ACT SCIENCE PRACTICE PAPER

DIRECTIONS: The passage in this test is followed by several questions. After reading the passage, choose the best answer to each question and fill in the corresponding oval on your answer document. You may refer to the passage as often as necessary.

You are NOT permitted to use a calculator on this test.

Passage I

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?

Individual Question

1. Scientist 1:Sublimation
   Scientist 2: Filled in by water
2. Scientist 1: Filled in by water
   Scientist 2: Sublimation
3. Scientist 1: Worn smooth by wind
   Scientist 2: Sublimation
4. 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?
Individual Question

5. Europa has a larger diameter than does Jupiter.
6. Europa has a surface made of rocky material.
7. Europa has a surface temperature of 20°C.
8. 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:
Individual Question

1. is being shaped by the movement of ice.
2. is covered with millions of meteorite craters.
3. is the same temperature as the surface of the Arctic Ocean on Earth.
4. 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?
Individual Question

5. No meteorites have struck Europa for millions of years.
6. Meteorite craters, once formed, are then smoothed or removed by Europa's surface processes.
7. Meteorite craters, once formed on Europa, remain unchanged for billions of years.
8. 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?
Individual Question

1. Nitrogen
2. Methane
3. Chlorine
4. 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?
Individual Question

5. Frozen nitrogen
6. Water ice
7. Dissolved salts
8. 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?
Individual Question

1. Pressure ridges
2. Cracks
3. Meteorite craters
4. Dark bands

Passage II

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 (NH_3) vapors react, they form solid ammonium chloride (NH_4Cl):

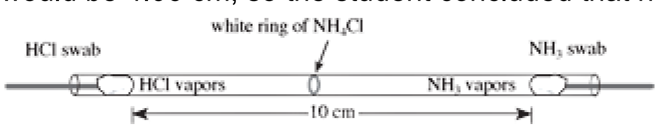
$HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$

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

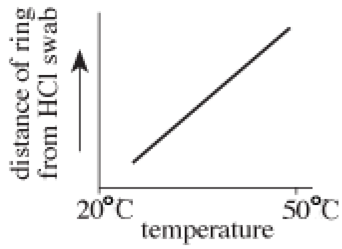
1.
Which of the following best describes the difference between the procedures used in Experiments 1 and 2 ? In Experiment 1, the:
Individual Question

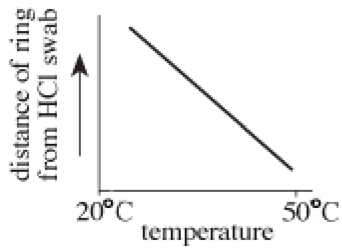
1. temperature was varied; in Experiment 2, the diameter of the tube was varied.
2. diameter of the tube was varied; in Experiment 2, the temperature was varied.
3. distance between the swabs was varied; in Experiment 2, the temperature was varied.
4. temperature was varied; in Experiment 2, the distance between the swabs was varied.

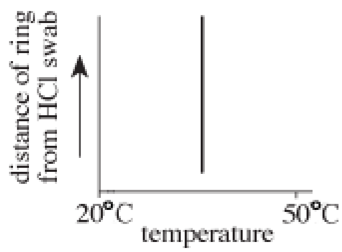
2.
Which of the following sets of trials in Experiments 1, 2, and 3 were conducted with identical sets of conditions?
Individual Question

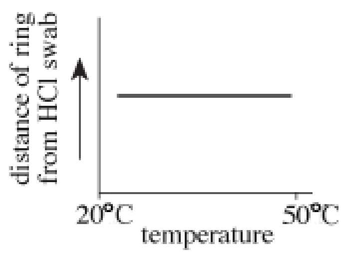
5. Trials 2, 3, and 4
6. Trials 1, 5, and 9
7. Trials 4, 7, and 9
8. Trials 10, 11, and 12

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?
Individual Question

1. 

2. 

3. 

4. 

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:

Individual Question

5. 8 cm
6. 10 cm
7. 12 cm
8. 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:

Individual Question

1. atmospheric pressure.
2. tube length.
3. temperature.
4. tube diameter.

6.

The student concluded that NH_3 diffuses at a greater rate than HCl. Do the results of Experiments 1–3 support her conclusion?

Individual Question

5. No; in Trials 1–9 the HCl vapors traveled farther than the NH_3 vapors.
6. No; in Trials 1–9 the NH_3 vapors traveled farther than the HCl vapors.
7. Yes; in Trials 1–9 the HCl vapors traveled farther than the NH_3 vapors.
8. Yes; in Trials 1–9 the NH_3 vapors traveled farther than the HCl vapors.

Passage III

A student performed 2 studies to investigate the factors that affect the germination of peony seeds.

Study 1

Peony seeds were placed in dry containers. Some of the containers were stored at 5°C for either 4, 6, 8, or 10 weeks. The temperature and time periods were defined as the storage temperature and the storage period, respectively.

The peony seeds were divided evenly so that there were 20 sets of 25 seeds. Twenty petri dishes were then prepared. Each contained damp paper. Each set of seeds was placed in a separate petri dish. Each petri dish was maintained at 1 of 4 temperatures for 30 days. The temperature and time periods were defined as the germination temperature and the germination period, respectively. Table 1 shows the number of seeds that germinated in each dish.

Table 1

Storage period (weeks)	Number of peony seeds that germinated when maintained at a germination temperature of:			
	13°C	18°C	23°C	28°C

0	0	0	0	0
4	0	2	0	0
6	3	8	6	0
8	7	22	18	0
10	15	24	21	1

Study 2

Peony seeds were placed in dry containers. The containers were stored at various temperatures for 10 weeks.

The peony seeds were divided evenly so that there were 20 sets of 25 seeds. Twenty petri dishes were then prepared. Each contained damp paper. Each set of seeds was placed in a petri dish. The petri dishes were maintained at 1 of 4 temperatures for 30 days. Table 2 shows the number of seeds that germinated in each dish.

Table 2

Storage temperature (°C)	Number of peony seeds that germinated when maintained at a germination temperature of:			
	13°C	18°C	23°C	28°C
0	15	24	21	1
5	16	23	21	1
10	0	6	4	0
15	0	0	0	0
20	0	0	0	0

Tables adapted from Joel Beller, Experimenting with Plants. ©1985 by Joel Beller.

1.

In general, the results of Study 1 suggest that peony seeds that are placed in a petri dish containing damp paper are most likely to germinate when they are maintained at which of the following temperatures?

Individual Question

1. 13° C
2. 18° C
3. 23°C
4. 28°C

2.

Suppose another set of 25 peony seeds had been included in Study 2 and these seeds had a storage temperature of 25°C and a germination temperature of 18°C. Based on the information provided, the number of seeds that would have germinated after being maintained for 30 days would most likely have been closest to:

Individual Question

5. 0
6. 8
7. 16
8. 24

3.

In Study 2, at the storage temperature of 5°C, as germination temperature increased from 13°C to 28°C, the number of seeds that germinated:

Individual Question

1. decreased only.
2. increased only.
3. decreased, then increased.
4. increased, then decreased.

4.

Which of the following sets of seeds were exposed to the same conditions prior to being placed in the petri dishes?

Individual Question

5. The seeds from Study 1 that were stored for 8 weeks and the seeds from Study 2 that were stored at 5°C
6. The seeds from Study 1 that were stored for 8 weeks and the seeds from Study 2 that were stored at 15°C
7. The seeds from Study 1 that were stored for 10 weeks and the seeds from Study 2 that were stored at 5°C
8. The seeds from Study 1 that were stored for 10 weeks and the seeds from Study 2 that were stored at 15°C

5.

A student stored 100 peony seeds at a constant temperature for 10 weeks. The student then divided the seeds into 4 sets and maintained them as described in Study 2. The results were as follows:

Germination temperature (°C)	Number of seeds that germinated
13	1
18	6
23	3
28	0

These seeds most likely had a storage temperature of:

Individual Question

1. 0°C
2. 5°C
3. 10°C
4. 15°C

6.

The experimental designs of Study 2 and Study 1 differed in that in Study 2:

Individual Question

5. storage temperature was held constant.
6. storage time was held constant.
7. germination temperature was varied.
8. germination time was varied.