Thermal Energy Transfer & Black Body Radiation

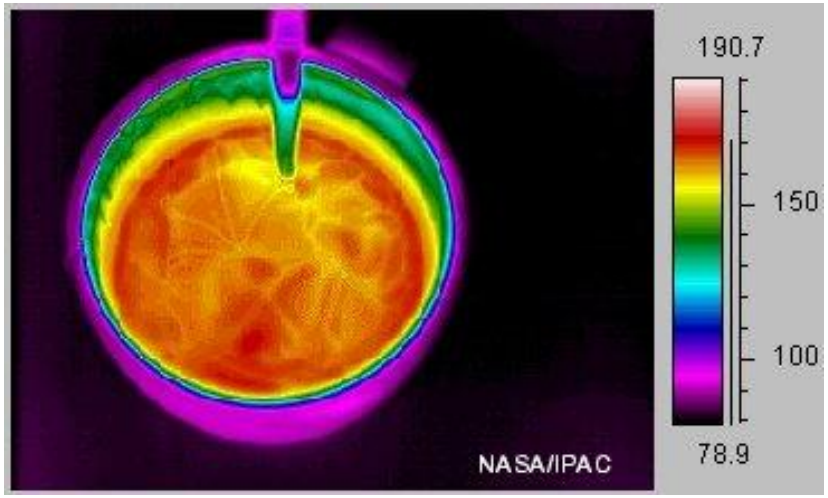
IB PHYSICS | ENERGY PRODUCTION

Heat Transfer

There are 3 primary ways that heat is transferred:

Conduction

Conduction occurs between objects in direct _____



Conduction

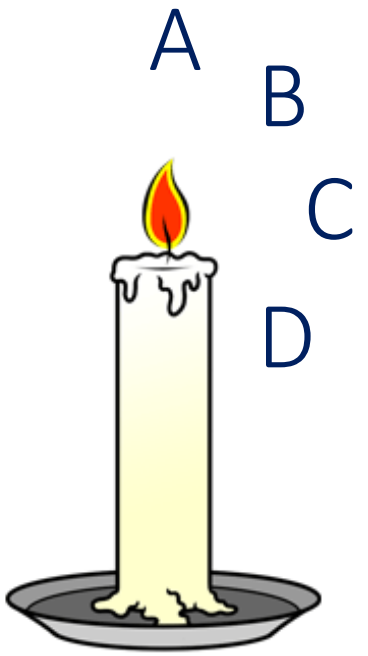
Why does this frying pan have a plastic handle?

Convection

Convection occurs when fluids (liquids or gases) move around due to temperature differences

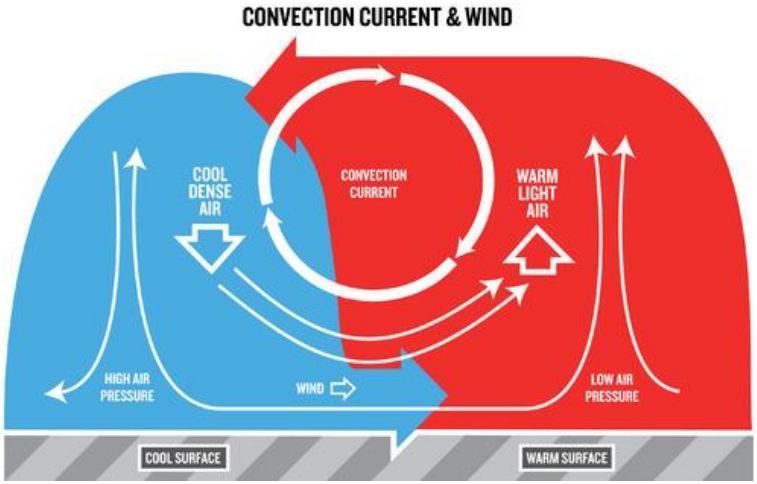
Hot Air _____

Cold Air _____



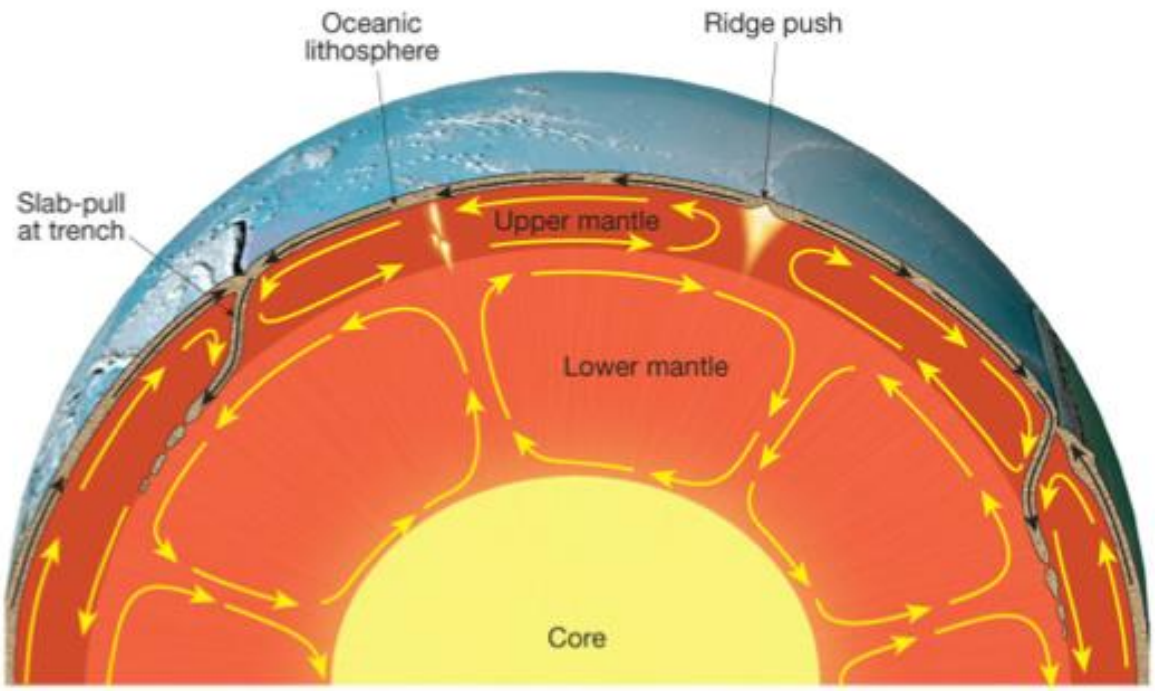
Where should I roast my marshmallow?

Convection



Why does hot air rise?

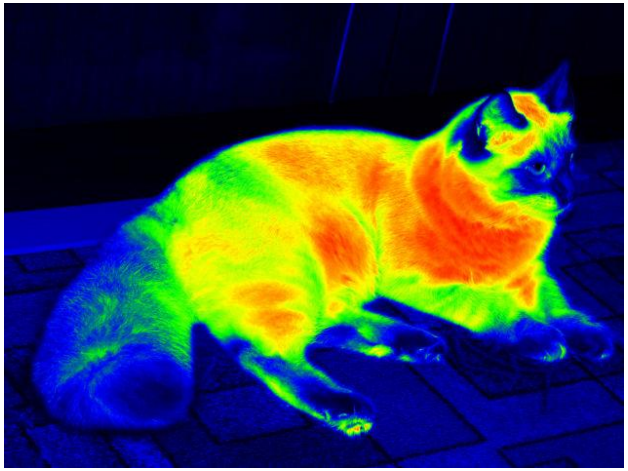
Convection

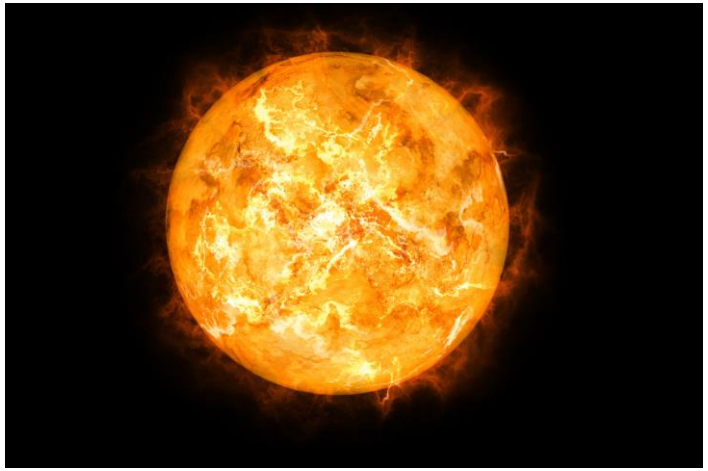

Oceanic lithosphere
Ridge push
Slab-pull at trench
Upper mantle
Lower mantle
Core


MATHMOS

Radiation

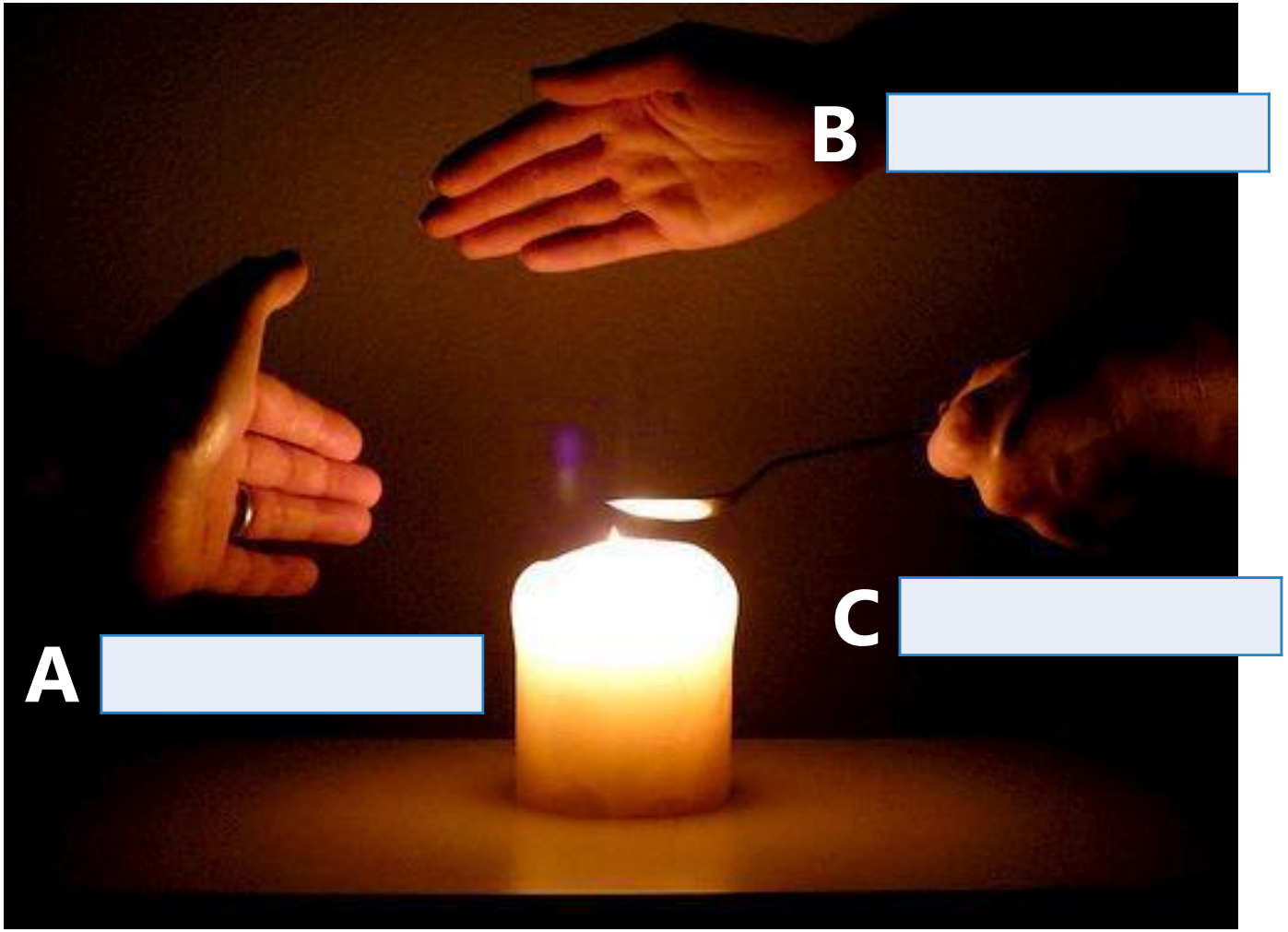
Radiation is energy that is transferred as waves such as visible light and infrared





Radiation can travel through _____

Label Me

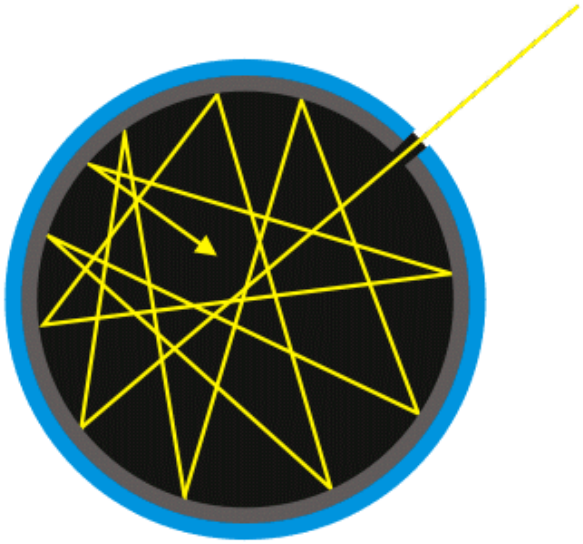


Emissivity

What color car heats up the most in the sun?

Black Body Radiator

A black body radiator is an object that is perfectly opaque and absorbs all energy



Conceptual Black Body

Emissivity

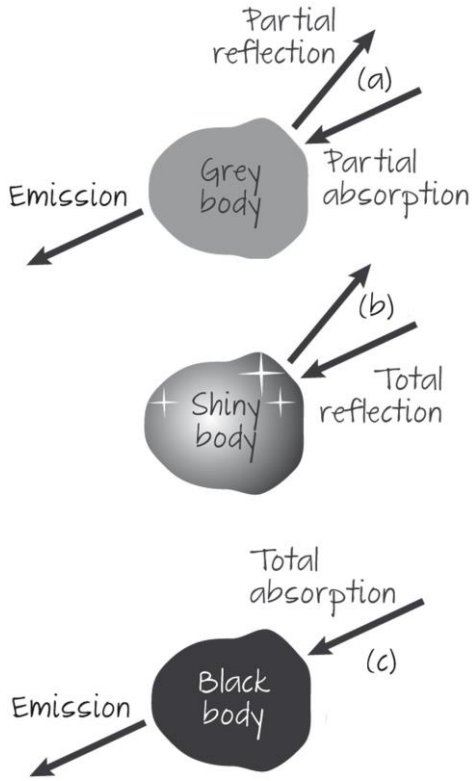
Emissivity	e	$\frac{power\ radiated\ by\ a\ surface}{power\ radiated\ from\ a\ black\ body\ of\ the\ same\ temperature\ and\ area}$

The emissivity is used to adjust for an object that isn't a perfect black-body radiator

This value is always between 0 and 1

$e \approx$

$e \approx$



Stefan-Boltzmann Law

$$P = e\sigma AT^4$$

Emissivity	e	$\frac{power\ radiated\ by\ a\ surface}{power\ radiated\ from\ a\ black\ body\ of\ the\ same\ temperature\ and\ area}$
Stefan-Boltzmann Constant	σ	$5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$

Try This

A star has a radius of 8.3×10^7 m and a surface temperature of 7500°C. Calculate the power it emits.

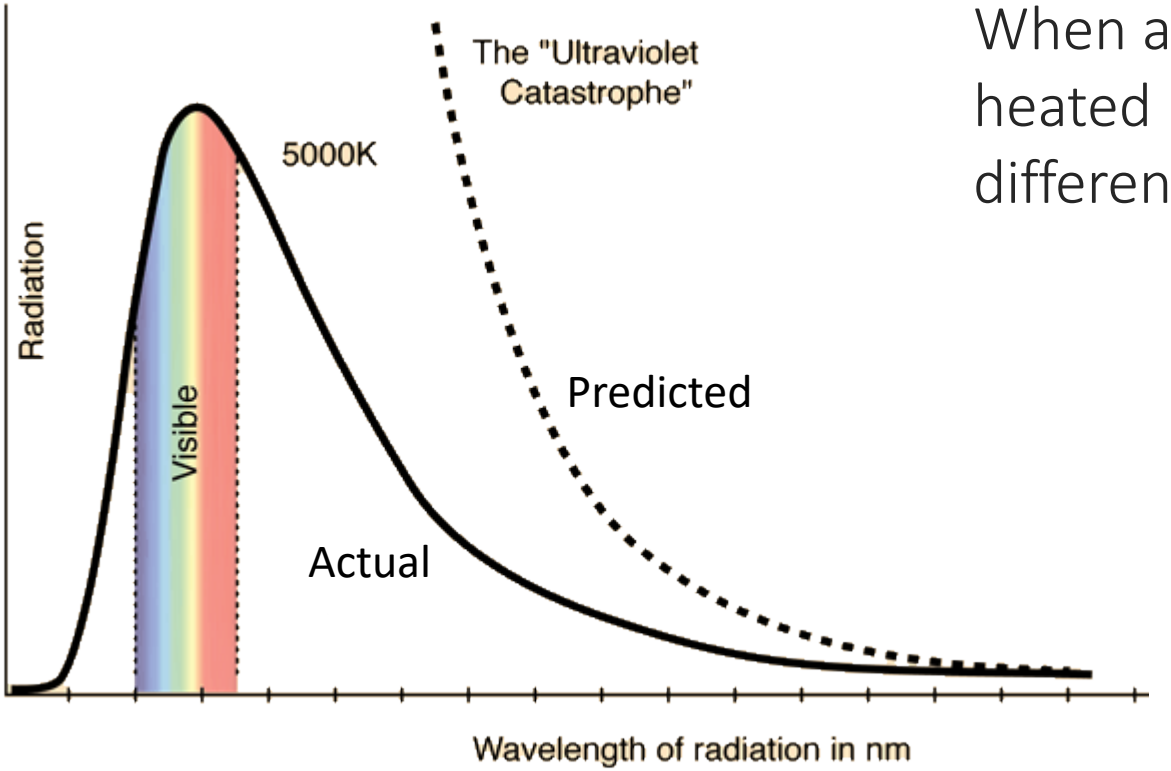
Proportionality

How much more heat energy is radiated from an 80°C cup of water than from a 20°C cup of water?

**Careful! Temperature must be converted into Kelvin*

$$P = e\sigma AT^4$$

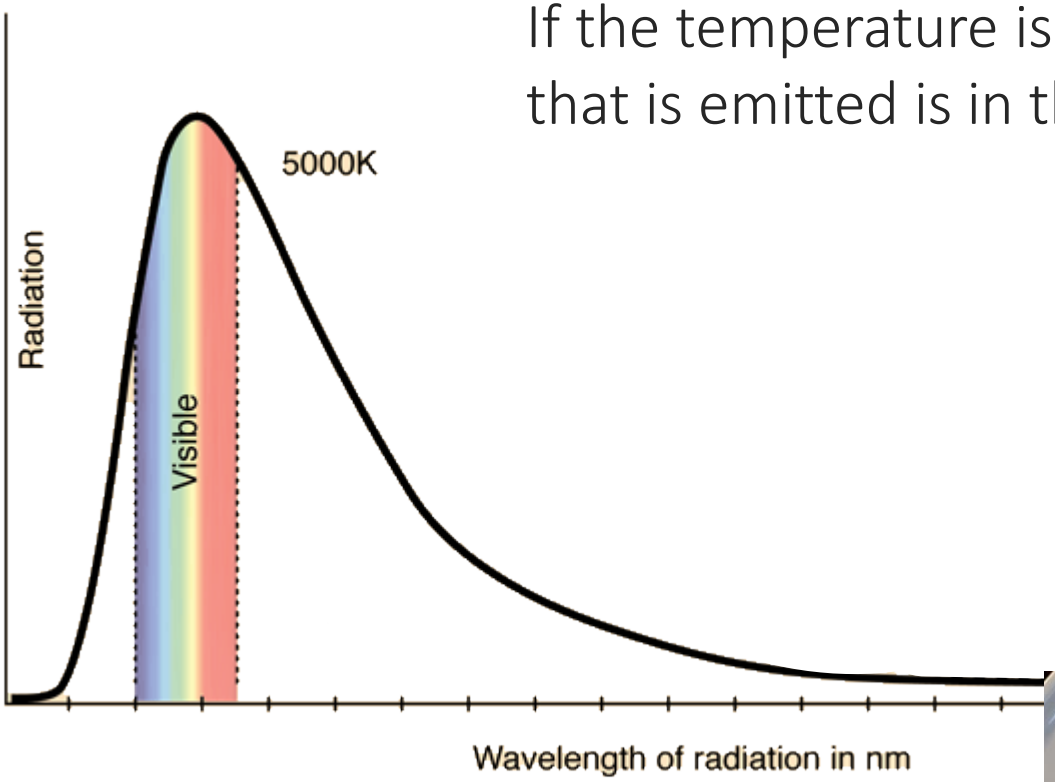
Radiated Energy

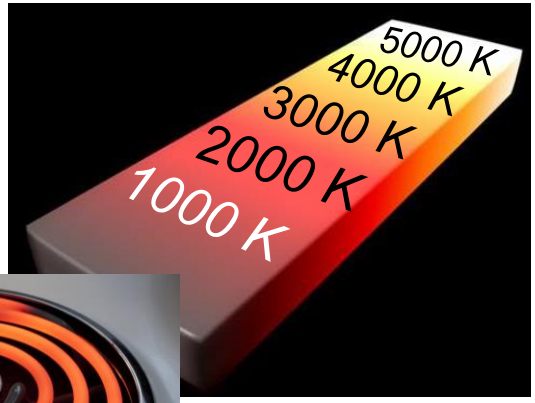


When a black body radiator is heated up, it emits a range of different wavelengths

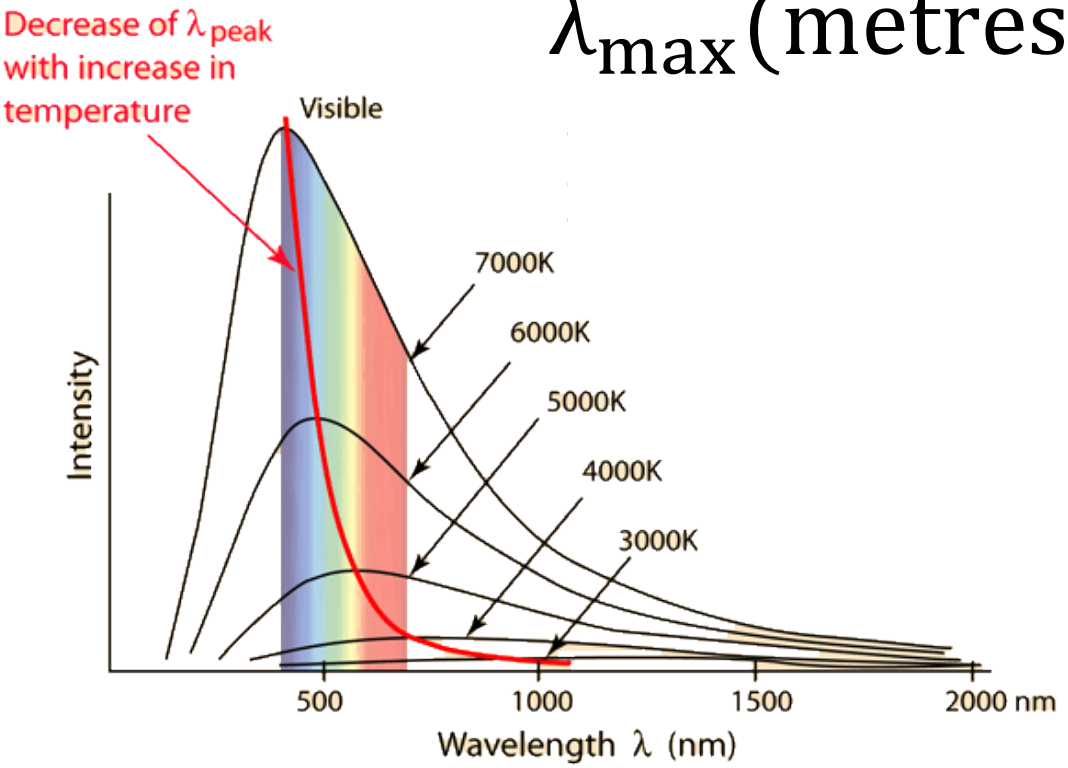
Glowing Hot

If the temperature is high enough the radiation that is emitted is in the visible spectrum





Wien's Displacement Law



$$\lambda_{max}(\text{metres}) = \frac{2.90 \times 10^{-3}}{\text{T (kelvin)}}$$

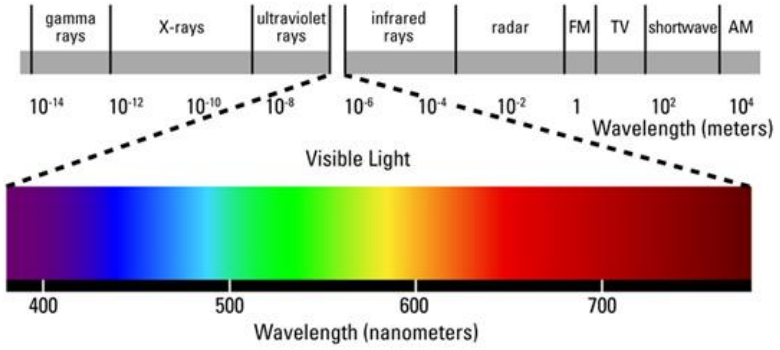
*Note: This assumes perfect blackbody radiation

Try This

$$\lambda_{max}(\text{metres}) = \frac{2.90 \times 10^{-3}}{\text{T (kelvin)}}$$

At what wavelength is the emitted radiation of the Sun maximized if it has a surface temperature of 5780 K?

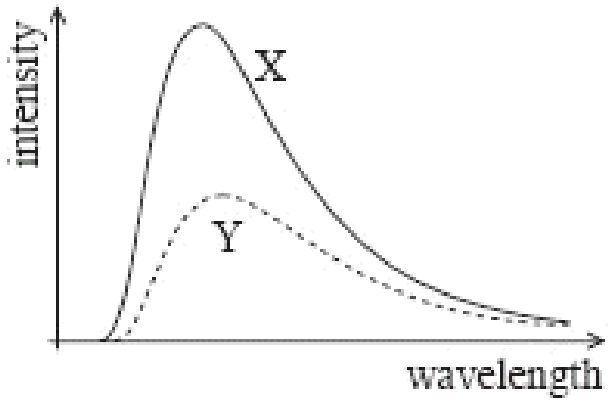
What is the most prevalent color of sunlight?



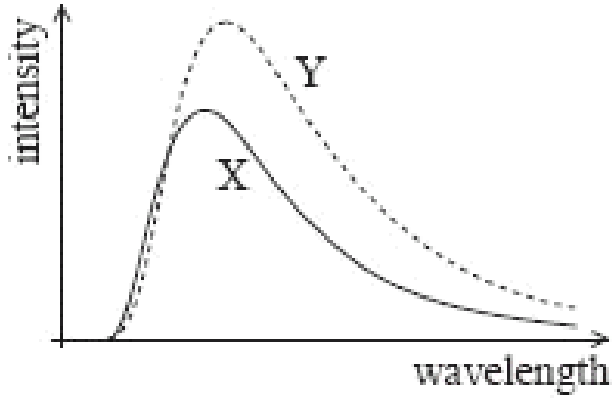
Sample IB Question

Two black bodies X and Y are at different temperatures. The temperature of body Y is higher than that of body X. Which of the following shows the black body spectra for the two bodies?

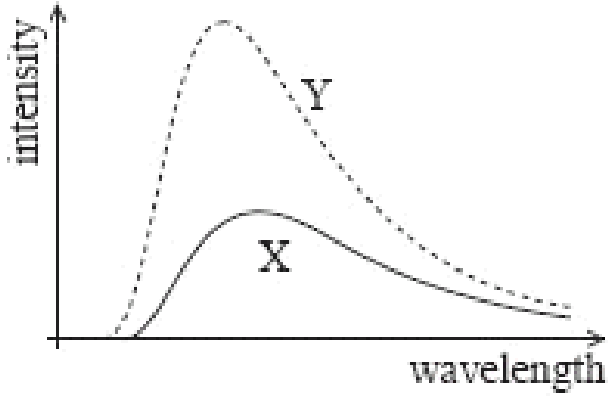
A.



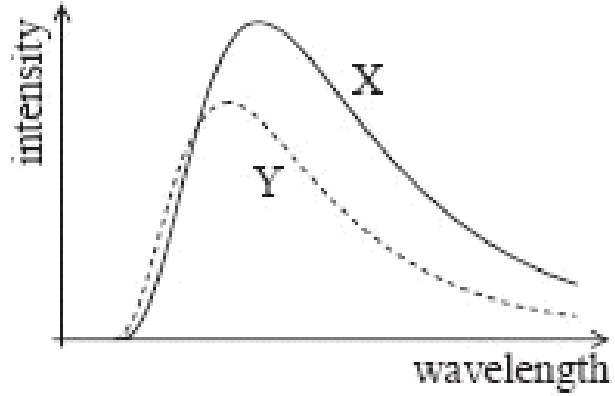
B.



C.



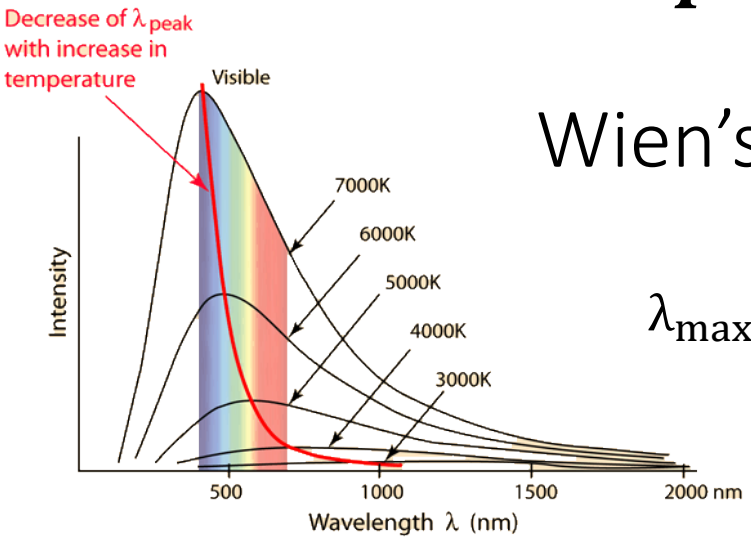
D.



Takeaways from Today

Know the difference between:

- Conduction
- Convection
- Radiation



Black Body Radiators

Emissivity

Stefan-Boltzmann Law

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Wien's Displacement Law

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