Name__________________________

EVST201a/G&G 140a (2011)

The Atmosphere, Ocean and Environmental Change

Second Exam

Useful physical and mathematical constants:

$R = 8314\ J/kmole \cdot Kelvin$; $\sigma = 5.735 \times 10^{-8}\ Wm^{-2}K^{-4}$; $\pi = 3.14159$ $G = 6.674 \times 10^{-11} m^3 kg^{-1} s^{-2}$

Earth parameters:

$R_E = 6371 km$; $a_E = 0.33$; $g = 9.81\ m/s^2$, $\Gamma = -g/c_p = -9.8^{o}C/km$, $Tilt = 23.5^{o}$

$H_S = R_a T / g \approx 8.4 km$; $S = 1380\ W/m^2$; $\Omega = 7.27 \times 10^{-5}\ s^{-1}$; $M = 5.974 \times 10^{24} kg$

Properties of air:

$R_{air} = 287 J/kg.C$; $\rho_{air} = 1.2 kg/m^3$; $C_{P_{Air}} = 1004 J/kg^{\circ}C$

Properties of water:

$\rho_{water} = 1000 kg/m^3$; $\rho_{ice} = 917 kg/m^3$; $\rho_{SEA} = 1025 kg/m^3$

$L_{COND} = 2.5 * 10^6 J/kg$; $L_{FREEZE} = 3.34 \times 10^5 J/kg$

$C_{P_{Water}} = 4218 J/kg^{\circ}C$

Useful definitions:

$RH = P/P_{sat}$; $ResTime = C/F$; $\delta D = [\left(\frac{D}{H}\right) / \left(\frac{D}{H}\right)_{REF} - 1] \times 1000$

Useful physical laws and balances:

$gM = PA$; $F_G = \frac{GMm}{r^2}$; $p = \rho RT$; $\Delta p = -\rho g \Delta Z$; $Rgas = Runiversal/M$

$V_e = \sqrt{2gR_E}$; $V_m = \sqrt{\frac{3\ RT}{M}}$; $Q = MC_P \Delta T$; $Q = L \Delta m_v$

$R = \sqrt{K \cdot T}$; $R_{plume} = \sqrt{Kx/U}$;

$CF = 2MU\Omega \sin\phi$; $\tau = 0.003 \rho_A U_A^2$;

$F = \sigma T^4$; $\lambda_m T = 2898 \text{microns}\ ^{\circ}K$

$PET(mm/month) \cong 5 \times T(C)$; $P = P_0 e^{-Z/H}$; $\rho = \rho_0 e^{-Z/H_S}$

$T = \sqrt[4]{\frac{S(1-a)}{4\sigma}}$; $T_{GH} = T/(1 - \frac{\varepsilon}{2})^{1/4}$

$A_S = 4\pi R^2$; $V = (4/3)\pi R^3$; $F = S\cos(\varphi)$

Open Yale courses

$WaterFlux = \rho_W UA$; $SaltFlux = S\rho_W UA$; $HeatFlux = C_P T\rho_W UA$

$(\Delta p / L)\,Vol = \rho \times 2 \times \Omega \times \sin\phi \times U \times Vol$

$PE = Mgz$; $EFF = \Delta T/T$; $Qout = K\sqrt{Zeff}$, $P(t) = P(t=0)\exp(\gamma t)$

$P_{Wind} = (\frac{1}{2})\varepsilon\rho U^3 A$, $P_{Solar} = \varepsilon S\tau_A A\cos(\varphi)$, $P_{HYDRO} = \varepsilon R\rho_W gzA$

Unit Conversions:

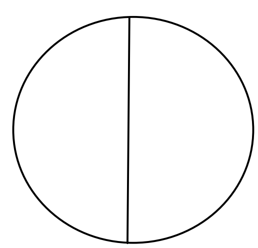
$ppmv = \frac{M_{AIR}}{M}\, ppmm$; $1\ mb = 100\ Pascals$; $0℃ = 273.1\ K$

$1\ knot = 0.54\ m/s$; $1\ inch = 2.54\ cm$; $℃ = \frac{5}{9}(℉ - 32)$ $1\ tonne = 10^3 kg$

T (°C)	P_{sat} (mb)
-10	2.9
0	6.1
10	12.3
20	23.4
30	42.4

Molecular Weights	
H_2	2
N_2	28
O_2	32
CO_2	44
Air	29

1. [10] A top view of a Foucault Pendulum base plate is shown with the track of the bob as it swings across. Sketch forces on the bob and explain how the track will rotate if the pendulum is in the southern hemisphere.



2. [10] Explain how cool winds and a gustfront are created by a thunderstorm.

3. [10] If at 45 degrees north latitude, the horizontal pressure gradient is 0.002Pa/m with pressure increasing towards the west:
    a. **Estimate** wind speed above the turbulent boundary layer.
    b. **Give** the wind direction. (include a **sketch** showing forces)
    c. **Explain** the force balance you have assumed to do this problem.

4. [10] Explain why the clear sky appears blue but a cloud appears white under similar illumination from the sun.

5. [10] Why are hurricanes not found over the sea
    a. Near the equator
    b. In the tropical south Atlantic

6. [10] Explain why water drops may form on the outside of a cool glass of water. What condition is required?

7. [10] Describe how the raindrops form that fall from a tall cumulo-nimbus cloud.

8. [10] If a mid-latitude cyclone in the northern hemisphere transports $10^{11} kg/s$ of air northward with T=20C and an equal mass of air moves southward with T=10C, **how much heat** is transported northward? Express your answer in Watts. **What happens** to this heat transported northward?

9. [10] On a rainy day, a centimeter of rain falls on a 10000 square kilometer area (i.e. 100 by 100km). **Estimate the latent heat** released to the atmosphere in the clouds causing that precipitation. Express your answer in Joules.

10. [10] **Explain** the reason for the rainy season at each location below.

    a. **Jerusalem** ,Israel/Jordan/Palestine (Lat =32N, Long = 35E) The wettest month is January (P = 5.1 inches; temperature of T = 44F). The driest month is July (P=0; T=73F).

    b. **Asuncion, Paraguay** (25S, 58W) The wettest month is December (P=6.2 inches, T=80F). The driest month is July (P=2.2 inches, T=64F)