Name: _____

Class: _____

Due Date: _____

Physics Topic 24 – Radiation and the Greenhouse Effect

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. State the law of conservation of energy.

2. C: Define *absorb*, *reflect* and *emit.*

3. State the definition, equation, and units for *emissivity*. What is the *emissivity* of a really dark colored object? What is the *emissivity* of a really light colored object?

4. State the definition, equation, and units for *albedo*. What is the *albedo* of a really dark colored object? What is the *albedo* of a really light colored object?

5. What is the mathematical relationship between the *albedo* and *emissivity* of an object?

6. C: Define *black body.*

7. A naked person has a surface area of $1.80\ \text{m}^2$, an emissivity of 0.980, and a skin temperature of 37.0°C. This naked person is in a room with room temperature of 20.0°C. How much energy does this person lose per minute?

8. By which factor does the power emitted by an object decrease when its temperature decreases from 800.0 K to 500.0 K?

9. On a hot summer day a forest receives an intensity of approximately $1{,}210\ \frac{\mathrm{W}}{\mathrm{m}^2}$. If the forest has an albedo of approximately 0.122 then determine how much energy is absorbed and reflected every second by each square meter.

10. The planet Saturn has an average surface temperature of -178°C and a radius of approximately 5.82×10^7 m. Suppose Saturn has an emissivity of approximately 0.650. Determine the rate of thermal energy emitted.

11. C: Define *luminosity L*. Units?

12. C: What does the *Stefan-Boltzmann law* tell us? State the equation and define each variable in the *Stefan-Boltzmann law*.

13. E: A spherical body of 5.00 cm in diameter is maintained at 700.°C. Assuming that it radiates as if it were a black body, at what rate (in Watts) is energy radiated from the sphere?

14. E: The average surface temperature of the Sun is 5.778×10^3 K and its average radius is 6.957×10^8 m. Assuming that it radiates as if it were a black body, at what rate (in Watts) is energy radiated from the sphere?

15. E: The radius of star X is four times that of star Y and its temperature is three times that of Y. Find the ratio of luminosity of Y to that of X.

16. E: A black body has a surface area of $4.00\ \text{m}^2$ and temperature of 450. K. The black body is in a closed room with room temperature of 293 K. How much energy does the black body lose per minute?

17.C: Define *apparent brightness b*. Units? What is the mathematical relationship between *apparent brightness b* and *luminosity L*?

18.E: The luminosity of the Sun is 3.846×10^{26} W and its distance from the Earth is about 1.50×10^{11} m. Determine the apparent brightness *b* of the Sun.

19.E: The apparent brightness of star X as observed from Earth is three times greater than that of star Y as observed from Earth. The luminosity of star X is two times greater than that of star Y. Determine the ratio of the distance of star Y to Earth to that of star X to Earth.

20. C: What does *Wien's displacement law* tell us? State the equation and define each variable for *Wien's displacement law*. Draw and label a graph describing *Wien's displacement law*.

21. E: The Sun emits electromagnetic waves with a maximum wavelength of 570. nm. According to this information what is the surface temperature of the Sun?

22. E: The maximum surface temperature of the red supergiant Betelgeuse is approximately 3.80×10^3 K. Determine the maximum wavelength emitted.

23. What is the meaning of the Sun-Earth *solar constant*?

24. The luminosity of the Sun is approximately 3.828×10^{26} W. The average distance from the Sun to Earth is 1.5×10^{11} m. Use the equation $I = \frac{P}{A} = \frac{P}{4\pi d^2}$ to determine the Sun-Earth *solar constant*.

25. Describe the equation $\bar{I} = \frac{P}{A} = \frac{S}{4}$.

26. The average albedo of Earth is approximately 0.300 and the average emissivity of the Earth is approximately 0.600. Use the solar constant to determine the average temperature of the Earth.

27. The average albedo of Earth is approximately 0.300. Use the solar constant to determine the average intensity reaching the Earth during the day or night.

28. Define the *greenhouse effect* and the *enhanced greenhouse effect*. What are the four major *greenhouse gases*? State their name and chemical formula.

Browse these websites for more information on climate change.

The world's most viewed site on global warming and climate change
www.wattsupwiththat.com

Climate Depot: Redefining Global Warming Reporting
https://www.climatedepot.com/

Part 3: Explain what went wrong from these climate predictions

https://cei.org/blog/wrong-again-50-years-of-failed-eco-pocalyptic-predictions/

https://extinctionclock.org/

https://mishtalk.com/economics/lets-review-50-years-of-dire-climate-forecasts-and-what-actually-happened/

1. 1967 Salt Lake Tribune: Dire Famine Forecast by 1975, Already Too Late
2. 1969 NYT: "*Unless we are extremely lucky, everyone will disappear in a cloud of blue steam in 20 years. The situation will get worse unless we change our behavior.*"
3. 1970 Boston Globe: Scientist Predicts New Ice Age by 21st Century said James P. Lodge, a scientist at the National Center for Atmospheric Research.
4. 1971 Washington Post: Disastrous New Ice Age Coming says S.I. Rasool at NASA.
5. 1972 Brown University Letter to President Nixon: Warning on Global Cooling
6. 1974 The Guardian: Space Satellites Show Ice Age Coming Fast
7. 1974 Time Magazine: Another Ice Age "Telling signs everywhere. Since the 1940s mean global temperatures have dropped 2.7 degrees F."
8. 1974 "Ozone Depletion a Great Peril to Life" University of Michigan Scientist
9. 1976 NYT The Cooling: University of Wisconsin climatologist Stephen Schneider laments about the "deaf ear his warnings received."
10. 1988 Agence France Press: Maldives will be Completely Under Water in 30 Years.
11. 1989 Associated Press: UN Official Says Rising Seas to 'Obliterate Nations' by 2000.
12. 1989 Salon: *New York City's West Side Highway underwater by 2019* said Jim Hansen the scientist who lectured Congress in 1988 about the greenhouse effect.
13. 2000 The Independent: "*Snowfalls are a thing of the past. Our children will not know what snow is*," says senior climate researcher.

14. 2004 The Guardian: The Pentagon Tells Bush Climate Change Will Destroy Us. “Britain will be Siberian in less than 20 years,” the Pentagon told Bush.
15. 2008 Associate Press: NASA Scientist says “We’re Toast. In 5-10 years the Arctic will be Ice Free”
16. 2008 Al Gore: Al Gore warns of ice-free Arctic by 2013.
17. 2009 The Independent: Prince Charles says Just 96 Months to Save the World. “*The price of capitalism is too high*.”
18. 2009 The Independent: Gordon Brown says “*We have fewer than 50 days to save our planet from catastrophe*.”
19. 2013 The Guardian: The Arctic will be Ice Free in Two Years. “The release of a 50 gigaton of methane pulse” will destabilize the planet.
20. 2013 The Guardian: US Navy Predicts Ice Free Arctic by 2016. “The US Navy’s department of Oceanography uses complex modeling to makes its forecast more accurate than others.
21. 2014 John Kerry: “*We have 500 days to Avoid Climate Chaos*” discussed Sec of State John Kerry and French Foreign Minister Laurent Fabious at a joint meeting.