ACT Science Study Guide

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Organize Your Goals:

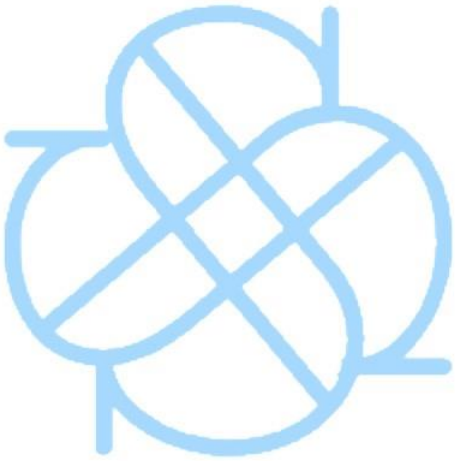
Score	Right Answers	Score	Right Answers
36	40	**22**	23-24
35	39	**21**	21-22
34	38	**20**	19-20
33	37	**19**	17-18
32	-	**18**	15-16
31	36	**17**	14
30	35	**16**	13
29	34	**15**	12
28	33	**14**	11
27	32	**13**	10
26	30-31	**12**	9
25	28-29	**11**	8
24	27	**10**	7
23	25-26	**9**	6

Goal Score_____ Current Score_____

Goal Score	Passages to attempt
<20	4 passages
20-27	4-5 passages
>27	5-6 passages

Breakdown:

- 35 minutes
- 6-7 passages
- 40 questions



Target Skills:

- Spot trends in data
- Predict outcomes
- Read graphs

Types of Passages:

1. ***Charts and Graphs***

- There are 2 passages and each passage has 6 questions
- These questions test your ability to read and interpret graphs

Linear - Trend increases or decreases proportionally (straight line)

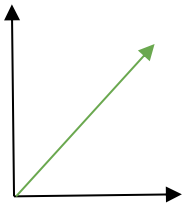
Exponential (J Curve) - One variable increases slowly at first but then increases quickly

Logistic (S Curve) - Decrease/increase slowly, then sharply, then levels off

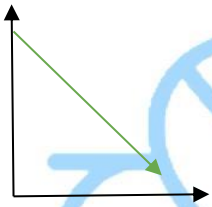
Flat Line - dependant variable is constant and the independent variable has no effect

No Trend - Look for answer choices that say "no trend" or "none of the above"

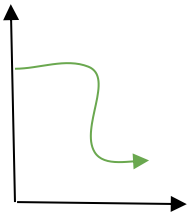
Types of Graphs:



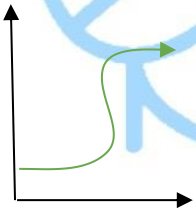
Increase



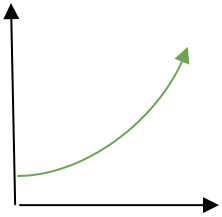
Decrease



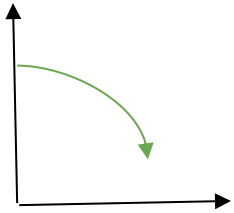
Negative S Curve



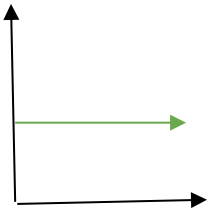
Positive S Curve



Positive J Curve



Negative J Curve



No Effect

2. ***Experiments***

- There are 3 passages and each passage has 7 questions each
- Uses tables and charts

Scientific Method:

1) Observation

- An observation is made about a naturally occurring process or event. Observation can lead to questioning and exploration.

2) Questioning

- Scientists ask questions based on observations.

3) Hypothesis

- A hypothesis is a scientist's explanation for an observation. Hypotheses predict what might have happened. Usually they are written as a 'if-then' statement.
- Example: If a student sleeps 8 hours a night, then they will score higher on a test.

4) Experiment

- Experiments are designed to test a hypothesis. Experiments are composed of an independent variable, dependent variable, and control group.

5) Interpreting Data

- After the experiment is concluded, the data collected is analyzed. Data is expressed through charts, tables and graphs.

6) Conclusion

- After data is analyzed, scientists either prove or disprove their hypothesis.

Tables:

Direct Proportion - As x increases, y increases & as x decreases, y decreases

Hours of Sleep	Test Scores
5	69
6	75
7	86
8	94

Inverse Proportion - As x increases, y decreases & as x decreases, y increases

Cups of Coffee	Hours of Sleep
0	8
1	7
2	6
3	5

What You Need to Know:

Independent Variable - Variable that is changed in the experiment (x)

Dependent Variable - Variable that depends on the independent variable (y)

Constant - Something that stays the same in the experiment

Control Group - Group in the experiment that remains unchanged to be compared to later

3. ***Conflicting Viewpoints Passage***

- There is 1 passage and the passage has 7 questions
- Compare and contrast
- Note the opinions of the first scientists
- Circle parts of the second scientist's views that agree or disagree with the first

Prioritize the Passages/Questions:

- Definitely, Later, Never
    - Prioritize questions in passages that ask about figures. These are definitely questions because the answers are quickly found in a table, chart, or graph
    - Save questions that ask about big pictures for later
- Definitely = chart and graph passages
    - Based upon figures
    - Quickest questions
    - Most likely to get right
- Later = experiment passages
    - Also include figures
    - More time consuming
    - Questions are not necessarily any harder
- Never = conflicting viewpoints
    - Text based
    - Time consuming
    - Do these passages last

Letter of the Day:

- Never leave bubbles empty
- Choose a letter of the day (LOTD)
- Bubble in any unanswered questions with this letter

Understand the Questions:

Based on the results...

- Tells you to look at the table, chart, or graph that represents the results of the experiment
- The answer will be derived from the results

Based on trials 1 and 2...

- Tells you to look at only trials 1 and 2 for the answer. Experiments usually have multiple trials

According to Figure X...

- Tells you that the answer is within the figure stated. Figures can be charts, graphs, tables, or pictures

According to the information provided...

- Tells you that the answer can be found in the resources connected to that question

Terminology:

PH

- A measure of how acidic/basic water is. PH levels range from 0 to 14. 7 is neutral and anything less indicates acidity. However, a PH higher than 7 indicates a base.

Mass

- Mass is the amount of space an object takes up. An object's mass determines the strength of its gravitational attraction. The SI unit of mass is the kilogram (kg).
- Formula: “mass = (density)(volume)”

Volume

- The space that a substance (solid, liquid, gas, or plasma) or shape contains. The SI unit of volume is the cubic meter.
- Formula: “volume = (length)(width)(height)”

Density

- The mass per unit volume.
- Formula: “density = mass/volume”

Now try some sample questions straight from ACT.org:

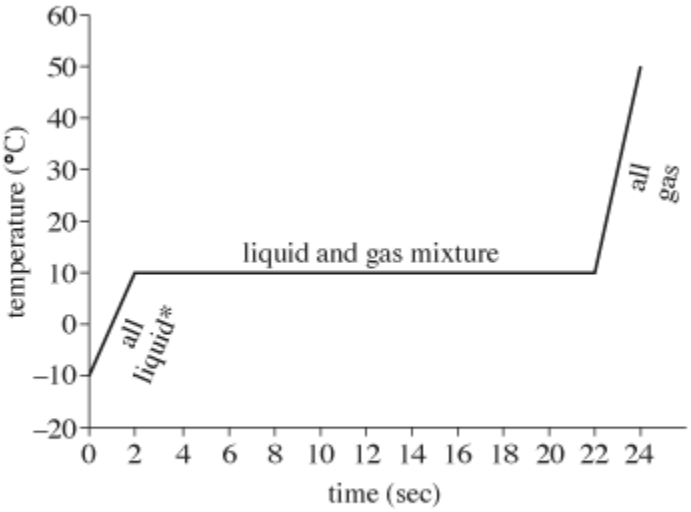
Passage I (Charts and Graphs)

Suppose that 1 gram (g) of Material A, initially a liquid, is kept in a cylinder fitted with a piston at a constant pressure of 1 atmosphere (atm). Table 1 and Figure 1, respectively, show how Material A's volume and temperature vary over time as Material A absorbs heat at a rate of 10 calories per second (cal/sec). Table 2 gives the boiling points of liquid Materials B–D at 1 atm; the heat absorbed refers to the amount of heat that is needed to turn 1 g of a liquid at its boiling point into a gas.

Table 1

Time (sec)	Volume of Material A (cm3)
0	1
2	1
4	136
6	271
8	406
10	541
12	676
14	811
16	946
18	1,081
20	1,216
22	1,351
24	1,541

Figure 1



*Between 0 and 2 sec, some gaseous Material A is present, but the amount is negligible.

Table 2

Material	Boiling Point (°C)	Heat absorbed (cal)
B	13	500
C	19	610
D	28	270

1) Based on Figure 1, Material A's temperature increased the fastest during which of the following time intervals?

A) 0– 2 sec
B) 2–12 sec
C) 12–22 sec
D) 22–24 sec

2) Based on the passage and Table 1, what was the density of liquid Material A?

E) 0.5 g/cm3

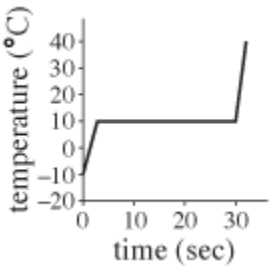
F) 1 g/cm3

G) 5 g/cm3

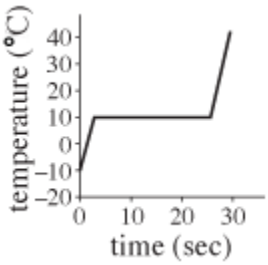
H) 10 g/cm3

3) Suppose 1 g of Material D at –10°C is heated at the rate of 10 cal/sec and kept at 1 atm until all of the liquid is vaporized. Based on Figure 1 and Table 2, a plot of Material D's temperature versus time would be best represented by which of the following graphs?

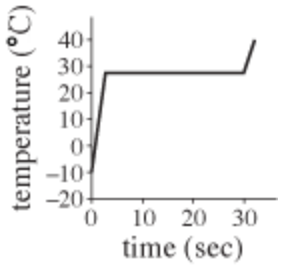
A)



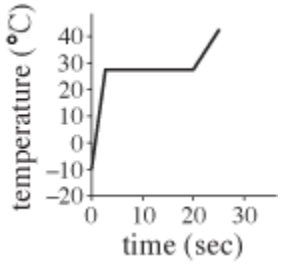
B)



C)



D)



4) Table 1 and Figure 1 best support which of the following hypotheses about the temperature and volume of Material A? (Note: Pressure is assumed to stay constant.)

E) If liquid Material A is in contact with gaseous Material A and the volume of the gas increases, the gas's temperature will increase.

F) If liquid Material A is in contact with gaseous Material A and the volume of the gas increases, the gas's temperature will decrease.

G) When the temperature of gaseous Material A increases, its volume will increase.

H) When the temperature of liquid Material A increases, its volume will increase.

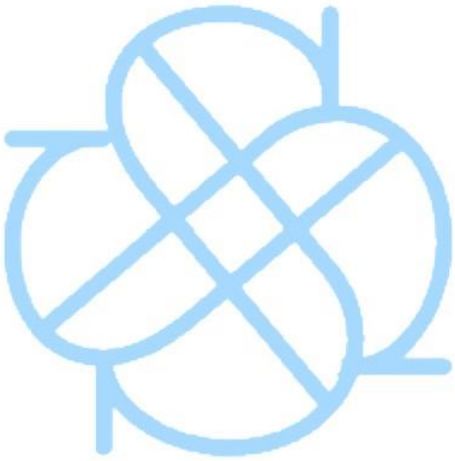
5) Suppose 1 g samples of liquid Materials A–D are just beginning to boil. If each of the liquids absorbs heat at the rate of 10 cal/sec while kept at 1 atm, which of the liquids will be the first to be completely turned into a gas?

A) Material A

B) Material B

C) Material C

D) Material D



ANSWERS:

1) During the time interval 0–2 sec, the temperature of Material A increased by 20°C. During the time interval 2–12 sec, the temperature of Material A was constant. During the time interval 12–22 sec, the temperature of Material A was constant. During the time interval 22–24 sec, the temperature of Material A increased by 25°C. Since the duration of the time interval 0–2 sec equals the time interval 22–24 sec. Since the increase in temperature was greater during the latter time interval, the temperature increased the fastest during the time interval 22–24 sec. **D is correct.**

2) Figure 1 shows that Material A was a liquid from Time 0 to Time 2. Table 1 shows that Material A had a volume of 1 cm3 during this time. The mass of Material A was 1 g. So liquid Material A's density was (1 g) ÷ (1 cm3) = 1 g/cm3. **F is correct.**

3) According to Table 2, the boiling point of Material D is 28°C. The horizontal portion of the graph should be at 28°C. Because 270 cal is required to transform 1 g of liquid Material D into a gas, the width of the horizontal portion of the graph must correspond to 270 cal of heating. Heating occurred at a rate of 10 cal/sec. Thus, the horizontal portion of the graph must extend over 27 sec. **C is correct.**

4) According to Figure 1, Material A was a gas from 22 sec to 24 sec. During this time, the temperature of Material A increased. According to Table 1, during this time, the volume of Material A also increased. **G is correct.**

5) Figure 1 shows that the boiling point of Material A was 10°C. At this temperature, Material A was transformed from liquid to gas. Material A was at its boiling point from 2 sec to 22 sec. During these 20 sec, it was heated at a rate of 10 cal/sec. 200 cal were needed to turn 1 g of liquid Material A at its boiling point into a gas. The amount of heat required to transform a liquid at its boiling point into a gas for Materials B, C, and D were 500 cal, 610 cal, and 270 cal. Therefore, the amount of heat required to transform is lowest for Material A. **A is correct.**

Passage II (Experiments)

A student studying how gases diffuse derived the following formula:

$$\frac{\text{distance Gas A travels}}{\text{distance Gas B travels}} = \frac{\sqrt{\text{molecular weight of Gas B}}}{\sqrt{\text{molecular weight of Gas A}}}$$

The following experiments were conducted to test her formula and to study factors affecting the rate at which gases diffuse.

Experiment 1

When hydrogen chloride (HCl) and ammonia (NH3) vapors react, they form solid ammonium chloride (NH4Cl):

$$HCl(g) + NH3(g) \rightarrow NH4Cl(s)$$

A swab soaked with HCl solution was inserted into one end of a glass tube (1 cm diameter), and, simultaneously, a swab soaked with NH3 solution was inserted into the other end, so that the swabs were 10 cm apart. The distance that each vapor traveled could be determined because, at the point they made contact, a white ring of NH4Cl formed (see Figure 1). The reaction was done at different temperatures. The time it took for the ring to start to form and its distance from the HCl swab were measured for each trial (see Table 1).

Table 1

Trial	Temperature (°C)	Time (sec)	Distance of ring from HCl swab (cm)
1	20	33	4.0
2	30	30	4.1
3	40	26	4.1
4	50	23	4.0

Using the formula, the student predicted that the distance of the ring from the HCl swab would be 4.06 cm, so the student concluded that her formula was correct.

Experiment 2

Experiment 1 was repeated, but the temperature was held constant at 20°C and the diameter of the tube was varied for each trial (see Table 2).

Table 2

Trial	Tube diameter (cm)	Time (sec)	Distance of ring from HCl swab (cm)
5	1.0	33	4.0
6	1.2	33	4.0
7	1.4	33	4.1
8	1.6	33	4.0

Experiment 3

Experiment 2 was repeated, but the diameter of the tube was kept constant at 1 cm and longer tubes were used so that the distance between the swabs could be varied for each trial (see Table 3).

Table 3

Trial	Distance between swabs (cm)	Time (sec)	Distance of ring from HCl swab (cm)
9	10	33	4.0
10	20	67	8.1
11	30	101	12.2
12	40	133	16.2

1) Which of the following best describes the difference between the procedures used in Experiments 1 and 2?

A) In Experiment 1, the temperature was varied; In Experiment 2, the diameter of the tube was varied.

B) In Experiment 1, the diameter of the tube was varied; In Experiment 2, the temperature was varied.

C) In Experiment 1, the distance between the swabs was varied; In Experiment 2, the temperature was varied.

D) In Experiment 1, the temperature was varied; In Experiment 2, the distance between the swabs was varied.

2) Which of the following sets of trials in Experiments 1, 2, and 3 were conducted with identical sets of conditions?

E) Trials 2, 3, and 4

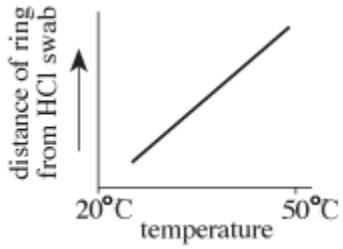
F) Trials 1, 5, and 9

G) Trials 4, 7, and 9

H) Trials 10, 11, and 12

3) Based on the results of Experiment 1, which of the following graphs best shows the relationship between the temperature and the distance of the ring from the HCl swab?

A)



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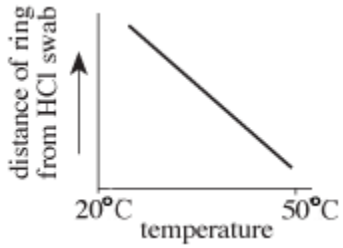
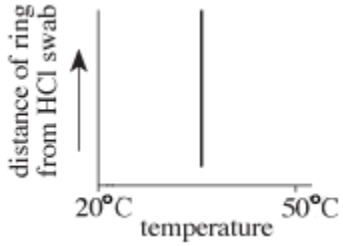
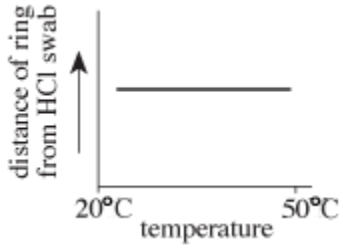


C)



D)



4) If a trial in Experiment 3 had been performed with the swabs 25 cm apart, the distance from the HCl swab to the ring would most likely have been closest to:

E) 8 cm

F) 10 cm

G) 12 cm

H) 14 cm

5) If another student wanted to test a factor that was not studied in Experiments 1–3, which of the following should he do next? He should test how the diffusion rates of gases are affected by:

A) atmospheric pressure.

B) tube length.

C) temperature.

D) tube diameter.

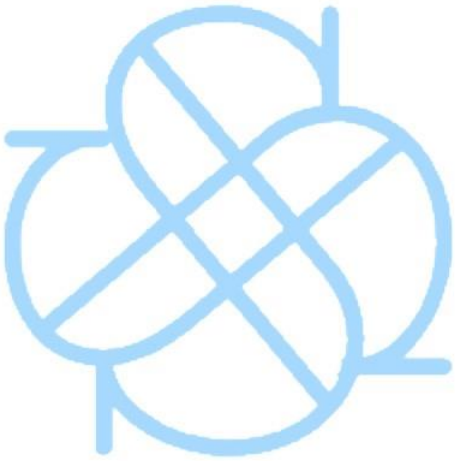
6) The student concluded that NH3 diffuses at a greater rate than HCl. Do the results of Experiments 1–3 support her conclusion?

E) No; in Trials 1–9 the HCl vapors traveled farther than the NH3 vapors.

F) No; in Trials 1–9 the NH3 vapors traveled farther than the HCl vapors.

G) Yes; in Trials 1–9 the HCl vapors traveled farther than the NH3 vapors.

H) Yes; in Trials 1–9 the NH3 vapors traveled farther than the HCl vapors.



ANSWERS:

1) Table 1 shows that in Experiment 1, there are 4 different temperatures used (20°C, 30°C, 40°C, and 50°C). Table 2 shows that in Experiment 2, there are 4 different tube diameters used (1.0 cm, 1.2 cm, 1.4 cm, and 1.6). So, in Experiment 1, temperature was varied. In Experiment 2, tube diameter was varied. **A is correct.**

2) In Experiments 2 and 3, all of the trials were at 20°C. In Experiment 1, only Trial 1 was at this temperature. So, Trial 1 must be part of the answer. In Experiment 2, trial 5 used the same conditions as Trial 1. (temperature = 20°C and tube diameter = 1.0 cm and swab distance = 10 cm). In Experiment 3, trial 9 used the same conditions as Trial 1. (temperature = 20°C and tube diameter = 1.0 cm and swab distance = 10 cm). **F is correct.**

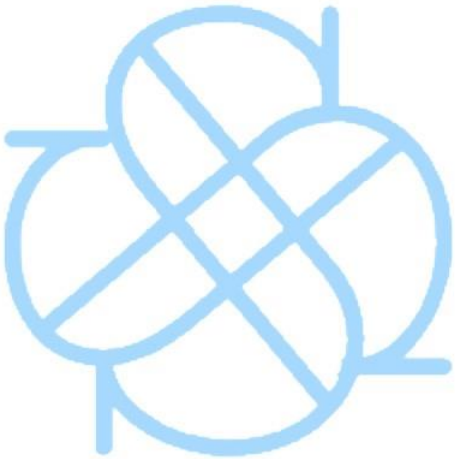
3) The graph indicates that as temperature increased, the distance of the HCL swab's ring stayed constant. Table 1 also shows that as temperature increased, the distance of the HCL swab's ring remained nearly constant. **D is correct.**

4) In Experiment 3, as the distance between the swabs increased, the distance of the HCL swab's ring increased. When the swabs were 20 cm apart, the distance between the HCL swab's ring and the HCl swab was 8.1 cm. When the swabs were 30 cm apart, the distance between the HCL swab's ring was 12.2 cm. So, if the swabs were 25 cm apart, the distance between the ring and the HCl swab would have been about 10 cm. This is halfway between 8.1 cm and 12.2 cm. **F is correct**.

5) Experiment 1 studied temperature.Experiment 2 studied tube diameter. Experiment 3 studied tube length. Atmospheric pressure was not studied in any of the 3 experiments. **A is correct.**

6) In each trial, the ring was closer to the HCl swab than to the NH3 swab. This shows that the HCl vapors traveled a shorter distance compared to the NH3 vapors.. For example, in

Trial 1, the vapors collided 4 cm from the HCl swab and 6 cm from the NH3 swab. This shows that NH3 diffuses at a greater rate than HCl. **H is correct.**



Passage III (Conflicting Viewpoints)

Unmanned spacecraft taking images of Jupiter's moon Europa have found its surface to be very smooth with few meteorite craters. Europa's surface ice shows evidence of being continually re smoothed and reshaped. Cracks, dark bands, and pressure ridges (created when water or
slush is squeezed up between 2 slabs of ice) are commonly seen in images of the surface. Two scientists express their views as to whether the presence of a deep ocean beneath the surface is responsible for Europa's surface features.

Scientist 1

A deep ocean of liquid water exists on Europa. Jupiter's gravitational field produces tides within Europa that can cause heating of the subsurface to a point where liquid water can exist. The numerous cracks and dark bands in the surface ice closely resemble the appearance of thawing ice covering the polar oceans on Earth. Only a substantial amount of circulating liquid water can crack and rotate such large slabs of ice. The few meteorite craters that exist are shallow and have been smoothed by liquid water that oozed up into the crater from the subsurface and then quickly froze. Jupiter's magnetic field, sweeping past Europa, would interact with the salty, deep ocean and produce a second magnetic field around Europa. The spacecraft has found evidence of this second magnetic field.

Scientist 2

No deep, liquid water ocean exists on Europa. The heat generated by gravitational tides is quickly lost to space because of Europa's small size, as shown by its very low surface temperature (–160°C). Many of the features on Europa's surface resemble features created by flowing glaciers on Earth. Large amounts of liquid water are not required for the creation of these features. If a thin layer of ice below the surface is much warmer than the surface ice, it may be able to flow and cause cracking and movement of the surface ice. Few meteorite craters are observed because of Europa's very thin atmosphere; surface ice continually sublimes (changes from solid to gas) into this atmosphere, quickly eroding and removing any craters that may have formed.

1) Which of the following best describes how the 2 scientists explain how craters are removed from Europa's surface?

A) Scientist 1: Sublimation
Scientist 2: Filled in by water

B) Scientist 1: Filled in by water
Scientist 2: Sublimation

C) Scientist 1: Worn smooth by wind
Scientist 2: Sublimation

D) Scientist 1: Worn smooth by wind
Scientist 2: Filled in by water

2) According to the information provided, which of the following descriptions of Europa would be accepted by both scientists?

E) Europa has a larger diameter than does Jupiter.

F) Europa has a surface made of rocky material.

G) Europa has a surface temperature of 20°C.

H) Europa is completely covered by a layer of ice.

3) With which of the following statements about the conditions on Europa or the evolution of Europa's surface would both Scientist 1 and Scientist 2 most likely agree? The surface of Europa:

A) is being shaped by the movement of ice.

B) is covered with millions of meteorite craters.

C) is the same temperature as the surface of the Arctic Ocean on Earth.

D) has remained unchanged for millions of years.

4) Which of the following statements about meteorite craters on Europa would be most consistent with both scientists' views?

E) No meteorites have struck Europa for millions of years.

F) Meteorite craters, once formed, are then smoothed or removed by Europa's surface processes.

G) Meteorite craters, once formed on Europa, remain unchanged for billions of years.

H) Meteorites frequently strike Europa's surface but do not leave any craters.

5) Scientist 2 explains that ice sublimes to water vapor and enters Europa's atmosphere. If ultraviolet light then broke those water vapor molecules apart, which of the following gases would one most likely expect to find in Europa's atmosphere as a result of this process?

A) Nitrogen

B) Methane

C) Chlorine

D) Oxygen

6) Based on the information in Scientist 1's view, which of the following materials must be present on Europa if a magnetic field is to be generated on Europa?

E) Frozen nitrogen

F) Water ice

G) Dissolved salts

H) Molten magma

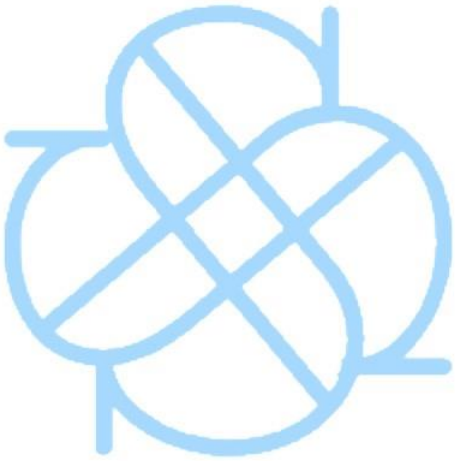
7) Assume Scientist 2's view about the similarities between Europa's surface features and flowing glaciers on Earth is correct. Based on this assumption and the information provided, Earth's glaciers would be least likely to exhibit which of the following features?

A) Pressure ridges

B) Cracks

C) Meteorite craters

D) Dark bands



ANSWERS:

1) Scientist 1 states that the craters are smoothed by liquid water that oozes up into the craters from the subsurface and then quickly freezes. Scientist 2 states that when ice sublimates, the craters are eroded and smoothed. **B is correct.**

2) Both scientists state that ice covers large portions of the surface and neither scientist discusses any other surface material. They both would most likely agree that Europa is completely covered by a layer of ice. **H is correct.**

3) Scientist 1 states that Europa's surface is partially composed of rotating large slabs of ice. Scientist 2 states that many of Europa's surface features look like features created by flowing glaciers on Earth. Both scientists would most likely agree that Europa's surface is being shaped by the movement of ice. **A is correct.**

4) Both scientists describe surface processes that either smooth or remove meteorite craters. Scientist 1 states that the craters become smooth when liquid water oozes into the craters and then quickly freezes. Scientist 2 states that the process is the result of sublimation of ice. **F is correct.**

5) Water vapor molecules are composed of hydrogen and oxygen. When broken down, they produce oxygen (O2) in the atmosphere. **D is correct.**

6) Scientist 1 states that a second magnetic field exists around Europa. This magnetic field is caused by an interaction between Jupiter's magnetic field and the salty ocean. So, Scientist 1 believes that the second magnetic field exists because of the presence of dissolved salts. **G is correct.**

7) Scientist 2 states that many features on Europa's surface look like features created by glaciers on Earth. These features include cracks, pressure ridges, and dark bands.

Therefore, Earth's glaciers might show these features. However, Scientist 2 does not indicate that Earth's glaciers might exhibit meteorite craters. **C is correct.**

Reminders:

The ACT science section is a race against time and yourself. Pace yourself, answer figure-based questions first, and select a LOTD. Most importantly, take care of yourself the night before the test!