Level 1: remembering.

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

Can the student recall or remember the information?

Identify TWO methods used to treat drinking water to reduce the risk of infection.

This question just asks for the name of the methods, and nothing else is required.

You don't need to write an explanatory paragraph. You don't even need to put the answer into a sentence.

- Boiling water
- Chlorination

Level 2: understanding.

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

Can the student explain ideas or concepts?

Q

Explain the importance of using controls in microbial experiments.

This question can have more than one answer and the length required is difficult to determine by looking at the question. Does your academic want an essay or do they want a one-liner?

You can address this by looking at how much this question is worth. In an exam each mark is worth about a minute of time, so the amount you need to write depends on the mark value.

A

Controls in microbial experiments allow us to validate the results. The control ensures that the microbial growth is a result of experimental conditions rather than contamination.

For example, when testing the presence of microbes in food, the control agar plate is left unopened / unexposed. No growth in the control culture plate will make sure the microbial growth in experimental plates is from food rather than from the contamination of nutrient agar.

Level 3: applying.

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

Can the student use information in a new way?

The colony-forming unit (CFU) is used to estimate the number of viable bacterial and fungal cells in a culture. Solve the following problem:

An overnight culture of Escherichia coli is used as a sample. One mL of this culture is added to a bottle containing 99mL of buffer. This dilution is mixed well and one mL of this is mixed in 9 mL of buffer. This second dilution is diluted by four successive 1/10 dilutions. The last (sixth) dilution is plated, i.e. 0.1 mL is plated on nutrient agar.

After incubating the plate, 98 colonies are counted. How many colony forming units were present per mL of E. coli culture?

Here is a classic mathematical question that asks you to demonstrate how well you understand the basic calculations associated with CFU determination.

When answering this kind of question it's a good idea to put in some explanations of your logic, rather than just writing numbers down. That way, even if your numbers are incorrect, your marker can see how you are thinking and you might get some marks. It also makes the answers easier to interpret; therefore you are more likely to get marked fully and fairly.

Remember, if a marker can't understand what you are doing they will not give you marks for your answer. If you don't provide an explanation of what you are doing it is also very hard for you to challenge the way something was marked.

To solve this problem, try writing out the procedure. This will help you to keep track of your calculations at each step.

This experiment is made up of 6 dilutions and then 0.1 mL is plated (equivalent to 7 dilutions). Make sure you keep track of every one. You can multiply the successive dilutions together (here is where scientific notation comes in handy, since it is easy to add the exponents without 'losing a zero').

Working backwards from the CFU count on the plate, you can calculate the CFU/mL of the original solution.

A

Plated CFU/mL:

98 colonies/0.1mL plated = 980 CFU/mL

The number of colony-forming units per mL of the plated dilution can then be divided by the initial dilution:

Initial dilution:

$\frac{1}{1+99} \text{ X } \frac{1}{1+9} \text{ X } \frac{1}{10} \text{ X } \frac{1}{10} \text{ X } \frac{1}{10} \text{ X } \frac{1}{10} = \frac{1}{1{,}000{,}000}$

OR

$10^{-2} \text{ X } 10^{-1} \text{ X } 10^{-1} \text{ X } 10^{-1} \text{ X } 10^{-1} \text{ X } 10^{-1} = 10^{-7}$

$\frac{980}{10^{-7}}$ = 980 CFU/mL X 10^{7}

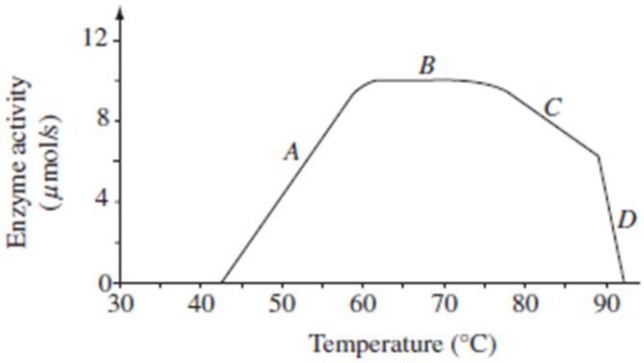
OR 9.8 X 10^{9} CFU/mL

Level 4: analysing.

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

Can the student distinguish between different parts?

The graph below shows the results obtained from testing the activity of a bacterial enzyme.



Analyse the graph and account for the activity of the enzyme at the parts of the graph labelled A, B, C and D.

This question is asking you to look at the four distinct sections of the graph, describe what you see and GIVE REASONS for why the enzyme activity is increasing, decreasing, or remaining steady.

Questions in this category will often ask you to list similarities or differences, or examine something in depth.

A = constant gradient indicating a constant increasing rate of enzyme activity as temperature increases.

B = graph level at a maximum (10 µmol / s). Enzyme-substrate complex operating at maximum even though temperature is increasing.

C = graph decreasing indicating a reduction in enzyme efficiency due to increasing temperature denaturing enzyme.

D = graph rapidly goes to 0 indicating enzyme activity stops because the enzyme is denatured.

Level 5: evaluating.

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

Can the student justify a stand or decision?

Explain how the contributions of Louis Pasteur, Robert Koch and MacFarlane Burnet have increased our understanding of the nature and prevention of infectious disease.

This question is asking you to draw on your knowledge of 3 well-known scientists that made significant contributions to our understanding of infectious disease.

You should try to create a logical series of paragraphs that include specific examples of discoveries made by each scientist and explain how these discoveries have impacted our society.

It's up to you to decide what examples you use to tell the story – there is no model answer.

The example answer below focuses on the causes and prevention of infectious disease. An alternative answer could have focused on the development of technologies of quarantine and antibiotics.

Through microscopic observations just prior to the 1800s, it was known that bacteria were the cause of food spoilage and decay of human tissue. Louis Pasteur was able to show that these bacteria were not the result of spontaneous generation. In his famous swan-necked flask experiment he proved that dust carried bacteria onto food and caused food spoilage. This understanding has led to treatment and storage of food to kill existing microbes and sealing of the food to prevent entry of new microbes. This has also reduced the incidence of food poisoning.

Pasteur's work also indicated that pathogenic microbes could be carried in the air by dust particles from human to human. This has led to development of aseptic techniques during surgery that have extended life expectancies and the success rate of surgery.

Robert Koch developed methodologies to isolate and determine the specific microbial cause of a disease. Termed 'Koch's postulates', they are steps to follow once a disease is observed in an organism. He developed the techniques of culturing microbes and identifying microbes by colony form and microscopic form. The steps also involved the description of the disease and the inoculation of a healthy organism with a culture of the suspected pathogen.

A

Once a list of disease and causative pathogens had been compiled and the means to culture the pathogen has been developed, the development of vaccines was facilitated.

In general terms, the techniques of weakening or killing microbes led to the development of vaccines for identified diseases. This was first demonstrated by Pasteur who conferred immunity to anthrax by using a weakened anthrax.

Specific studies and development of techniques to understand viruses also led MacFarlane Burnet to begin our understanding of the immune system. Burnet concluded that a human immune system contained unactivated B cells that could be activated and produce an immune response following their exposure to a microbe.

This led to the development of the understanding of mechanisms underlying previous vaccination technologies and led to the exploration of further vaccination technologies such as sub unit vaccines.

Level 6: creating.

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

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

Q

Bacteria can be used to produce human blood protein that functions at pH 7.4.

Two bacterial species are described in the table.

Species	pH growth conditions			Efficiency of plasmid uptake
	Minimum pH	Optimum pH	Maximum pH	
Sulfolobus acidocaldarius	1.0	2.5	5.0	Low
Thiobacillus novellus	5.7	7.0	9.0	High

These two species of bacteria were mixed together.

Describe how a biotechnologist in the 1940s would have isolated them from each other using an experimental procedure based on these data and standard techniques.

i

This question is asking you create a protocol for isolating two species of bacteria from a mixed sample, using technology available in the 1940s.

This question relies on a good knowledge of microbiology and the laboratory techniques used in culturing bacteria.

Think about how you would perform this in the lab and then outline detailed steps that will allow someone to perform the experiment.

The steps should include important details relating to specific techniques used in microbiology experiments.

A

1. Make two batches of agar plates: one batch with a pH of 2.5, one batch with a pH of 7.0.

2. Flame an inoculating loop in a Bunsen flame. Cool by touching on sterile agar. Touch the loop onto the mixture of bacterial strains.

A

3. Streak the pH 2.5 with the loop, while holding the lid of the plate just ajar to prevent airborne bacteria entering.

4. Re-flame and cool the loop and repeat to streak a plate at pH 7.0.

5. Incubate the plates until colonies begin to form.

6. Do not streak some pH 2.5 plates and some pH 7.0 plates to compare with the streaked plates to ensure that agar was sterile originally and that sterile techniques employed were working.