Level 1: remembering.

Frequently used task words: define, list, label, name.

Can the student recall or remember the information?

Q

Name five chemical compounds that make up plant root exudates.

The question just asks you to name five chemical substances found in plant root exudates. You do not need to write explanatory paragraphs, or put the answers into sentences. There are more than five compounds found in exudates, but you only need to list five of them that you can remember.

A

Amino acids, organic acids, sugars, phenolic compounds, flavonoids.

Level 2: understanding.

Frequently used task words: describe, explain, identify & example.

Can the student explain ideas or concepts?

Q

What are the three principal gases in soil pores and how does their concentration changes with soil depth in a well-drained grass pasture soil?

The question asks you to a) identify three gases in soil pores b) explain the concentration of each gas changes with depth. Your answer should address both parts of the question.

A

Carbon dioxide: low overall concentration, increases with depth due to plant roots and soil microbes respiring, releasing CO2.

Nitrogen: inert gas, present in the highest concentration, does not change much with depth since it is not metabolised. Being a grass pasture, there is little nitrogen fixation likely which could otherwise cause a decline in nitrogen.

Oxygen: intermediate concentration, its concentration decreases with depth due to plants roots and soil microbes respiring oxygen. It is stated that the soil is well drained, therefore no anoxic conditions likely.

Level 3: applying.

Frequently used task words: apply, illustrate, solve, use & demonstrate.

Can the student use information in a new way?

Q

Why is soil crusting both a physical and chemical problem?

The question requires you to know the processes involved in soil crust formation and how this is affected by the physical and chemical properties of the soil. Therefore, you need to explain two aspects of the crusting process in context.

A

Soil crusting is the process of rearranging soil particles to form a denser and harder surface layer (crust) caused by weak aggregate strength. The crust impedes water infiltration and seedling emergence. The physical process involves the energy input by raindrops. Raindrops hitting the soil surface break up soil aggregates and result in rearrangement of clay particles and fine sand near the surface.

The chemical process is the presence of high sodium concentration in the soil which results in dispersion of clay minerals and aggregate destruction. A low concentration of sesquioxide clay minerals and lack of organic matter also increases the risk of aggregate destruction and leads to crusting.

Level 4: analysing.

Frequently used task words: analyse, compare, contrast, examine.

Can the student distinguish between different parts?

Q

Basaltic parent material has weathered into an undulating landscape. Apply your understanding of soil forming factors and basic mineralogy to explain where in the landscape you would expect to find red friable soils, and where in the landscape would you expect to find black soils?

i

The question has two parts:
a) Where are red soils found in the landscape, and why?

b) Where are black soils found in the landscape, and why?

A

Red soils are characterised by iron sesquioxide minerals (hematite) which are formed in humid well-drained conditions, and are commonly formed from basalt parent material. Well-drained conditions are likely to be found on the top of hills or upper slopes since water flows downhill. Therefore, red soils are likely found at the crest or upper slopes.

Black soils are indicative of poorly drained soil and can be caused by accumulation of minerals and organic matter. Foot slopes and flood plains tend to be wetter since water flows downhill. Wetter soils which accumulated minerals are more fertile and encourage vegetation growth, resulting in black soils. Therefore, black soils are likely to be found at foot slopes and floodplains.

Level 5: evaluating.

Frequently used task words: justify, defend, argue, evaluate, assess

Can the student justify a stand or decision?

As environmental officer at Supercheap Coal Mine Ltd, you are responsible for the revegetation of the mine site. Before revegetating the site, you have set up a trial to identify soil constraints that could affect the revegetation outcome. The table below shows the average height (in cm) of 10 trees per treatment.

	Nothing added	$Ca(NO_3)_2$ added	$CaCl_2$ added	$NaNO_3$ added	Irrigation
No lime	78	142	74	138	82
Lime added	99	157	102	161	108

Which soil factor is the most limiting to plant growth and needs to be overcome to ensure revegetation success?

You first need to identify which treatment is the control (this is the first cell in the table (no lime and nothing added)).

Secondly, you need to estimate if differences between treatments might be significant. Since no statistical measure of variance is given, you need to rely on you general knowledge of variation in biological systems – a difference between treatments of less than 10% is usually not significant (i.e. the treatments statistically are giving the same result).

Thirdly, the question asks to identify the most limiting factor. Therefore, you need to look for the largest treatment differences.

Comparing the tree height in the control (78 cm) to tree height in the liming treatment (99 cm) gives an improvement in growth, but growth was much greater without lime but with addition of Calcium nitrate (142 cm). However, Calcium nitrate consists of both calcium and nitrate ions and it is not clear if the improved growth is due to Calcium ions or nitrate ions. However, a treatment with sodium nitrate (138 cm) gave a similar improvement in growth. Both calcium nitrate and sodium nitrate have nitrate as common anion. Therefore, the growth improvement is due to nitrate ions, i.e. the soil is nitrogen deficient.
The addition of Ca-chloride did not improve growth, therefore, calcium is not responsible for the improved growth with calcium nitrate, confirming the earlier conclusion that nitrogen is deficient. Therefore, the soil needs to be treated with nitrogen fertiliser for best outcomes.

Level 6: creating.

Frequently used task words: create, design, develop, formulate, construct.

Can the student create a new product or point of view?

Q

During extended drought, the brick garden wall separating neighbouring houses developed cracks. A building inspector suggested that this was caused by a tree planted in the neighbouring yard near the border wall 2 years earlier. A legal case was initiated by the neighbouring parties and you are approached by lawyers to give a professional opinion on the matter.

How would you defend your argumentation?

This hypothetical question is similar to a question that you may encounter in your professional life. You need to think about causes for the cracking. Is the tree the cause of the problem? Is the drought the cause of the problem? Is the build quality of the wall the cause of the problem? You need to critically evaluate all aspects of the problem.

A

Areas your answer could address:

How could the tree cause the damage considering that the tree is only 2 years old?
Is there another larger tree in the vicinity?
What type of tree is it – is the type of tree know to interfere with footings?
Does the tree have shallow or deep roots?
Is the water extraction by the tree drying the soil and causing shrinkage, resulting in cracking?
Is there a dense grass cover that could also cause shrinkage?
Is the tree regularly watered, in which case there would be no shrinkage of the soil?
Is the wall cracking due to poor building quality/poor footings?
How deep are the foundations of the wall?
How old is the wall?
How was the ground prepared prior to building the wall? Is the soil a fill?
Is the drought (and soil shrinkage) the main reason for the cracking? Would it have an effect in well-watered gardens?
Is the soil known to be shrinking / swelling in response to changes in rainfall, such as cracking clays?