

**Passage I**

*To investigate the hypothesis that the volume of a fixed amount of gas varies when subjected to different amounts of pressure, three experiments were performed on the same balloon:*

**Experiment 1:** The balloon was subjected to 1 atmosphere pressure for 30 minutes at a temperature of 25° C. At the end of that time, the volume of the balloon was 1 liter.

**Experiment 2:** The balloon was placed in a vacuum chamber that reduced the pressure on the balloon to  $\frac{1}{2}$  atmosphere at a constant temperature of 25° C. After 30 minutes under these conditions, the volume of the balloon was 2 liters.

**Experiment 3:** The balloon was placed in a pressure tank and subjected to 2 atmospheres pressure at a temperature of 25° C. At the end of 30 minutes, the volume of the balloon was  $\frac{1}{2}$  liter.

**1. Which of the variables was not kept constant in the experiments:**

The pressure was changed in each experiment. The volume changed only as a result of the pressure changes.

The correct answer is C, The pressure.

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**2. Which of the three experiments served as the control?**

Since Experiment 1 keeps the balloon at 1 atmosphere (standard atmospheric pressure) at a volume of 1 liter, it must be the control. The other balloons adjust the atmospheric pressure, which in turn affects the volume of the balloon.

The correct answer is F, 1.

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**3. To study the effect of temperature on gas volume, one could**

Since Experiment 1 is the control, we would start with this as the baseline. As the temperature is adjusted, we would compare any balloon volume changes to the known control volume of 1 liter.

The correct answer is A, repeat Experiment 1 at other temperatures.

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**4. If the volume of a balloon decreased at constant temperature, and the balloon had no leak, what must be true?**

By comparing the results of Experiments 2 and 3, we see that when pressure is decreased, volume increases. We also see that when pressure is increased, volume decreases. Therefore, if the volume decreases, the pressure must have increased.

The correct answer is F, The pressure increased.

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**5. What would happen if the balloon floated 800 feet into the air?**

There is less pressure at higher elevations. So as a balloon floats higher in the air, and the pressure decreases, the balloon's volume will increase.

The correct answer is A, Its volume would increase.

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**6. What would happen if the balloon were held underwater?**

There is more pressure underwater. So as a balloon is held under water, and the pressure increases, the balloon's volume will decrease.

The correct answer is G, Its volume would decrease.

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**7. If a fourth experiment were performed using the same balloon at 35° C and 2 atmospheres pressure, which experiment would be a good control?**

The control balloon must be the same size at the same pressure. Only one variable can change at a time in a valid experiment. Since the temperature changes to 35° C, the other variables must remain the same. Therefore, Experiment 3, at 2 atmospheres of pressure, would serve as the control.

The correct answer is C, 3.

### Passage II

A scientist investigated the effect of heat on the length of bars made of different metals. Both bars were originally at 20° C. The data collected is presented below. (All lengths are in centimeters; temperatures are in degrees C;  $\Delta$  Length means "change in length.")

TABLE I Metal A

Experiment	Initial Length	Final Length	Final Temp.	$\Delta$ Length
1	20	20.8	220°	0.8
2	20	20.4	120°	0.4
3	40	40.8	120°	0.8
4	60	64.8	420°	4.8

TABLE I Metal B

Experiment	Initial Length	Final Length	Final Temp.	$\Delta$ Length
5	20	20.2	220°	0.2
6	20	20.1	120°	0.1
7	40	40.2	120°	0.2
8	60	64.8	1680°	4.8

**8. Which experiment would be a good control for Experiment 4?**

Only one variable can be changed by the experimenter in a valid experiment. Experiment 4 starts with a 60 cm bar of metal A heated to 420° C. The control would have to be 60 cm bar of metal B heated to 420° C. Since this scenario does not occur for metal B, there is no control for Experiment 4.

The correct answer is J, None.

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**9. Which conclusion is valid based on Experiment 6 alone?**

Experiment 6 begins with a 20 cm bar of metal B heated to 120° C. We see that the length of the bar increased to 20.1 cm as a result of the heating process. We cannot conclude that answer choice A or B is valid since we can only take the results of Experiment 6 into consideration to answer this question.

The correct answer is C, B expands when heated.

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**10. Which conclusion is valid based on Experiments 3 and 7?**

Experiment 3 begins with 40 cm of metal A heated to 120° C. Experiment 7 begins with 40 cm of metal B heated to 120° C. The only difference between these two experiments is the type of metal. We can compare these two experiments since only one variable changes. We can see that metal A

gains 0.8 cm in length whereas metal B only gains 0.2 cm in length. Therefore, metal B expands less than metal A.

The correct answer is G, Metal B expands less than metal A under same conditions.

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**11. What variable is probably not significant for this experiment?**

Answer choices A, B, and C all list important variables in this series of experiments. The barometric pressure is not mentioned in the given data, so must not be a factor in the experiments.

The correct answer is A, Barometric pressure.

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**12. The easiest way to see whether the metal contracts to the same extent as it expands would be to**

We have no evidence of what happens to the metals when they are cooled lower than 20° C, so choices A and B would not be good methods to follow. Cooling the metals below 20° C or creating an alloy of two metals would introduce additional factors to the experiments that we could not adequately analyze with the given information. We know that the metals expand when heated, so letting them cool back to 20° C would allow us to see if the metals contract back to their original lengths.

The correct answer is H, measure the bars again after they have cooled to 20° C.

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**13. What would likely be the final length of a bar of metal A, 60 cm in length at 20° C, if it were heated to 120° C?**

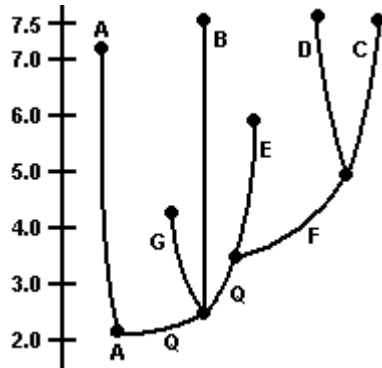
We do not have an experiment for metal A beginning at 60 cm and heated to 120° C. We can use the information from Experiments 2 and 3 since both involve metal A heated to 120° C. Experiment 2 begins with a bar 20 cm in length and expands 0.4 cm while Experiment 3 begins with a bar 40 cm in length and expands 0.8 cm. From this we see a total expansion of 1.2 cm. We can then infer that a bar beginning at 60 cm would expand to 61.2 cm under these conditions.

The correct answer is C, 61.2.

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**Passage III:**

The evolutionary tree of the animal life on the asteroid Ungerlus is shown. The time is represented in millions of years since the birth of Ungerlus (present time is 7.5 million years).



**14. Which life form is the oldest still existing on Ungerlus?**

Looking at present time, 7.5 million years, we see that only branches B, D, and C still exist. Of these, B is the oldest.

The correct answer is G, B.

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**15. Which pair branched away from each other most recently?**

Looking at the top of the diagram, which is most recent, we see that lifeforms C and D branched most recently.

The correct answer is D, C and D.

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**16. Which life form gave rise to the most other life forms directly?**

Looking at the bottom of the diagram, which is oldest, we see that lifeform A branched off to Q and then Q branched off to all other lifeforms.

The correct answer is H, Q.

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**17. Which life form passed out of existence 4 million years ago?**

Four million years ago was 3.5 million years. Looking across the diagram from the 3.5 mark, we can see that lifeform Q branched off to E and F and went out of existence itself.

The correct answer is C, Q.

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**18. How many animal life forms are still in existence on Ungerlus?**

Looking across from the 7.5 million years mark, we see that A went out of existence at the 7.0 million year mark and the three lifeforms B, D, and C are still in existence.

The correct answer is H, 3.

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**19. What conclusion is drawn about the animal life on Ungerlus?**

By examining the diagram, we see that some life forms pass out of existence and new ones evolve.

The correct answer is C, Animals have changed on the asteroid over the years.

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**20. Which of the following lifeforms is probably least similar to D?**

About 3 million years separate the point where A branched off and D originated.

The correct answer is F, A.

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