# Lecture 07 – February 03 2009

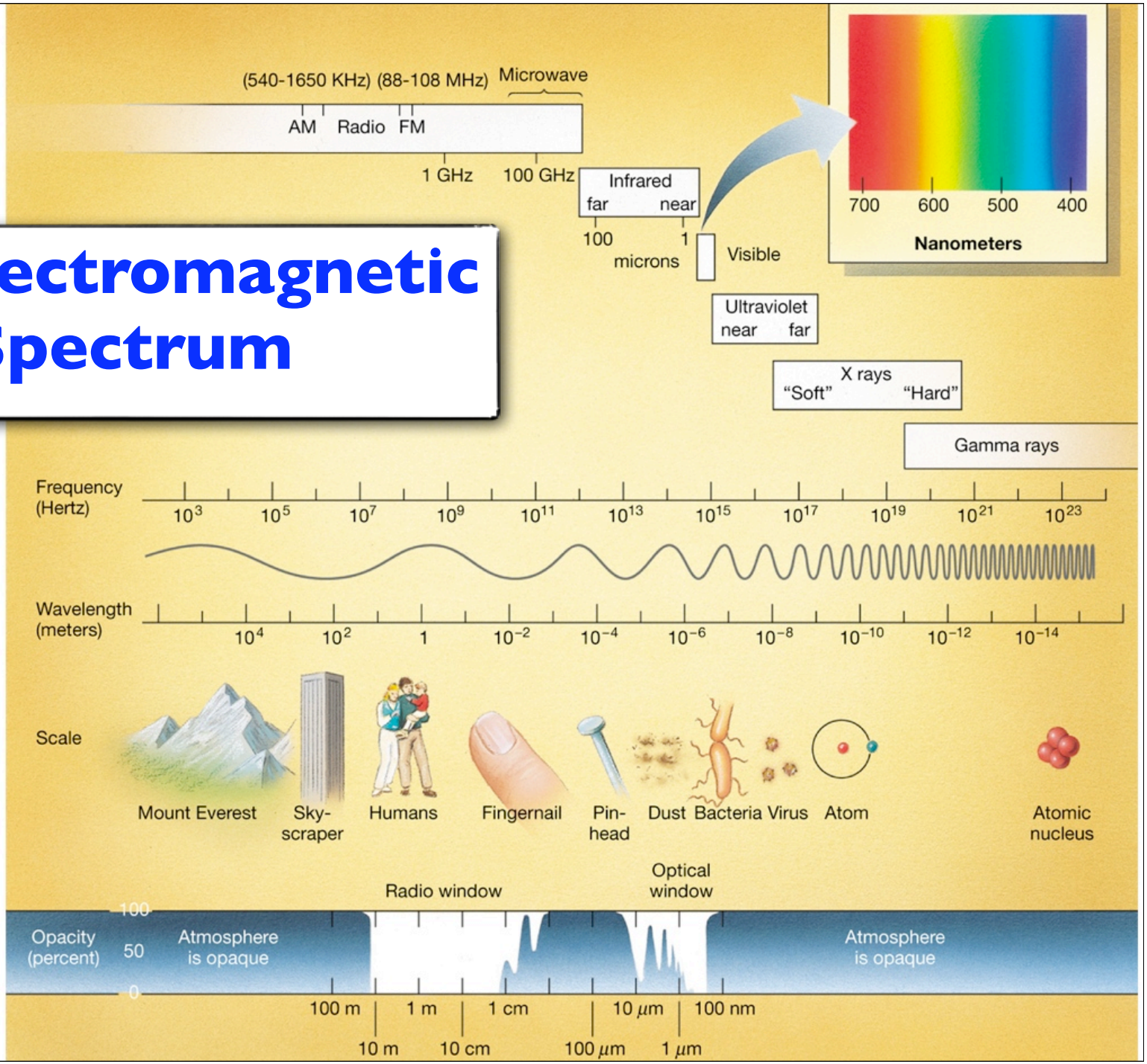
**HWK 2: due TONIGHT, 23:59**
**TEST 1: THURSDAY, February 05 2009**

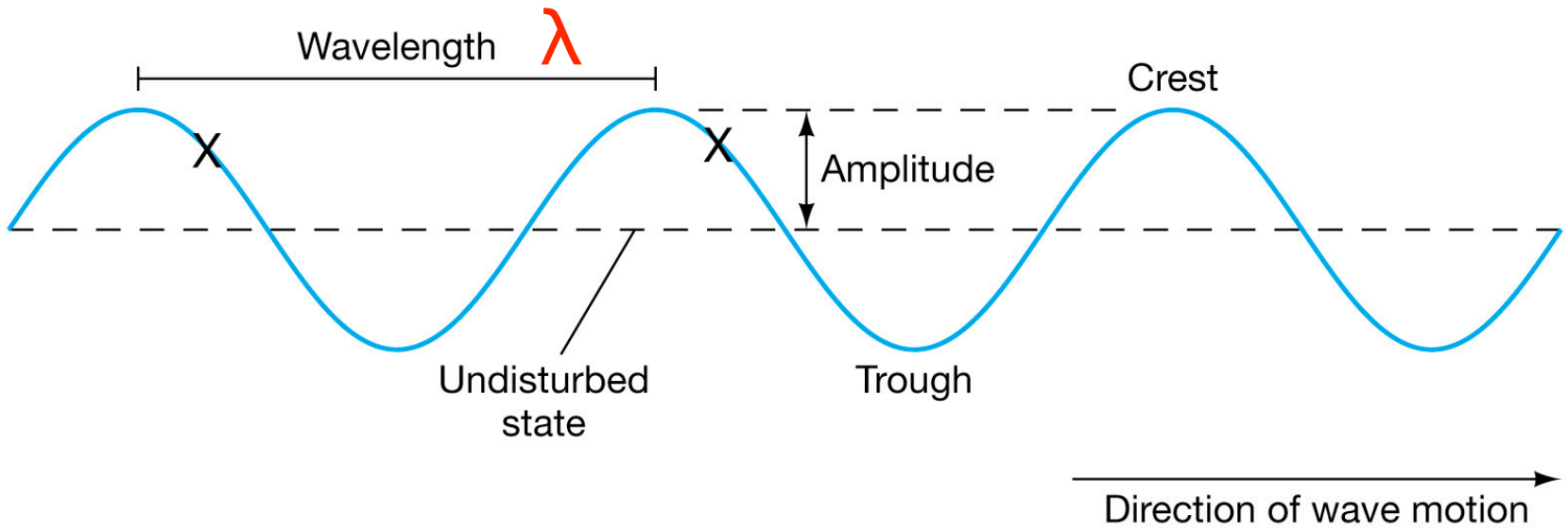
- **SCIENCE TOPICS**:
  What is light? (cont.)
  Dispersion and Spectra
  Blackbody radiation
- **READING**
  Ch 2, Sec 2.4–2.8
- **EXTRA PRACTICE**
  p.66 Review: 6,8-10,14,15
  p.67 Self-Test: 2, 3, 6, 8, 11
  p.67 Problems: 4, 5

# About Test 1

- ***When and Where***: Thursday, 05 February 2009 in this classroom, during regular class time (11:20am - 12noon)
- ***Format and Time Limit:***
  40 multiple choice questions; 1 minute per question
- ***What to Bring:***
  - **your PSU ID card**
  - #2 pencils and eraser
  - a calculator
- ***Other Rules and Regulations:***
  - closed book, closed notes
  - work on your own
  - items other than the above out of sight (*especially* cellphones)

# The Electromagnetic Spectrum






Relation between wavelength and frequency:

$$c = \lambda \nu$$

speed of the wave (m/s)

wavelength (m)

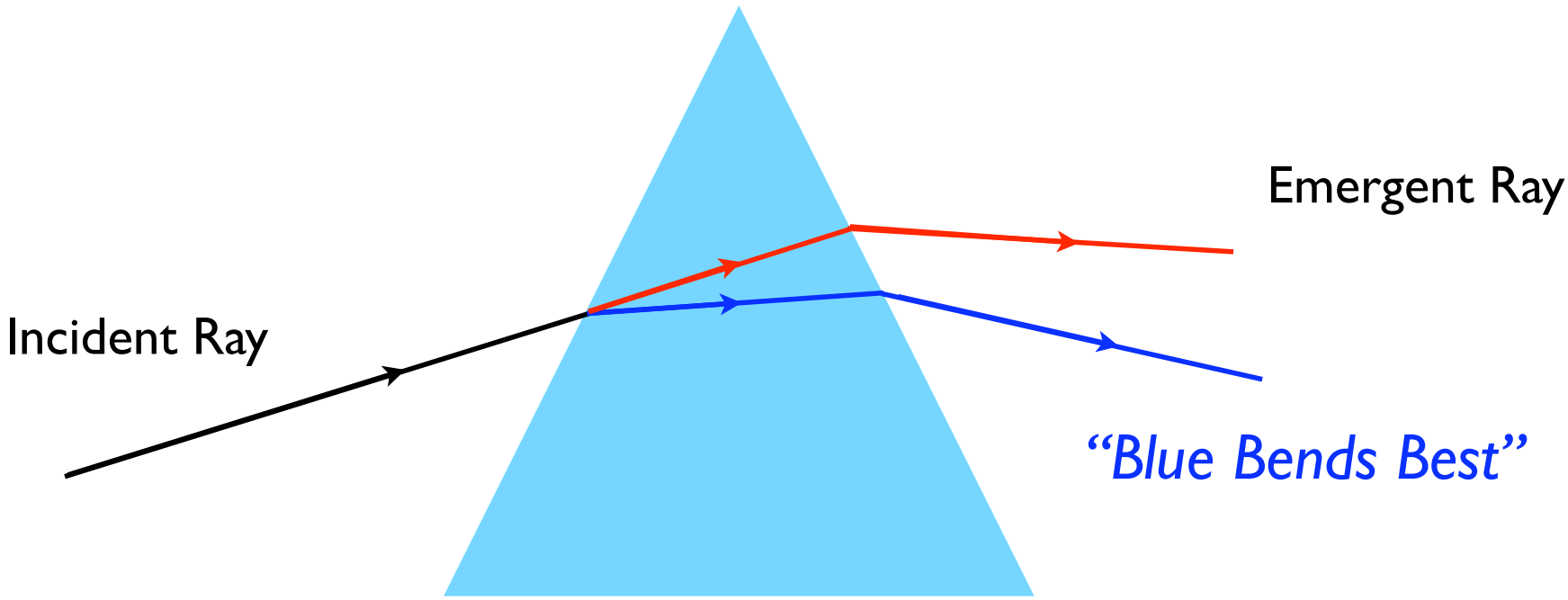
frequency (Hz)

# Dark Side of the Moon

- Pink Floyd. Also “The Wall”.

# Dispersion and Spectra

# Passing Light through a Prism

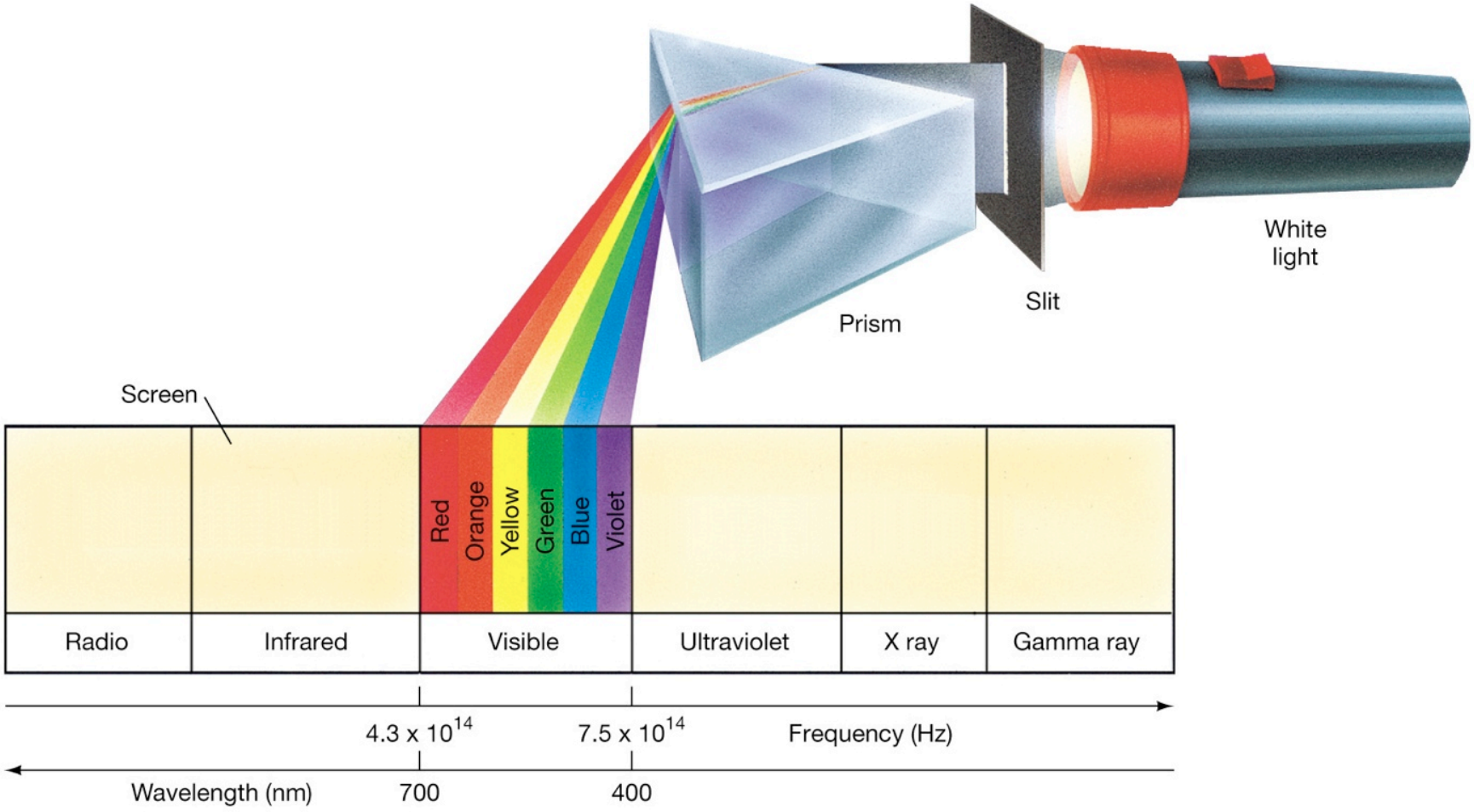



*Refraction* at air/glass interface leads to *dispersion* (the "fanning out" of the colors)

# Slightly wrong...

- Dispersion and happens *inside* the prism

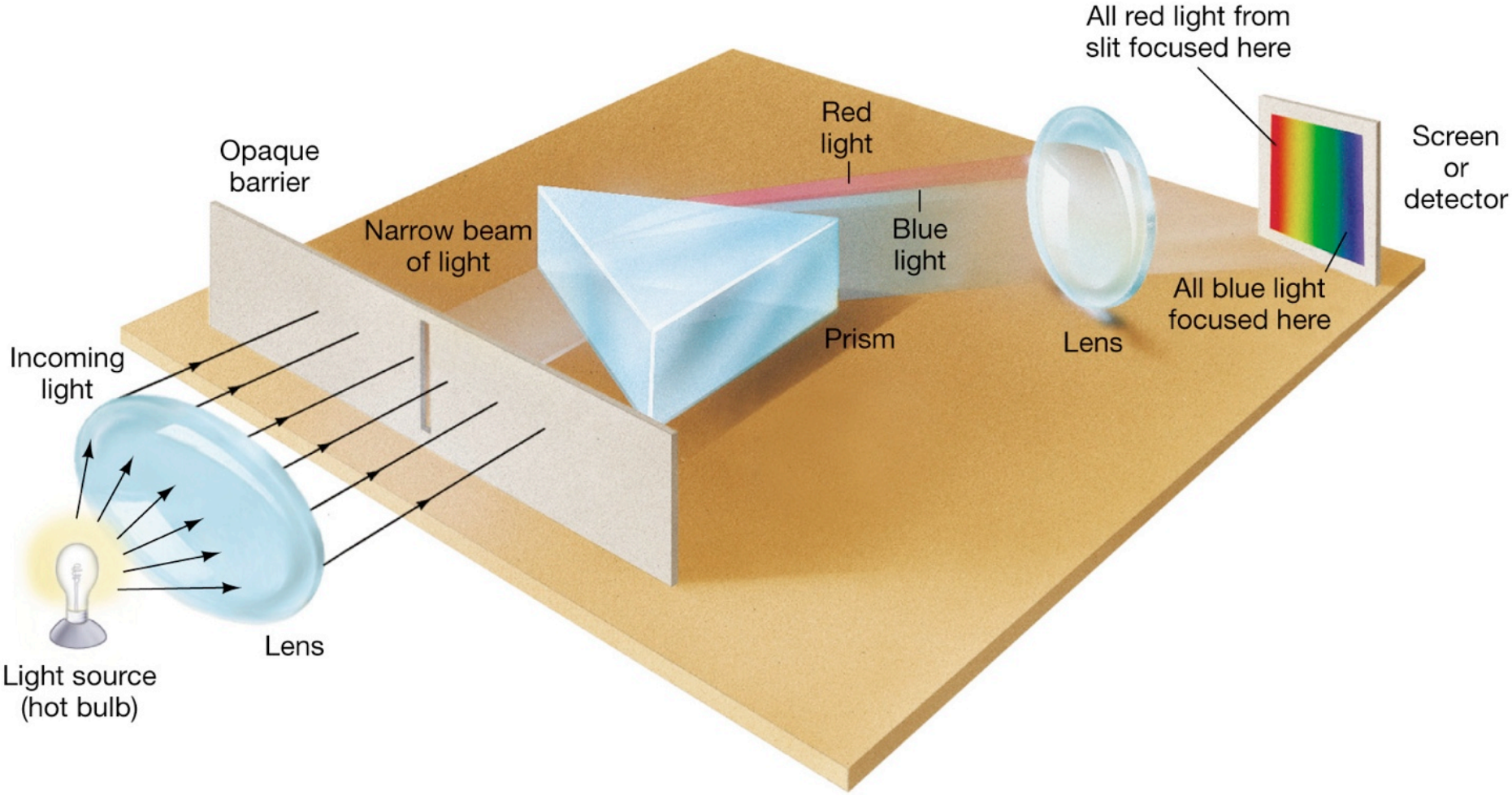
# Dispersion


White light
Slit
Prism
Screen
Red
Orange
Yellow
Green
Blue
Violet
Radio
Infrared
Visible
Ultraviolet
X ray
Gamma ray
4.3 x 10^14
7.5 x 10^14
Frequency (Hz)
Wavelength (nm)
700
400

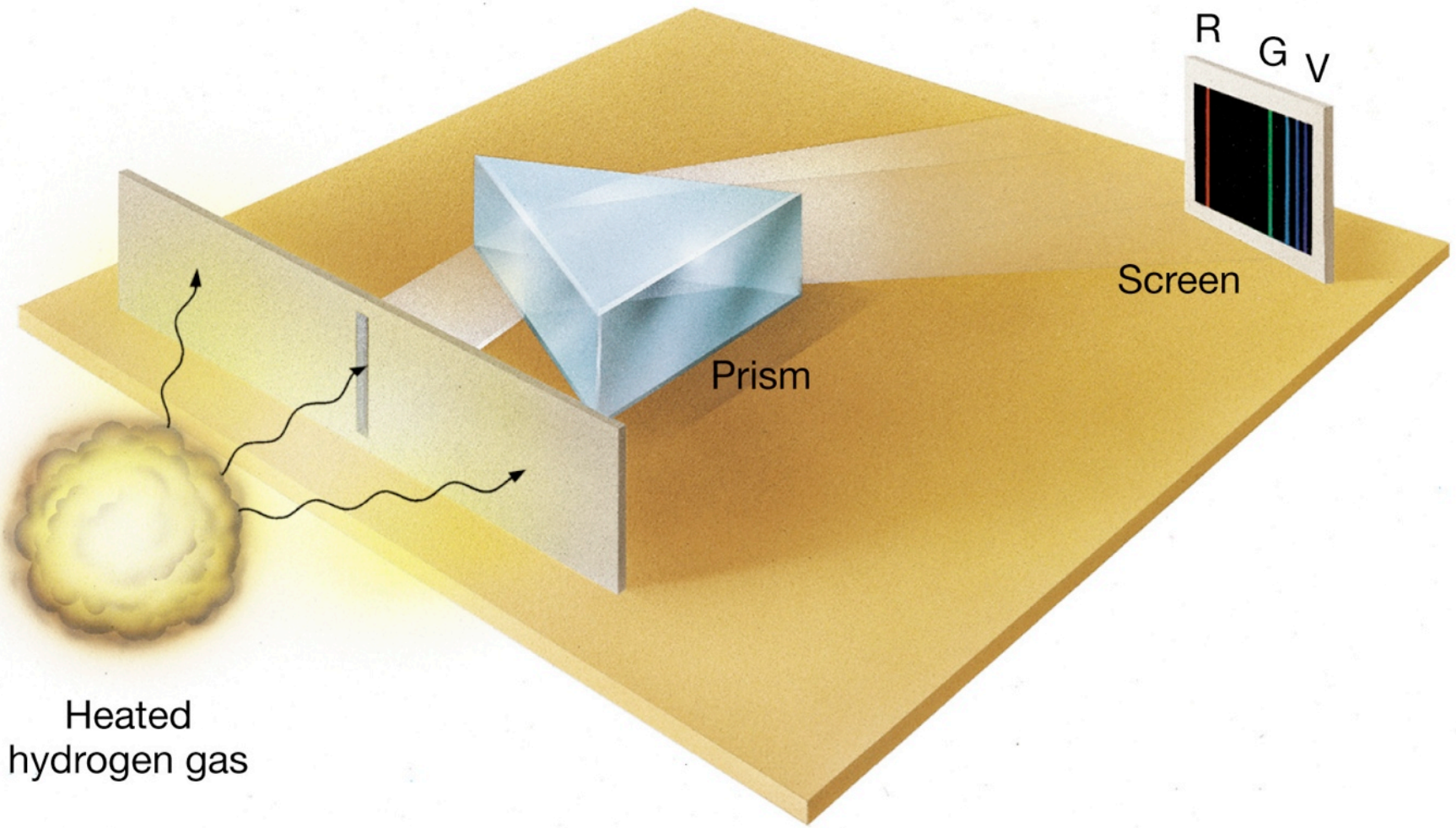
# Spectra:

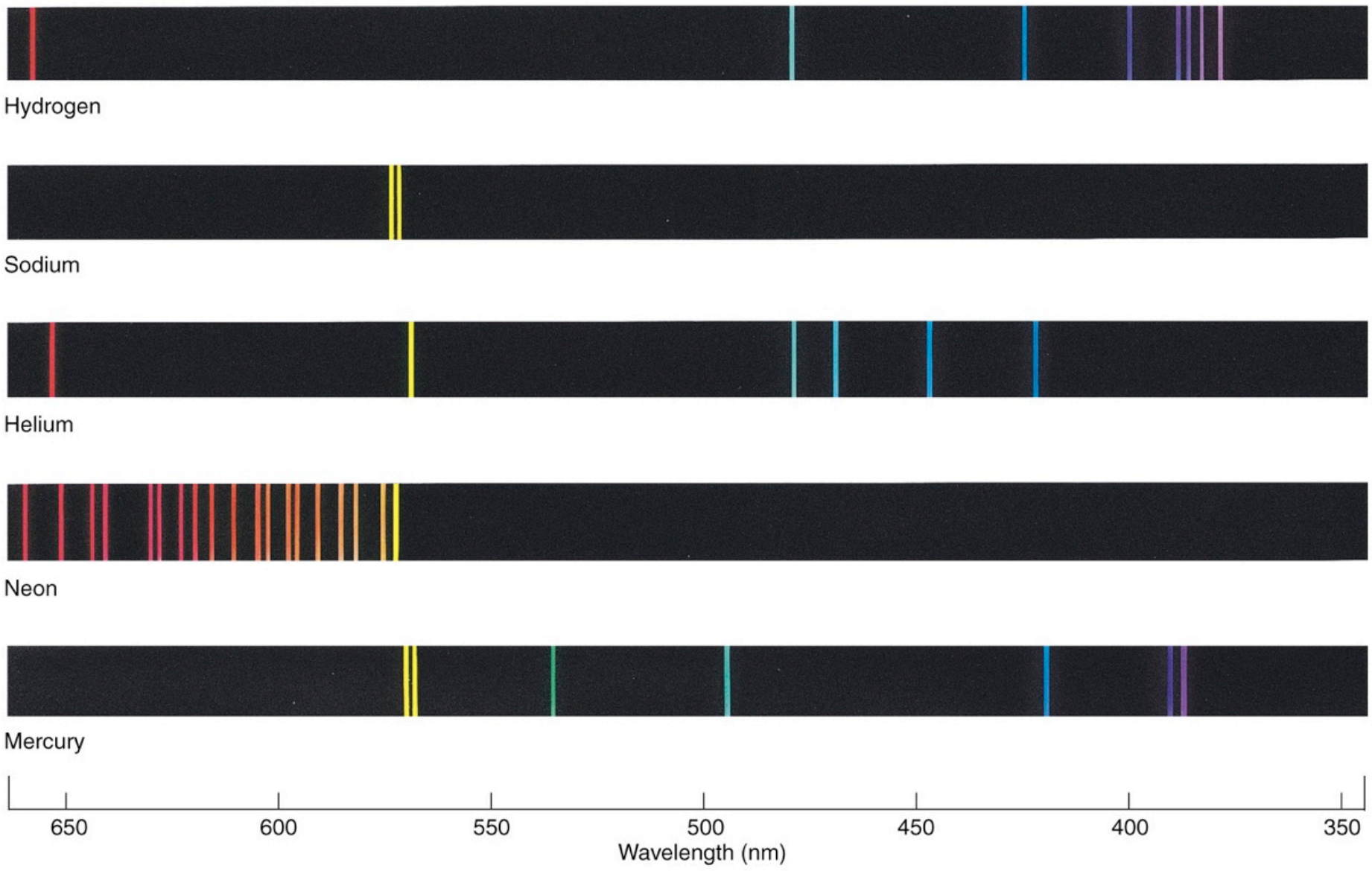
- Continuous
- Emission Line
- Absorption Line

# Continuous Spectra

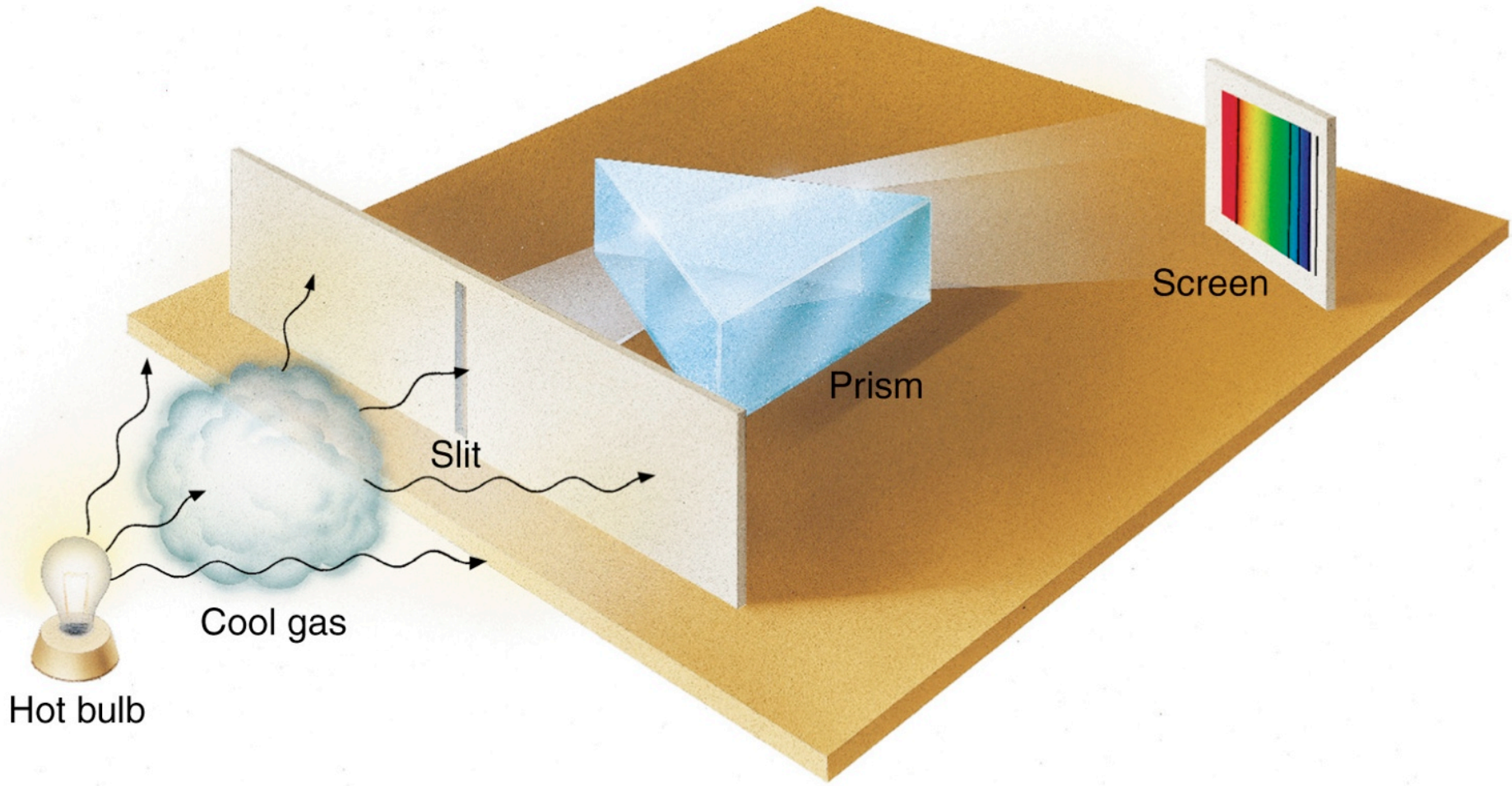


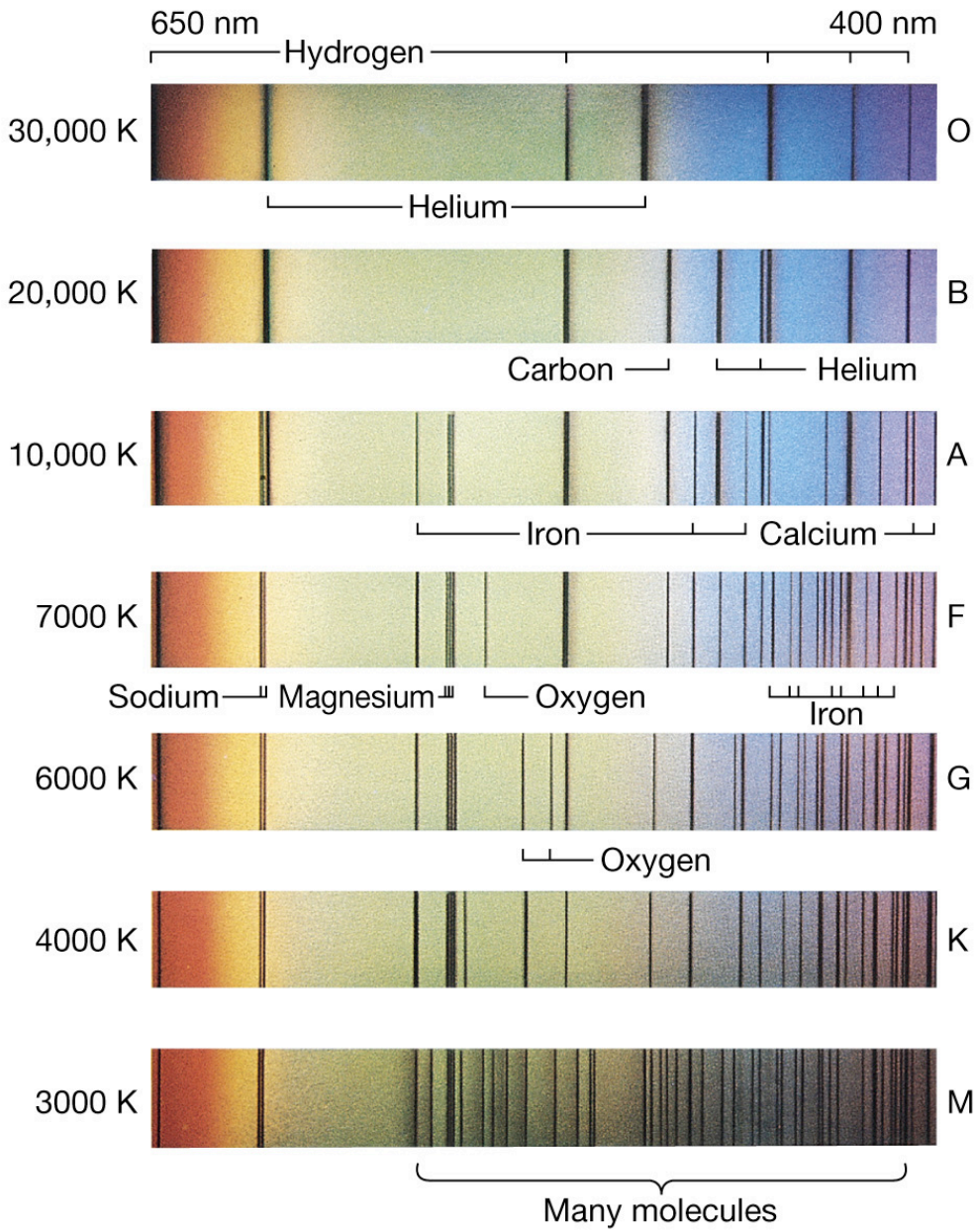
# Emission Spectra

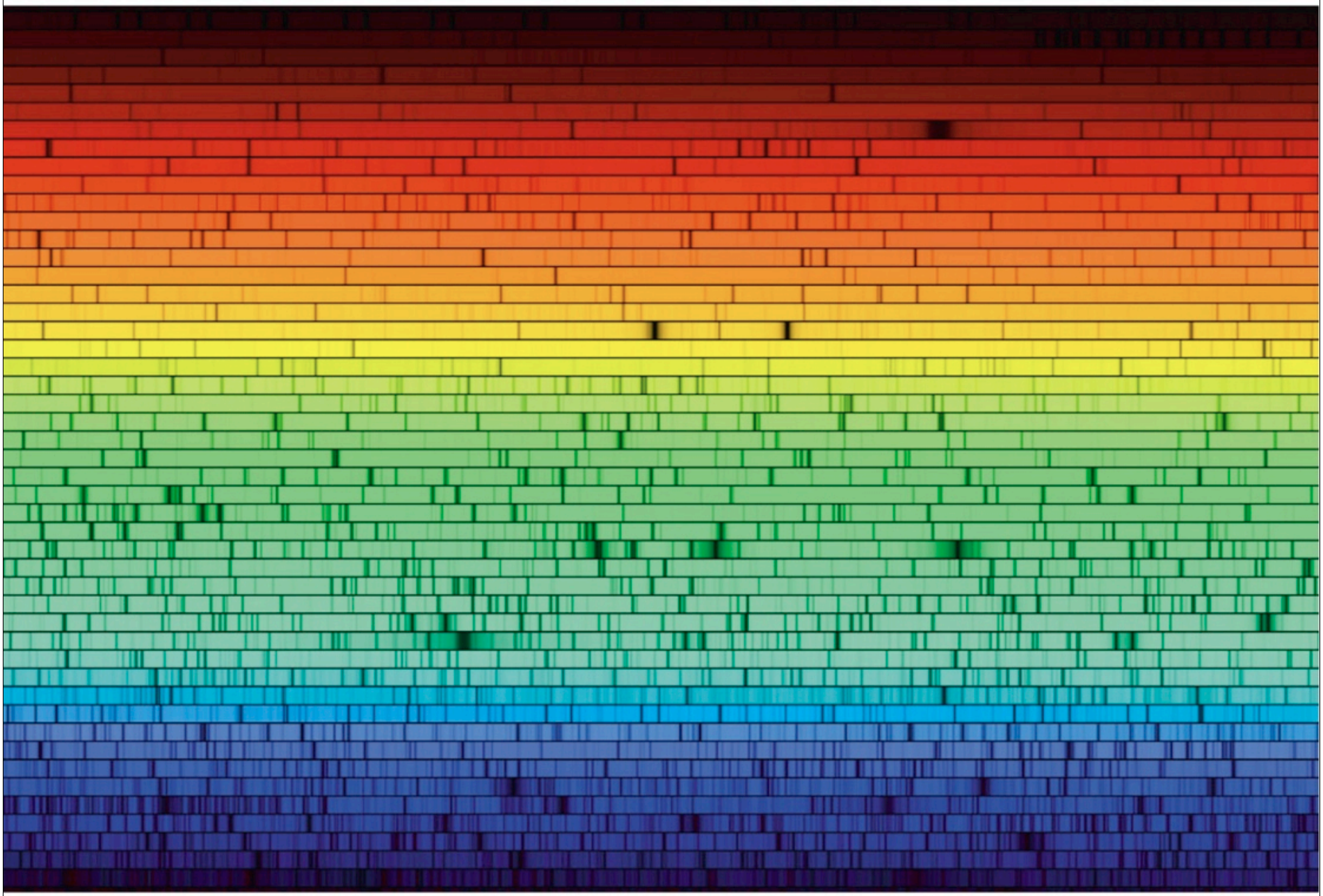



Hydrogen
Sodium
Helium
Neon
Mercury
650
600
550
500
450
400
350
Wavelength (nm)

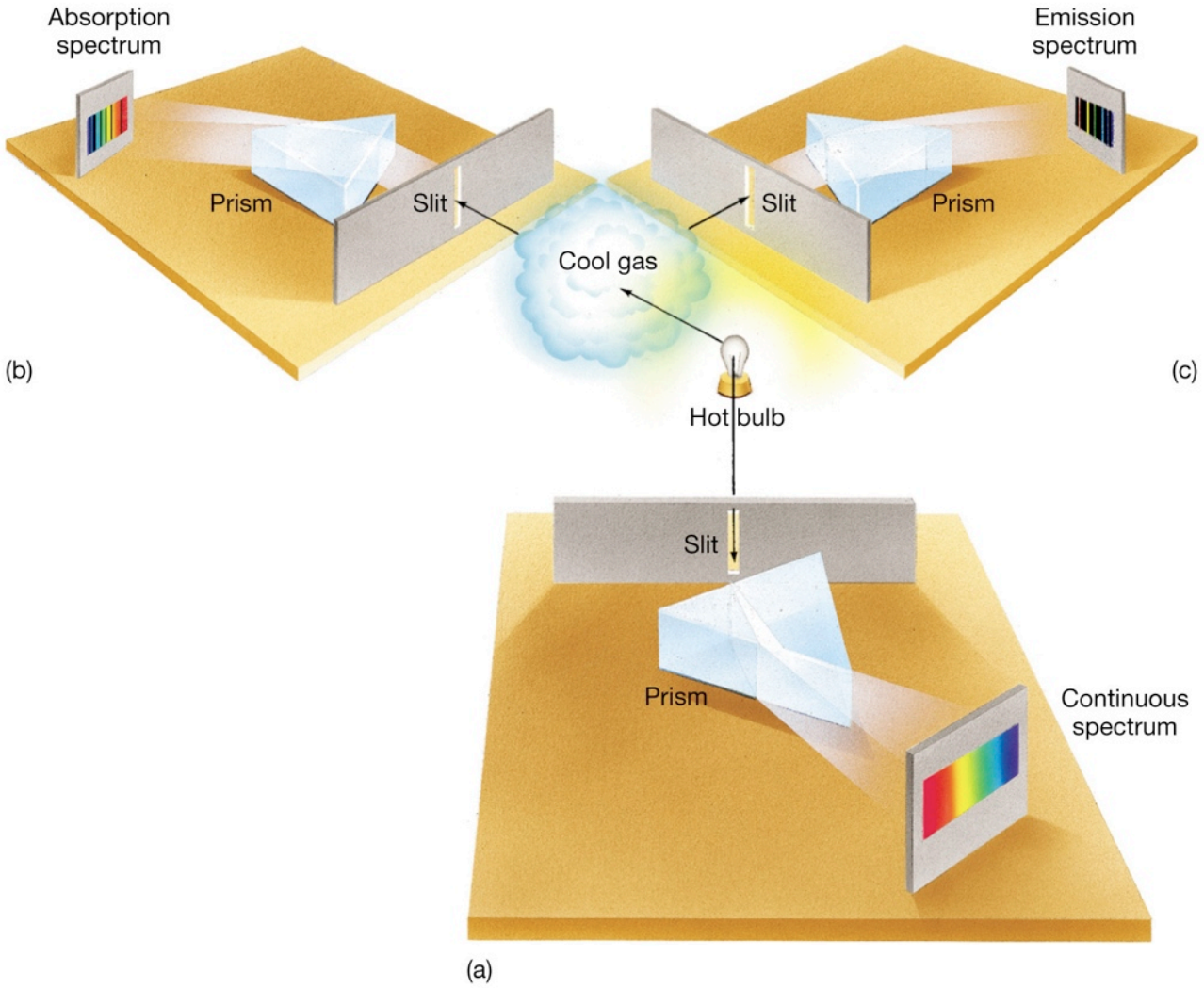
# Absorption Spectra




650 nm
400 nm
Hydrogen
30,000 K
O
Helium
20,000 K
B
Carbon
Helium
10,000 K
A
Iron
Calcium
7000 K
F
Sodium
Magnesium
Oxygen
Iron
6000 K
G
Oxygen
4000 K
K
3000 K
M
Many molecules



# In Summary...


Absorption spectrum
Emission spectrum
Prism
Slit
Slit
Prism
Cool gas
(b)
(c)
Hot bulb
Slit
Prism
Continuous spectrum
(a)

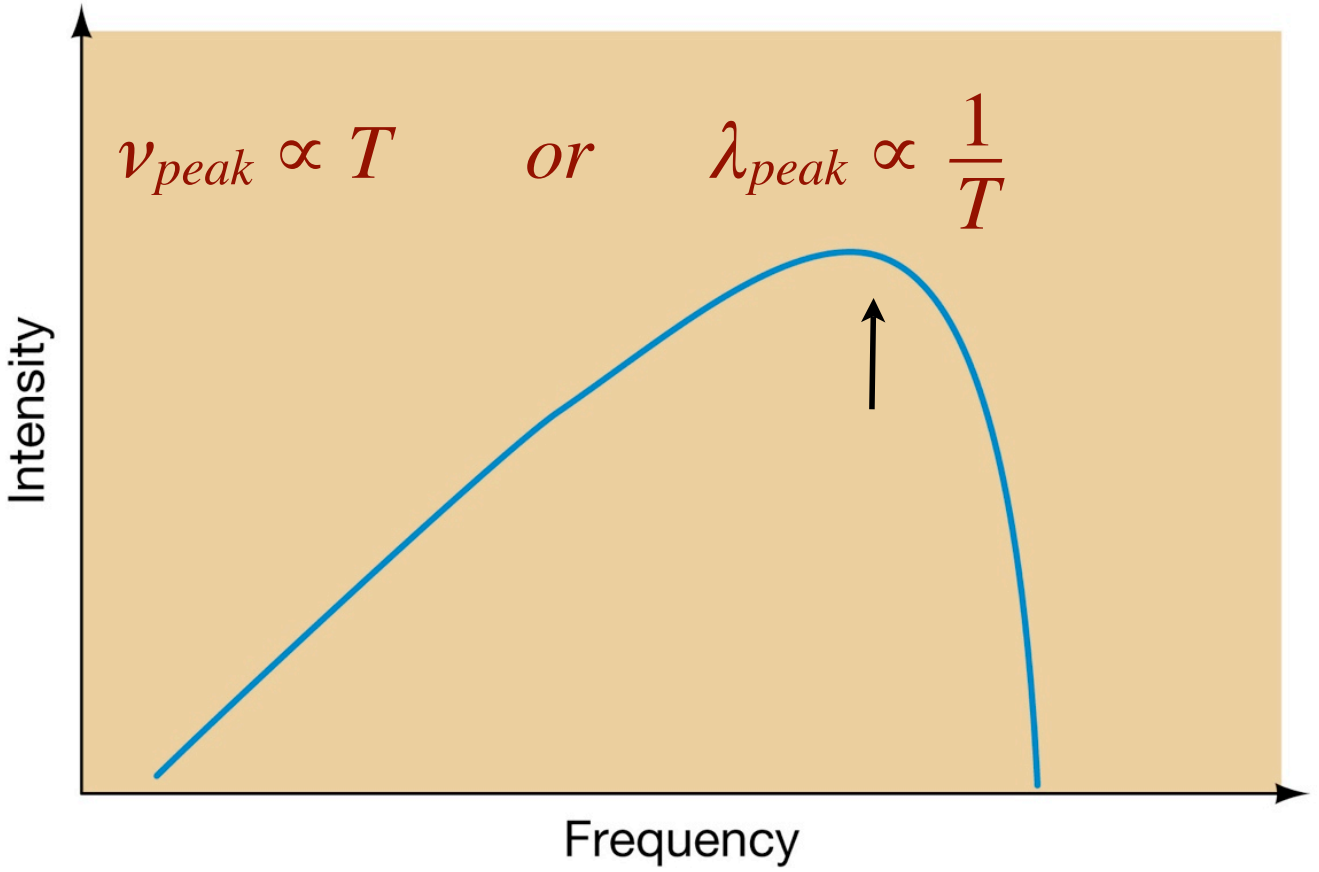
# A Black body

- A *black body* is a theoretical object that absorbs all electromagnetic radiation that falls on it.
- Because no light (EM radiation) is reflected the object appears black when it is cold.
- If a *black body* is hot however, then it will emit thermal radiation i.e. light, that has a *black body spectrum*.
- The shape of this spectrum only depends on the objects ***TEMPERATURE***.
- a.k.a. The *Planck* Spectrum or *Planck's Law*

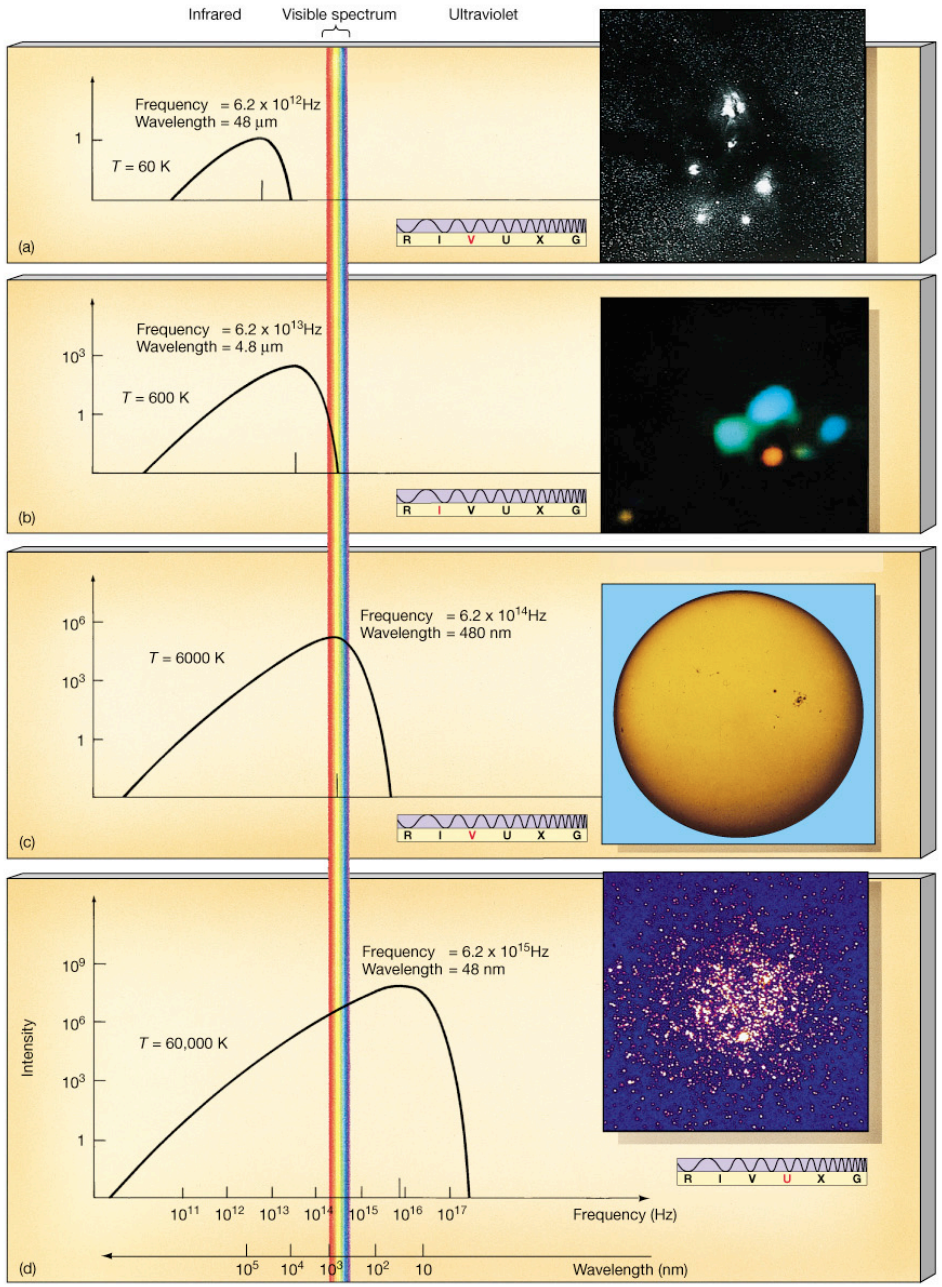
# A Black body

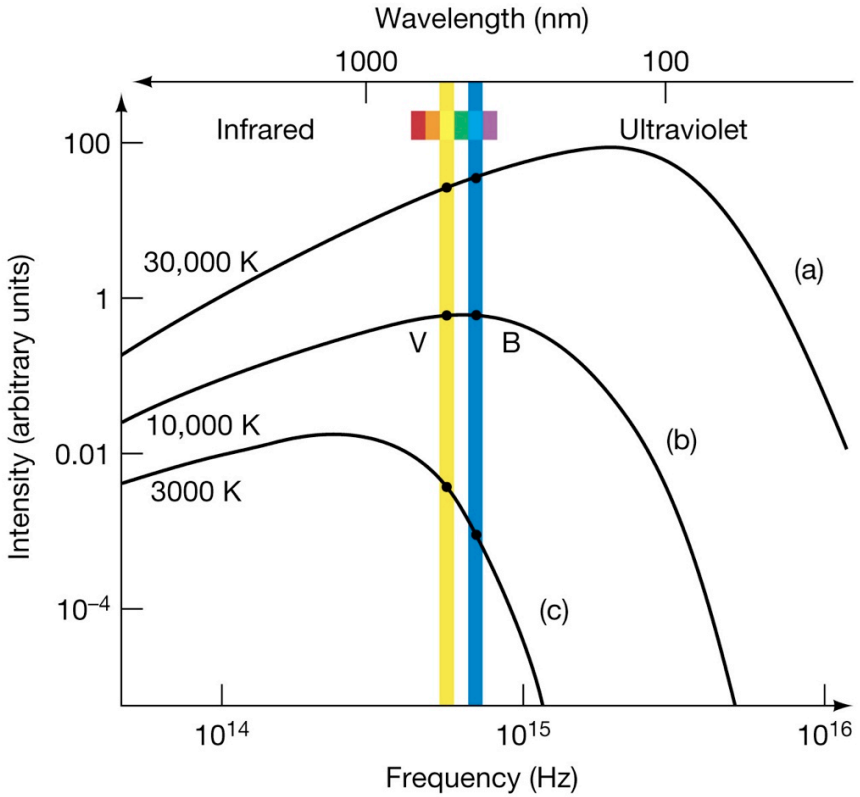
- Why is black body radiation important for astronomy?
  - A black body is a very good start to describing the energy emission, i.e. in the form of light and heat, of ***stars***
  - The heat left over from the Big Bang, the "**Cosmic Microwave Background**", is *very nearly* a perfect black body. (Emission peaks at $\lambda_{peak}$ = 1 mm)

# The Planck or Blackbody Spectrum




- The shape of this spectrum only depends on the objects ***TEMPERATURE***.


Infrared
Visible spectrum
Ultraviolet
Frequency = 6.2 x 10^12 Hz
Wavelength = 48 μm
T = 60 K
(a)
Frequency = 6.2 x 10^13 Hz
Wavelength = 4.8 μm
T = 600 K
(b)
Frequency = 6.2 x 10^14 Hz
Wavelength = 480 nm
T = 6000 K
(c)
Frequency = 6.2 x 10^15 Hz
Wavelength = 48 nm
T = 60,000 K
Intensity
Frequency (Hz)
Wavelength (nm)
(d)
R I V U X G


Wavelength (nm)
1000
100
Infrared
Ultraviolet
100
1
0.01
10^-4
30,000 K
10,000 K
3000 K
V
B
(a)
(b)
(c)
Intensity (arbitrary units)
10^14
10^15
10^16
Frequency (Hz)

# TEST 01 on THURSDAY!