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.

- Some equations:
  \[
  \vec{A} \cdot \vec{B} = |\vec{A}||\vec{B}| \cos \theta
  \]
  \[
  \vec{A} \times \vec{B} = |\vec{A}||\vec{B}| \sin \theta \hat{n}
  \]
  \[
  \frac{\partial f(x_0)}{\partial x} \approx \frac{f(x_0 + \Delta x) - f(x_0 - \Delta x)}{2\Delta x}
  \]
  \[
  \frac{\partial^2 f(x_0)}{\partial x^2} \approx \frac{f(x_0 + \Delta x) - 2f(x_0) + f(x_0 - \Delta x)}{\Delta x^2}
  \]
  \[
  \nabla A = \frac{\partial A_i}{\partial x} \hat{i} + \frac{\partial A_j}{\partial y} \hat{j} + \frac{\partial A_k}{\partial z} \hat{k}
  \]
  \[
  \vec{U} = u \hat{i} + v \hat{j} + w \hat{k}
  \]
  \[
  \nabla \cdot \vec{U} = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}
  \]
  \[
  \nabla \times \vec{U} = \left( \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \right) \hat{i} - \left( \frac{\partial w}{\partial x} - \frac{\partial u}{\partial z} \right) \hat{j} + \left( \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right) \hat{k}
  \]
  \[
  \frac{dB}{dt} = \frac{\partial B}{\partial t} + \vec{U} \cdot \nabla B
  \]
  \[
  \text{PGF (per unit mass): } -\frac{1}{\rho} \nabla p
  \]
  \[
  p = \rho RT
  \]
  \[
  F_{\text{gravity}} = -\frac{GMm}{|\vec{r}|^2} \left[ \begin{bmatrix} x \\ y \\ z \end{bmatrix} \right]
  \]
  \[
  \vec{V}_{\text{tan}} = \omega \vec{R}
  \]
  \[
  f = 2\Omega \sin \phi
  \]
  \[
  \vec{\Omega} = \vec{\Omega} \cos \phi \vec{j} + \vec{\Omega} \sin \phi \vec{k}
  \]
  \[
  (\frac{d\vec{U}}{dt})_{\text{Coriolis}} = -2\vec{\Omega} \times \vec{U}
  \]

- Some constants and conversions (subscript “d” for dry air):
  \[
  R_d = 287 \text{ J kg}^{-1} \text{ K}^{-1}; \ c_{pd} = 1004 \text{ J kg}^{-1} \text{ K}^{-1}; \ c_{vd} = 717 \text{ J kg}^{-1} \text{ K}^{-1}
  \]
  \[
  g_0 = g = 9.81 \text{ m s}^{-2} \text{ (Using 10 m s}^{-2} \text{ is OK.)}
  \]
  \[
  \epsilon = 0.622
  \]
  \[
  1 \text{ mb} = 100 \text{ Pa}.
  \]
  \[
  \Omega = 7.292 \times 10^{-5} \text{ s}^{-1}
  \]
  \[
  \text{Earth radius} = 6371 \text{ km}.
  \]