National Exams May 2003

98-CIV-A4 Geotechnical Materials and Analysis

3 Hours Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.

2. Type 2 "Closed Book" however, two (2) textbooks maximum are permitted. Written notations in books are acceptable. Drawing instruments and scales are permitted. No notes may be used.

3. Candidate may use one of two calculators, the Casio or Sharp approved models.

4. Graph paper will be provided.

5. There are six (6) questions. **Complete questions 1, 2, 3, 4, and one other question.** Only the first five (5) questions as they appear in your answer book will be marked.

6. All questions are of equal value.

7. **Page #8 must be returned with your examination answer sheets!!!!**

Question 1.

A. A sample of clay was obtained from 1.5 m below the ground surface.
The groundwater was located 2.0 m below ground surface.
Laboratory tests determined the following:
water content, w = 12.5%,
Specific Gravity, G_s = 2.67, and
Degree of Saturation, S = 67%.

Calculate the wet and dry unit weights (in kN/m^3), porosity, and void ratio.
Calculate the water content if the degree of saturation was 100%.
Clearly state any necessary assumptions.

B. From the data below, classify the soil according to:
1. USCS (Name and Group Symbol)
2. AASHTO ***or*** British Soil Classification System

Use the "Mechanical Analysis" graph on page #8 for plotting Grain Size Distribution. Be sure to submit page #8 with your answer sheets!

3. Assume this soil is to be used in a compacted fill.
Estimate the maximum dry unit weight (in kN/m^3), and optimum moisture content for this soil.
Explain how you determined these values.

Sieve		Soil Sample
No.	Opening	% Passing
	(mm)	
10	2	69
20	0.85	61
40	0.425	50
60	0.25	42
100	0.15	34
200	0.075	28
Consistency (Atterberg Limits)		
LL - w_L		44
PL - w_P		33

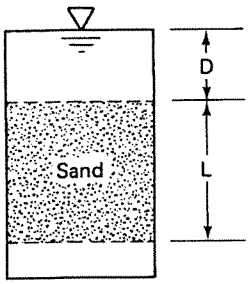
Question 2. For each case illustrated below:

A. PLOT total stress, pore water pressure, and effective stress versus height. These plots should be approximately to scale.

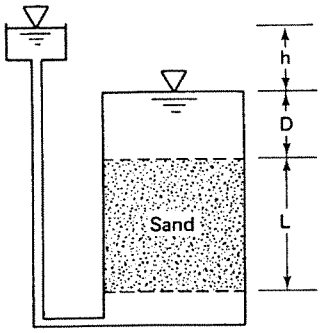
B. Derive the formulas for the three stresses at the top an bottom of the sand layers in terms of the dimensions shown and the unit weights of the soil and water.

The sand is supported on a porous disc and screen in a vertical cylinder. Each condition shown is in equilibrium.

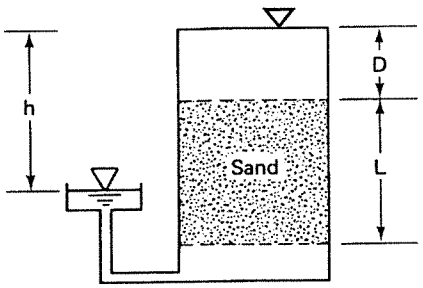
Clearly state any necessary assumptions.



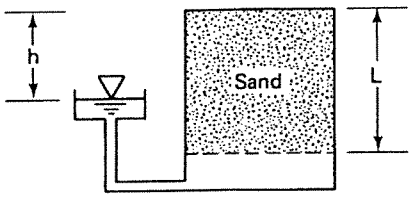
Case I



Case II



Case III



Case IV. Assume that the sand is fine enough to remain 100% saturated up to its top surface by capillarity.

Question 3. A warehouse structure is supported on two wall footings 50 m long by 3 m wide that are embedded 1.0 m below the ground surface (see drawing below). The **applied stress on the wall footings** due to the structure is **60 kPa**.

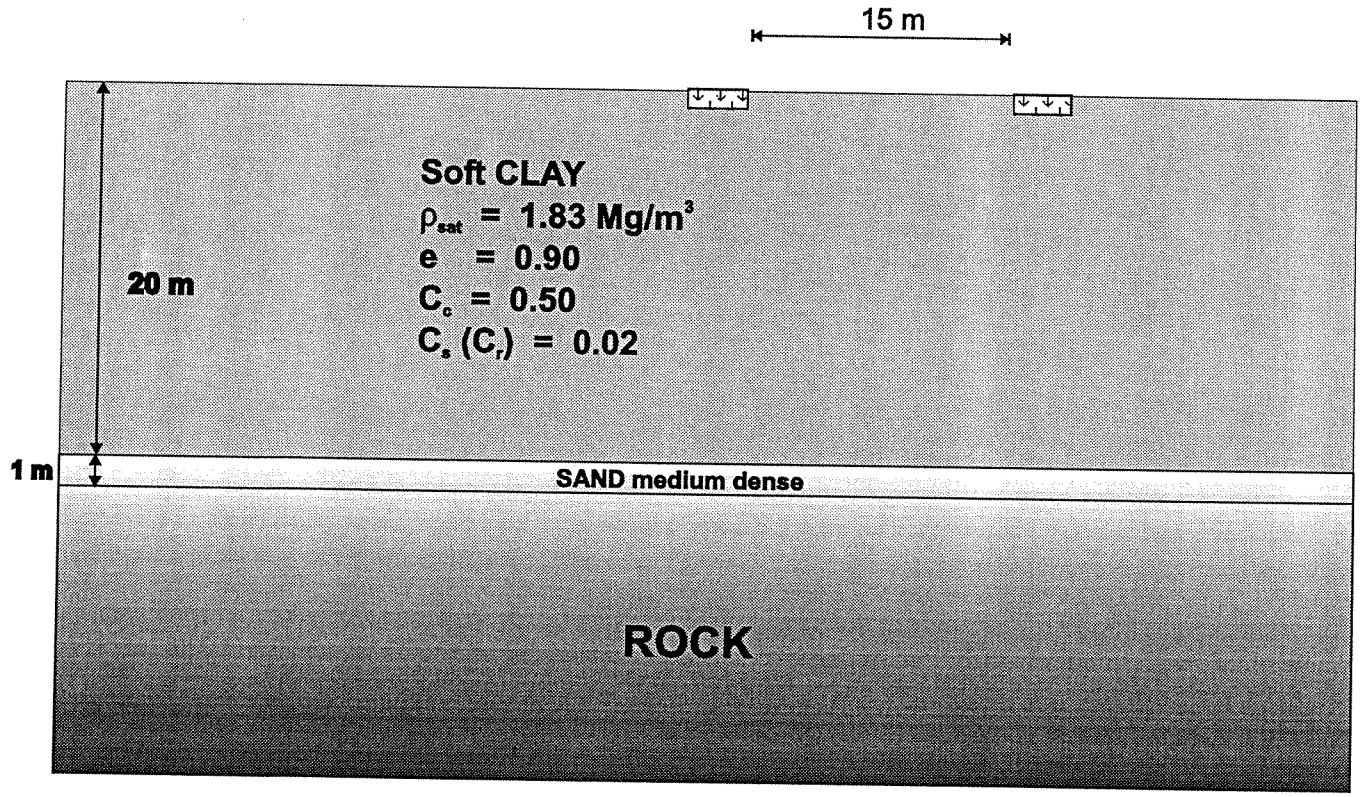
The average properties of the clay were determined from tests on 'undisturbed" samples from a depth = 10 m. Properties are summarized below and on the figure below:

pre-consolidation pressure, σ'_p **= 189 kPa;**
consolidation coefficient, c_v **= 0.5 m²/year;**
unconfined compressive strength, q_u **= 48 kN/m²**

A. Determine the ***maximum total settlement***. Where does it occur?

B. If the design life of the building is 40 years, what settlement would the building experience? (***Assume*** *consolidation settlement,* S_c ***= 25 mm.***)

C. What is the Factor of Safety of the footings with respect to Bearing Capacity?



Question 4.

A conventional triaxial compression test was carried out on a saturated, normally consolidated clay. The cell pressure was held constant at 10 kPa, while the axial stress was *increased* to failure.

A. Plot the $\Delta\sigma$ and Δu versus axial strain curves. Determine Skempton's pore water pressure parameters, B *and* A_f.

B. Plot total and effective stress paths for the axial compression test. Sketch the total stress path for a lateral extension test.

C. What is ϕ'? ***Clearly state any necessary assumptions.***

Axial Strain ε_{axial} (%)	Axial Stress $\Delta\sigma_{axial}$ (kPa)	Pore Water Pressure Δu (kPa)
0	0	0
1	3.5	1.9
2	4.5	2.8
4	5.2	3.5
6	5.4	3.9
8	5.6	4.1
10	5.7	4.3
12	5.8 fail	4.4

Question 5.

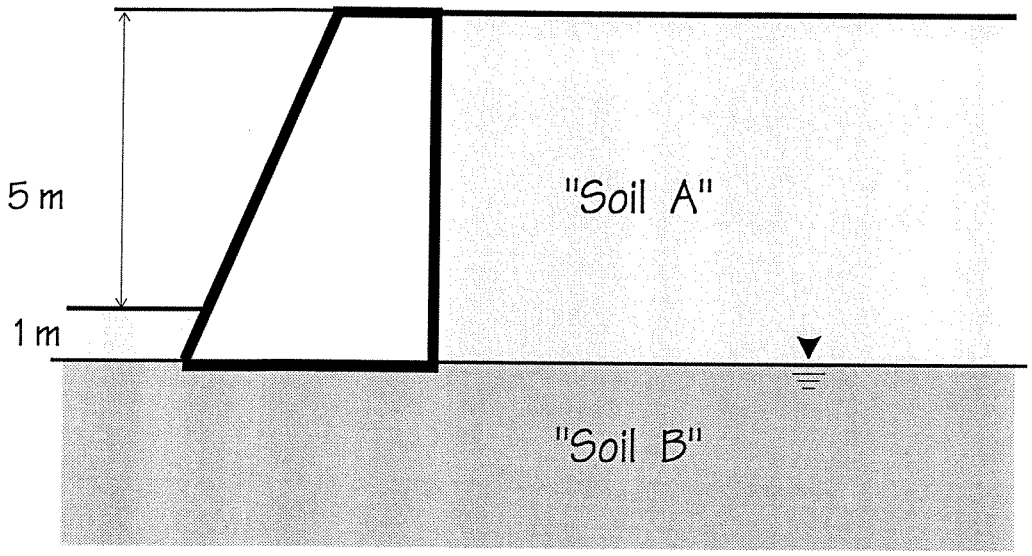
The soil conditions for a rigid gravity retaining wall (see figure) are given below. The wall is free to move to the left. Assume the wall friction is 24° behind the wall and 0° in front of the wall.

Calculate the active and passive earth pressure forces acting on the wall (indicate magnitude, direction and locations).

"Soil A" c' = 0 kPa ; ϕ' = 36°; unit weight, γ_{sat} = 20 kN/m^3 ; γ_{moist} = 18 kN/m^3

"Soil B" c' = 10 kPa; ϕ' = 28°; unit weight, γ_{sat} = 18 kN/m^3

Clearly state any necessary assumptions



Question 6.

A. Determine the factor of safety for a homogeneous clay slope using the "stability number (or coefficient)" method after Taylor (1937).

Slope Angle, $\beta = 26°$; Height, H = 12 m; Depth to rock, z = 10 m (below toe);

Shear strength, $c_u = 195$ kPa; unit weight, $\gamma = 17.5$ kN/m^3.

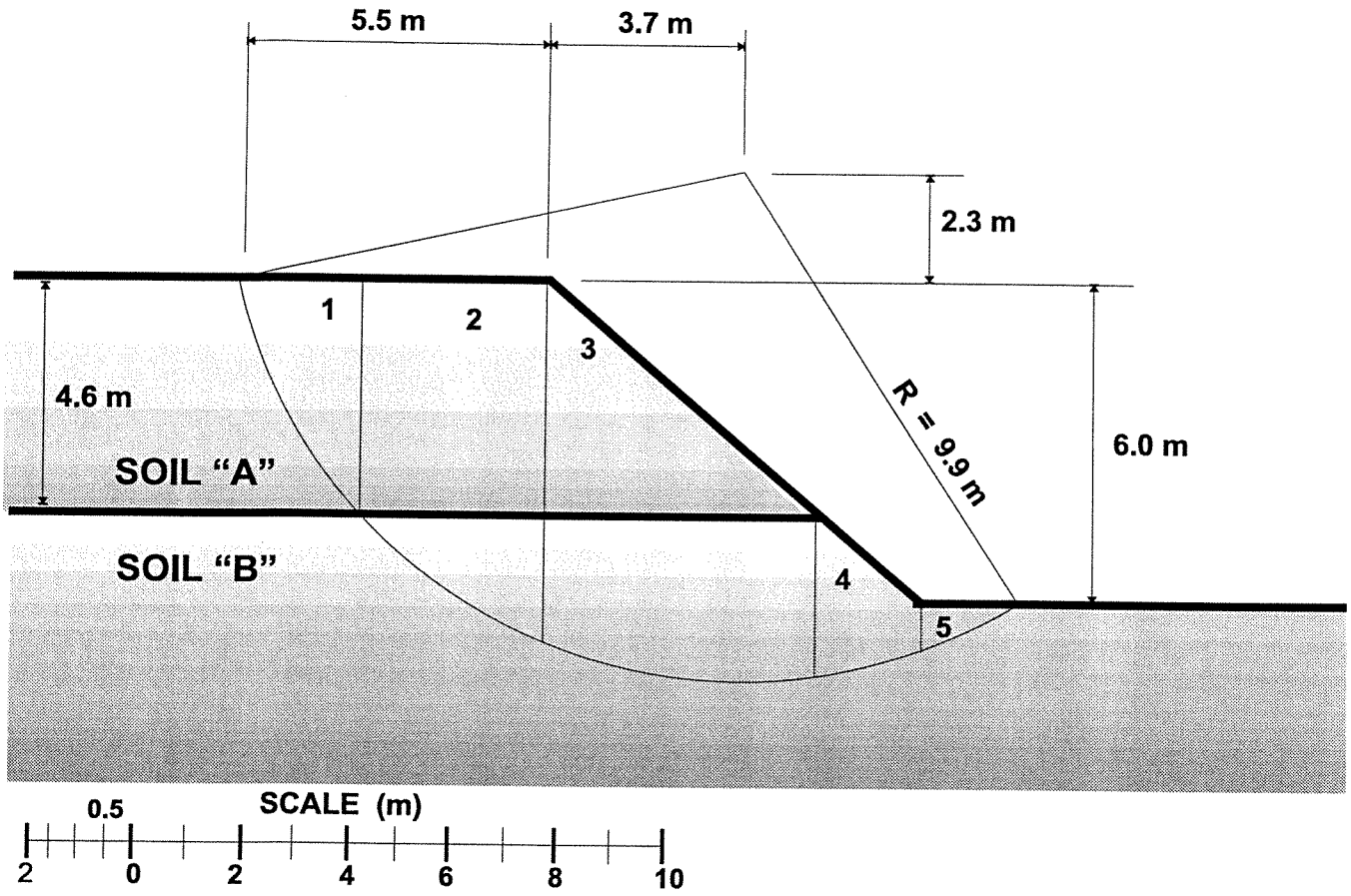
B. Use the Method of Slices (Fellenius/Ordinary) to determine the Factor of Safety for the slope shown below assuming effective stress condition.

SOIL PROPERTIES:

SOIL A	
$\gamma_{tot} = 19.0$ kN/m^3	
c' = 0.0 kPa	$\phi' = 25^0$
$c_u = 73$ kPa	

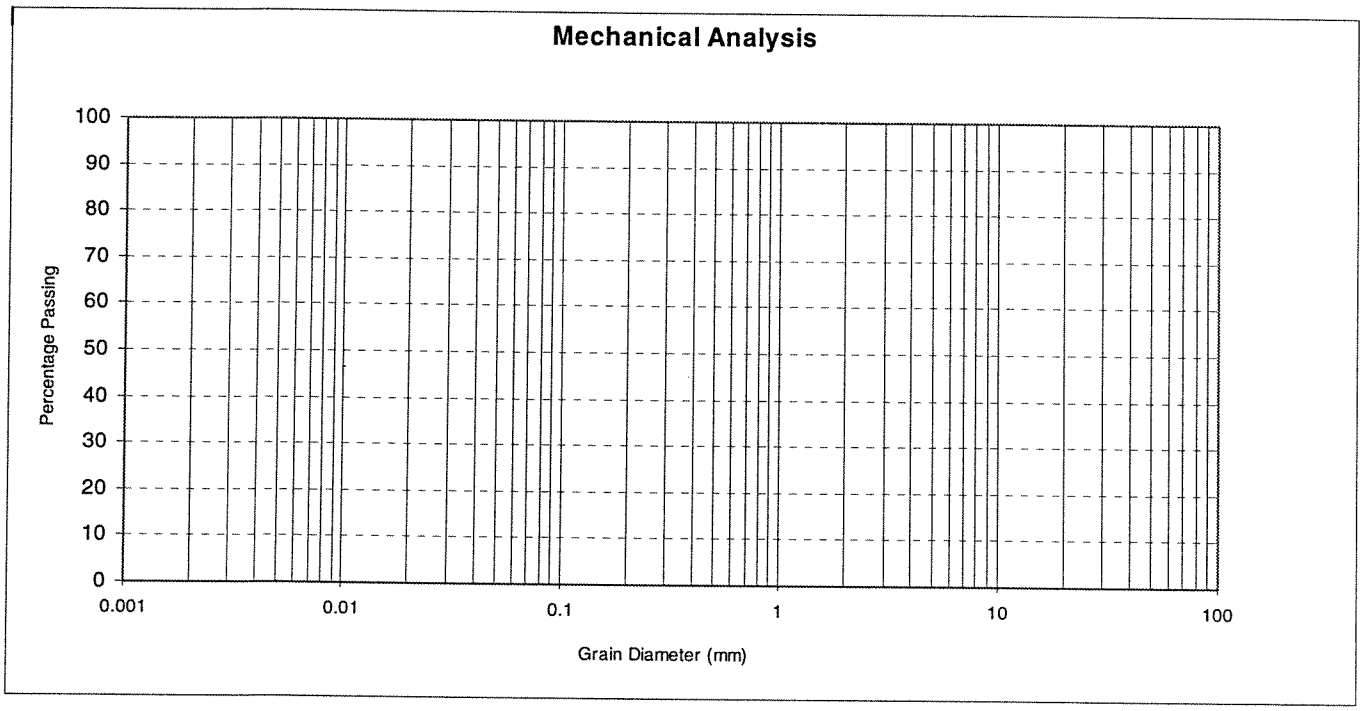
SOIL B	
$\gamma_{tot} = 19.0$ kN/m^3	
c' = 0.0 kPa	$\phi' = 28^0$
$c_u = 97$ kPa	

Water table is 2.8 m below toe of slope.

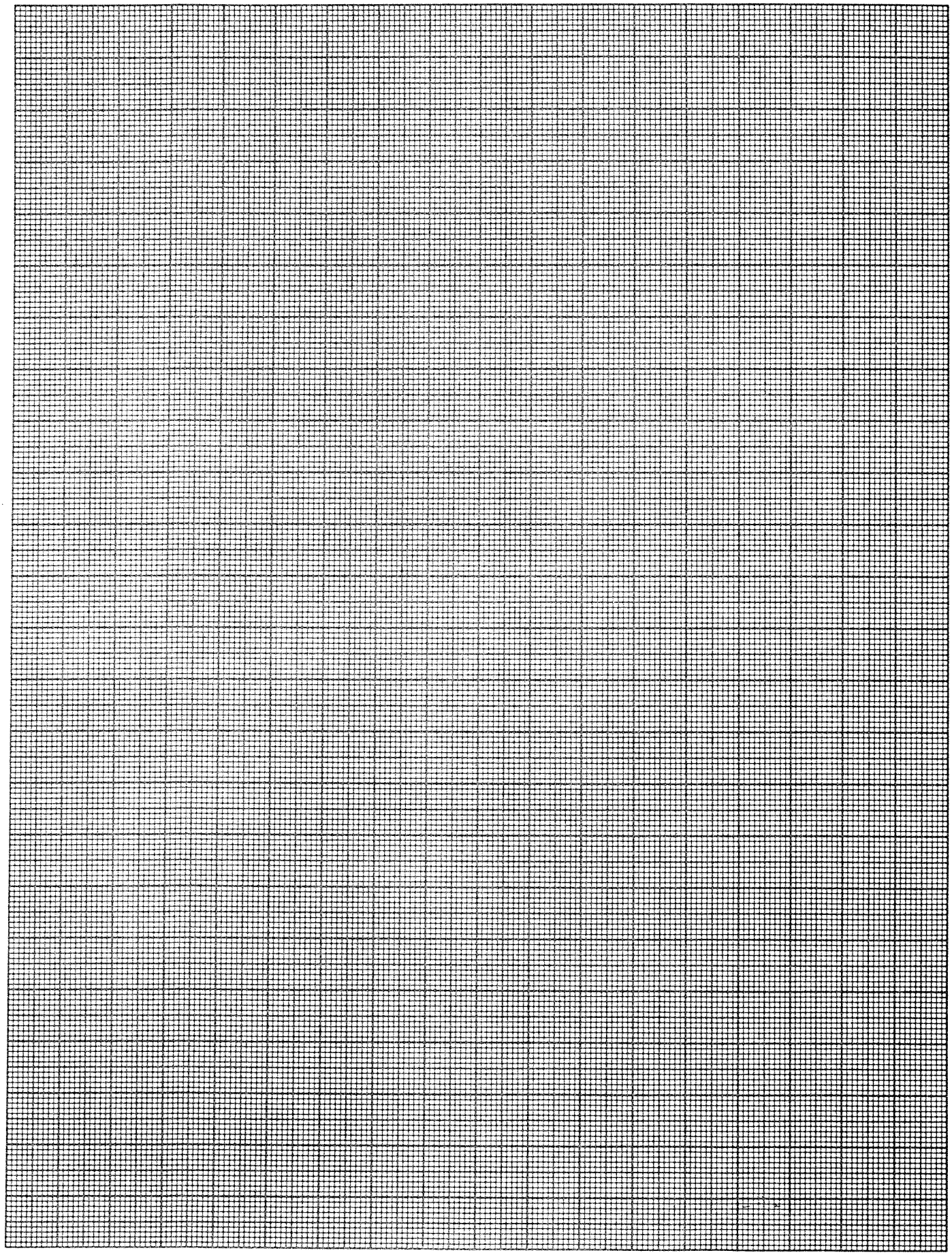


SUBMIT THIS PAGE WITH YOUR ANSWER SHEETS!!!!

NAME (Print): _____



Graph for Question 1. B.



10 MM/CM