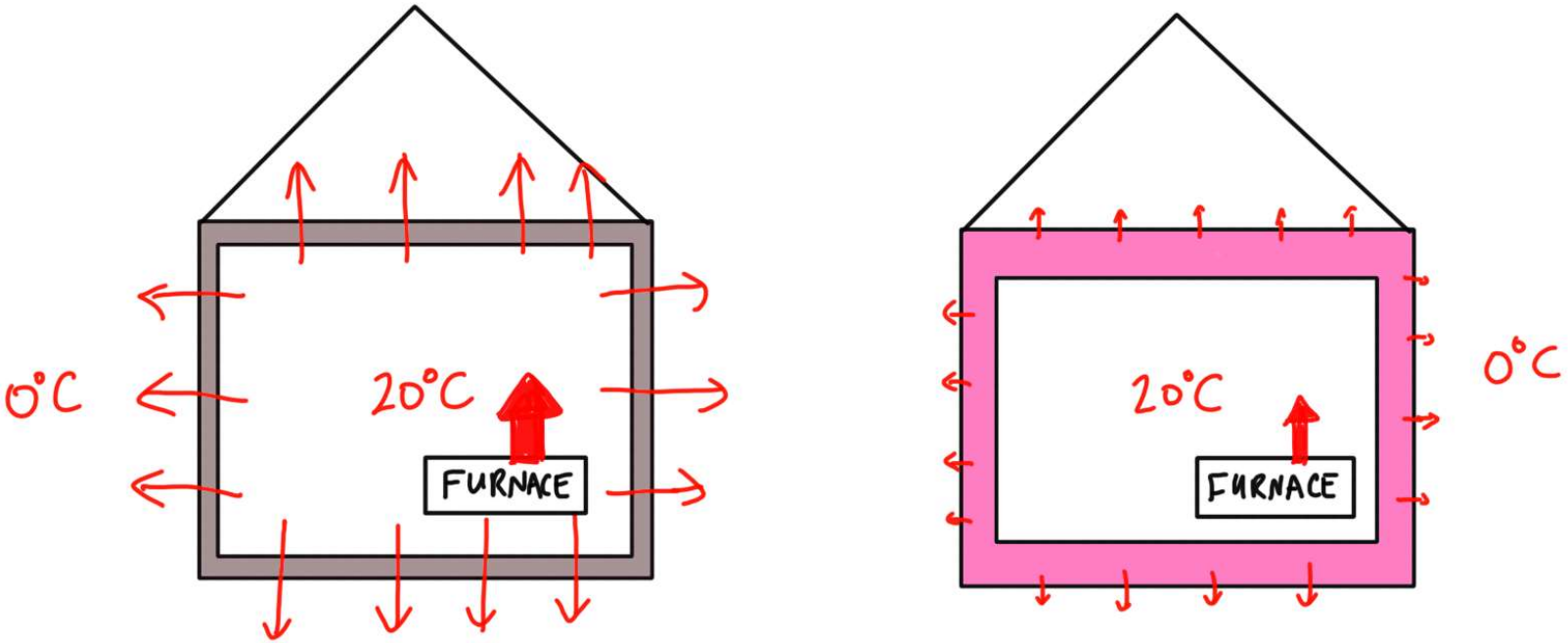
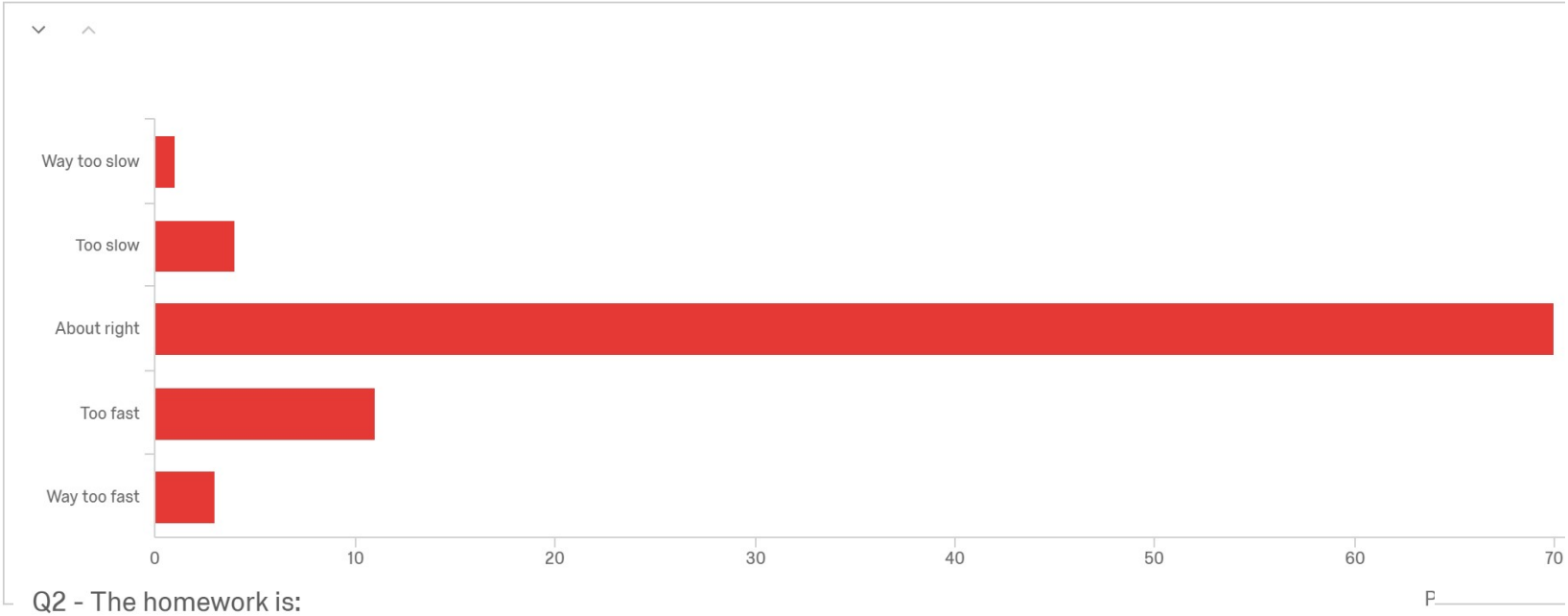
Office hours today: 3-5pm Hennings 420



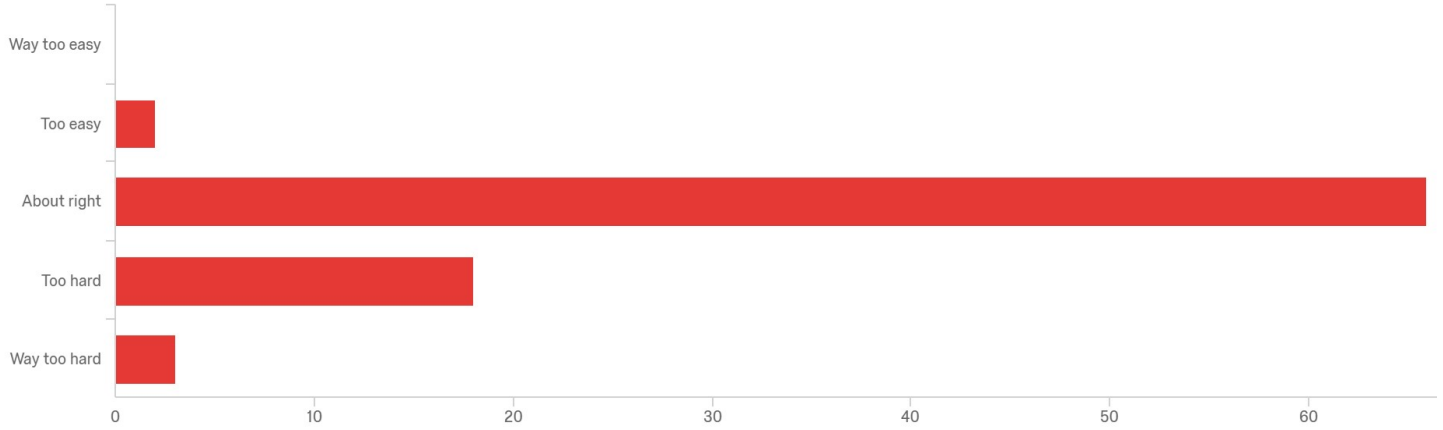
The second house has insulation that is twice as thick and made with a material that has half the thermal conductivity. To maintain the same inside temperature, the amount of fuel needed to be burned by the furnace in the second house is:

A) The same B) 1/2 as much C) 1/4 as much
D) 1/8 as much E) 1/16 as much

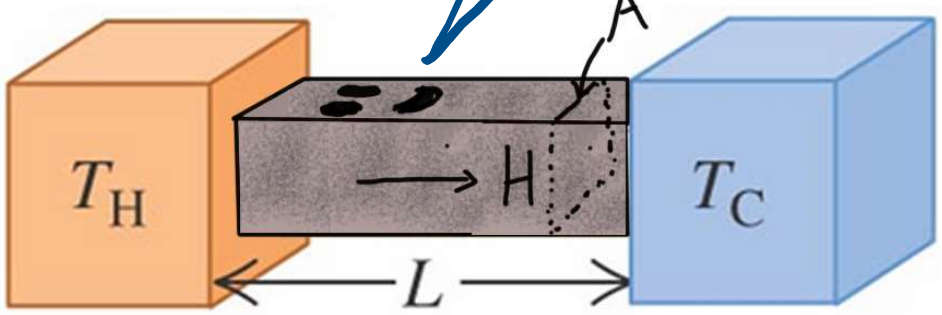
Q1 - The pace of the course is:



Q2 - The homework is:



Last time in Phys 157...



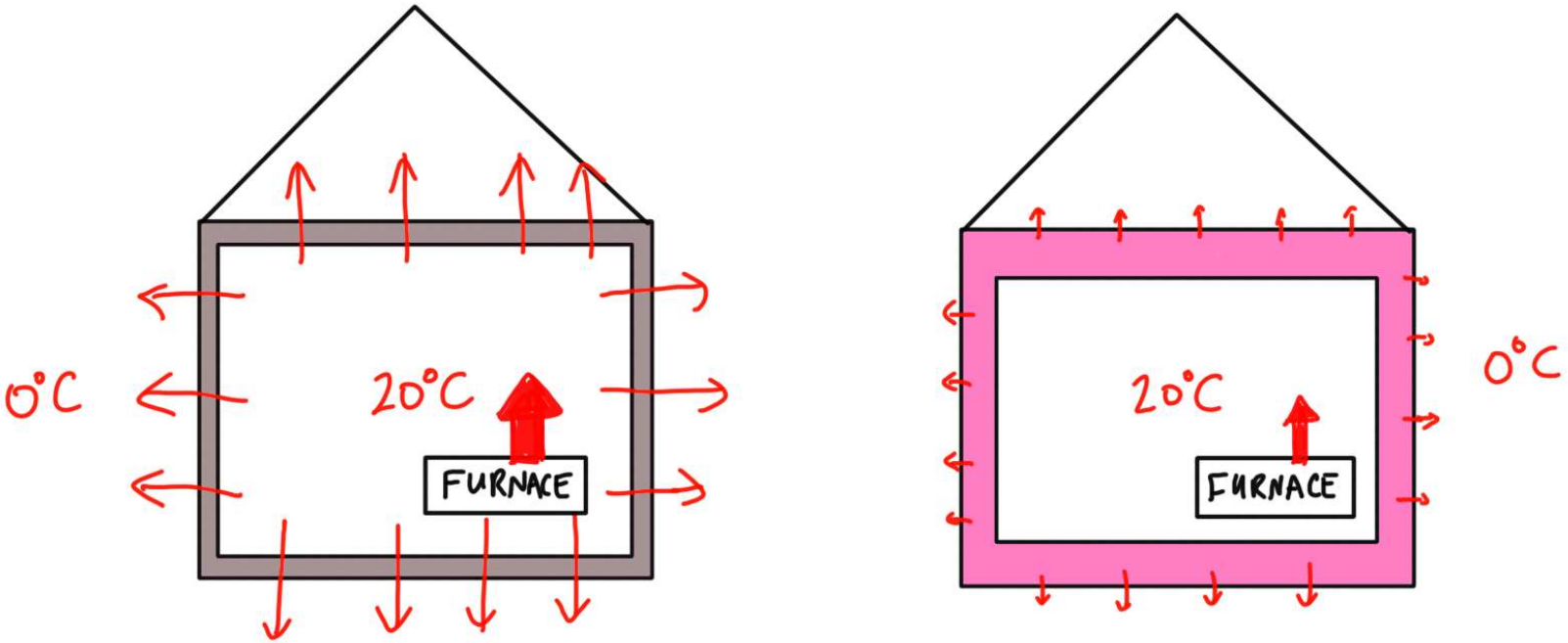
$$H = kA\frac{T_H - T_C}{L}$$

$\frac{T_H - T_C}{L}$ } temperature gradient

Heat current = Heat per time

Thermal conductivity

Application: insulation



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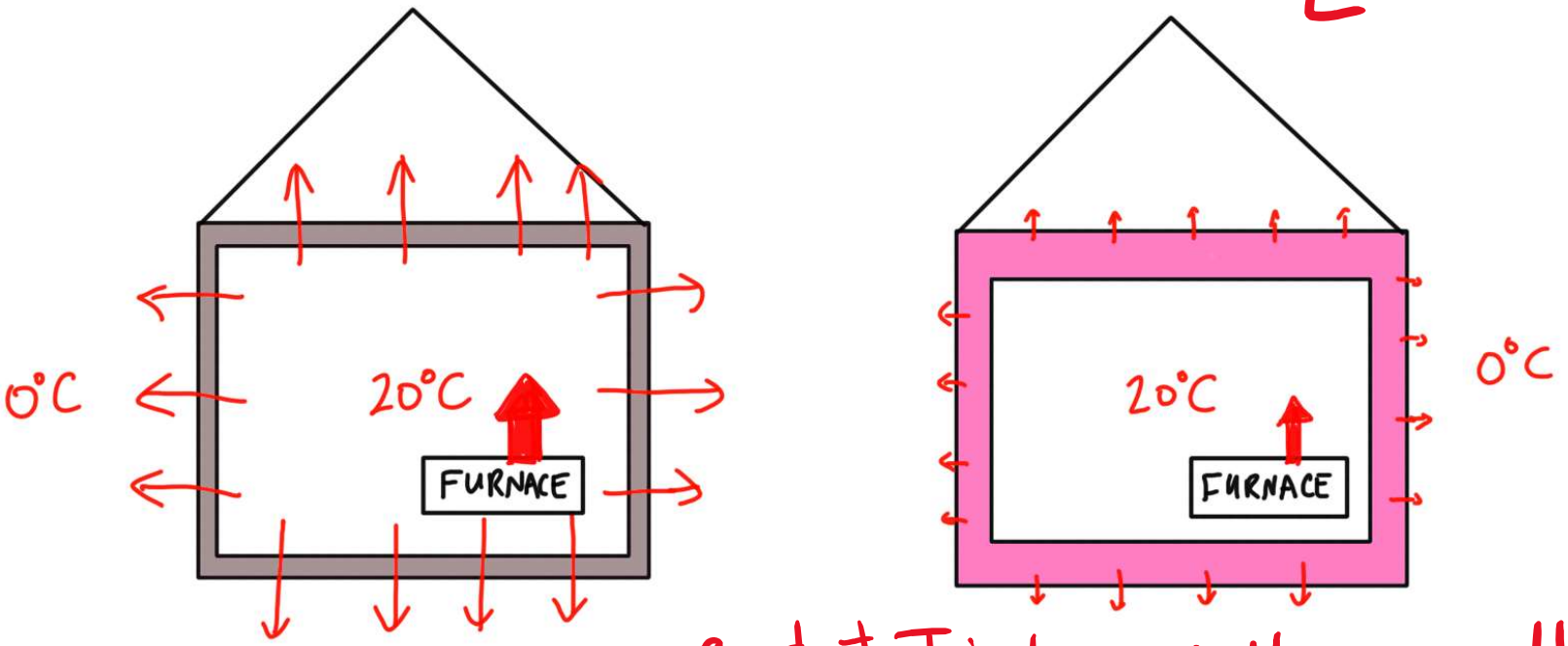
Application: insulation

$$H = kA\cdot\frac{T_H - T_C}{L}$$



Constant T in house ⇒ $H_{furnace} = H_{through\ walls}$

The second house has insulation that is twice as thick and made with a material that has half the thermal conductivity. To maintain the same inside temperature, the amount of fuel needed to be burned by the furnace in the second house is:

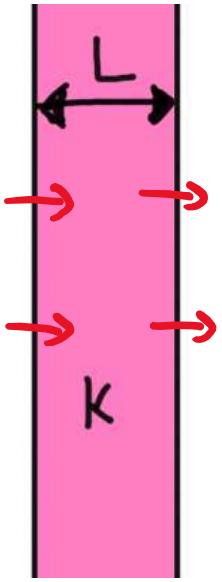
L is double
k is half

A) The same B) 1/2 as much C) 1/4 as much

D) 1/8 as much E) 1/16 as much

∴ H is $\frac{1}{4}$

THERMAL RESISTANCE: measures effectiveness of insulation layer



$$R = \frac{L}{K}$$

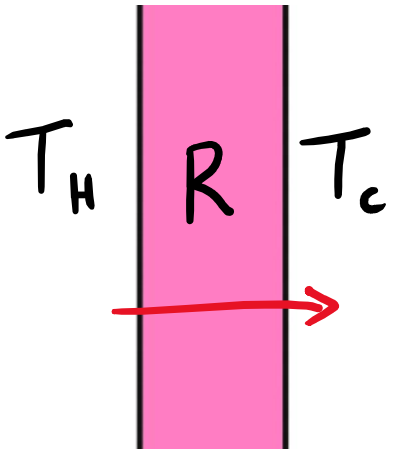
L ← thickness

K ← thermal conductivity

"R-value" is this quantity in units of

$$ft^2 \cdot F^\circ \cdot \frac{hours}{Btu}$$

Larger is better

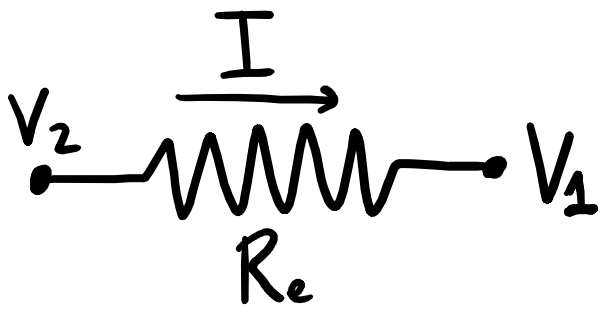


$$\frac{H}{A} = \frac{T_H - T_c}{R}$$

heat current per area

thermal resistance $\frac{L}{k}$

Analogy with electrical resistance + Ohm's Law:

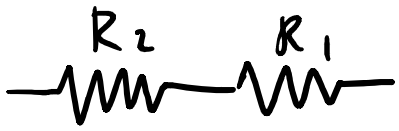


$$I = \frac{V_2 - V_1}{R_e}$$

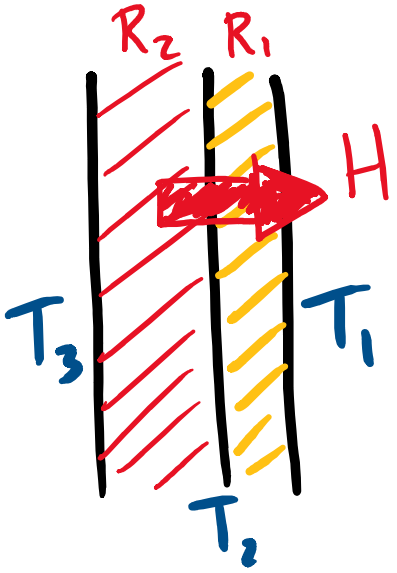
current

electrical resistance

R values add for multiple layers



$R = R_1 + R_2$



$R = R_1 + R_2$

How to show this:

$$T_3 - T_2 = \frac{H}{A} \cdot R_2$$

$$T_2 - T_1 = \frac{H}{A} \cdot R_1$$

Add these:

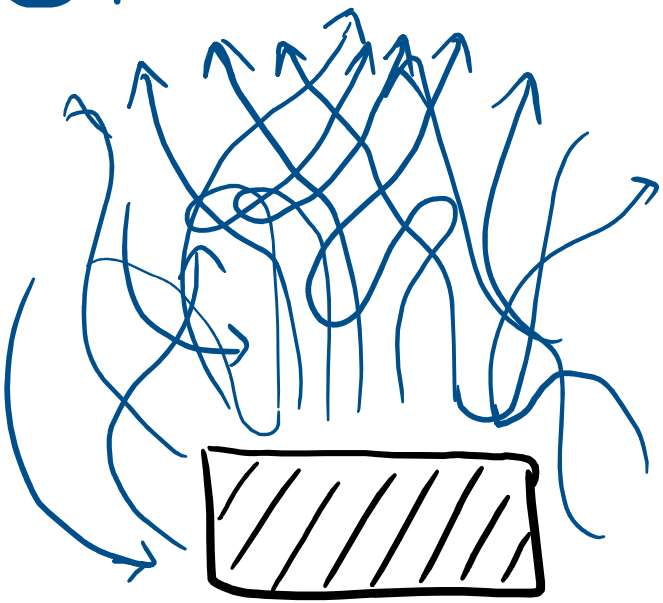
$$T_3 - T_1 = \frac{H}{A}(R_1 + R_2)$$

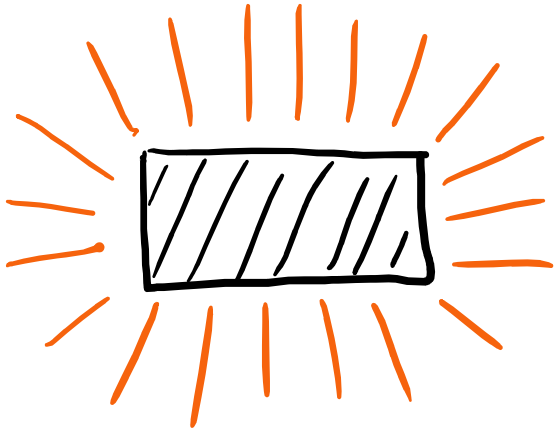
net temp. difference

heat current

net resistance

Other mechanisms for heat transfer:





CONVECTION: heat transfer via macroscopic motion of fluids

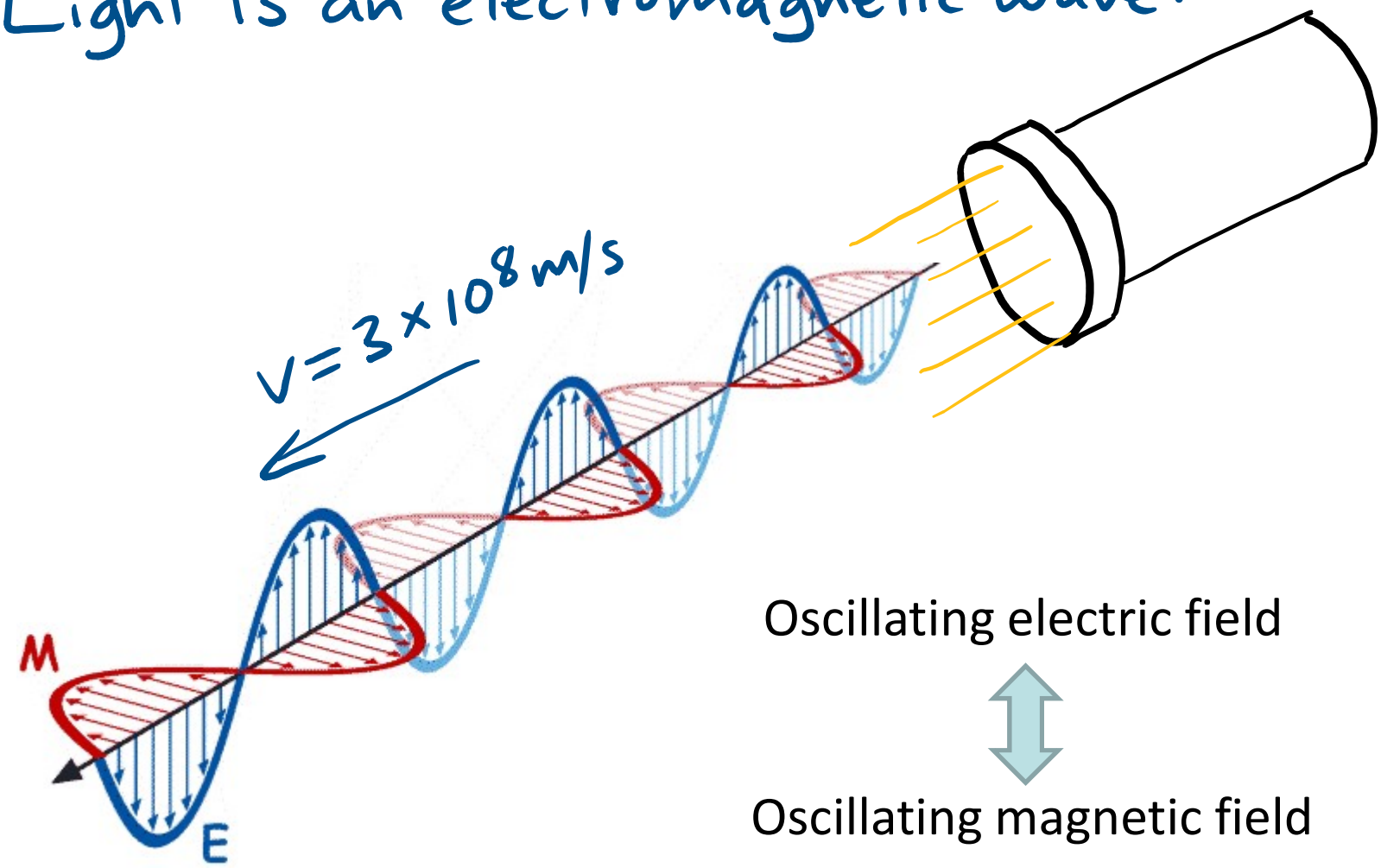
- very complicated fluid dynamics to understand

RADIATION: all objects give off electromagnetic radiation (light, IR, etc...)

- this carries energy away from the object

ELECTROMAGNETIC RADIATION:

Light is an electromagnetic wave:



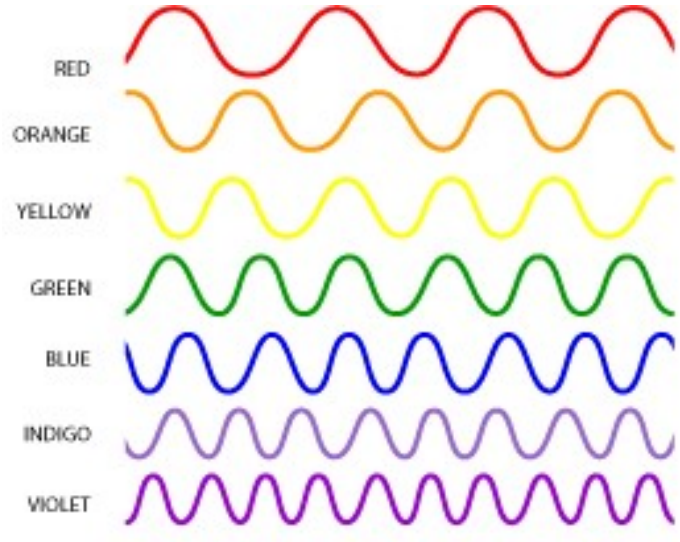
Oscillating electric field

Oscillating magnetic field

James Clerk Maxwell 1864

Properties of Light

Colour: determined by wavelength



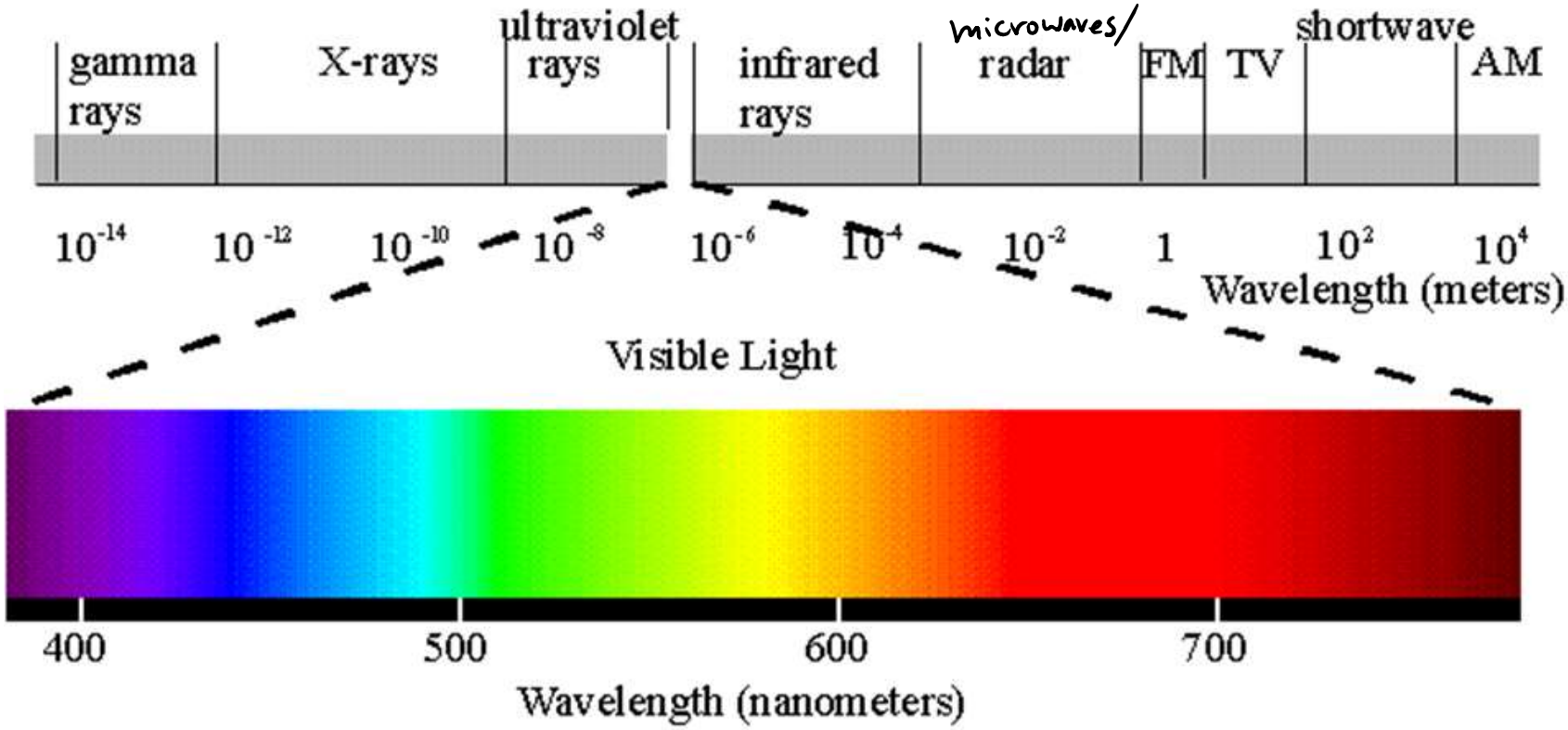
Intensity/brightness: determined by amplitude

↳ light carries energy!

Can have electromagnetic waves at all wavelengths:

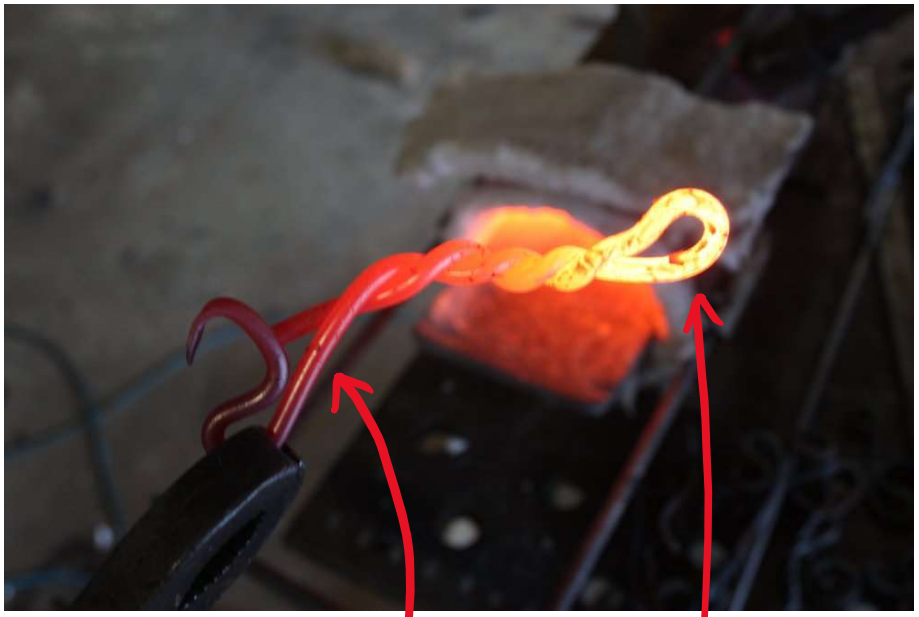
$V = 3 \times 10^8 m/s$

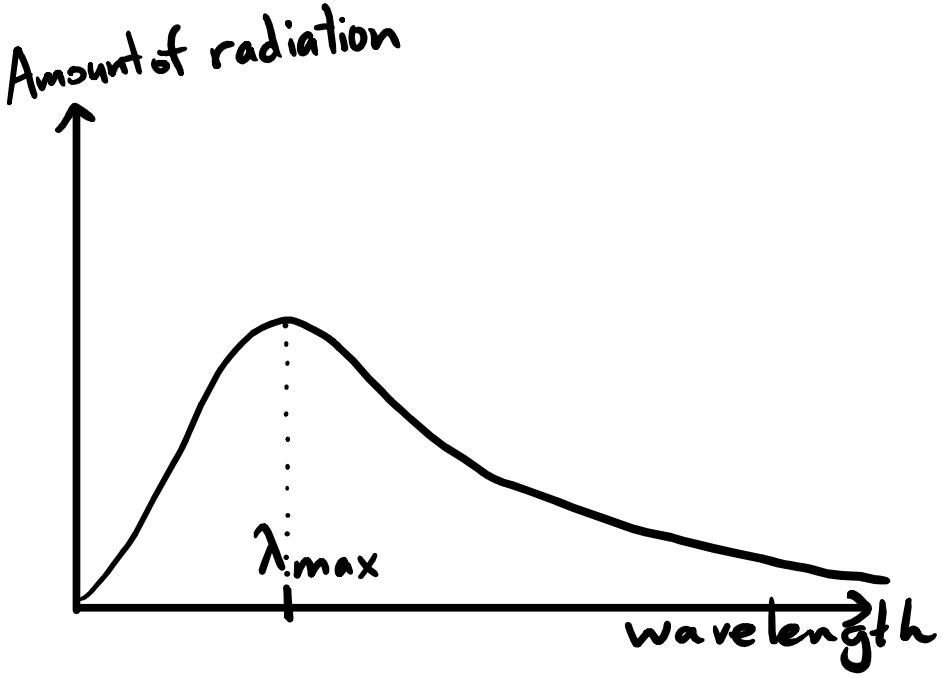
$V = 3 \times 10^8 m/s$

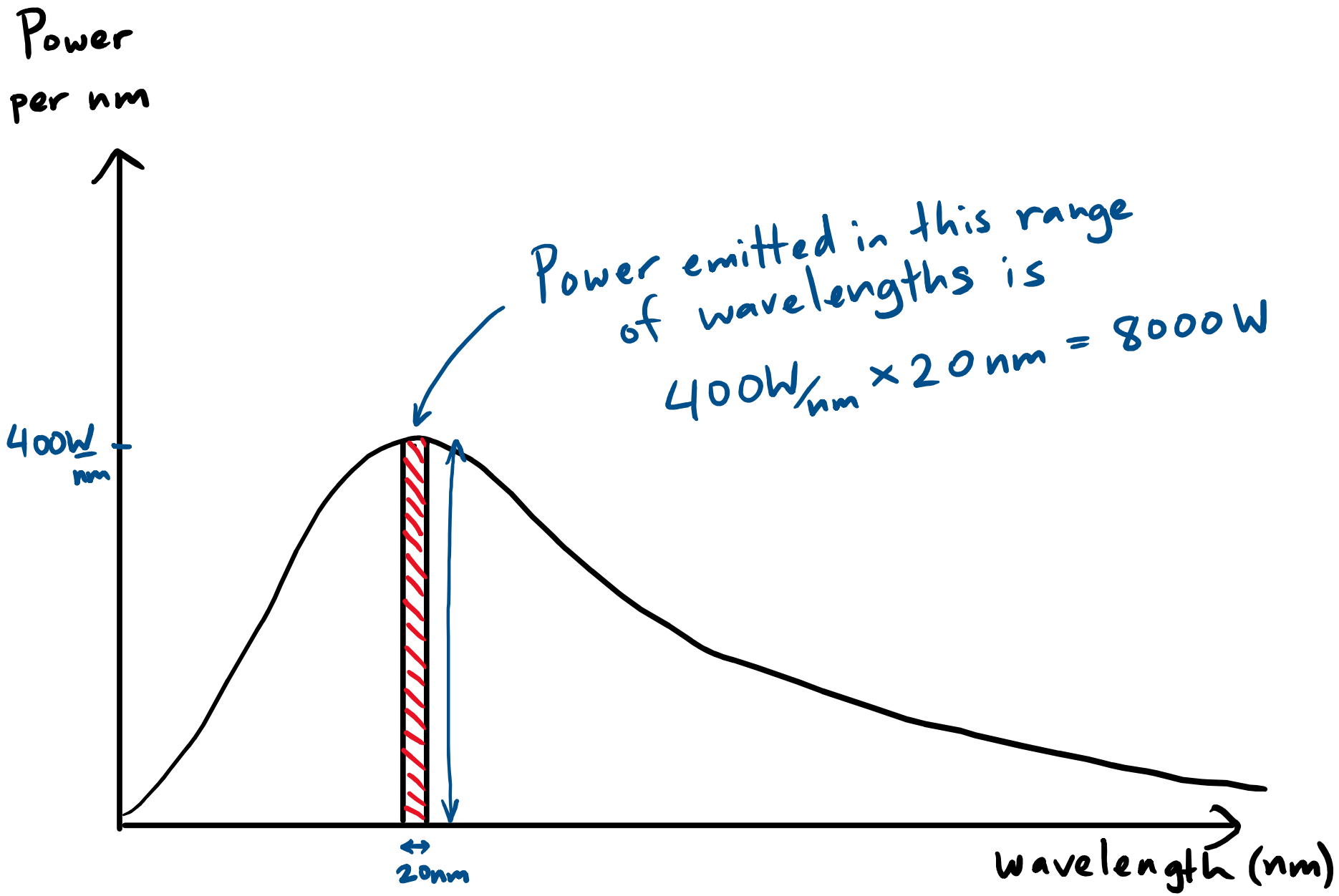


Thermal radiation from an object:

- typically in IR / visible
- can measure energy current at various wavelengths = spectrum






Power
per nm
400W/nm
Power emitted in this range of wavelengths is
400W/nm × 20nm = 8000W
20nm
wavelength (nm)

The spectrum for a certain lightbulb is shown. The total power of the bulb is closest to

A) 0.1W B) 1W C) 10W

D) 100W E) 1000W