Short Answers & Problems [total 12 points]

1. What does the shortwave atmospheric window do [1 pt.]
___________________________________________________________________________________________________________

2. What is responsible for our (a) day and night (b) our day length [1 pts.]
   (a)_________________________________________________ (b) ____________________________________________________

3. What is the noon solar altitude at 22.5 degrees S. on December 21 [2 pts.]
_____________________________________________________________________Answer ______________________

4. A simulation weather balloon is been launched as part of your G109 Lab. At the surface before launch the balloon has a volume of 1 m³, temperature is -5 °C and the atmospheric pressure is 1000 mb. At about 6 km altitude the temperature is still -5 °C.

5. (a) What is the mass of the air within the balloon at launch? [2 pts.] _________________________________________________
_____________________________________________________________________________Answer:______________________
   (b) What is the density of the balloon at launch? [1 pt.] _________________________________Answer: _________________
   (c) Using the fractional reduction of atmospheric pressure for ~6 km. What is the volume of the balloon at 6 km altitude? [3 pts.]
_________________________________________________________________________________________________________
____________________________________________________________________________Answer: _______________________

6. How much radiation is emitted from a short grass surface with a surface temperature of 25 °C and an emissivity of 0.95 [2 pts.]
________________________________________________________________________________________________________
________________________________________________________________________________Answer:_________________

7. Fill In The Blanks [total points 6]
   a) The earth’s source of energy is ____________________ [1 pt]
   b) The name of two of the three ranges on the electromagnetic spectrum important for weather and climate are [2 pt]:
      ___________________________________________ and ___________________________________________
   c) The three fate of solar radiation in the atmosphere are ______________________ [1 pt] to the surface,
______________________[1 pt] back to space and __________________________[1 pt] by the atmosphere
Part B: Multiple Choice (1 point each) [total 22]

Answer all Questions by marking the corresponding number on the NCS form and on this paper
Use only the pencil provided to mark answers on the NCS form

Only one answer per question. Multiple answers will be treated as incorrect

1. Which of the following is not a permanent gas
   a. oxygen
   b. argon
   c. nitrogen
   d. water vapor

2. Carbon Dioxide
   a. is only found in the stratosphere
   b. is a permanent gas
   c. makes the hole over Antarctica
   d. is a greenhouse gas

3. Most weather phenomena develop in
   a. the troposphere
   b. the stratosphere
   c. the tropics
   d. the polar regions

4. Which of the following is true about ozone
   a. it is a harmless gas at the surface
   b. its presence in the Stratosphere is essential for life
   c. it is evenly distributed in the atmosphere
   d. it is a permanent gas

5. This method of energy transfer does not require a transport medium.
   a. conduction
   b. convection
   c. radiation
   d. all of the above

6. Convection
   a. does not involve an actual transfer of energy
   b. involves potential energy only
   c. occurs only in liquids and gases
   d. is another term for conduction

7. Reflectivity of the surface is expressed as
   a. emissivity
   b. ability to absorb
   c. albedo
   d. transmission

8. When dew point temperature equals air temperature
   a. The air is saturated
   b. The air is unsaturated
   c. $e_d$ does not equal $e_s$
   d. none of these
9. Vapor density is
   a. a measure of humidity in the atmosphere
   b. an expression of pressure exerted by water vapor molecules in the atmosphere
   c. does not change with temperature
   d. none of the above

10. Which of the following surfaces is most likely to have the highest Bowen ratio
    a. Forest
    b. freshly cut grass
    c. desert
    d. irrigated cotton field

11. The annual surface radiation budget
    a. has a deficit at the equator
    b. has a surplus in the tropics
    c. is balanced at all locations across the earth
    d. is balanced only over the oceans

12. Given only temperature and the Clausius-Clapeyron curve you can:
    a. find saturation vapor pressure
    b. calculate relative humidity
    c. calculate the dew point temperature
    d. calculate latent heat flux

13. Variable gasses are important for climate mainly for their:
    a. Greenhouse effect
    b. Small quantities
    c. Large quantities
    d. Effect on clouds

14. The tilt of the earth on the ecliptic is
    a. 66.5°
    b. 0°
    c. 23.5°
    d. 90°

15. The coldest layer of the atmosphere is the
    a. Thermosphere
    b. Troposphere
    c. Mesosphere
    d. None of the above

16. Wien’s Displacement Law states that
    a. a rise in temperature only increases the total radiation
    b. maximum emission is in the longer wavelengths
    c. the hotter the body the shorter the wavelength of maximum emission
    d. the hotter the body the longer the wavelength of maximum emission

17. Radiation that is dispersed as a larger number of weaker rays in all directions is
    a. specular reflection
    b. transmission
    c. diffuse reflection and scattering
    d. selective absorption
18. Specific Humidity is:
   a. A measure of humidity
   b. Is conservative
   c. Decreases from tropics to poles
   d. All of the above
   e. None of the above

19. What would be expected on an overcast (cloudy) night
   a. Increased $K_{\downarrow}$
   b. Increased $L_{\downarrow}$
   c. Temperature remains warm
   d. b,c
   e. a,c

20. If there is an increase in air temperature (all else been constant)
   a. Saturation vapor pressure goes down and RH goes up
   b. Saturation vapor pressure goes up and RH goes up
   c. Saturation vapor pressure goes up and RH goes down
   d. Saturation vapor pressure goes down and RH goes down
   e. None of the above

21. What common component is present in both the water and energy balance, linking them and establishing the global heat pump
   a. Latent heat flux
   b. Net radiation
   c. Sensible heat flux
   d. Solar radiation

22. Weather is
   a. A statistical concept
   b. The spatial variation of meteorological processes over time
   c. The manifestation of the atmospheric processes
   d. Cannot be experienced directly

Hand in all pages
| \( \lambda_{\text{max}} = \frac{a}{T} \) | \( \lambda_{\text{max}} \) wavelength of maximum emission (\( \mu \text{m} \))  
\( T \) emission temperature (K)  
\( a= 2897 \ \mu \text{m K} \) |
| --- | --- |
| \( F_{\text{tot}} = \varepsilon \cdot \sigma \cdot T^4 \) | \( F_{\text{tot}} \) total irradiance (\( \text{W m}^{-2} \))  
\( T \) emission temperature (K)  
\( \varepsilon \) emissivity  
\( \sigma = 5.67 \times 10^{-8} \ \text{W m}^{-2} \ \text{K}^{-4} \) |
| \( Q^* = \frac{K_{\uparrow} - K_{\downarrow}}{K^*} + \frac{L_{\downarrow} - L_{\uparrow}}{L^*} \) | \( Q^* \) net radiation (\( \text{W m}^{-2} \))  
\( K_{\uparrow,\downarrow} \) shortwave radiation in, reflected  
\( L_{\uparrow,\downarrow} \) longwave radiation out, in (\( \text{W m}^{-2} \))  
\( \alpha \) albedo |
| \( P = \rho \cdot R \cdot T = \frac{m}{V} \cdot R \cdot T \) | \( P \) pressure (\( \text{Pa} = \text{J m}^{-3} \))  
\( \rho \) density (\( \text{kg m}^{-3} \)) = \( \frac{m}{V} \) |
| \( P_1 \cdot V_1 = P_2 \cdot V_2 \) | \( m \) mass (kg)  
\( V \) volume (m\(^3\))  
\( R \) gas constant (air) = 287 J kg\(^{-1}\) K\(^{-1}\)  
\( T \) temperature (K) |
| Conversions | \( \text{K} = {}^\circ \text{C} + 273 \)  
\( 1 \text{mb} = 10^2 \ \text{Pa} = 100 \ \text{Pa} \) | \( \text{Temperature: Celsius to Kelvin} \)  
\( \text{Pressure: Millibar to Pascal} \) |

A dot means multiply