AP® BIOLOGY
2010 SCORING GUIDELINES (Form B)

Question 4

On a trip to a dense forest, a biologist noticed that millipedes (small invertebrates) were plentiful under logs but were rarely seen in any other location.

(a) **Propose** THREE environmental variables (two abiotic and one biotic) that could explain why millipedes are found more frequently under logs. (**1 point each; 3 points maximum)**

The following list is not exhaustive.

Abiotic factors 2 points maximum	**Biotic factors 1 point maximum**
Light	Reproduction
Temperature	Predation
Water	Food supply
Soil Texture Nutrients pH	Competition
Wind	
Periodic disturbances — fire/storms/volcanoes	

Note: Nutrient can be abiotic or biotic depending on how it is used. Climate/weather/shelter are too general!

(b) For ONE of the abiotic environmental variables you chose above, **design** a controlled experiment to test a hypothesis that this factor affects the distribution of millipedes on the forest floor. **Describe** data that would support your hypothesis. **(1 point each; 6 points maximum)**

Must relate to one of the two abiotic factors accepted in part (a) AND measure/relate to millipede distribution.

- **Hypothesis** — proposes a relationship between one abiotic factor and the distribution of millipedes.
- **Prediction/expected results** — states what should be observed if the hypothesis is supported. Can be in an "if … then" format.
- **Design** — describes an experiment that manipulates one abiotic independent variable/factor.
- **Constants** — explicitly holds all other factors constant.
- **Control** — indicates a valid control group that serves as a comparison for experimental groups.
- **Data collection** — describes what observations will be collected or how they will be collected, or both.
- **Sample size** — indicates test of multiple millipedes or replicates.
- **Statistical analysis** — suggests a mathematical and/or statistical comparison of control and experimental groups or of observed and expected. A specific statistical test need not be mentioned.
- **Feasibility** — experiment could be performed and would yield data that would answer the question posed.

AP® BIOLOGY
2010 SCORING GUIDELINES (Form B)

Question 4 (continued)

(c) Suppose that you were examining the distribution of a plant, instead of the millipede. **Describe** modifications in the experiment that you designed in (b) that would be required to determine whether the abiotic factor you chose affects the distribution of the plant. **(1 point each; 3 points maximum)**

Must be *reasonable* adaptation of experiment

- Modifications **(up to 2 points)** — description of the change(s) made.
- Control — description of changes in control group, if any.
- Explanation — why factor would affect a plant.
- Feasible design — experiment can be performed.

4. On a trip to a dense forest, a biologist noticed that millipedes (small invertebrates) were plentiful under logs but were rarely seen in any other location.

   (a) **Propose** THREE environmental variables (two abiotic and one biotic) that could explain why millipedes are found more frequently under logs.

   (b) For ONE of the abiotic environmental variables you chose above, **design** a controlled experiment to test a hypothesis that this factor affects the distribution of millipedes on the forest floor. **Describe** data that would support your hypothesis.

   (c) Suppose that you were examining the distribution of a plant, instead of the millipede. **Describe** modifications in the experiment that you designed in (b) that would be required to determine whether the abiotic factor you chose affects the distribution of the plant.

Millipedes prefer to be under logs because of humidity, temperature, and predators. Because sun light does not reach under logs, the millipedes may enjoy the moisture and wetness under the logs. They would not want to be dried out or get desiccated, and they can obtain water more easily under the log. Moreover, millipedes would also avoid high temperatures because they are ecto-thermic. It is cooler under logs because of moisture, evaporation, and absence of sunlight, so the millipedes would be attracted by the milder temperature under the log. Furthermore, millipedes can hide from predators by staying under the log. The log will prevent the predators from sighting the millipedes, so the millipedes are more likely to survive by remaining under logs.

HYPOTHESIS: millipedes would prefer moist environment with higher humidity to a dry region.

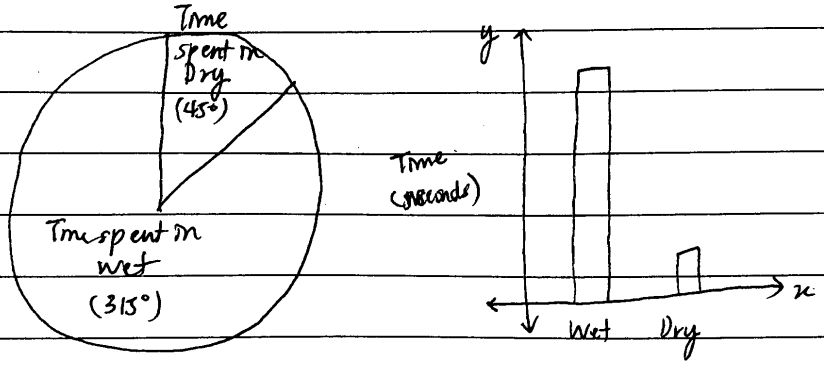
Firstly, obtain two petri dishes combined together by forming a tunnel in between the dishes. In one dish, apply wet soil whereas on the other dish, apply dry soil. Afterwards, select millipedes with the same sex, age, size, and species.* Place one millipede at a time at the tunnel, and in a data chart, write where the millipede is staying after every interval of 10 seconds for 5 minutes. Repeat this procedure for twenty or more millipedes. The amount of time millipedes stay in wet region or dry region can be represented with a pie chart or a bar graph (see diagram 1).

* The millipedes should not be educated or from a different environment. The temperature, light intensity, humidity, air pressure should be the same for all millipedes while experimenting.

GO ON TO THE NEXT PAGE.

360° = 5 minutes

ADDITIONAL PAGE FOR ANSWERING QUESTION 4



△ Diagram I

For the control, the same type of petri-dish combination must be used. However, both dishes should be applied with wet soil. The same millipedes must be placed one after the another in the control with equal constants as earlier experiment. The time spent in both wet petri dishes should be 50% and 50%, indicating that the experiment is valid without any error in part of the dishes.

I predict that the millipedes would all move into the wet soil petri dish in the variable experiment because it would not want to dry out and has to obtain moisture.

In case of a plant, I would obtain ~~two~~ big pots, ~~two~~ five filled with wet soil and ~~two~~ five filled with dry soil. Afterwards, I would plant the same type, age, size, mass, volume of seeds in each of the pots.* If the plant grew more in the humid, or wet soil, the distribution of plant would be efficient in moist environments. My hypothesis is that the plants would proliferate or grow more healthily in wet ~~soil~~ soil. I predict that this would happen because seeds need oxygen, soil, and water to germinate well.

*All the pots should be placed in the same area with equal opportunities for sunlight, same temperature, same altitude, ~~and~~ and same oxygen (air).

GO ON TO THE NEXT PAGE.

4. On a trip to a dense forest, a biologist noticed that millipedes (small invertebrates) were plentiful under logs but were rarely seen in any other location.

   (a) **Propose** THREE environmental variables (two abiotic and one biotic) that could explain why millipedes are found more frequently under logs.

   (b) For ONE of the abiotic environmental variables you chose above, **design** a controlled experiment to test a hypothesis that this factor affects the distribution of millipedes on the forest floor. **Describe** data that would support your hypothesis.

   (c) Suppose that you were examining the distribution of a plant, instead of the millipede. **Describe** modifications in the experiment that you designed in (b) that would be required to determine whether the abiotic factor you chose affects the distribution of the plant.

a) Millipedes may be residing under logs due to abiotic factors such as ~~temperature~~ light intensity or moisture, or biotic factors such as predation from other organism Birds usually eat millipedes, therefore, the millipedes seek ~~prota~~ protection from them by hiding under logs. Or, because of the intense heat or light of the forest, the millipedes prefer to reside in a cooler area, and seek shelter under a log. They may also ~~(have)~~ choose to live under logs due to ~~an increased~~ a greater level of moisture found under there.

b) Set up an experiment with some millipedes, two large discs containing earthy matter and a bright lamp. ~~and a~~ Place the millipedes between both discs. Place one of the discs under the ~~intensely~~ lit lamp, while leaving the other in a ~~dark~~ shaded area. Wait and watch to see ~~how many~~ which millipedes choose which disc. Record the number of millipedes that choose the disc under the lit lamp. ~~And~~ Repeat the experiment numerous

GO ON TO THE NEXT PAGE.

times and keep recording your data. According to the data found by the biologists, more millipedes should choose the shaded disks. The reason for this hypothesis is that logs provide shades for organisms and if millipedes are found more frequently under logs, they should choose the shaded ~~disk~~ discs as the discs under the lamps are brighter.

c) Pick out ~~two~~ two plants of the same species and at the same stage of life. Place them both in cups of equally moist soil. Then, place one plant underneath a brightly lit lamp and another under shade. Record how much each plant grows over a period of two days, watering each plant regularly. Repeat this experiment with different plants, but under exactly the same conditions.

4C,

4. On a trip to a dense forest, a biologist noticed that millipedes (small invertebrates) were plentiful under logs but were rarely seen in any other location.

   (a) **Propose** THREE environmental variables (two abiotic and one biotic) that could explain why millipedes are found more frequently under logs.

   (b) For ONE of the abiotic environmental variables you chose above, **design** a controlled experiment to test a hypothesis that this factor affects the distribution of millipedes on the forest floor. **Describe** data that would support your hypothesis.

   (c) Suppose that you were examining the distribution of a plant, instead of the millipede. **Describe** modifications in the experiment that you designed in (b) that would be required to determine whether the abiotic factor you chose affects the distribution of the plant.

(a) Abiotic and biotic environmental influences can cause variations in organisms such as millipedes. An abiotic reason why millipedes may prefer living under logs could be that the temperature under the logs may be cooler (which reduces H2O loss) than other areas. Another reason could be that millipeds are organisms that dislike light (which causes them to dry out through their skin) therefore they hide in shadier regions such as under the logs (prevent heat loss). A biotic reason why they live under logs could be that predators can't get to them. Since millipedes are small organisms they fit under logs but larger predators such as birds probably wouldn't fit there.

(b) For an experiment to test the hypothesis (millipedes prefer living in shadier regions because they are smaller in size and don't want to go through heat loss through their high surface area to volume ratio) we need to design an apparatus where half the side is exposed to light and the other is in the shade. The independent

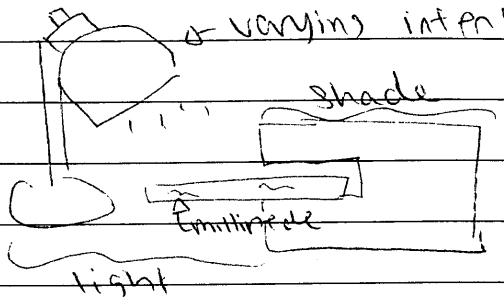
GO ON TO THE NEXT PAGE.

4C2

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

variable would be how much light (light intensity) they get and the dependent variable would be how fast they move toward the shadier side. The faster they move would mean that they don't like the light shining on them.

Apparatus:



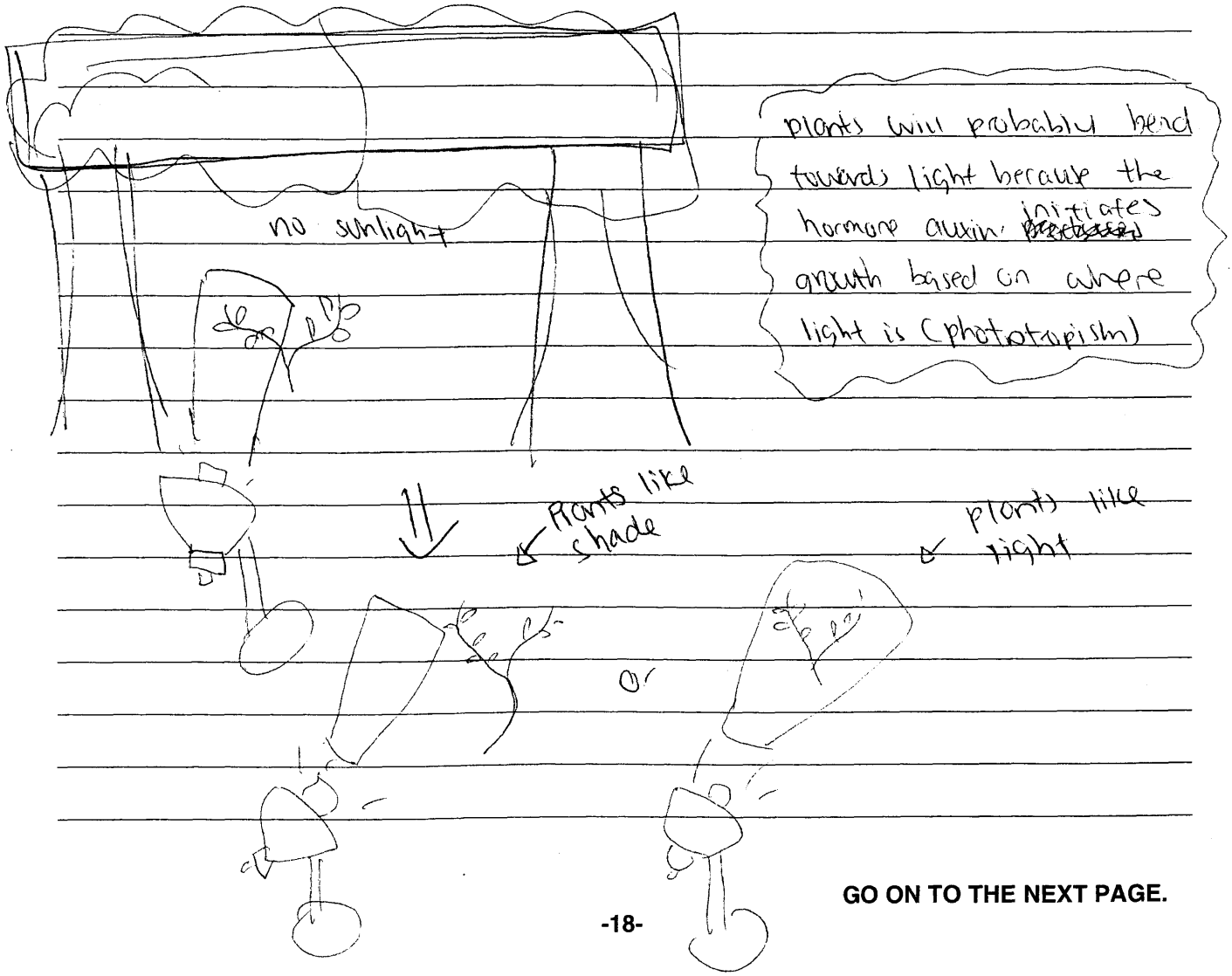
The control variable would be the apparatus used and the size of the millipedes. The data that would support my hypothesis would be the data that shows faster movements of millipedes to shady side when the light intensities are higher. Because like previously mentioned, this would mean that the millipedes dislike the light.

(c) If this experiment was done on plants instead of millipedes then the apparatus would need to be done on a larger scale which would mean less control on the variable. Instead of using the apparatus for (b), to test if plants prefer segregating to shadier regions would involve a larger source of light and also land for plants to grow. This could be done in a patch of garden where no sunlight hits (reduced variable) and where a larger lamp is positioned so that

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 4

only ~~one~~ half of the plant is hit by the light. Then the dependent variable, instead of seeing how fast it travels would instead be whether the plant grows away or to the light over a controlled period of time. The experimental data would support the idea that plants dislike light if they grow towards shade. If it shows that the plants grow towards sunlight then that would mean that plants, unlike millipedes prefer the sun.



GO ON TO THE NEXT PAGE.

AP® BIOLOGY
2010 SCORING COMMENTARY (Form B)

Question 4

Sample: 4A
Score: 10

This response is well organized. Information meeting the criteria for the question is presented in a logical and clear sequence. Three acceptable environmental factors ("humidity, temperature, and predators") are listed, earning 3 points for part (a). It was not necessary to identify which were abiotic and which was biotic. The discussion was not necessary to earn the points but does not contradict the choices.

The second part of the response is a description of an experiment that will test the effects of one of the abiotic variables listed in part (a). The first point was earned with the statement of a hypothesis. A second point was earned for a design that tests a single variable, moisture. A third point came from stating other factors to be held constant or controlled in the design. The fourth point was earned for a specific description of the data to be collected and how the data will be collected. The fifth point was earned for giving a design that includes replication and a definite sample size. The final point was earned for the description of the control in the experiment. A point could have been awarded for the prediction, but the response had already earned the maximum 6 points for part (b).

In part (c) 1 point was earned for the description of a modification of the experiment to test the effects of the same variable on plants. An additional point could have been awarded for the feasibility of the experiment, but the response had already earned the maximum 10 points.

Sample: 4B
Score: 8

This response earned 3 points in part (a) for listing "light intensity" and "moisture" as abiotic variables and "predation" as a biotic variable. The subsequent discussion was not necessary but clarifies the choices and does not contradict them.

The experimental design earned 3 points in part (b). The first point came from a design that varies one abiotic factor initially identified, light. A second point was earned for a design that incorporates replications. The third point was earned for predicting the outcome of the study and telling what it would mean in terms of millipede behavior. This response does not distinguish hypothesis from prediction but received the third point anyway. The description is not clear enough to determine the feasibility of the experiment.

The final 2 points were earned in part (c) for the description of a design modification to test the effect of light on plant growth, and for the experiment that is feasible as described. The modification is to measure plant growth in response to light and to repeat the experiment using different plants.

Sample: 4C
Score: 4

Three points were earned in part (a) for indicating "temperature" and "light" as the abiotic factors and "predators" as the biotic factor.

Question 4 (continued)

In part (b) 1 point was earned for the hypothesis that "millipedes prefer … shadier regions." However, the experiment design indicates that millipede movement, rather than distribution, would be measured, so no points were earned for the experimental design.

No points were earned in part (c).