1) Free-air anomaly from a single station

At latitude φ = 30°, elevation H = 850 m. Observed gravity $g_{\rm obs} = 9.780820$ m·s⁻². Drift correction +0.10 mGal, tide −0.05 mGal. Compute the **free-air anomaly** (FAA).

- Convert: $g_{\rm obs} = 978082.0$ mGal
- Apply drift/tide: $g_c = 978082.0 + 0.10 - 0.05 = 978082.05$ mGal
- Normal gravity (Somigliana):
  $\gamma(30^\circ) = 978032.677[1 + 0.0053024\sin^2 30^\circ - 0.0000059\sin^2 60^\circ] = 979264.97$ mGal
- Free-air correction: $+\,0.3086\,H = 0.3086 \times 850 = 262.31$ mGal
- FAA $= g_c - \gamma + \mathrm{FAC} = 978082.05 - 979264.97 + 262.31 = \boxed{-920.61\ \mathrm{mGal}}$

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2) Full Bouguer anomaly at low elevation

Same station as #1, density $\rho = 2.67$ g·cm⁻³, terrain correction $TC = +6.8$ mGal. Find **Bouguer anomaly**.

- Bouguer slab: $BC = 0.04193\,\rho\,H = 0.04193 \times 2.67 \times 850 = 95.21$ mGal
- Δg_B $= \mathrm{FAA} - BC - TC = -920.61 - 95.21 - 6.8 = \boxed{-1\,022.62\ \mathrm{mGal}}$

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4) Isostasy (Airy model) – mountain root

Average crust $\rho_c = 2.80$ g·cm⁻³, mantle $\rho_m = 3.30$ g·cm⁻³. A mountain stands $h = 3.0$ km above sea level. Estimate root thickness t.

- $t = h\,\dfrac{\rho_c}{\rho_m - \rho_c} = 3000\,\dfrac{2.80}{0.50} = \boxed{16.8\ \mathrm{km}}$

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5) Microgravity void detection (spherical cavity)

A spherical cavity (negative density contrast $\Delta\rho = -2.0$ g·cm⁻³ = −2000 kg·m⁻³), radius $a = 10$ m, depth to center $z = 15$ m. Compute $\Delta g_{\max}$ at the surface above center.

$$\Delta g_{\max} = \frac{G \cdot \frac{4}{3}\pi a^3 \Delta\rho}{z^2}$$

- Using $G = 6.674 \times 10^{-11}$ SI: $\Delta g_{\max} = -2.485 \times 10^{-6}$ m·s⁻²
- Convert to mGal: $-2.485 \times 10^{-6} \times 10^5 = \boxed{-0.248\ \mathrm{mGal}}$

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6) Sphere depth from half-width

A positive anomaly has $\Delta g_{\max} = 3.0$ mGal and half-width at half-maximum $x_{1/2} = 400$ m. Estimate depth z (sphere).

- For a sphere, $z \approx 1.305\,x_{1/2} = \boxed{522\ \mathrm{m}}$

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7) Horizontal cylinder radius from peak

2-D body, $\Delta g_{\max} = 5.0$ mGal at depth $z = 600$ m; $\Delta\rho = 0.45$ g·cm⁻³ = 450 kg·m⁻³. Find radius R.

$$\Delta g_{\max} = \frac{2\pi G \Delta\rho R^2}{z} \Rightarrow R = \sqrt{\frac{\Delta g_{\max} z}{2\pi G \Delta\rho}}$$

- $\Delta g_{\max} = 5.0$ mGal $= 5.0 \times 10^{-5}$ m·s⁻²
- $R = \sqrt{\dfrac{5.0 \times 10^{-5} \times 600}{2\pi \times 6.674 \times 10^{-11} \times 450}} = \boxed{408 \text{ m}}$

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8) Latitude effect – difference between 20° and 60°

Using Somigliana, compute $\gamma(\varphi)$ at 20° and 60° and their difference.

- $\gamma(20^\circ) = 978636.93$ mGal
- $\gamma(60^\circ) = 981917.79$ mGal
- Difference $= \boxed{+3280.86 \text{ mGal}}$ (gravity is higher at higher latitude).

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9) Unit conversion check

Convert 0.0125 m·s⁻² to mGal.

- $1 \text{ mGal} = 10^{-5} \text{ m}\backslash \quad \text{s}^{-2} \rightarrow 0.0125/10^{-5} = \boxed{1.25 \times 10^3 \text{ mGal}}$

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11) Bouguer correction uncertainty due to density

Elevation $H = 950$ m, $\rho = 2.60 \pm 0.10$ g·cm⁻³. Find u_{BC}.

- $BC = 0.04193\,\rho\,H$ → sensitivity $\partial BC/\partial\rho = 0.04193\,H = 39.83 \text{ mGal per } (\text{g}\backslash \quad \text{cm}^{-3})$
- $u_{BC} = 39.83 \times 0.10 = \boxed{3.98 \text{ mGal}}$

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12) Regional–residual removal along a line

Regional trend $= -0.06$ mGal·km⁻¹. Station at $x = 18$ km has Bouguer anomaly $+4.9$ mGal. Find residual.

- Regional at station $= -0.06 \times 18 = -1.08$ mGal
- Residual $= 4.9 - (-1.08) = \boxed{+5.98 \text{ mGal}}$

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13) Free-air projection between two elevations

Same location, compare readings at $H_1 = 120$ m and $H_2 = 520$ m (no intervening mass). What correction to project the high station down to the low station?

- $\Delta H = 520 - 120 = 400$ m; FAC $= +0.3086 \times \Delta H = \boxed{+123.44 \text{ mGal}}$ (add to the higher station to compare at the lower datum).

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14) Slab thickness from local positive anomaly

Measured local positive $\Delta g = +18.5$ mGal caused by a denser tabular body (infinite slab) with $\Delta\rho = 0.35$ g·cm^{-3}. Estimate thickness t.

- $\Delta g = 0.04193\, \Delta\rho\, t \Rightarrow t = \dfrac{18.5}{0.04193 \times 0.35} = \boxed{1.26 \times 10^3 \text{ m}}$