

Example Questions in Preparation for the Final Exam

1. Which air mass exerts a greater surface air pressure, a warm and humid or an equally warm but dry air? Explain your response.
2. When referring to cyclogenesis, what is “self-development”?
3. If the wind is in geostrophic balance, then:
 - (a) What can you say about the relative magnitudes and direction of the pressure gradient force and the Coriolis force?
 - (b) What can you say about the magnitude and direction of the friction force?
 - (c) What can you say about the direction of the wind?
 - (d) What can you say about the shape of the isobars or geopotentials?
4. List a number of meteorological conditions that may indicate the passage of a frontal zone.
5. Why do the Westerlies normally increase in intensity with increasing altitude?
6. Where are the principal zones of cyclogenesis in North America? What factors lead to a favorable environment for cyclogenesis?
7. A sample of air has a temperature of -5°C at an atmospheric pressure of 800 hPa. What is its potential temperature?
8. Suppose a noncurving wind blows from the west at 20 m s^{-1} (assume constant), at latitude 40°N . Initially, the tropospheric depth is 10 km. Then, the air flows over the Western Cordillera, where you can assume the relative terrain depth is 1 km above the neighbouring plains. Find the potential vorticity, and the radius of curvature over the mountains.
9. Find the geostrophic relative vorticity for the following scenario (see handout) assuming constant $f_0 = 10^{-4}\text{ s}^{-1}$:

Hint: Apply the equation for vorticity:

$$\zeta_g = \frac{g}{f_0} \nabla^2 z_p$$

which, evaluated with finite differences of length d gives:

$$\zeta_g = \frac{4g}{f_0 d^2} [\bar{z} - z_0]$$

where d ($= 300\text{ km}$) is the distance between the centre point (height z_0) and the four surrounding points (north, south, east and west of the centre point).

10. Suppose upper level divergence has an effective vertical velocity of 0.03 m s^{-1} over a cyclone, while the boundary layer pumping causes a vertical velocity of 0.01 m s^{-1} . The rainfall rate is 5 mm h^{-1} . Sea-level pressure decreases 1 kPa across a distance of 200 km to the west of the cyclone, and there is a steering wind from the west at 20 m s^{-1} . Find the sea-level pressure tendency.