1. Fill in the blanks.

a. The equipotential surface that coincides with mean sea level on the Earth is termed the ___________________.

b. Unstable gravimeters measure ___________________ gravity.

c. In these materials the spin magnetic moments of unpaired electrons between neighboring atoms are magnetically coupled but the moments are anti-parallel and unequal. ________________________________.

d. Earth tides, spring creep or fatigue, and temperature variations cause gravimeters to experience a phenomenon known as ____________________.

e. The propagation velocity and path of seismic waves are controlled by the __________________ and __________________ of the material through which they pass.

f. The magnetic dip poles are places on the Earth's surface where the inclination of the magnetic field is __________________________.

g. The phenomena of ground state splitting of electron energy levels in the presence of a magnetic field is called the ________________________________.

h. This category of geophysical methods involve these involve measuring the spatial variation of static or natural fields of force: ___________________________

i. Electrical conductivity is the 'operative' physical property in both ___________________________ and ________________________________.

j. The process of making a series of alternate readings at recorded times at two stations to determine the difference (after correction for drift) in gravity between an IGSN station and the local base is called ____________________.

k. This type of magnetism occurs in minerals containing transitional elements and is associated with electron spin: ____________________________
a. Lateral variations in ______________ give rise to spatial variations in the gravity field of Earth.

b. Minerals lose their spontaneous magnetization as they pass through their ______________ temperature.

n. Gravity is ______________ proportional to the frequency of a pendulum.

o. Magnetic anomalies are caused by lateral changes in these two physical properties: ___________________ and ___________________.

2. What is a Bouguer gravity anomaly? Bouguer anomalies tend to be large and negative over mountain ranges. Explain why this is so.

3. How do stable and unstable gravimeters differ?
4. Each of the following magnetometers measures a different specific quantity that is proportional to Earth’s magnetic field intensity. What is the specific quantity measured by each? And what component of the magnetic field is most commonly measured by each during a ground magnetic survey?

   i. proton precession magnetometer

   ii. fluxgate magnetometer

   iii. alkali vapor magnetometers

   iv. vertical gradiometers using proton precession heads

5. What are the two angles and 3 vectors used to describe the orientation of the magnetic field at a given location? Draw a diagram illustrating their relationship to each other.
6. On the Bouguer anomaly map shown below:

   a. Draw in the regional gravity field and then on the same figure draw in the residual using a 25 gu contour interval. Be Neat.

   b. Assuming the regional is related to crustal thickness, what directional is the crust becoming thicker? Why?

   c. Which of the following explanations is most probable: Sedimentary rocks with density 2500 kg/m$^3$ are intruded by (1) rock salt in southern Texas; (2) granite with a density of 2680 kg/m$^3$ in central Virginia.

7. The gravitational acceleration on the surface of the moon is 163,000 mgals and the mean density of the moon is 3340 kg/m$^3$. What is the radius of the moon?
8. Gravity reduction problem:

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<th>Station</th>
<th>Time</th>
<th>Reading (du)</th>
<th>Elevation (m)</th>
<th>Distance (m)</th>
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</table>

Gravimeter dial constant = 0.9745 gu/du
Bouguer reduction density = 2.67 Mg/m³
Observed gravity at base BS = 9,805,003.2 gu
Latitude of base = 47.4°N
gth at base = 9,808,360.6 gu
Elevation of the base = 200 m
Station 1 is located 500 meter West and 200 m South of the base station
Survey line runs N/S with Station 1 is the northern most station

a. What is the drift correction for Station 1?

b. What is the drift correction for station 3 with respect to 8:00 base reading?

c. What is the difference in gravity between stations 1 and 3 due to latitude only and which station would have the higher value due to this effect?

d. What is the difference in gravity between stations 1 and 3 due to elevation only and which station would have the higher value due to this effect?

d. What is the simple Bouguer anomaly at station 1 if the reference level is mean sea level?
9. Match the terms to the diagrams below.
   a. secular variation
   b. diurnal variation
   c. magnetic storm
   d. Nettleton’s method
   e. Hysteresis
Equation Sheet

\[ F = G m_1 m_2 / r^2; \quad g = G m / r^2; \]
\[ G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg-sec}^2; \quad GM = 3.986005 \times 10^{14} \text{ m}^3/\text{sec}^2; \quad \omega = 2\pi/T \]
\[ g_{\text{th}} = 9780318.46(1+0.005278895 \sin^2 \lambda +0.000023462 \sin^4 \lambda) \text{ gu} \]

Free Air correction: \[ C_{\text{FA}} (\text{gu}) = 3.086 h (\text{m}) \]
Bouguer slab correction: \[ C_{\text{BS}} (\text{gu}) = 0.4191 \rho h (\text{m}) \] where \( \rho \) is in Mg/m^3

Theoretical gravity gradient: \[ \Delta g_{\text{th}} (\text{gu}) = 8.11 \times 10^{-3} \sin 2 \lambda \Delta s (\text{m}) \]
Terrain correction: \[ C_T (\text{gu}) = 0.4191 \rho/n (r_2 - r_1 + \sqrt{r_1^2 + z^2} + \sqrt{r_2^2 + z^2}) \]
where \( C_T \) = terrain correction of a sector; \( \rho \) = Bouguer reduction density (Mg/m^3); \( n \) = number of sectors in a zone; \( r_1 \) = inner radius of zone (m); \( r_2 \) = outer radius of zone (m); and \( z \) = modulus of elevation difference between observation point and mean elevation of the sector (m).

\[ g = 4\pi^2 I / T^2 \quad g_1 T_1^2 = g_2 T_2^2; \quad g = 2(s_2 t_1 - s_1 t_2) / t_2 t_1 \]
\[ R = R_e (1 - f \sin^2 \lambda); \quad f = 1/298.247; \quad R_e = 6,378,139 \text{ m}; \quad R_{\text{ave}} = 6.371,000 \text{ m} \]
\[ \Delta g_x = (4/3)\pi G \Delta \rho R^3 z / (x^2 + z^2)^{3/2} \]
\[ \Delta g_x = 2\pi G \Delta \rho R^2 z / (x^2 + z^2) \]
\[ \Delta g_x = 2\pi G \Delta \rho t \]
\[ z = 1.305 x_{1/2} = 0.65 w_{1/2} \]
\[ z = x_{1/2} = 0.5 w_{1/2} \]
\[ \iiint g_x dx dy = 2\pi G \Delta M; \quad \Delta M = \Sigma \Delta g_x \Delta x \Delta y / 2\pi G; \quad M_T = (\rho_{\text{ore}}/\Delta \rho) \Delta M \]
\[ B_r = 2(\mu_0 m/4\pi r^3) \cos \rho = 2(\mu_0 m/4\pi r^3) \sin \lambda; \quad B_\theta = (\mu_0 m/4\pi r^3) \sin \rho = (\mu_0 m/4\pi r^3) \cos \lambda \]
\[ |B| = \sqrt{B_r^2 + B_\theta^2} = (\mu_0 m/4\pi r^3)(4 \cos^2 \rho + \sin^2 \rho)^{1/2} \]
\[ \tan I = 2 \cot \rho = 2 \tan \lambda \]
\[ B = \mu_0 H + \mu_0 J; \quad B = \mu H \quad \mu = \mu_0 \mu_r \quad \mu_r = 1 + k \]
\[ \mu_0 = 4\pi \times 10^{-7} \text{ webers/Am} \]
\[ X^2 + Y^2 + Z^2 = T^2 \quad X^2 + Y^2 = H^2 \]

\[ H = T \cos I; \quad Z = T \sin I; \quad Z = H \tan I \]

\[ \tan D = \frac{Y}{X}; \quad X = H \cos D; \quad Y = H \sin D \]