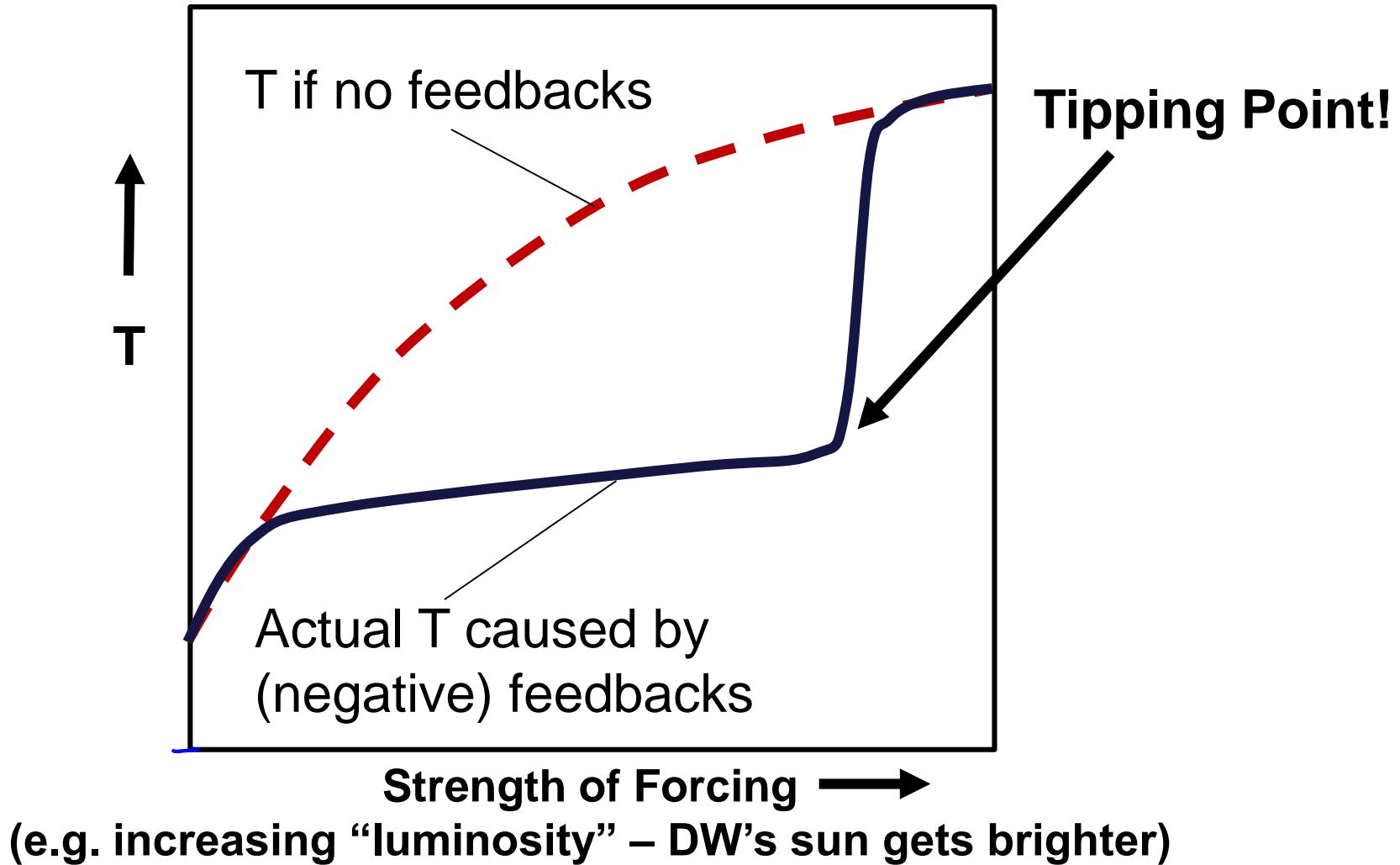


Feedback Effect –DW Example



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- A system with both negative and positive feedbacks can lead to ***“tipping points”*** – where the scary is
- Life can unintentionally affect climate
 - But to what extent? Negative feedbacks often noted, but positive ones too

Daisy World Fun

- [Daisy World Simulator](#)
- <http://www.gingerbooth.com/flash/daisyball/DaisyBall.html>

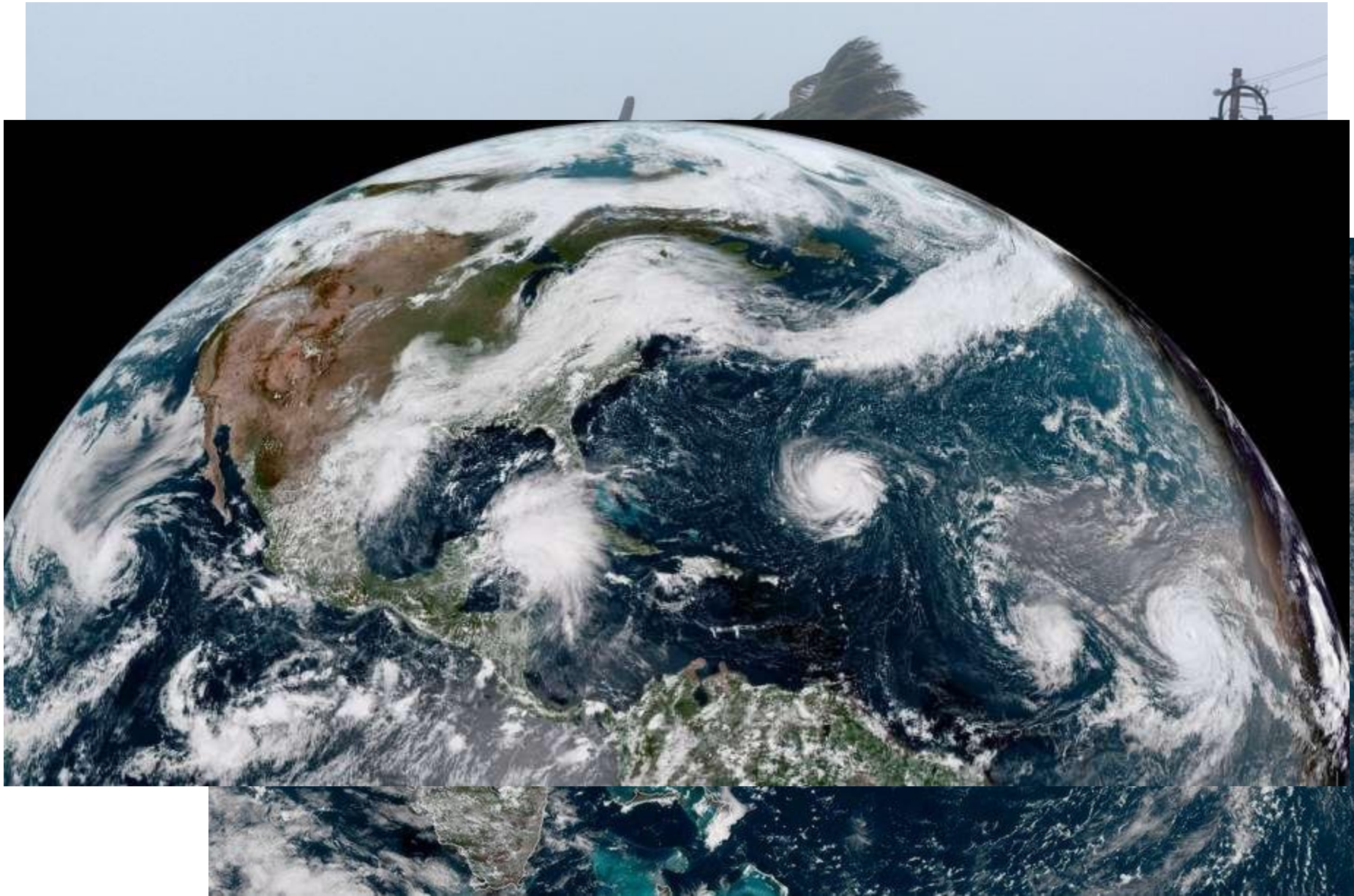
Energy in the Climate System



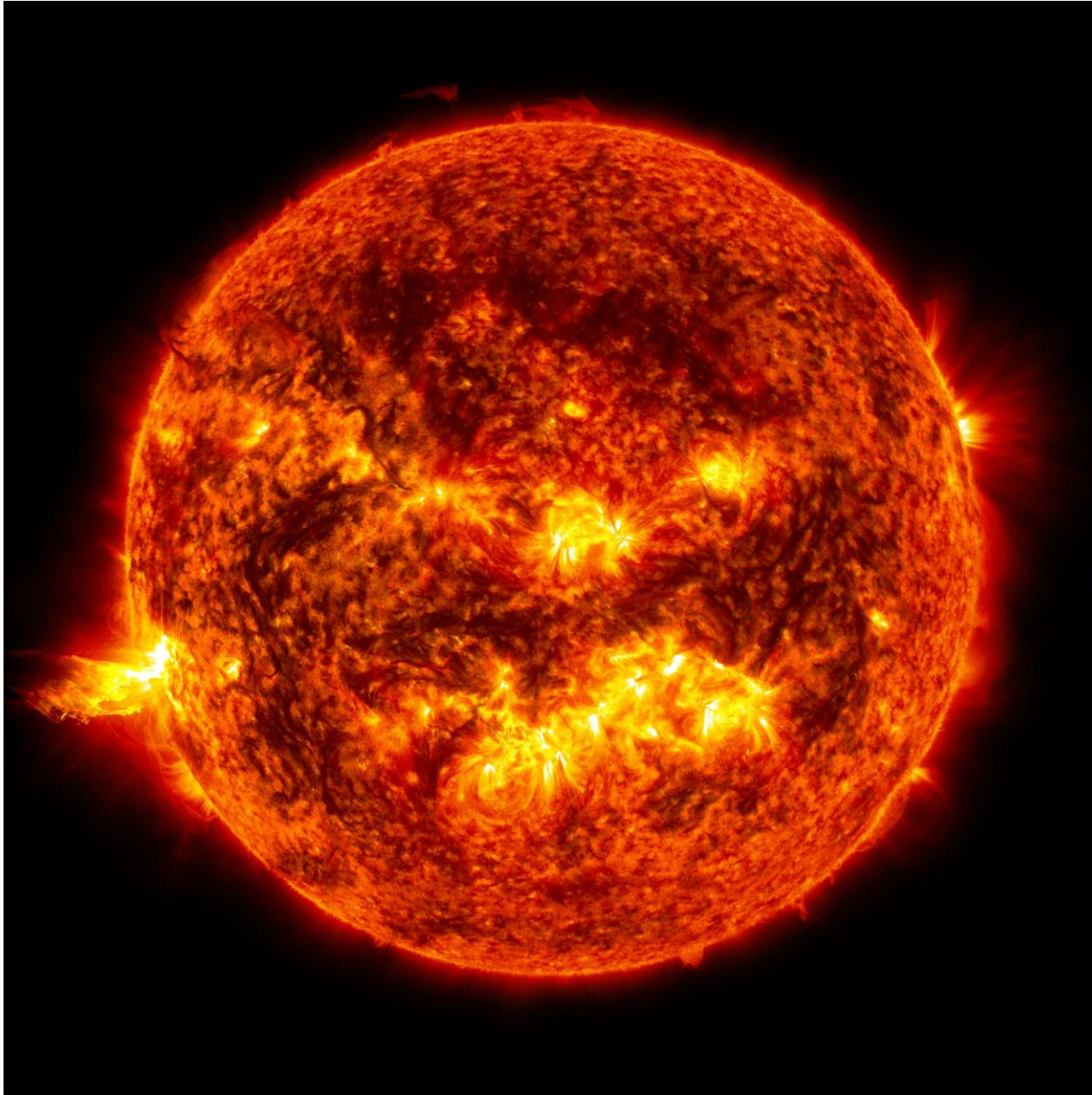
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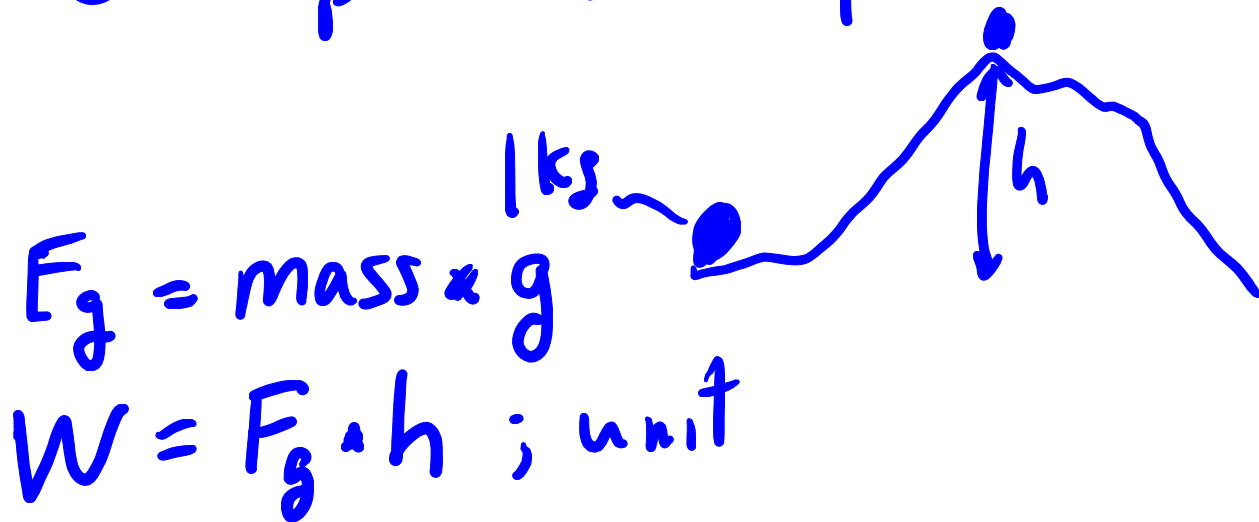
Energy in the Climate System



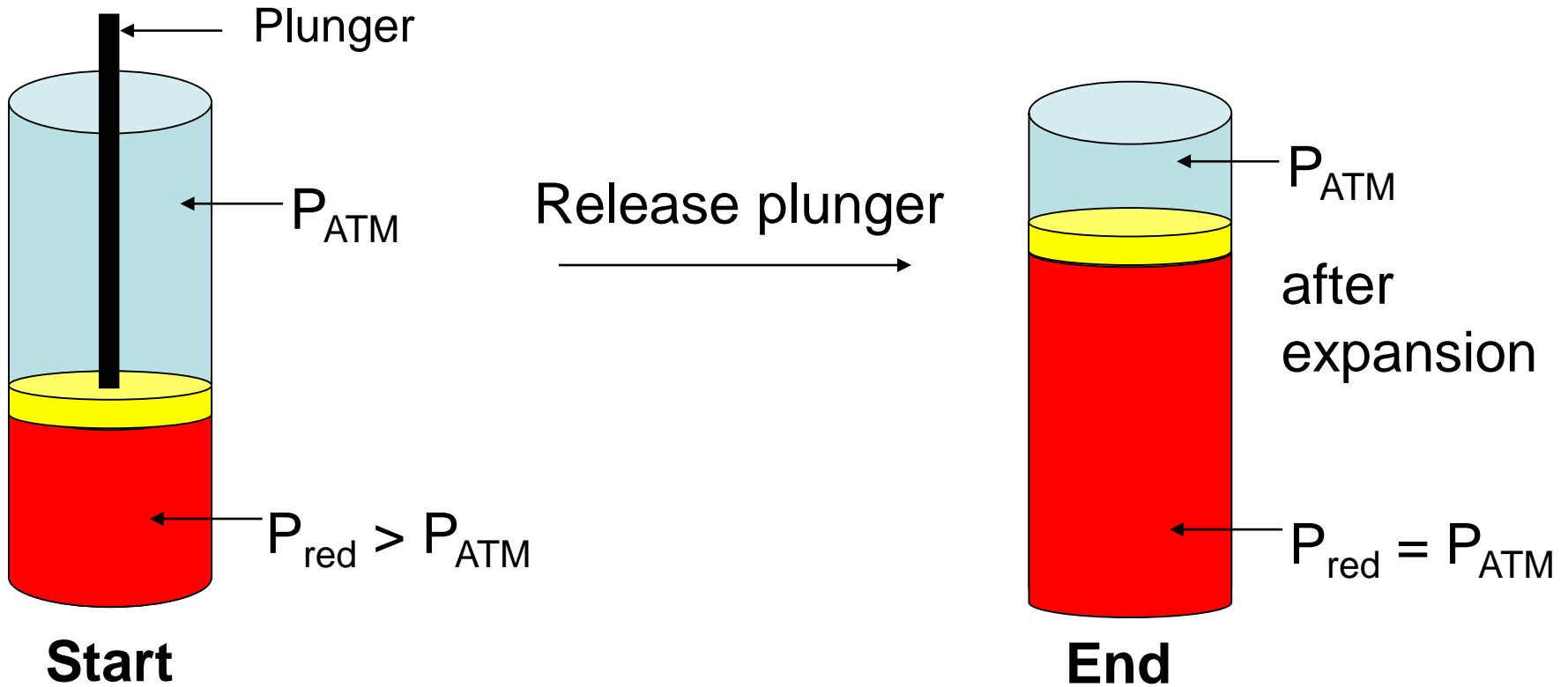
Energy: the capacity to do work

- Work = moving an object against a force
 - gravity, friction, pressure gradients

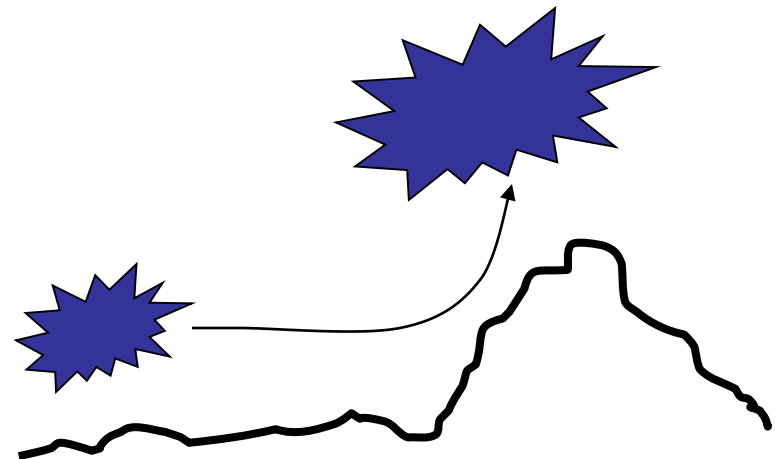
example: ball up a hill



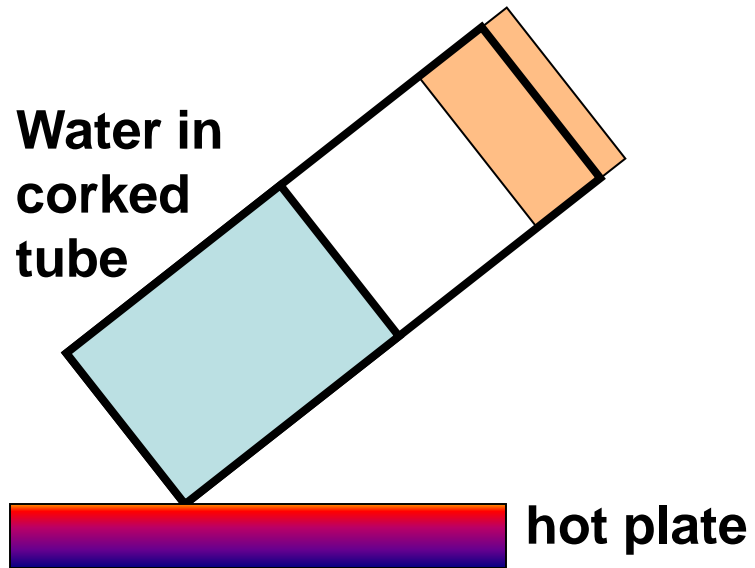
Mechanical (Expansion) Work



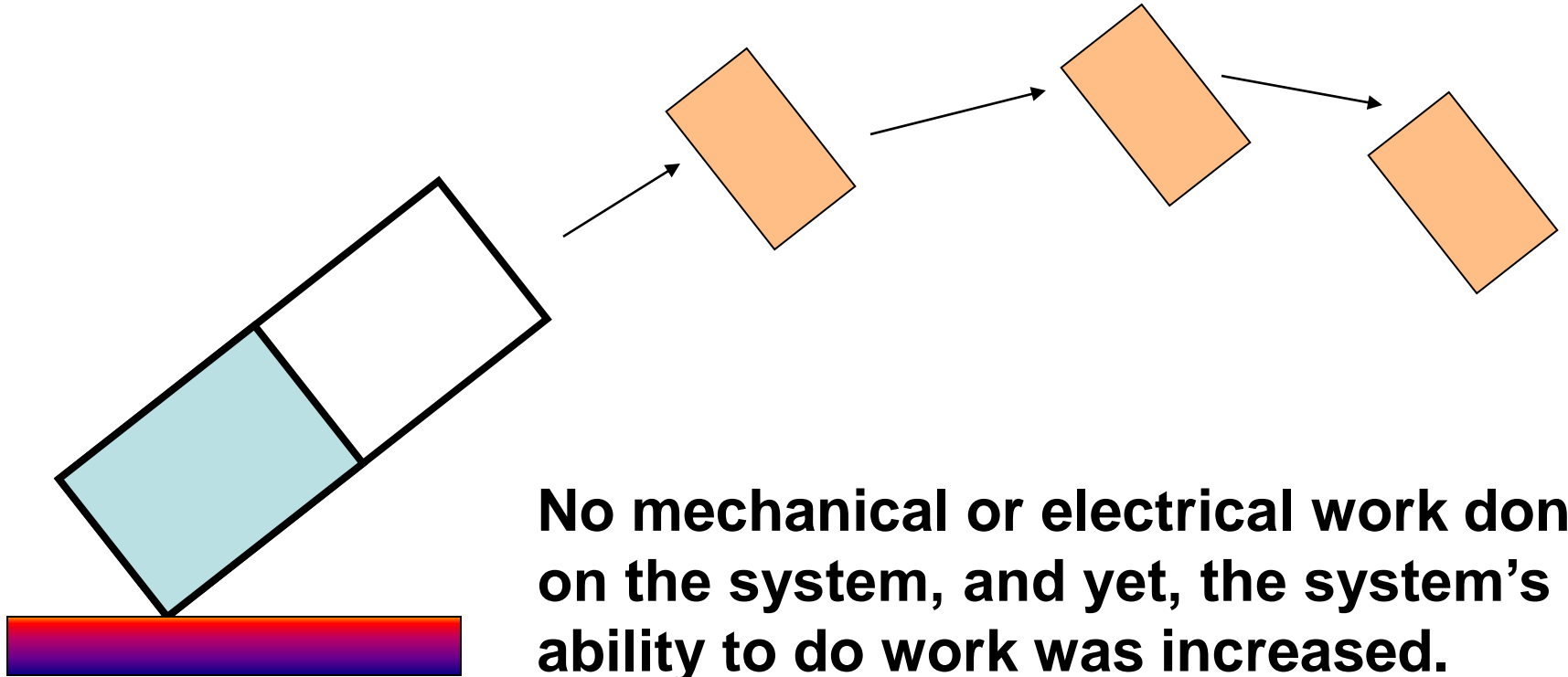
Connection to
atmospheric
motions



Something Else Besides Work

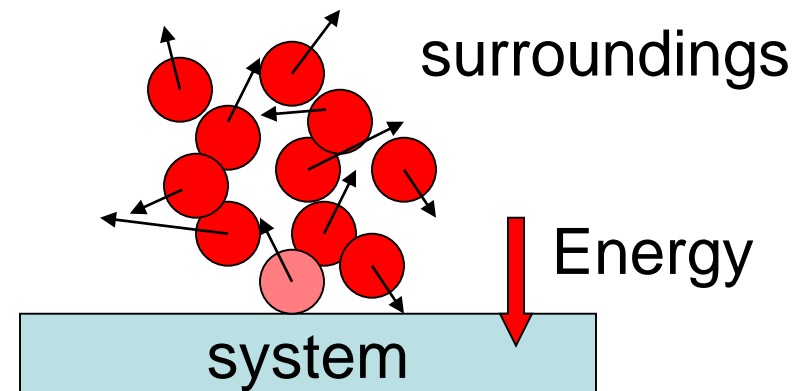
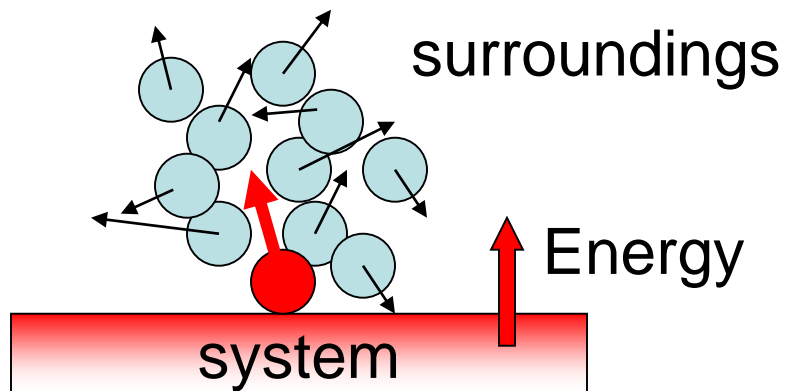


Something Else Besides Work



No mechanical or electrical work done on the system, and yet, the system's ability to do work was increased.

Heat: microscopic energy transfer



Heat transport through Earth components is a fundamental aspect of climate and weather

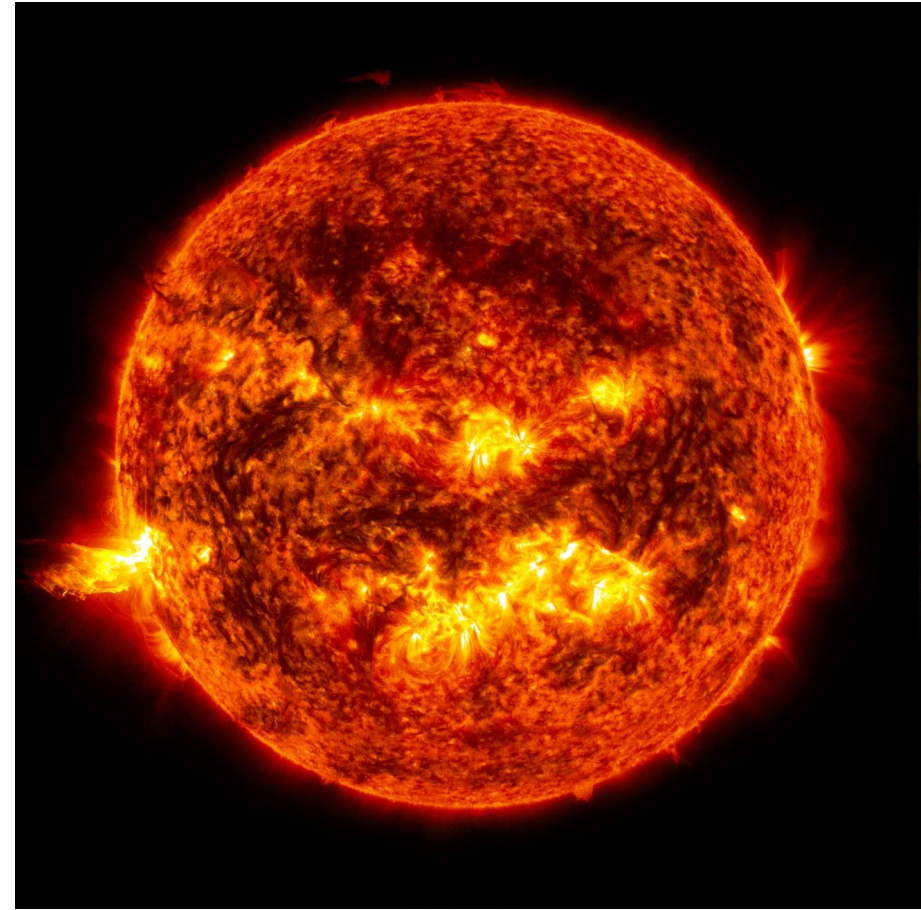
Heat and Temperature

- Temperature *is related to* heat, but temperature *is NOT* heat
- Temperature is a property of an object, heat is an *energy transfer process*
- Heat and temperature are related by an object's *heat capacity*

$$\Delta E = \Delta W + \Delta Q$$

- **1st Law of Thermodynamics**
- **When the energy of a system changes,**
 - **there has been a change in work done to or by the system**
 - **and/or a change in heat flow into or from the system**

Earth's Primary Energy Source



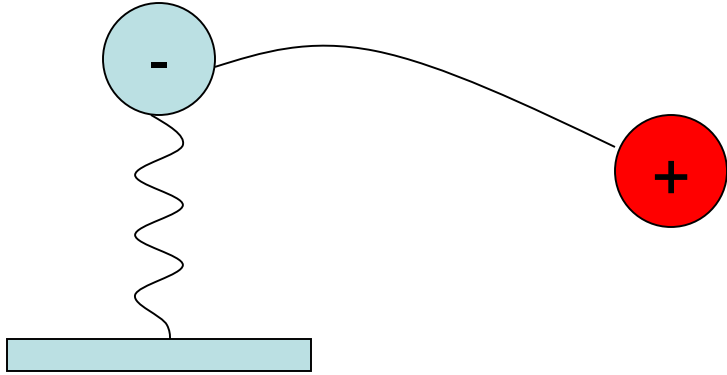
- Light is energy?
- How much energy does the Earth receive from the sun?

Charged Particle Motion



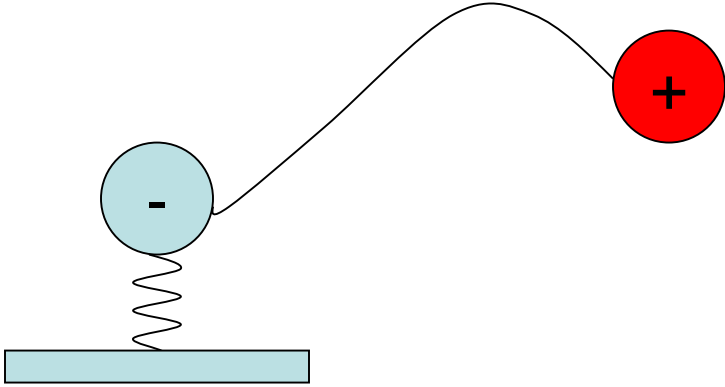
Electromagnetic field disturbance

Charged Particle Motion



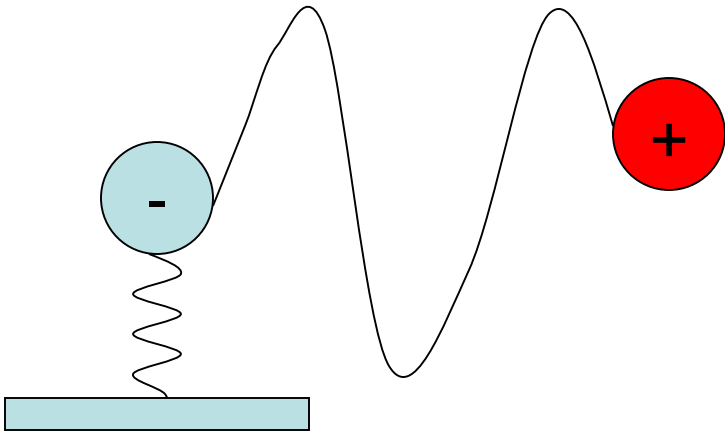
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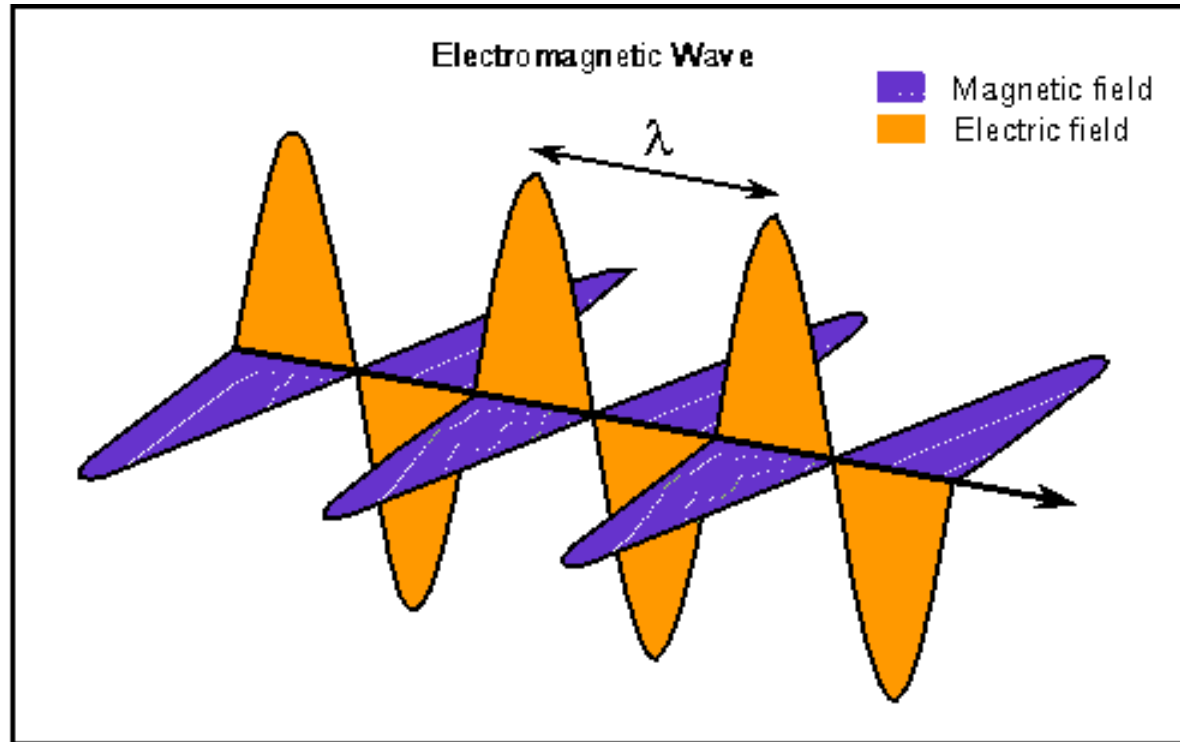
Charged Particle Motion



Oscillations in the electric and magnetic fields move, “radiate”, through space.

Such oscillations are known as **electromagnetic radiation (which encompasses light)**

Electromagnetic Radiation

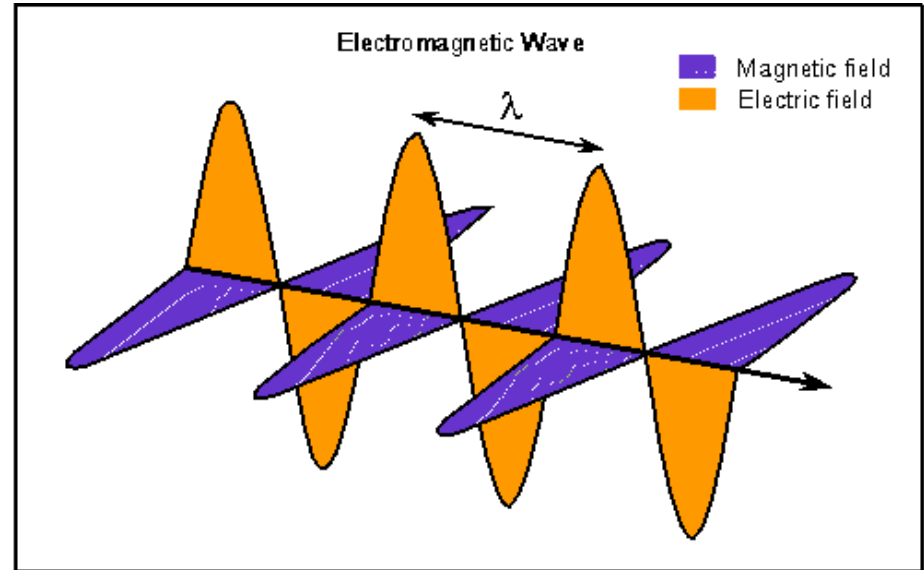


Wavelength (λ): distance between peaks: m, cm, μm , nm

Frequency (ν): # of full cycles passing a point per second: Hz

λ and ν related by speed of light (c): $\nu = c/\lambda$

Energy Carried by Radiation (Light)

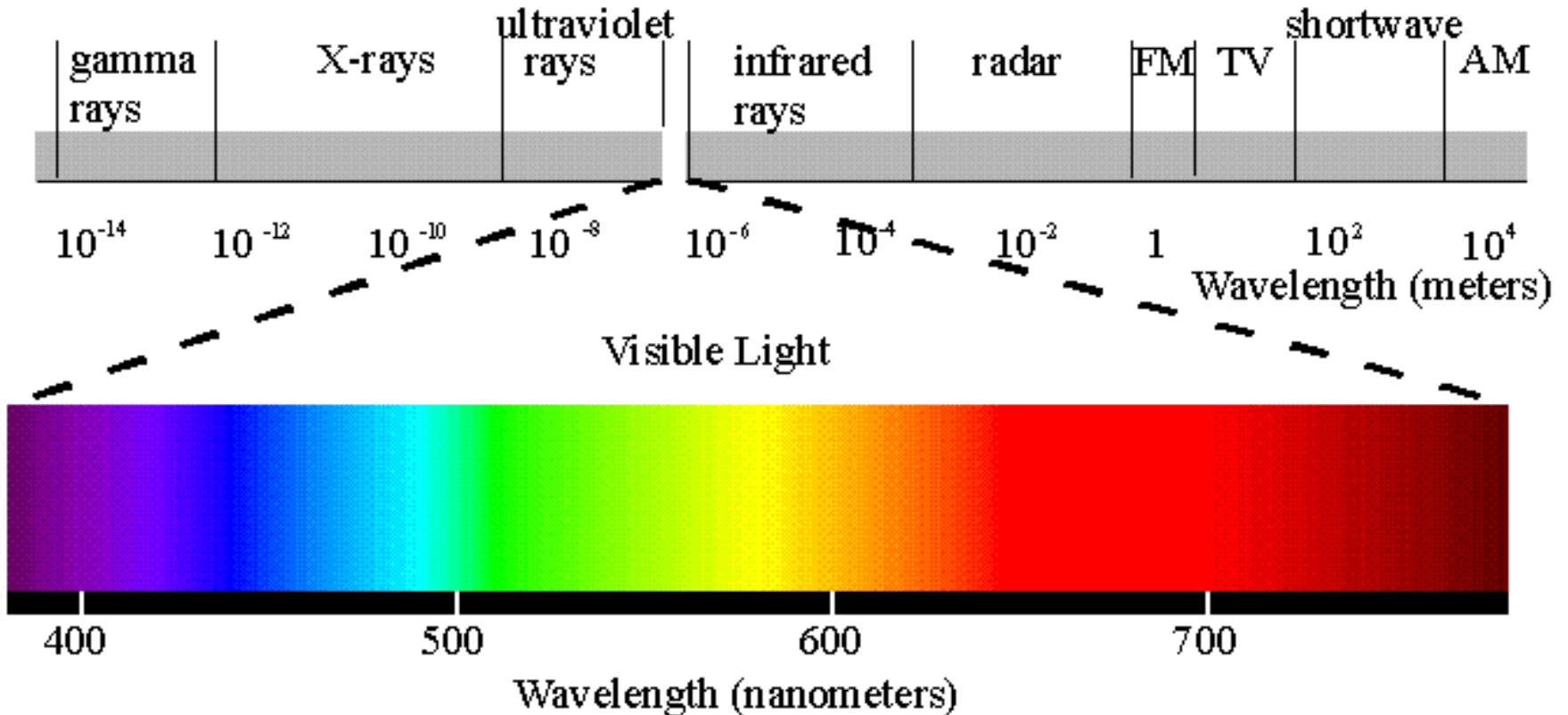


Electromagnetic Radiation Spectrum

Energy increases
this way



Wavelength increases
this way



W

Which part of the Jack-o-lantern is emitting more energetic photons

When poll is active, respond at PollEv.com/thornton211
Text **THORNTON211** to **22333** once to join



Blue

Orange

Red

Visual settings /

Activate

Show results

Show correct

Lock

Clear results

Fullscreen

Next

Previous

Total Results: 0

Energy Summary

- ❑ Energy is the capacity to do work – 1 **Joule** moves an object 1m against a force of 1 Newton
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- ❑ Radiation carries energy (as “photons”):
 - ❑ E_{photon} is proportional to the **frequency** (ν) and inversely proportional to the **wavelength** (λ) of the radiation