2. The activities of organisms change at regular time intervals. These changes are called biological rhythms. The graph depicts the activity cycle over a 48-hour period for a fictional group of mammals called pointy-eared bombats, found on an isolated island in the temperate zone.

(a) **Describe** the cycle of activity for the bombats. **Discuss** how **three** of the following factors might affect the physiology and/or behavior of the bombats to result in this pattern of activity.

- temperature
- food availability
- presence of predators
- social behavior

(b) **Propose** a hypothesis regarding the effect of light on the cycle of activity in bombats. **Describe** a controlled experiment that could be performed to test this hypothesis, and the results you would expect.
Question 2

2. (a) **A maximum of 5 points**

**Description of the cycle of activity (1 point)**

A student could earn a point if he/she accurately summarized the graph. A simplistic statement such as, “Bombats are active during the day and quiet at night” which ignored the shape and obvious peaks and valleys of the graph did not receive the point. To earn this point, the student had to identify the peak of activity at “noon,” “midday,” or “12:00 p.m.,” AND indicate a lower activity at “night.” The student could also be specific about the lowest activity being at “midnight,” or “12:00 a.m.” The description had to be clearly distinguishable from the rest of the answer and not simply implied in another part of the response.

**Discussion of how THREE factors might affect the physiology and/or behavior resulting in the cyclic activity pattern (1 point each)**

To earn points here, each of the descriptions had to (a) be biologically plausible and consistent with typical mammalian behavior and physiology (no fictional biology); (b) indicate a cause and effect relationship beyond a simple restatement of the question. This had to include at least a very brief indication of how or why the factor had any effect at all on the bombat — or in some cases its prey; and finally, the discussion could not be inconsistent with the part of the curve described or time of day referenced in the explanation.

**Elaboration on any one of the three factors (1 point)**

Here the readers were looking for exemplary descriptions of physiology and/or behavior that reflected an unusual depth of understanding and clarity of expression. With special regard to temperature, a student who demonstrated an understanding that the activity curve was different from a temperature curve or that mammal physiology, unlike that of ectotherms, is typically insensitive to temperature could earn an elaboration point.

2. (b) **A maximum of 7 points**

**Hypothesis (1 point)**

The student was required to indicate that a CHANGE in the light (intensity, duration, wavelength) causes a CHANGE in the cycle of activity or biorhythm. There also could be a prediction of a change of light having no effect on the cycle of activity. Like the description of the curve above, the hypothesis statement had to be clearly distinguishable from the rest of the answer and not simply implied in another part of the response. The student may have failed to earn this point if the experiment he/she designed below clearly used a different light characteristic (independent variable), and/or produces a different result (dependent variable) from the ones indicated in his/her hypothesis.
Experimental Design (5 points maximum)

If the experimental design used a factor other than light for the independent variable, AND it satisfies AT LEAST THREE of the following standards, the answer was still allowed to earn 1 point total for this and the “Description of Results” section combined.

1 point Specified an appropriate control group for comparison. In this control, the environmental conditions had to be very similar to the natural conditions in which you find the bombat population, and not simply placing them into the dark, etc.

1 point Indicated that the independent variable (light) was manipulated. This was usually a change in light intensity or photoperiod.

1 point Held confounding variables constant or indicated that all variables other than the independent variable are held constant. To earn the point for listing the variables being held constant, the student had to list at least two.

1 point Verified results with reasonable sample size (at least two bombats in each group), and/or repeated trials. With repeated trials, the point was not awarded if the same bombat was used over and over.

1 point “Measured,” “recorded,” etc. (using quantitative terminology) bombat activity levels (dependent variable). If the student used the verb “observe,” then some measurement activity had to be specified.

1 point Included a mathematical and/or statistical comparison of control and experimental groups, or of observed and expected results. A specific kind of inferential statistic (chi square, t-test, etc.) did not need to be mentioned. A comparison of slopes of curves on a graph was also acceptable.

Description of results (1 point)

If the student had earned AT LEAST 3 POINTS in the Experimental Design section above, he/she became eligible for 1 point earned for a graph, data table and/or description of results consistent with the experimental design.
2. The activities of organisms change at regular time intervals. These changes are called biological rhythms. The graph depicts the activity cycle over a 48-hour period for a fictional group of mammals called pointy-eared bombats, found on an isolated island in the temperate zone.

![Graph showing bombat activity levels over time]

- High
- Low
- Midnight
- 4 A.M.
- 8 A.M.
- Noon
- 4 P.M.
- 8 P.M.
- Midnight

Time of Day

(a) **Describe** the cycle of activity for the bombats. **Discuss** how three of the following factors might affect the physiology and/or behavior of the bombats to result in this pattern of activity.

- temperature
- food availability
- presence of predators
- social behavior

(b) **Propose** a hypothesis regarding the effect of light on the cycle of activity in bombats. **Describe** a controlled experiment that could be performed to test this hypothesis, and the results you would expect.

- The lowest point of activity occurs consistently at midnight.

As the day progresses, the activity continues to increase until it peaks around noon time. Then after that the activity begins to steadily decline until its lowest point at midnight. One reason that may cause this is food availability since many organisms are inactive during the night. The bombats wouldn’t be able to acquire a lot of food and would just waste energy finding it. However, as the day wears on, activity increases, which means the prey the bombats hunt also increases its activity. The high point for both is around noon, and continues to decrease after that as night begins to approach.

The second factor could be temperature. During the night it is cooler and the sun is not out. This means that organisms...
sleep to conserve body heat and energy. As the sun begins to rise, temperature goes up and more and more organisms begin to move about. When the sun is at its highest point around noon, the temperature are high and organisms are new everywhere. This means that it is easier for combats to find food and they expend less energy keeping warm because the sun's rays do it for them. As temperature begin to cool down, organisms begin to retreat back into their home and activity decreases.

The last factor could be predator. The organisms that hunt combats may be nocturnal and hunt them at night. The combat activity decreases so that they have a better chance of not getting captured by a predator. Since most nocturnal animals sleep during the day, the combats are most active then because their chances of getting killed are less. As night approaches, they slow down their activity because predators will be around and more and more of them will become active during the night to again, decreasing their activity at night lowers their chance of dying.

The problem is whether or not light has an effect on the activity of combats. One tentative hypothesis is that the more light shines on them, the more light helps the combats see their prey better, which would account for their increased activity during the hours around noon time.
One way to test this is to first select an area of land where both beetles and their prey are living. For the control group monitor how effectively the beetles can capture prey during certain times of the day and record results. It will be necessary to mark about 30 individuals and monitor their progress only over a period of about 3 days.

For the experimental group, catch a new group of 30 beetles and mark them. Use another plot of land with the same/ near same conditions as the other one. Record search for how effectively this group of beetles can capture prey for three days using the same method as before. For the variable, at night set up large flood lights as light source. Then record the amount of prey caught by these beetles for three more days.

Recording the results would be displayed best on a line graph. The x-axis would be the time of day and the y-axis would be the amount of prey caught. If the light did have an affect on improving the beetles, night time the amount of prey caught in the experimental group should be higher.

Thus, if the results proved the hypothesis, then that means that light does have an effect on beetle's catching their prey. This would also prove why they hunt more during the day time than at night.
Question 2

Sample 2R (10 points)

In part (a), the student picked up a point for an accurate description of the activity cycle and 3 more points for giving reasonable cause and effect descriptions for how food availability, temperature, and predators might affect the physiology and/or behavior of the bombats to result in the activity pattern. In part (b), following a proper hypothesis, the student used the natural environment as a control and then changed the light pattern to see if the change in light affected the bombats’ effectiveness as a predator. With 5 strong points in the experimental design (a control, good sample size, controlling confounding variables, measuring the dependent variable, and manipulating the light), the student accumulated the 10-point maximum before ever stating the results.

Sample 2S (8 points)

In part (a), the student failed to describe the cycle of activity for the bombats, but successfully earned 3 points for giving reasonable cause and effect descriptions for how temperature, food availability, and predators might affect the physiology and/or behavior of the bombats to result in the activity pattern. In part (b), the student earned a total of 4 points for the hypothesis, controlling confounding variables, manipulating the independent variable (light), recording the dependent variable. Because the student earned at least 3 points in the experimental results section, he/she became eligible for the results point and earned it with a plausible statement of expectations.

Sample 2T (5 points)

In part (a), the student picked up a point for an accurate description of the activity cycle and 3 more points for giving reasonable cause and effect descriptions for how temperature, food availability, and predators might affect the physiology and/or behavior of the bombats to result in the activity pattern. In part (b), the student misses the opportunity to earn 4 or 5 additional points when he/she proposed a hypothesis and designed an experiment using an independent variable other than light as required by the question. Because the student’s experimental design did satisfy at least three of the experimental design standards, he/she was allowed to earn 1 point in part (b).
2002 Q&A Question 2

What was intended by the question?

The intent of the question was two-fold: first, it required students to think about the observed behavior of an organism in a creative way, and second, it tested students’ experimental design skills. The choice of a fictional mammal, bombats, rather than a particular kind of animal that might be more familiar to some students on a regional basis, allowed all students to enjoy a “level” playing field.

How well did students perform?

Students who described the given curve, managed to give some explanation of how or why the factor affected the bombat and resulted in the activity cycle shown, and then gave several basic features of any good experiment (changing the independent variable, keeping confounding variables constant, establishing a good sample size, measuring the dependent variable quantitatively, etc.) could garner 6-7 points without a great deal of sophistication in their answers. The question had a mean of about 4.4. Most students earned 2-3 points on part (a) and 2-3 points on part (b). The fact that there were few zeros and blank papers indicated that most students were able to score points on the question, but just under 10 percent of the scores were in the 8, 9, and 10 range.

What were common errors or omissions?

Many students were under the impression that in a temperate environment, the temperature will be highest when the light is brightest. This led them to suggest relationships between temperature and bombat behavior that would be inconsistent with the shape of the given curve.

Identifying a proper control group was a challenge for many students. Putting bombats in total darkness would be, in essence, creating an experimental group and not actually addressing the effect on the cyclic behavior. Many other students, however, were able to recognize that the control should be the bombat in its “natural” or “normal” conditions.
A number of students designed natural observation procedures like the kind that might produce the observed cycle of bombat activity, but failed to design an actual controlled experiment to evaluate the effect of one variable on that cycle. Also, an alarming number of students put only one bombat into their control and experimental groups.

*Based on your experience at the AP Reading, what message would you like to send to teachers that could improve the performance of their students on the exam?*

Teachers should continue to emphasize the importance of designing controlled experiments. Students should be encouraged to be thorough on their answers. They should think in depth and write in depth. When introducing new material, asking students to probe into the hows and whys of the material they study as well as its connection to other big ideas is consistent with a thematic approach and important in terms of exam preparation.