Name:_____, **Team:**_____

1. When choosing the operating frequency for a GPR survey, you must make a compromise between _____ and _____?
   (a) Resolution and probing distance
   (b) Probing distance and skin depth
   (c) Signal velocity and resolution
   (d) Signal velocity and probing distance

2. By decreasing the operating frequency of the transmitter antenna, we _____ the period of the source wavelet and _____ the wavelength of the signal that propagates through the Earth.
   (a) Decrease, decrease
   (b) Increase, decrease
   (c) Decrease, increase
   (d) Increase, increase

3. Which of the following materials has the **largest** skin depth?
   (a) Air
   (b) Ice
   (c) Dry sediments
   (d) Concrete

4. When can we use the 'wave regime' approximation to understand GPR signals?
   (a) When the conductivity (σ) is small
   (b) When the operating frequency (f_c) is high
   (c) When the dielectric permittivity (ε) is large
   (d) When σ is much smaller than the product of f_c and ε

5. Which of the following **is not** a reason for shielding the transmitter and receiver antennae:
   (a) To reduce noise from nearby radio towers
   (b) To reduce the effects of ringing
   (c) To avoid measuring reflections from above ground objects
   (d) To avoid measuring the direct air wave

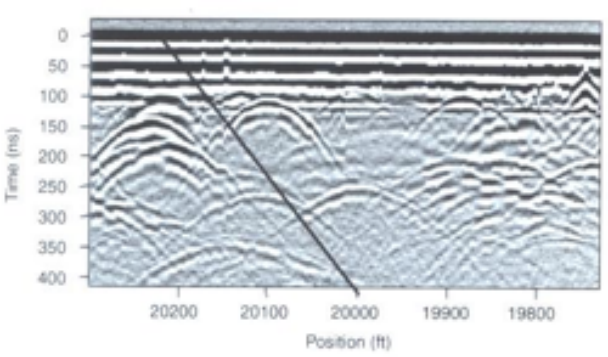
6. For a **zero offset** survey, what information **can't** be obtained by analyzing a hyperbolic signature in a radargram?
   (a) The dielectric constant of the object
   (b) Horizontal and vertical location of the object
   (c) Velocity of the medium
   (d) The dielectric constant of the medium

7. Assume that you have collected common midpoint data for a bunch of different midpoint locations. If you wanted to, could you apply NMO corrections, stack the corrected traces, then apply migration to the set of stacked traces?

   (a) Yes

   (b) No

8. The radargram below contains hyperbolic signatures from both above ground and below ground objects. How can we determine which objects are below ground and which objects are above?



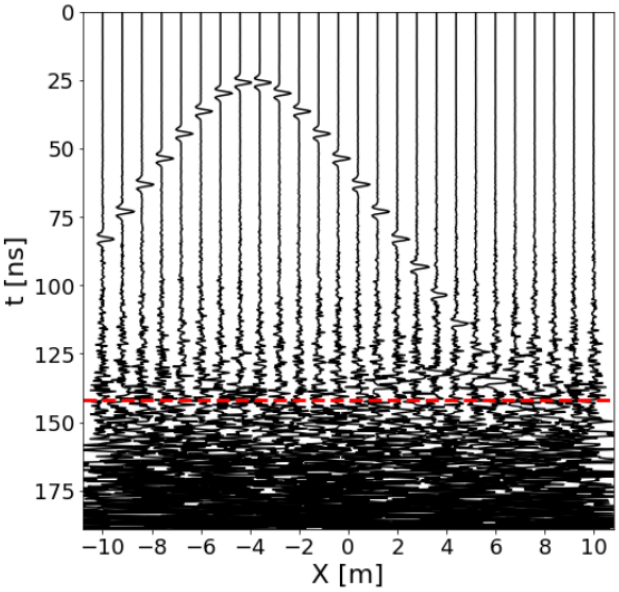
   (a) The slopes of the hyperbolic curves at sufficient lateral distances is 2/C for above ground objects

   (b) The slopes of the hyperbolic curves at sufficient lateral distances is 1/C for above ground objects

   (c) The signatures from above ground objects will be observed at earlier times

   (d) It is impossible to tell

9. The radargram below shows data collected over two compact objects. Object 1 is located at (x,z)=(-4m,-2m). Object 2 is located at (x,z)=(4m,-10m). Why can't we see the hyperbolic signature from object 2?



   (a) The objects are too close together

   (b) The operating frequency of the instrument is too low

   (c) Object 2 is below the probing distance (depth of investigation)

   (d) 'b' and 'c' are correct

10. Which of the following is **not** a processing step commonly applied to raw GPR data?

   (a) Gain correction

   (b) Windowed integration

   (c) Stacking

   (d) Time to Depth conversion

Formulas:

Reflection coefficient:	$R = \frac{\sqrt{\varepsilon_1} - \sqrt{\varepsilon_2}}{\sqrt{\varepsilon_1} + \sqrt{\varepsilon_2}}$
Transmission coefficient:	$T = \frac{2\sqrt{\varepsilon_2}}{\sqrt{\varepsilon_1} + \sqrt{\varepsilon_2}}$
Coefficient relationship:	$T + R = 1$
Rulse length (Δt) and central frequency (f_c) of wavelet:	$\Delta t = \frac{1}{f_c}$
GPR signal velocity:	$v \approx \frac{c}{\sqrt{\varepsilon_r}}$
GPR wavelength:	$\lambda = \frac{V}{f_c}$
Vertical resolution limit:	$L > \frac{\lambda}{4} = \frac{V}{4f_c}$
Horizontal resolution limit:	$L > \sqrt{\frac{Vd}{2f_c}}$
Refraction Angles	$\frac{\sin\theta_1}{v_1} = \frac{\sin\theta_2}{v_2}$
Skin depth (quasi-static)	$\delta = 503\sqrt{\frac{1}{\sigma f}}$
Skin depth (wave regime)	$\delta = \frac{0.0053\sqrt{\varepsilon_r}}{\sigma}$
Velocity of light	$c = 0.3m/ns$ or $3 \times 10^8 m/s$