

PHYS 1200 Physics of Everyday Experience

Review questions and exercises for Lecture 18 (T-3)

1. What is thermal radiation?
2. How are the colors of visible light distinguished physically?
3. In terms of wavelengths, how does thermal radiation compare to visible light?
4. If the temperature of a radiating object is doubled, how does the intensity of the emitted radiation change?
5. What happens to an object if it absorbs more radiation than it emits?
6. Are shiny metallic objects good or poor emitters of thermal radiation?
7. Why is it better to wear light clothing in the summer?
8. In outer space heat transfer by convection and conduction cannot occur. How is thermal energy removed from a spacecraft?
9. You remove a roasted chicken from the oven but will not be ready to serve it for 15 minutes. What can you do to keep it from getting cold too fast?
10. Often when cooking a pie, the edges of the pie crust will get brown before the rest of the crust. What can be done to prevent the edges of the pie crust from burning?
11. If you want to keep an object cool, is it better to paint it with silver paint or black paint?
12. Two objects have the same temperature and the same emissivities but object A has an area of 2 m^2 and object B has an area of 10 m^2 . How much radiation is emitted per second from object A compared to object B?
13. Why does the inside of a car parked outside on a summer day get very hot?
14. What is the effect of CO_2 in the atmosphere?
15. Is the elimination of all greenhouse gases a good idea?
16. What are climate forcings?
17. What does the term anthropogenic refer to in terms of climate change?

Answers:

1. Thermal radiation is invisible electromagnetic radiation emitted by all hot objects.
2. The colors of the visible light spectrum are quantified in terms of the wavelength of the electromagnetic waves.
3. The wavelengths of thermal radiation are longer than visible light.
4. The intensity of thermal radiation is proportional to the temperature of the object raised to the 4th power. If the temperature increases by a factor of 2, the radiated power increases by a factor of $2^4 = 2 \times 2 \times 2 \times 2 = 16$.
5. If an object absorbs more radiation than it emits, its temperature will increase.
6. Shiny metallic objects are poor emitters of thermal radiation.
7. Light clothing absorbs less thermal radiation than dark clothing.
8. The only mechanism for heat removal on a spacecraft is by radiation.
9. The chicken should be covered immediately with aluminum foil. The rate of heat loss by radiation is proportional to T^4 . When it is hottest it radiates at its highest rate, so this heat loss must be reduced as soon as possible.
10. You should wrap the edges of the pie crust with Al foil which will reflect the heat.
11. You want to allow it to radiate as much heat as possible and dark (black) objects radiate more than light objects.
12. The rate of radiation emission is proportional to the area of the object. Therefore, $Q_A/Q_B = A_A/A_B = 10/2 = 5$.
13. Sunlight enters the car through the windows and heats up the inside of the car. The hot surfaces inside the car radiate energy in the infrared which is trapped in the car since infrared radiation is blocked by the glass windows. This is the greenhouse effect.
14. CO₂ molecules in the atmosphere reflect some of the thermal radiation emitted by the earth back to the earth.
15. The greenhouse effect regulates the earth's temperature. If there were no greenhouse effect, the average temperature of the earth would be – 20 F.
16. Climate forcings are effects that bring about changes in climate.
17. Anthropogenic effects are those that are attributed to human behavior. For example, the burning of fossil fuels produces CO₂.