ATM 316 Midterm Exam #2 SAMPLE EQUATION SHEET

Fall, 2020 – Fovell

Some useful information

- **Show work and draw pictures whenever possible.** Show your steps. I can't give partial credit unless I can figure out what you were doing. **Answers without work or justification have no value.**
- **If you cannot answer a particular question owing to insufficient information, state what information you need to answer it. If you cannot answer it for any other reason, give me something I can use to possibly justify some partial credit.**
- The ideal gas law always applies.
- Some equations:

$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$

$\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|\sin\theta\ \hat{n}$ (where $\hat{n}$ perpendicular to $\vec{A}$ and $\vec{B}$)

$\frac{\partial f(x_0)}{\partial x} \approx \frac{f(x_0+\Delta x)-f(x_0-\Delta x)}{2\Delta x}$

$\nabla A = \frac{\partial A}{\partial x}\hat{\imath} + \frac{\partial A}{\partial y}\hat{\jmath} + \frac{\partial A}{\partial z}\hat{k}$

$\vec{U} = u\hat{\imath} + v\hat{\jmath} + w\hat{k}$, $\nabla\cdot\vec{U} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$, $\nabla\times\vec{U} = (\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z})\hat{\imath} - (\frac{\partial w}{\partial x} - \frac{\partial u}{\partial z})\hat{\jmath} + (\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y})\hat{k}$

$\frac{dB}{dt} = \frac{\partial B}{\partial t}\frac{dt}{dt} + \frac{\partial B}{\partial x}\frac{dx}{dt} + \frac{\partial B}{\partial y}\frac{dy}{dt} + \frac{\partial B}{\partial z}\frac{dz}{dt} = \frac{\partial B}{\partial t} + \vec{U}\cdot\nabla B$

PGF (per unit mass): $-\frac{1}{\rho}\nabla p$

$p = \rho RT = \rho R_d T_v$

$F_{gravity} = -\frac{GMm}{|\vec{r}|^2}\left[\frac{\vec{r}}{|\vec{r}|}\right]$

$\vec{V}_{tan} = \omega\vec{R}$

$f = 2\Omega\sin\phi$, $\vec{\Omega} = \Omega\cos\phi\hat{\jmath} + \Omega\sin\phi\hat{k}$

$(\frac{d\vec{U}}{dt})_{Coriolis} = -2\vec{\Omega}\times\vec{U}$

$\frac{\partial p}{\partial z} = -\rho g$

$R_o = \frac{U}{f_0 L}$

$u_g = -\frac{1}{f\rho}\frac{\partial p}{\partial y}$, $v_g = \frac{1}{f\rho}\frac{\partial p}{\partial x}$

$\Delta Z = \frac{R_d\bar{T_v}}{g_0}\ln\left[\frac{p_0}{p_1}\right]$

$d\Phi = g dz$

$\frac{V^2}{R} + fV = -\frac{1}{\rho}\frac{\partial p}{\partial n}$

$\frac{V^2}{R} + fV - fV_g = 0$

- Some constants and conversions:

$R_d = 287$ J kg^{-1} K^{-1}; $g_0 = g = 9.81$ m s^{-2} (Using 10 m s^{-2} is OK.); $\Omega = 7.292\times10^{-5}$ s^{-1}, $\epsilon = 0.622$

1 mb = 100 Pa. Earth radius = 6371 km.