

National Exams December 2008

04-Agric-A2, Soil Physics & Mechanics

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 assumptions made.
2. This is an OPEN BOOK EXAM.
Any non-communicating calculator is permitted.
3. Four (4) questions constitute a complete exam paper.
The first four questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Some questions require a written answer. Clarity and organization of the answer are important.

Marking Scheme:

1: 5, 10, 5, 5
2: 5, 5, 5, 5, 5
3: 7, 7, 6, 5
4: 5, 5, 5, 5, 5
5: 7, 7, 6, 5
6: 7, 7, 6, 5

1.(25 Marks)

The table below summarizes the results from two consolidated-undrained triaxial tests on an unsaturated cohesive soil.

- What is meant by an "undrained" test?
- What are the apparent shear strength parameters, c and ϕ ?
- What are the effective shear strength parameters, c' and ϕ' ?
- What other means are available for determining the shear strength characteristics of a soil besides a triaxial test?

Test	σ_1 (kPa)	σ_3 (kPa)	u (kPa)
1	190	65	35
2	340	130	60

Note: a sheet of graph paper is provided at the end to help answer this question.

2.(25 Marks)

The data below has been collected for two soils to be used as fill material for the leaching bed of an on-site septic system.

Sieve		% Finer	
Number	Opening (mm)	Sample 1	Sample 2
4	4.76	90	100
8	2.38	64	90
10	2.00	54	77
20	0.85	34	59
40	0.425	22	51
60	0.25	17	42
100	0.15	9	35
200	0.075	7	33
Characteristics of the -40 Fraction			
	LL	N/A	46
	PL	N/A	29

- On the attached graph paper, draw the grain size curves for the two soil samples.
- What are the coefficients of uniformity and concavity of the two soils?
- Which of the soils is more poorly graded?
- If the soil with the higher permeability is preferred for the leaching bed, which soil would you recommend?
- Classify the soil you recommended according to the Unified Soil Classification System.

3.(25 Marks)

An excavation in a soil is made to determine some of the in-situ properties. The excavation is 1 m deep, with vertical walls. On one of the walls of the excavation a steel ring with an inside diameter of 3.3 cm and length of 2.8 cm is driven into the soil and removed with the soil flush at both ends. It is immediately placed in an air tight bag for later analysis. At the lab the soil is removed from the ring, weighed, then dried in an oven at 100°C for 24 hours and then weighed again. The data below was obtained:

Mass of the soil before drying:	41.023 g
Mass of soil after drying:	37.122 g
Density of soil particles:	2.68 g/cm ³

- What is the in-situ bulk density of the soil?
- What is the dry density of the soil?
- What is the moisture content of the soil as collected in the field?
- What problems can you identify with this approach to determining the in situ properties above?

4.(25 Marks)

Soil from a borrow pit is to be used for a constructed fill in the construction of a storage lagoon. The construction details call for the fill to be placed and compacted to 95% Proctor density. This is known to correspond to a void ratio of 0.35. The material to be used for the fill comes from a borrow pit with a void ratio of 0.60.

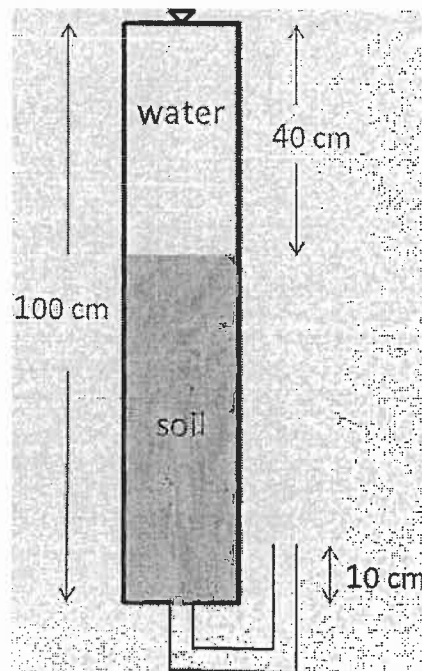
- Describe what "95% Proctor Density" means.
- What volume of material from the borrow pit will need to be removed to make up the required 1000 m³ of in place material?
- Plot the relationship between water content and bulk density for a soil undergoing a standard compaction effort.
- Show on the same graph as used for item c, the affects of increasing or decreasing the compaction effort.
- Suggest ways that the required compaction might be achieved in the construction.

5.(25 Marks)

A sample of soil is collected in the field by driving a 100 cm long pipe into the soil a total depth of 60 cm. The pipe has an inside diameter of 18.5 cm. Back in the lab the soil column is first saturated with water from below until the water exits the top of the soil. This takes exactly 5.650 L of water to accomplish. Water is then added to the top so that the remaining 40 cm of pipe above the soil is full of water. Water exits the bottom through a small tube whose exit is 10 cm above the bottom of the tube as shown in the figure. (The figure shows the condition at time = 0.0 hr.) The water is then allowed to drain from the column through the small tube and the water level on top drops. The data below was collected relating the water level above the soil with time.

Time (hrs)	Water level above soil (cm)
0	40
1	33
2	26
3	20
4	14
5	9

- Assuming the soil was initially at a moisture content of 0%, what is the porosity of the soil?
- What is the saturated hydraulic conductivity of the soil?
- If a depth of water above the soil of 40 cm is maintained, what is the velocity of the water passing through the soil grains? (If you could not answer part b, you may use a value for the hydraulic conductivity of 0.1 m/day).
- Suggest other methods of determining the saturated hydraulic conductivity of a soil.



6.(25 Marks)

Given in the table below is the void ratio verses pressure data from a laboratory test. The initial sample height is 200.00 mm and the sample diameter = 62.3 mm. Plot e vs. p and e vs. $\log(p)$ and determine:

- a) The coefficient of compressibility, a_v ,
- b) The coefficient of volume compressibility, m_v ,
- c) The compression index, C_c
- d) What soil factors most affect the field compaction obtained for a soil? Explain why they do.

Pressure, p (kPa)	Void Ratio, e
0	1.02
25	0.98
50	0.975
100	0.954
200	0.880
400	0.781
800	0.688
1600	0.575
400	0.781

Note that two additional sheets of graph paper are provided at the end of the exam for this question.

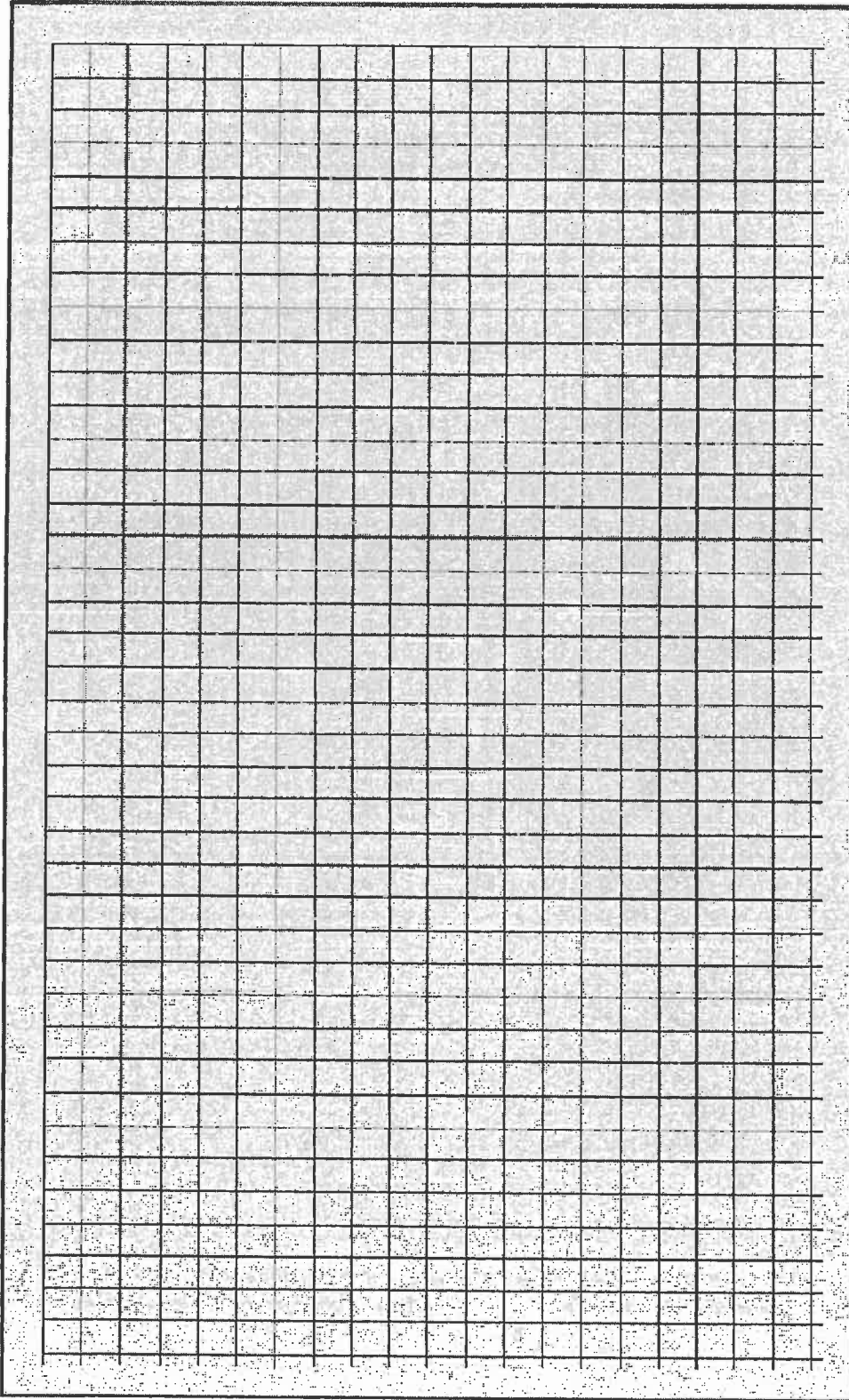


Figure to be used with question 1, include this page with your answer book.

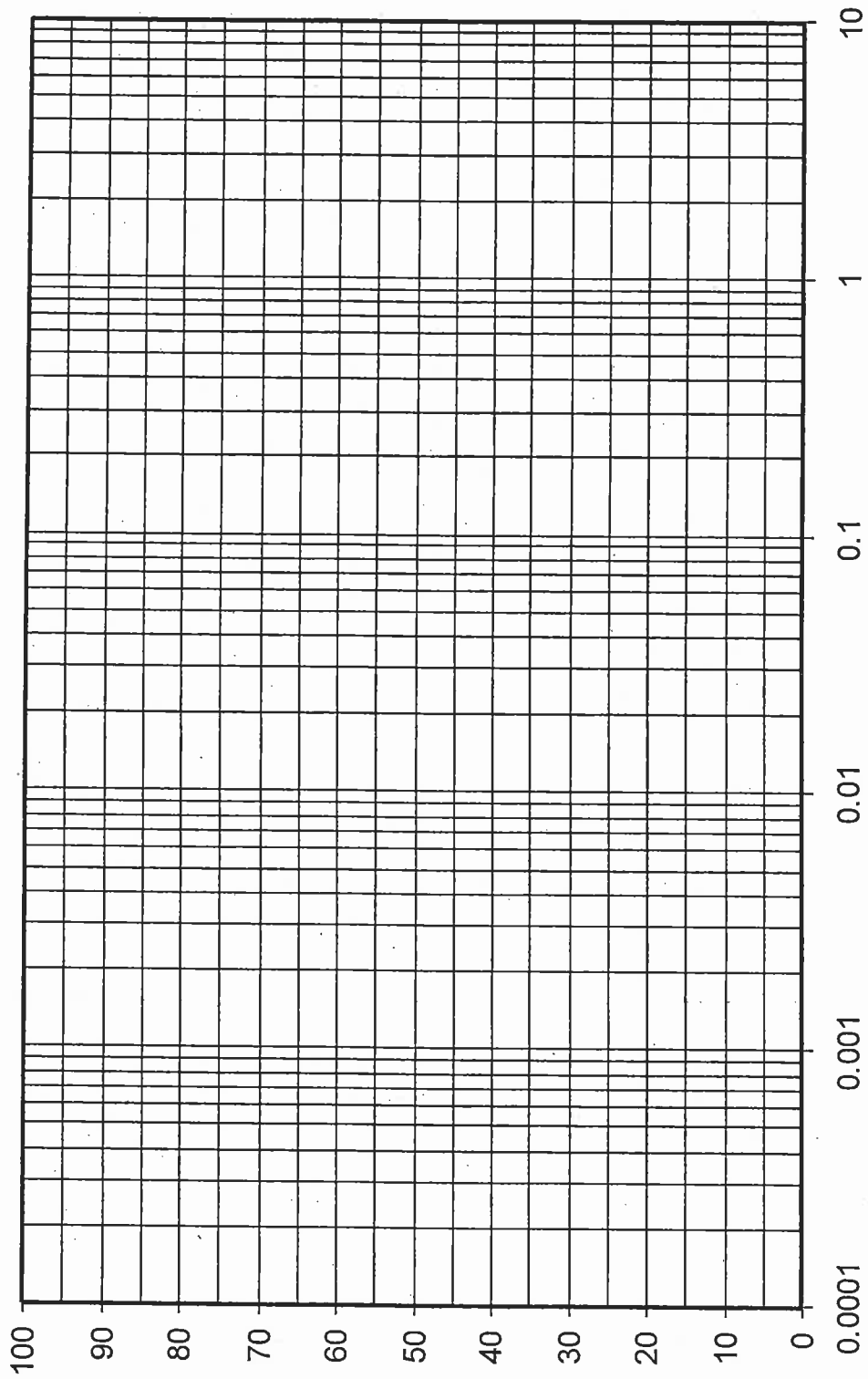


Figure to be used with question 2, include this page with your answer book.

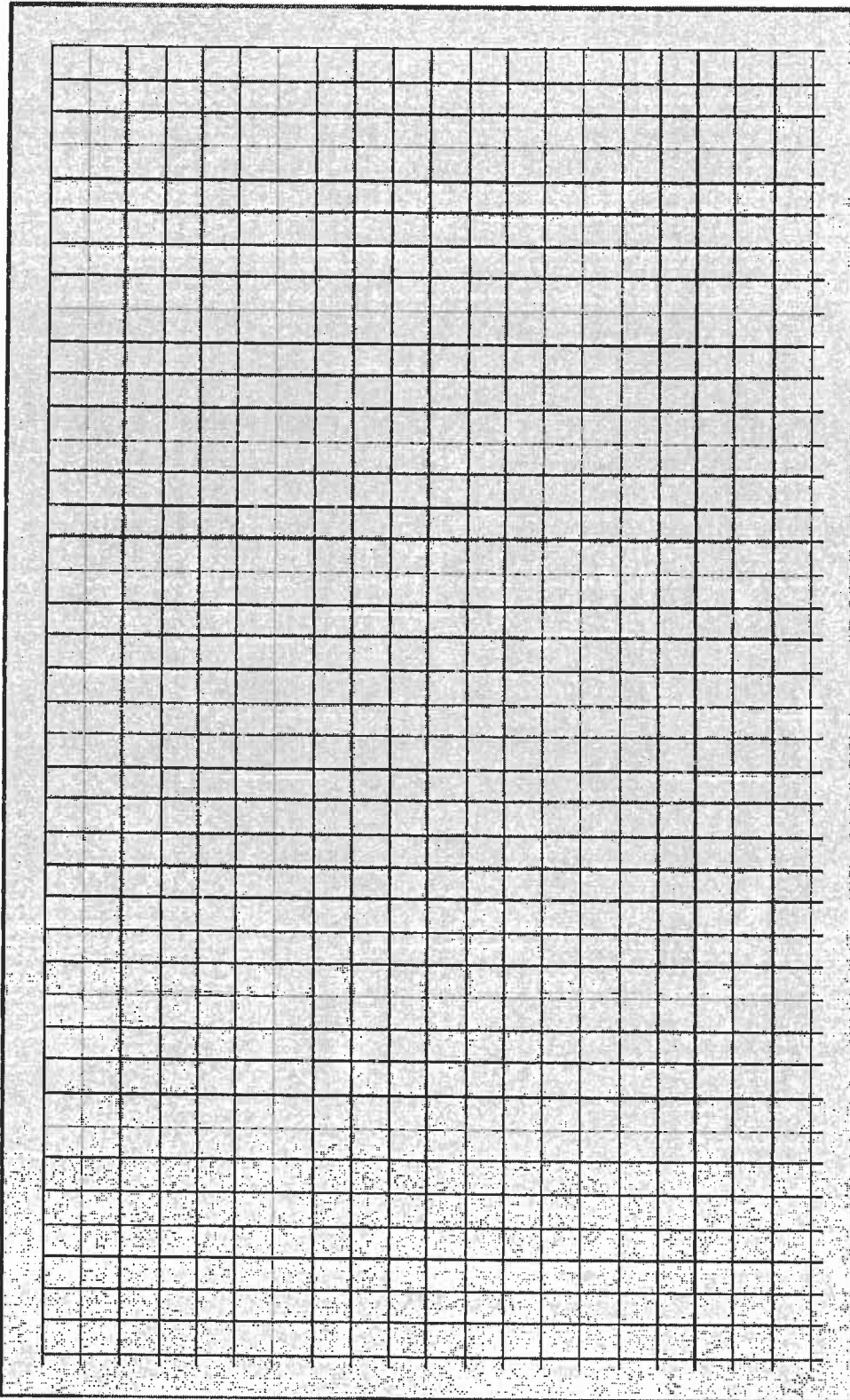


Figure to be used with question 6, include this page with your answer book.

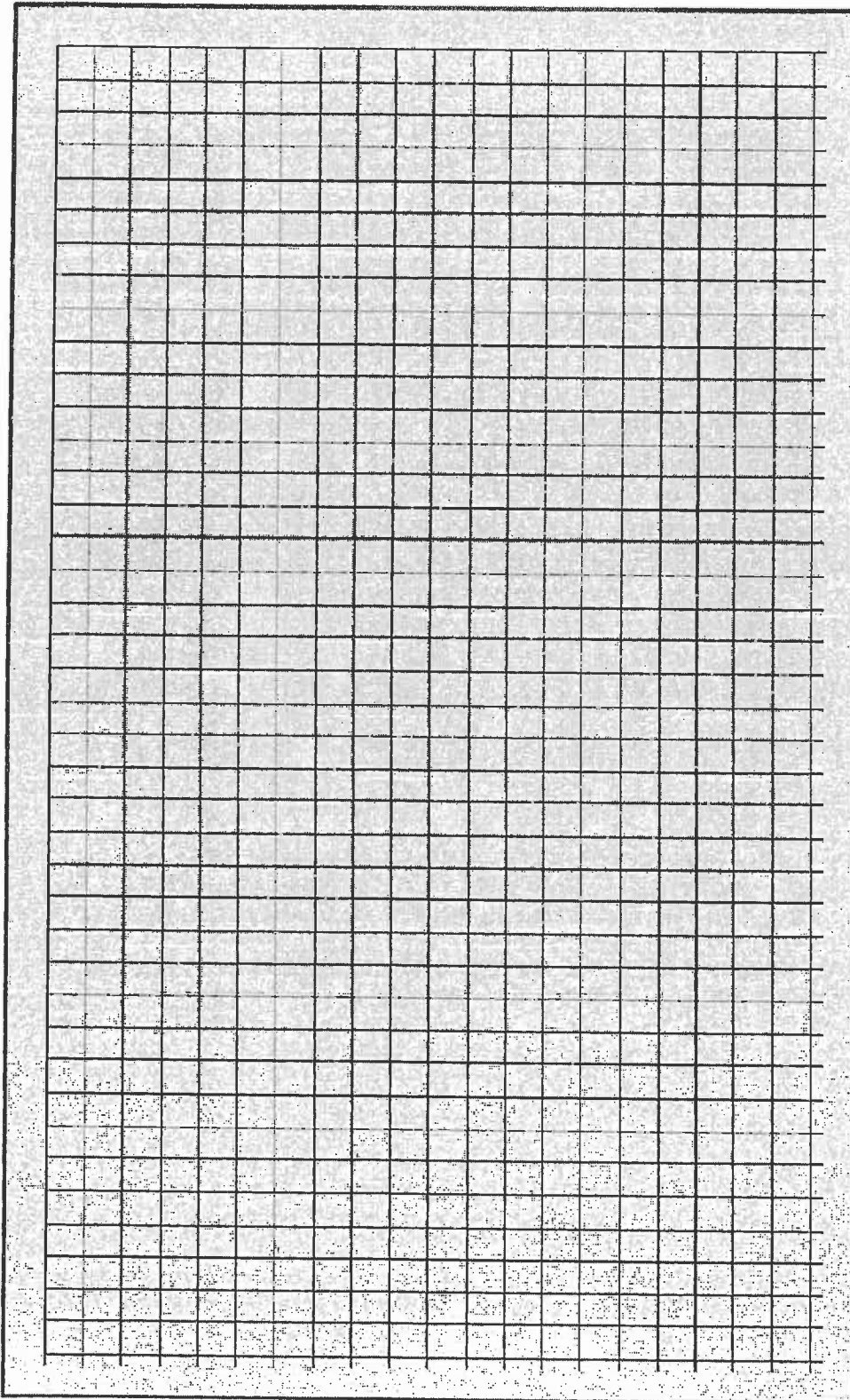


Figure to be used with question 6, include this page with your answer book.