

**The University of Melbourne**  
**The Institute of Land and Food Resources**

**Soil and Water Resources**

Reading Time 15 minutes  
Examination Duration 3 hours  
This paper has 4 pages including this cover.

**Authorized Materials**  
Hand held calculators are allowed

**Instructions to Invigilators**  
Students will require script books only (initially 3)

Examination paper can be deposited in Library

**Instructions to students**  
This paper contributes 50% of the total subject mark.  
You are to answer six (6) questions. There are three (3) sections. You must answer two (2) questions from each section.  
Separate script books are to be used for each section

All questions are of equal value.

## Section 1

1. Describe the key distinguishing properties of five of the main soil orders, recognized in the Australian Soil Classification of Isbell (1996), which are found in Victoria. What land management issues can be inferred from these soil properties.

2. The following is an extract from a soil test report.

Available phosphate (Colwell P)	68 mg/kg
Available phosphate (Olsen P)	30 mg/kg
pH (water)	5.2
pH (CaCl <sub>2</sub> )	4.4
EC	1.78 dS/m

### Exchangeable cations

Calcium	8.10 meq/100 g
Magnesium	4.27 meq/100 g
Sodium	1.50 meq/100 g
Potassium	1.00 meq/100 g
Aluminium	1.95 meq/100 g

(Note – 1 meq/100 g is equivalent to 1 cmol charge (+)/kg)

(a) Perform whatever calculations are necessary on the above results to determine if the soil is likely to require gypsum and/or lime, and give reasons for your conclusion.

(b) What other factors need to be managed in this soil for improved productivity and protection of adjacent water resources? Make a recommendation as to how each limitation could be remedied? (both parts are of equal value)

3. Why does the surface of a Vertisol (black clay soil) crack when it is dry, and swell when it is wet? Contrast this behaviour with that of a Ferrosol. Explain your answer with reference to the types of clay minerals normally found in these soils and comment on their crystal structure and properties.

## **Section 2**

4. Provide a brief definition of the following terms as they relate to soil:

- isomorphous substitution
- B Horizon
- hydraulic conductivity
- cation exchange capacity
- slaking and dispersion
- bulk density

(all parts are of equal value)

5. Soil acidification is a major degradation problem. Describe:

- a). the key processes involved in soil acidification,
- b) the effects of acidification on soil properties;
- c) the strategies available to minimise soil acidification in agricultural systems

6. Discuss the mineralisation of nitrogen in soil. How and why does the C/N ratio of a decomposing organic substrate relate to nitrogen availability. Describe two examples of nutrient transformations carried out by organisms in the mineralisation of nitrogen.

(each part is of equal value)

7. Discuss the main factors affecting P availability in soils.

### **Section 3**

7. You are a land manager converting a long term pasture to a tree plantation for Carbon Credits. Explain how this land use change may affect the local hydrologic balance, with reference to each of the factors in the water balance equation.

8. An irrigator applies 10 ML of irrigation water per hectare per year to 20 ha of trees and pasture. The annual average evapotranspiration and rainfall is 900 mm and 450 mm respectively. The electrical conductivity of the irrigation water is 900  $\mu\text{S}/\text{cm}$ , with sodium as the dominant cation.

(a) What is the potential depth of water accession to groundwater each year, assuming no runoff occurs?

(b) What is the leaching requirement and leaching fraction? Is enough leaching likely to occur to avoid salinizing the root zone?

(c) What is the potential volume of groundwater accession for the 20 ha of pasture?

(d) What are the implications of this irrigation management for the region in which it occurs, and how could practices be improved?

(e) What is the mass of salt applied annually and the mass of salt leached (each part is of equal value)

9. In the context of catchment management, how does land use and location in the catchment impact on water salinity, nutrient concentration and risk of pathogens?

10. Discuss the relationship between irrigation systems, drainage requirements and types of irrigated enterprise. Comment on how these components affect the overall sustainability of the system.

*end of exam*