ANSWER KEY

RATE PROBLEM p. 12

RELIEF = 7000 ft

DEPOSIT THICKNESS = 20 ft

ERUPTION RATE = 1500 yr / DEPOSIT

A) $\left(\frac{1\ \text{DEPOSIT}}{1500\ \text{yr}}\right)\left(\frac{20\ \text{ft}}{\text{DEPOSIT}}\right) = 0.013\ \text{ft}/\text{yr}$

(B) $0.013\ \frac{\text{ft}}{\text{yr}} \times 1000 = 13\ \text{ft}/\text{T.Y.}$

(C) $\frac{13\ \text{ft}}{\text{T.Y.}}\ \frac{1\ \text{m}}{3.28\ \text{ft}} = 3.96\ \text{m}/\text{T.Y.}$

(D) $7000\ \text{ft}\left(\frac{1\ \text{yr}}{0.013\ \text{ft}}\right) = 538{,}461\ \text{yr}$

(E) RIVER, GLACIER, MASS WASTING

KEY

In-Class Exercise - Soil Texture Analysis

(1) In groups, measure approximately 200 grams of soil sample, divide into two 100-gram aliquots.

(2) Place one of the 100-g samples in a plastic bag, shake and disaggregate the peds.

(3) Select a set of sieves: use the following sizes (stacked from top to bottom)

-2 mm (-1 phi) mesh opening	(> 2 mm = "gravel", < 2 mm = sand and finer)
-0.625 mm (4 phi) mesh opening	(>0.625 mm = "sand", <0.625 mm = silt and finer)
0.0039 mm (8 phi) mesh opening	(>0.0039 mm = "silt", < 0.0039 mm = "clay")
Pan on Bottom	(Pan catches all clay)

(4) Place the sample in the stack of sieves, shake vigorously, take sieves apart and determine the mass for each size fraction. Fill in the following table:

Sieve Size (Phi)	SIZE	Mass (grams)	Weight % (Col 2 / Total x 100%)
COARSE -1 phi	0.7 >2 SAND	0.7	0.7%
4 phi	75.33 SAND	75.33	75.7%
8 phi	4.64 SILT	4.64	4.7%
FINE pan	18.85 CLAY	18.85	18.9%
	Total	99.52g.	100%

(5) Plot your data in terms of %sand-silt-clay on the attached triangular diagram.

SAND 75.33 = 76%
SILT 4.64 = 5%
CLAY 18.85 = 19%
98.82

(6) Classify your soil sample in terms of texture (derive from plot on triangular diagram).

SANDY LOAM

(7) Disaggregate your second 100-gram sample. Record the following observations:

A. Degree of "grittiness" between your fingers. VERY

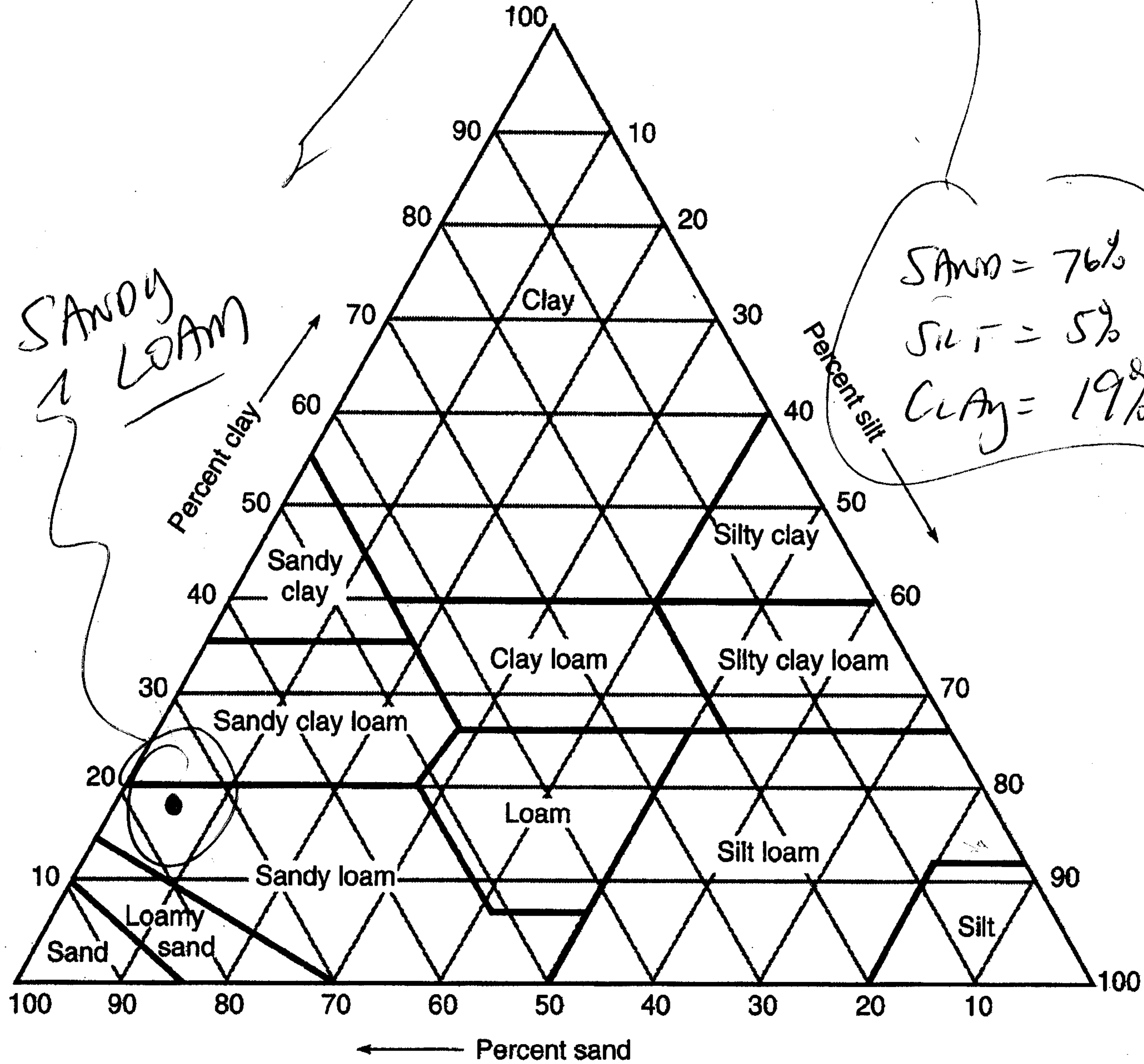
B. Cohesiveness when wet. NOT VERY

C. Color (use Munsell color chart)

wet color:
dry color: N/A

SANDY LOAM

SAND = 76%
SILT = 5%
CLAY = 19%



(a) violet
(b) indigo
(c) blue
(d) green
(e) yellow
(f) orange
(g) red

(5) infrared (0.7 - 14 um; too long to see)
(6) Microwave (0.1-100 cm)
(7) radio waves (>100 cm up to several km's)

** photographs record em radiation in the 0.3-0.9 um region of the spectrum (UV-visible-infrared)**

In Class Exercise

Given the following formulas and conversion factors, fill in the electromagnetic spectrum chart below.

$\lambda =$ wavelength (units: km, m, cm, µm, nm)
$f =$ frequency (units: 1 hertz = 1 hz = 1 cycle/sec = 1 sec^{-1})
c = speed of light = 3×10^8 m/sec
$c = \lambda f$ where λ = wavelength, f = frequency

Length Conversion: 1 m = 100 cm = 106 µm = 109 nm

Show all your work in the space provided.

$C = \lambda f = 3 \times 10^8$ m/sec, $f = \frac{C}{\lambda}$

Wavelength	Frequency (Hz)	Class of EM Radiation	
2 km = 2000 m	150,000 Hz	RADIO	$\frac{3 \times 10^8 \text{ m/sec}}{2000 \text{ m}} = 150,000$ Hz
0.5 µm = 5×10^{-7} m	6×10^{14} Hz	VISIBLE - BLUE	$\frac{3 \times 10^8 \text{ m/sec}}{5 \times 10^{-7} \text{ m}} = 6 \times 10^{14}$ Hz
0.035 nm = 3.5×10^{-11} m	8.6×10^{18} Hz	X RAY	$\frac{3 \times 10^8 \text{ m/sec}}{3.5 \times 10^{-11} \text{ m}} = 8.6 \times 10^{18}$ Hz
20 cm = 0.20 m	1.5×10^9 Hz	MICRO WAVE	$\frac{3 \times 10^8 \text{ m/sec}}{0.20 \text{ m}} = 1.5 \times 10^9$ Hz
10 µm = 1×10^{-5} m	3.0×10^{13} Hz	INFRARED	$\frac{3 \times 10^8 \text{ m/sec}}{1 \times 10^{-5} \text{ m}} = 3.0 \times 10^{13}$ Hz

What is the range of wavelength in centimeters, that is detected by your eye or standard camera film?

In-Class Activity: Force Analysis of Particle-on-Slope Model

(1) Choose our class favorite block-of-rock sample and set up the inclined plane.
(2) Determine the mass of our block-of-rock sample by using the balance in the room.
(3) Using the appropriate equations listed above, calculate the force vectors and fill in the table below. Show your calculations in the space provided!

Mass of Rock Block 0.179 kg   179g

Weight of Rock Block 1.75 N

Wt = mg = (0.179 kg)(9.8 m/sec²) = 1.75 N

Slope Angle (Degrees)	Normal Force (N) σ	Shear Force τ (N)
0	1.75	0
10	1.72	0.30
20	1.64	0.59
30	1.52	0.88
40	1.34	1.12
50	1.12	1.34
60	0.88	1.52

σ = wt(cos θ)

θ = slope ∡

τ = wt(sin θ)

Given that shear force is oriented downslope and normal force is oriented perpendicular to slope, answer the following questions:

A. Which of the two forces will drive the rock-block downslope when it fails? τ - Shear

B. Which of the two forces will tend to resist downslope movement of the rock block? Normal

C. Intuitively, when do you think the block will begin sliding down the slope (choose 1: shear = normal, shear < normal, shear > normal)? Shear > Normal

(4) Place the rock-block on the inclined plane and determine the critical angle at which it slides down the slope. Calculate the following:

Critical Angle of Rock-Block Sliding (degrees): 19°

Critical Normal Force at Critical Angle 1.65 (N)

Critical Shear Force at Critical Angle 0.57 (N)

D. How do your inclined-plane results compare to your prediction in question C above?

DO NOT ACCOUNT for FRICTION /

E. List some ideas as to why your results turned out like they did. What other physical factors have not been accounted for in our set of equations / slope analysis?

Surface interaction

In-Class Exercise

A 3.6 m thick mass of regolith rests on top of a sloping bedrock surface. The hillslope angle is 8 degrees. A geotechnical engineering firm conducted an in-situ slope stability analysis with the following results:

regolith cohesion = 2155 N/m^2
effective normal stress = 71855 N/m^2
angle of internal friction = 10°
specific weight of regolith = 25921 N/m^3

Calculate the safety factor for the slope (show your work):

$F = \frac{\sigma}{T} = \frac{91508 \text{ N/m}^2}{12937 \text{ N/m}^2} = 7.9$

$F > 1 \Rightarrow$ STABLE

Shear Strength

$S = c + \sigma' \tan\phi$

$S = 2155 \frac{N}{m^2} + \left(71855 \frac{N}{m^2}\right)(\tan 10°) =$

$S = 14825 \text{ N/m}^2$

Shear stress

$T = \gamma h (\cos\theta)(\sin\theta)$

$= \left(25927 \frac{N}{m^3}\right)(3.6m)(\cos 8)(\sin 8)$

$= (25927 \text{ N/m}^3)(3.6m)(0.99)(0.14)$

$= 12936.5 \text{ N/m}^2$

Normal stress

$\sigma = \gamma h (\cos^2\theta)$

$= \left(25921 \frac{N}{m^3}\right)(3.6m) \cos^2(8°) = 91508.2 \text{ N/m}^2$

Questions

(1) Is the slope stable or unstable with respect to shear strength vs. shear stress? Why?

STABLE

$F > 1$; SHEAR STRENGTH > SHEAR STRESS

(2) What slope stability factors could easily be changed (say during the course of a week), that would result in driving the slope to a critical threshold? (Do some thinking and hypothesizing here). Directly relate your ideas to the pertinent equations used to calculate slope stability.

RAINFALL = ADDS TO WT. OF MASS

= ADDS PORE PRESSURE, REDUCES NORMAL STRESS