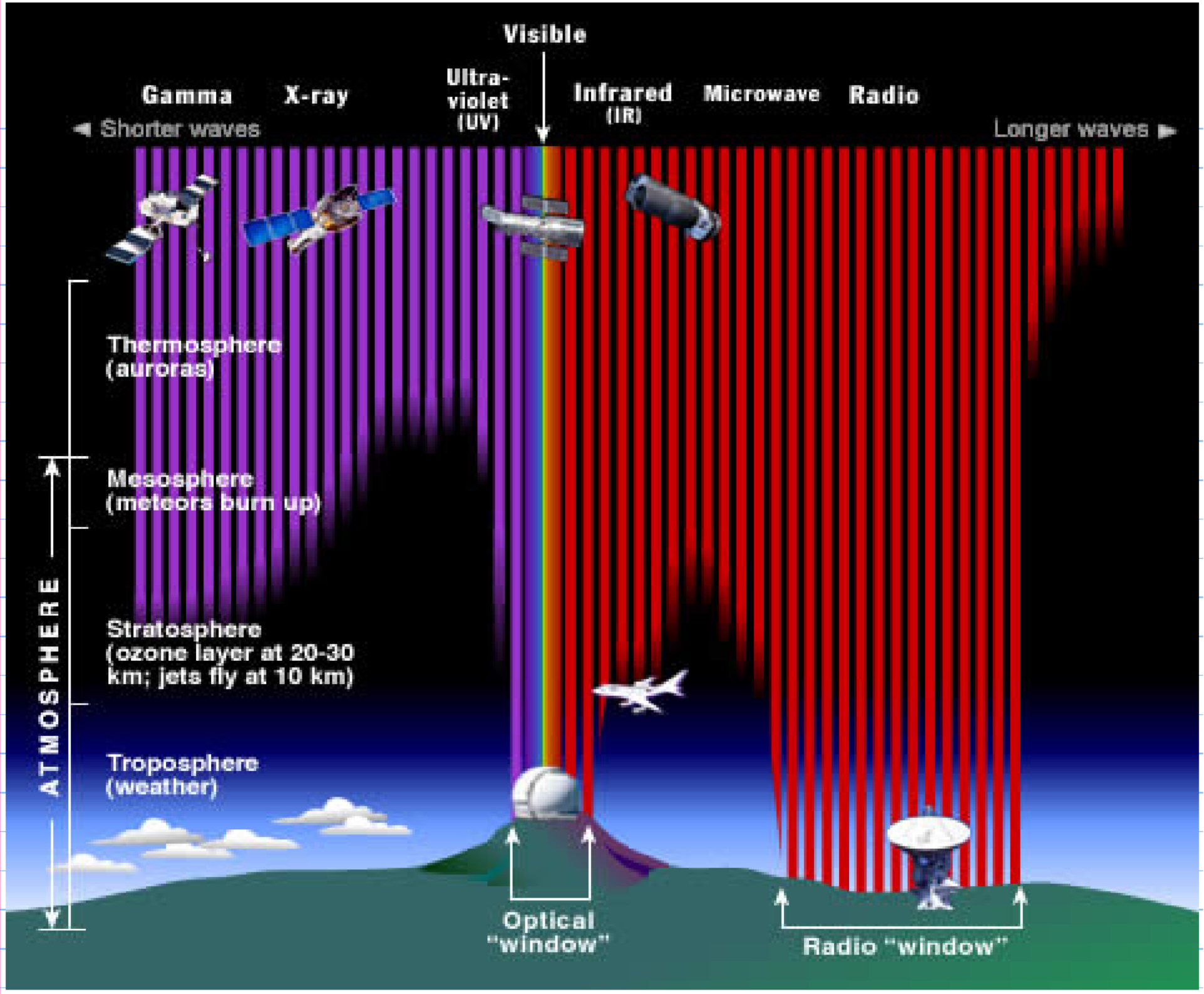
IR: RANDOM THERMAL MOTION OF MOLECULES DUE TO THEIR THERMAL ENERGY. WE CAN FEEL IR, BUT NOT SEE IT.

VISIBLE: TRANSITIONS OF e^- INSIDE ATOMS

UV: CAN SPLIT MOLECULES → CANCEROUS

X-RAY: FROM e^- COLLISIONS ON METALS → HOSPITALS

γ-RAY: FROM RADIOACTIVE MATERIALS → BIOLOGICAL DAMAGE


Visible
Gamma
X-ray
Ultra-violet (UV)
Infrared (IR)
Microwave
Radio
Shorter waves
Longer waves
Thermosphere (auroras)
Mesosphere (meteors burn up)
Stratosphere (ozone layer at 20-30 km; jets fly at 10 km)
Troposphere (weather)
ATMOSPHERE
Optical "window"
Radio "window"