Environmental Science: Numerical Questions – Geostrophic Wind

Geostrophic Winds

Q 1 At a latitude of $30°$, there is pressure gradient of 5.0 mb per 100 km . Given the density of air $\square 1.25 \frac{\text{kg}}{m^3}$, the geostrophic winds will have velocity $\left({}^{m}/_{s} \right)$:

(1) 5.48 m/s

(2) 54.86 m/s

(3) 109.72 m/s

(4) 27.43 m/s

Answer: Option (2) 54.86 m/s

Given Values are,

Latitude = 30° (Sin 30° = 0.5)

Pressure $= 5$ mb $(5\text{mb} \times 100 = 500$ Pa)

Density of Air $= 1.25 {}^{\text{kg}}/_{m^3}$

Distance $= 100$ km $(100\text{ km} \times 1000 = 100000m)$

$$V_g = \frac{P}{2\Omega \times \delta \times \sin \phi \times d}$$

Where,

Vg = Geostrophic wind Velocity

P = Pressure (in Pascal)

$\Omega =$ Angular Velocity of Earth $\left(7.3 \times 10^{-5}\right)$

$\delta =$ Density of Air

Sin ϕ = Latitude

D = Distance (in meters)

Now putting the given values in the equation,

$$V_g = \frac{500}{2 \times 7.3 \times 10^{-5} \times 1.25 \times 0.5 \times 100000}$$

$$V_g = \frac{500}{2 \times 7.3 \times 1.25 \times 0.5}$$

$V_g = 54.79$ m/s

Q 3 If at latitude φ = 30°, pressure gradient is 15 mb per 1000 km, the geostrophic wind velocity will be:

(1) ~20.54 m/s

(2) ~15.92 m/s

(3) ~7.96 m/s

(4) ~10.27 m/s

Answer: Option (2) ~15.92 m/s

Given Values are,

Latitude = 30° (Sin 30° = 0.5)

Pressure $= 15\ \text{mb}\ (15\text{mb} \times 100 = 1500\ \text{Pa})$

Density of Air = 1.25 kg/m^3

Distance $= 1000\ \text{km}\ (1000\ \text{km} \times 1000 = 1000000m)$

$$V_g = \frac{P}{2\Omega \times \delta \times \sin\phi \times d}$$

$$V_g = \frac{1500}{2 \times 7.3 \times 10^{-5} \times 1.25 \times 0.5 \times 1000000}$$

$$V_g = \frac{150}{2 \times 7.3 \times 1.25 \times 0.5}$$

$$V_g = \frac{150}{9.125}$$

$V_g = 16.43$ m/s

✍ Mayank

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