ATM 651 Fall 2020: Exam on basic grammar **Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Part I: Vocabulary and concepts and units table**

Fill in the white boxes. One point per white box. *gray box: no response asked*

**Paperless folks: 1-30 a-d can be written on scratch paper if easier.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Word** | **a. Symbol or math term** | **b. Units** | **c. Definition**  **or concept (explained)** | **d. Relevant sketch**  **(or extra space for more explanaton)** |
|  | T(x,y,t) |  | a variable that measures warmth |  |
| 1. Local or Eulerian tendency of T(x,y,t) |  |  | definition (hint: a *limit)* | what aspect of this T(t) graph at a point? |
| 1. Laplacian of T(x,y,t) |  |  |  |  |
|  |  | (kg) m-2 s-1 | units tell you it is a *flux* |  |
| 1. Lagrangian time tendency of T(x,y,t) |  |  |  |  |
| 1. Mass of 1 cc = 1 ml of water in MKS |  |  |  |  |
| 1. Gradient of pressure p(x,y) |  |  | sketch vectors for this scene with a Low at left and a High at right |  |
| 1. *speed* of wind whose components are u(x,y), v(x,y) |  |  |  |  |
|  |  | W m-2 |  | (hint: a flux of something, often a flux across the Earth's surface or at top of atmosphere) |
|  |  | (m/s) m-2 s-1 |  | Hint: a flux of what? |
|  | **V** |  | **i**u+**j**v+**k**w |  |
| 1. planetary vorticity |  |  |  |  |
| 1. PGF term *in pressure coordinates* |  |  |  |  |
| 1. Circulation. *Relate it to vorticity (Stokes' theorem):* | C |  |  |  |
|  | w |  | = dz/dt |  |
| 1. del operator |  |  |  | *(an operator* cannot really be drawn) |
| 1. meridional advection of specific humidity q |  |  |  |  |
| 1. Laplacian (curvature) of p(y only), where p is pressure |  |  | *curvature*  (use *one dimensional* derivative notation in y domain) | clearly show + and - regions along this p(y) curve's sketch:  |  |  |  |  |\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| 1. Which momentum advection in x-y coords. is centrifugal force here? |  |  | hint: the other 3 advection terms are all zero (@center of red circle): |  |
| 1. dot product of a forceand velocity |  |  |  |  |
| 1. Coriolis parameter f |  |  |  | <-- put some brief, true explanatory text in here |
| 1. stratosphere: about how high, and defined how? |  |  |  | z  |  |  |  |\_\_\_\_\_\_\_\_\_\_\_\_  T |
| 1. Gradient of (x,y,t) where = gZ |  |  | use **i,j** (Cartesian unit vectors) |  |
| 1. zonal advection of vertical momentum |  |  | (w = dz/dt) |  |
| 1. vector *velocity* *field* of pure divergence | **Vdiv**(x,y) |  | divergent wind field |  |
| 1. omega |  |  | , vertical velocity of air in p coord. | Q: upward or downward air motion for >0? |
|  |  |  | One unit of vorticity plus one unit of deformation |  |
|  |  |  |  | hint: Pierre Simone Laplace is involved |
| 1. Equation governing a conserved tracer  | Lagrangian form: |  | Eulerian form: |  |
| 1. mutual advection of same-signed point vortices |  |  | V decreases how rapidly w/ distance?  \_\_\_\_\_\_\_\_\_\_ |  |

**Part II: write the Primitive Equations in this grid, one term per box:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F | G |
| 1. mass continuity |  |  |  |  |  |  |  |
| 2. zonal wind  component  (**any form you like**) |  |  |  |  |  |  |  |
| 3. meridional (write **advection on RHS in xyp coords w/ no vectors**) |  |  |  |  |  |  |  |
| 4. hydrostatic balance |  |  |  |  |  |  |  |
| 5. First Law for T |  |  |  |  |  |  |  |

Which box or row contains each of the following:

1. the force of gravity along a pressure surface
2. zonal advection of meridional momentum
3. horizontal convergence of wind
4. thickness of a pressure layer
5. radiative heating rate
6. latent (condensational) heating rate
7. adiabatic compression warming
8. Coriolis force (two boxes)
9. F=ma in the vertical direction
10. slope of a pressure surface