



AP[®] Environmental Science 2002 Sample Student Responses

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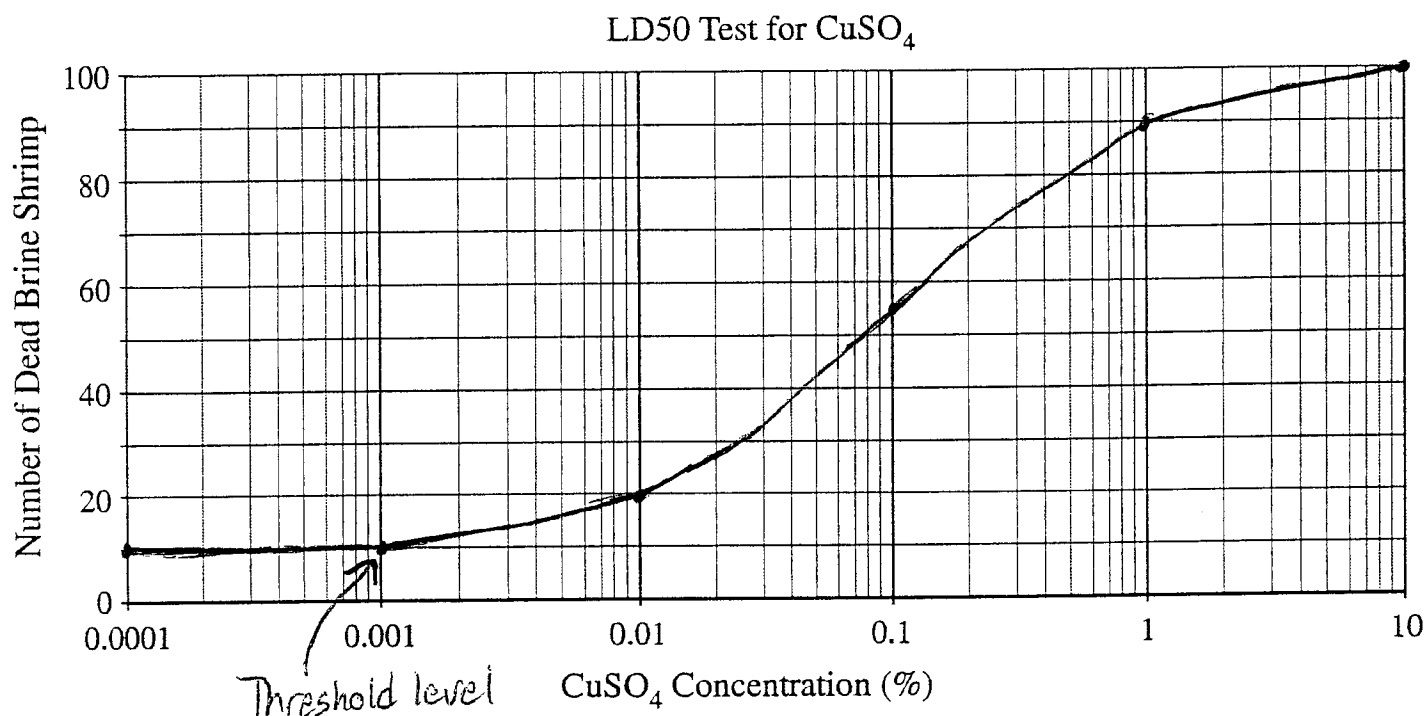
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3. An experiment is performed to test the toxicity of copper sulfate (CuSO_4) using brine shrimp as a test organism. Six different concentrations of CuSO_4 solution are prepared in separate petri dishes, and 100 brine shrimp are placed in each dish. After 48 hours, the number of brine shrimp that have died is counted and recorded. The results of this experiment are shown in the table below.

CuSO_4 Concentration (%)	Number of Dead Brine Shrimp
< 0.0001	10
0.001	10
0.01	20
0.1	55
1	90
10	100

(a) Plot these data on the blank semi-log graph provided below. Draw a smooth curve through the data points to illustrate the overall trend of the data.



(b) Explain the meaning of the term LD50 (ED50). What is the LD50 concentration of CuSO_4 for brine shrimp?

(c) Explain the meaning of the term “threshold level of toxicity”. What is the threshold level of toxicity of CuSO_4 for brine shrimp? Label this point on the graph.

(d) Provide one argument for extending these toxicity results to humans and one argument against doing so.

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b) The LD50 is the dose of toxin that kills 50% of a population of test subjects. ~~For~~ For the brine shrimp in the study, the LD50 is approximately a CuSO_4 concentration of 0.087%, ~~as each data line on the graph represents an increase~~ as that is the concentration that corresponds to a value of 50% mortality on the graph.

c) The "threshold level of toxicity" is the level of concentration of the toxin below which the subjects show no effects as a result of the toxin and above which the subjects display effects as a result of exposure to the toxin. The threshold level for brine shrimp exposed to CuSO_4 is a concentration of 0.001%.

d) These ~~results~~ results can be extended to humans because most organisms will respond to a toxin in similar ways. We can think of brine shrimp as tiny humans in this sense and estimate the amount of CuSO_4 it would take for humans to reach an LD50 level.* However, shrimp live in a totally different environment than humans, so it is very difficult to predict the amount of CuSO_4 needed in the atmosphere to kill 50% of humans. Unless the shrimp were perfect microcosms of humans,

* Also, brine shrimp reproduce quickly, so we can effectively conduct tests on them. Doing so on humans would be unsafe, ~~all~~ unethical, and time-consuming.

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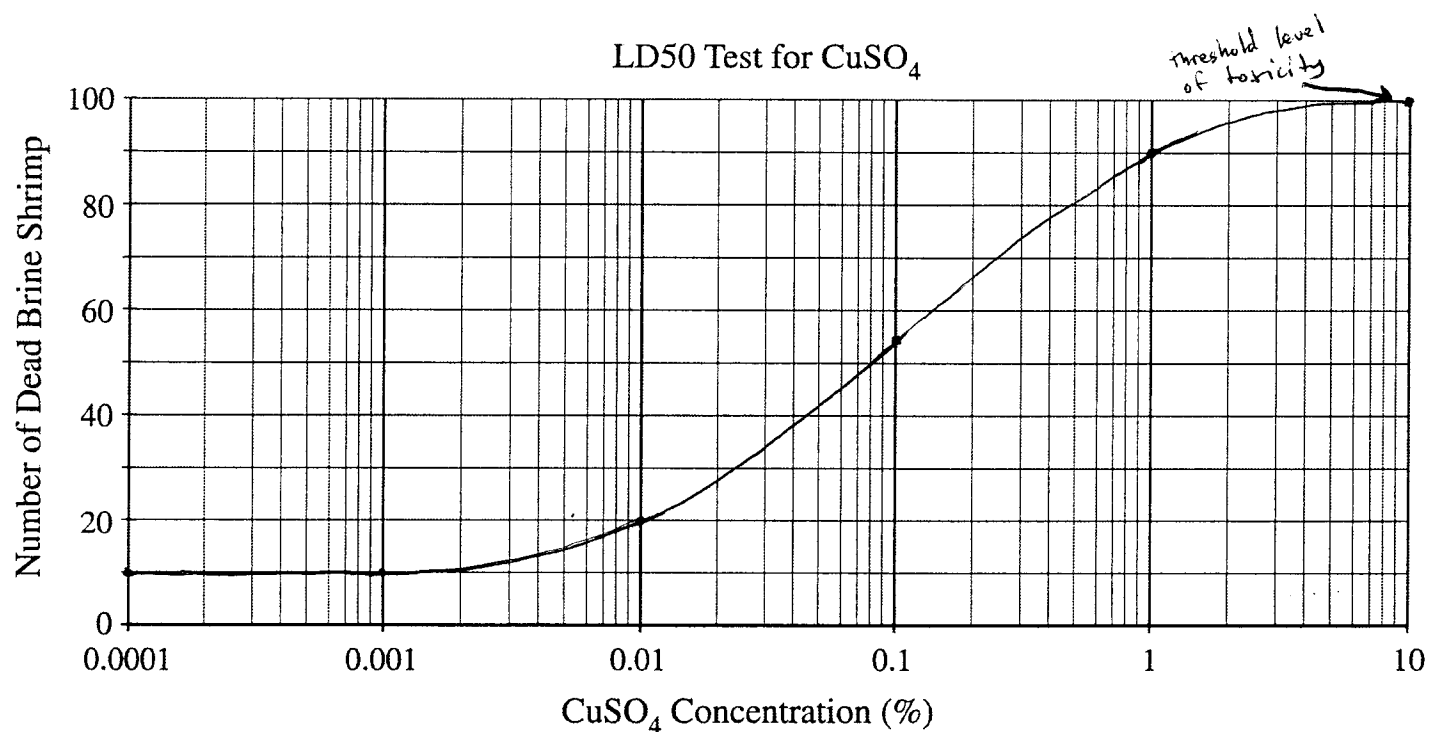
ADDITIONAL PAGE FOR ANSWERING QUESTION 3

There is no reason to believe that test results would be able to be transferred and applied to a completely different species.

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b) The term LD50 (ED50) refers to the concentration of the toxin at which 50% of the organism tested still survive. This point would be located at where 50 shrimp died, and 50 survived. The graph shows this point to occur when the concentration reaches 0.08% roughly.

c) The "threshold level of toxicity" is the level at which an organism can no longer survive in the presence of that amount of the toxin. In this case, the level of CuSO_4 at which the shrimp can no longer survive. In this case, shrimp can still survive in small numbers past 1%, but not 10% so the ~~the~~ threshold level of toxicity is somewhere between there.

d) Extending these ~~test~~ toxicity results to humans is important because humans can suffer from many of the same toxins as brine shrimp. If brine shrimp die out at a certain level of this toxin, there is a physiological reason for this death that may show up in selected humans if they are exposed to the toxin.

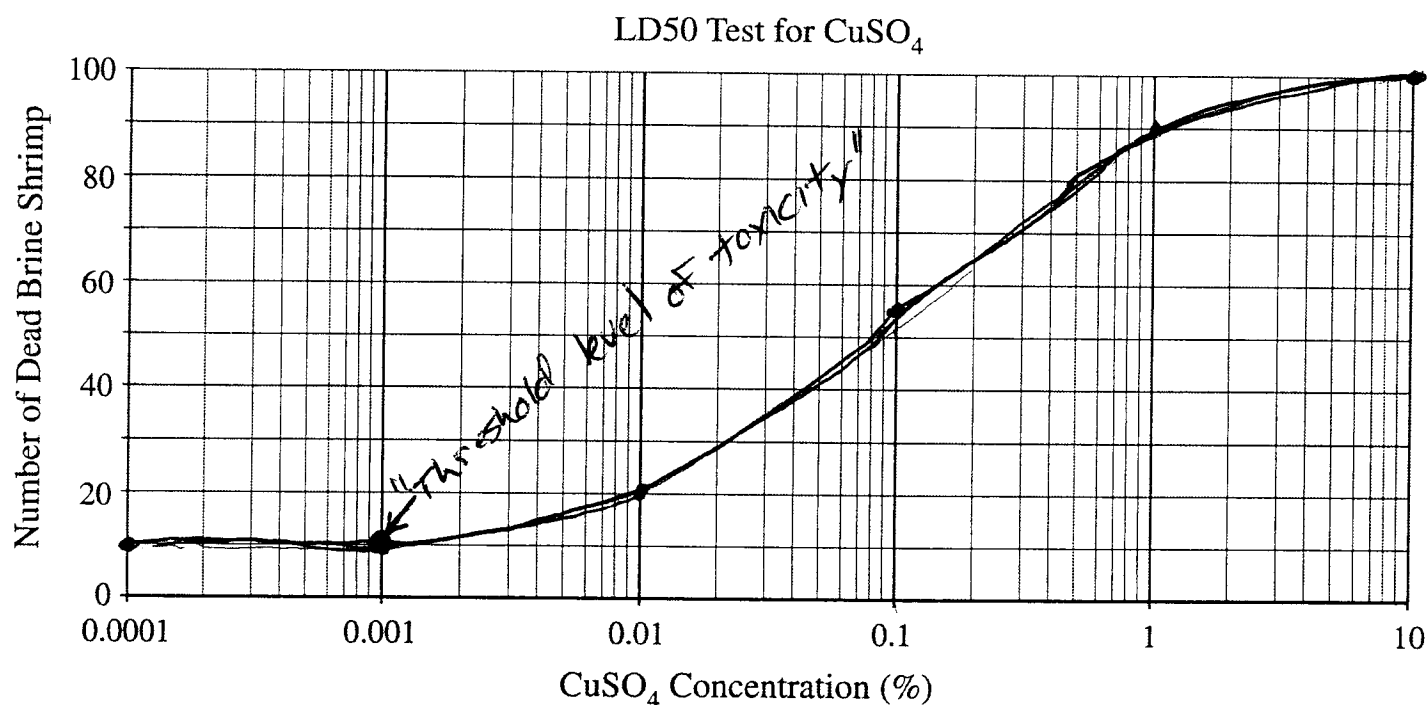
At the same time, humans are not immersed in a fluid solution of CuSO_4 and thus they will not necessarily encounter nearly as high a concentration. They also have a much higher body mass and will need a higher amount to have an effect on their bodies. For this reason the results of the experiment may have absolutely nothing to do with humans.

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The LD₅₀ of a substance is the amount of that substance that is lethal to 50 percent of the ~~the~~ group being tested. For brine shrimp, the LD₅₀ of ~~the~~ CuSO₄ is about .1% concentration.

The threshold level of toxicity is the point at which ~~a~~ a substance begins to clearly affect the survivorship of a species. It is the point at which the death rate begins to increase as a result of the substance. The threshold level of toxicity of CuSO₄ for brine shrimp is .001% concentration. Before this point, the death rate is constant regardless of the concentration of CuSO₄. After this point, it increases as the concentration does.

Extending these results to humans could make them aware that CuSO₄ can be deadly. ~~Being~~ ^{Being} so could initiate regulations of this substance, reducing it. These would be positive effects.

Negative effects of extending these results to humans could include the fact that the LD₅₀ of CuSO₄ for brine shrimp could be different for humans. The regulations may not be stringent enough and humans could still be harmed or killed.

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