Science practice paper
Passage I

In 1908, an object from outer space devastated 2,000 km2 of forest in Siberia. The object was between 10 m and 100 m in diameter and traveled at a maximum speed of 15 km/sec. It exploded at an altitude of 8 km and released energy equivalent to 20 million tons of TNT. Two scientists discuss whether this object was a comet or an asteroid.

Scientist 1

The object was a comet, a body made of ices (such as frozen water or methane) and dust. Most of this cometary material is volatile (easily vaporized) and low in density. Friction in Earth's atmosphere heated the comet to a temperature at which it exploded, high above the ground. The majority of the ices and dust were vaporized in the explosion, which explains why no crater was formed at the site and why no large, identifiable fragments of the object were found. An asteroid would not have been completely destroyed. Intact asteroid fragments that reached the ground would have created one or more craters upon impact and left behind recoverable pieces. Evidence shows that the object decelerated rapidly before it exploded. Because of their low density, comets are capable of such rapid deceleration, whereas high-density objects, such as asteroids, are not.

Scientist 2

The object was a stony asteroid. As it entered Earth's atmosphere, its high speed created a large air pressure difference between the area just in front of the asteroid and the area just behind the asteroid. The large pressure difference eventually exceeded the structural strength of the asteroid. The asteroid flattened, decelerated rapidly due to the dramatic increase in its surface area, and fragmented before reaching the ground. This fragmentation would have appeared like an explosion. Calculations show that a comet between 10 m and 100 m in diameter would explode at an altitude much higher than 8 km, but a stony asteroid of that size would fragment at or near an altitude of 8 km. Recovery of large asteroid fragments is difficult due to the area's boggy soil; however, small, glassy fragments were recovered and are believed to be melted and resolidified pieces of the asteroid.

1. Which of the following phrases best describes the major point of difference between the 2 scientists' hypotheses?
F. The location of the event
G. The speed the object was traveling
H. The density of Earth's atmosphere
J. The type of object that entered Earth's atmosphere

2. According to Scientist 2's viewpoint, compared to the altitude at which a stony asteroid would have exploded in Earth's atmosphere, a comet of similar size would most likely have exploded at:
A. the same altitude.
B. a higher altitude.

C. a slightly lower altitude.
D. a much lower altitude.

3. Scientist 1's viewpoint indicates that when the materials that compose most of a comet are sufficiently heated, they change to:
F. solids.
G. gases.
H. liquids.
J. a vacuum.

4. Which of the following statements best describes how Scientist 2 would explain why no large, identifiable fragments of the object have been recovered?
A. Any large, identifiable fragments that reached the ground have been removed from the area by erosion.
B. Any large, identifiable fragments were thrown hundreds of kilometers from the site.
C. No large, identifiable fragments of the object reached the ground.
D. No large, identifiable fragments of the object have been recovered due to the soil conditions in the area.

5. How would the behavior of the asteroid differ from that described in Scientist 2's viewpoint if the asteroid had not been flattened by the air pressure difference? The asteroid would:
F. not have entered Earth's atmosphere.
G. have struck another planet in the solar system.
H. have decelerated more gradually.
J. have frozen.

6. Which of the following statements would both scientists most likely use to explain the damage to the forest caused by the object's explosion? Energy from the explosion:
A. traveled rapidly down to Earth's surface.
B. dissipated in the upper atmosphere.
C. was released less than 1 km above Earth's surface.
D. was released as the object struck Earth's surface.

7. Scientist 1's viewpoint would be weakened by which of the following observations about comets, if true?
F. Comets are composed mainly of frozen materials.
G. Comets are much larger than 100 m in diameter.
H. Comets often pass close enough to Earth to intersect Earth's atmosphere.
J. Comets orbit the Sun.

Passage II

The seeds of some plants attract ants with a nutritious structure called an elaiosome. The ants carry the seeds to their nests, eat the elaiosomes, and then leave the seeds in a waste pile, where some seeds germinate (begin to grow). Three studies were conducted to examine this process.

Study 1

For 2 plant species (A and B), seed mass per seed in milligrams (mg), elaiosome mass per seed (mg), and percentage of seed mass composed of elaiosome were recorded (see Table 1).
TABLE 1

Species	**Seed mass(mg)**	**Elaiosome mass per seed(mg)**	**Percentage of seed mass composed of elaiosome**
A **B**	**6.8** **14.9**	**0.420** **0.924**	**6.2** **6.2**

Study 2

Three study sites were established in order to determine the rate of seed collection by a single species of ant for the plants used in Study 1. In Site 1, Species A plants were absent; in Site 2, Species B plants were absent. Both plants were absent in Site 3.

Two seed dishes were placed in each site: 1 containing 20 Species A seeds and 1 containing 20 Species B seeds. The dishes were left out for 48 hours and the number of seeds taken from each dish was recorded. The results appear in Table 2.

Table 2

Site	**Plant species absent**	**Number of seeds removed from seed dishes containing:** **Species A** **Species B**
1	**A**	13 3
2	B	2 12
3	A and B	8 9

Study 3

The researchers planted 2,550 seeds from a third species, Species C. They also observed 2,550 Species C seeds that were planted by ants in similar environments. All seeds were observed for 2 years.

Table 3

Maturation of Species C seeds	Results from: hand-planted seeds	Results from: ant-planted seeds
Seeds that germinated	26	39
Plants alive after 1 year	9	20
Plants alive after 2 years	4	13
Seeds produced per plant after 2 years	2,187	2,163

Questions :

1. Based on the results of Study 3, one could generalize that compared to hand-planting of seeds, ant-planting of seeds results in:
A. increased seed germination.
B. increased seed production per plant.
C. decreased plant survival after 1 year.
D. decreased plant survival after 2 years.

2. Which of the following variables was controlled in the design of Study 2 ?
F. The number of ants in each site
G. The number of seed dishes placed in each site
H. The mass of the elaiosome of each seed
J. The type of seeds taken by the ants in each site

3. According to the results of the studies, Species A and Species B are most similar in that their:
A. seed masses are the same.
B. germination rates on ant waste piles are the same.
C. percentages of elaiosome mass per seed are the same.
D. rates of production of seeds after 1 year are the same.

4. In Study 2, Site 3 was used to study the:
F. preference of a different ant species for the seeds of both plant species.
G. seed preference of ants in an area in which both plant species were absent.

H. growth and survival of both plant species in an area where ants were not present.
J. effects of elaiosome mass on the seed preference of ants.

5. Which of the following is a weakness of the design of Study 2 ?
A. Some plants were not present at each site.
B. Some seeds were not present at each site.
C. The seeds may have been removed from the dishes by animals other than ants.
D. The plants may have been eaten by animals other than ants.

6. The results of Study 2 suggest that which of the following factors most affects the seed preference of ants?
F. Seed mass
G. Elaiosome mass
H. Percentage of seed mass composed of elaiosome
J. Abundance of a plant in a given area

Passage III

Some students conducted experiments using different brands of adhesive tape, one kind each of paper and plastic, a board, and a spring scale.

Experiment 1 A student stuck one end of a piece of tape onto the edge of a board that was wrapped with paper. The other end of the tape was clamped to a spring scale, as shown in Figure 1.

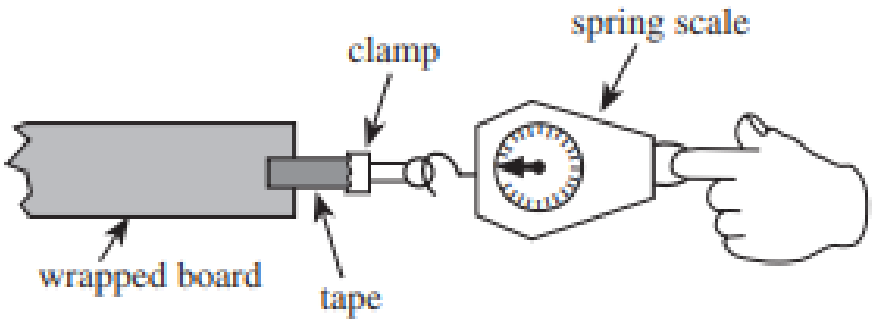

Figure 1

While one student held the board, a second student pulled the spring scale until the tape came off the paper wrapping; a third student recorded the force in newtons, N, indicated on the spring scale at the moment the tape came off the paper wrapping. The procedure was repeated for 3 different brands of tape; each brand of tape came in many different widths, of which 2 or 3 were tested. The results are shown in Table 1.

Table 1					
Tape brand	Tape width (cm)	Force (N) to remove tape:			
		Trial 1	Trial 2	Trial 3	Average
X	1.0 2.0 3.0	1.6 3.9 6.0	1.9 3.7 5.6	2.2 4.1 5.8	1.9 3.9 5.8
Y	2.0 2.5	4.0 5.4	4.5 5.1	4.3 5.7	4.3 5.4
Z	1.0 2.0	2.2 4.1	1.6 3.9	1.8 3.6	1.9 3.9

Experiment 2 The students performed an experiment similar to Experiment 1, except that the paper wrapping was replaced by a plastic wrapping. The results are shown in Table 2.

Table 2					
Tape brand	Tape width (cm)	Force (N) to remove tape:			
		Trial 1	Trial 2	Trial 3	Average
X	1.0 2.0 3.0	1.7 3.2 5.0	1.5 3.2 5.0	1.6 3.3 5.1	1.6 3.2 5.0
Y	2.0 2.5	4.3 5.5	4.3 5.4	4.3 5.4	4.3 5.4
Z	1.5	2.8	2.8	2.9	2.8

1. The results of the 2 experiments support the conclusion that, for a given brand of tape, as the tape's width increases, the force required to remove the tape from a given wrapping:

A. increases only.

B. decreases only.
C. remains constant.
D. varies, but with no particular trend.

2. In Experiment 2, had Brand X tape in a 4.0 cm width been tested, the force required to remove the tape from the plastic wrapping would have been closest to:
F. 5.0 N.
G. 7.0 N.
H. 9.0 N.
J. 11.0 N.

3. Based on the average results of Experiments 1 and 2, which of the following brands of tape adhered better to the paper than to the plastic?
A. Brand X
B. Brand Y
C. Brands X and Y
D. Brands Y and Z

4. Which brand(s) of tape was/were used at only 2 different widths in both experiments?
F. Brand X only
G. Brand Y only
H. Brand Z only
J. Brands Y and Z only

5. For the students to determine the force required to remove tape from a wrapping, which of the following attractive forces had to exceed the adhesive force between the tape and the wrapping?
A. The force between the clamp and the tape
B. The force between the clamp and the paper or plastic wrapping
C. The force between the Earth and the wrapping
D. The force between the Earth and the tape

6. The students' instructor gave them a strip of tape that was 2.5 cm wide and asked them to identify the brand. The students repeated the procedures from Experiments 1 and 2 using the tape and obtained average forces of 4.9 N for paper and 4.1 N for plastic. Which of the following brands would most likely have produced these results?
F. Brand X only
G. Brand Y only
H. Brands X and Y only
J. Brands Y and Z only

Passage IV

Researchers conducted an experiment to determine the factors affecting heat flow. In each trial, one or more blocks of a particular material was (were) placed between two walls at constant temperatures T1 and T2 in one of the configurations shown in Figure 1. Heat was transferred through the block(s) from the hotter wall to the cooler wall. This heat flow, measured in joules per second (J/sec), is shown in Table 1.
(Note: All blocks used in the experiment were identical in size and shape. In each configuration, the contact area was the surface area of the end of the block(s) against one wall.)

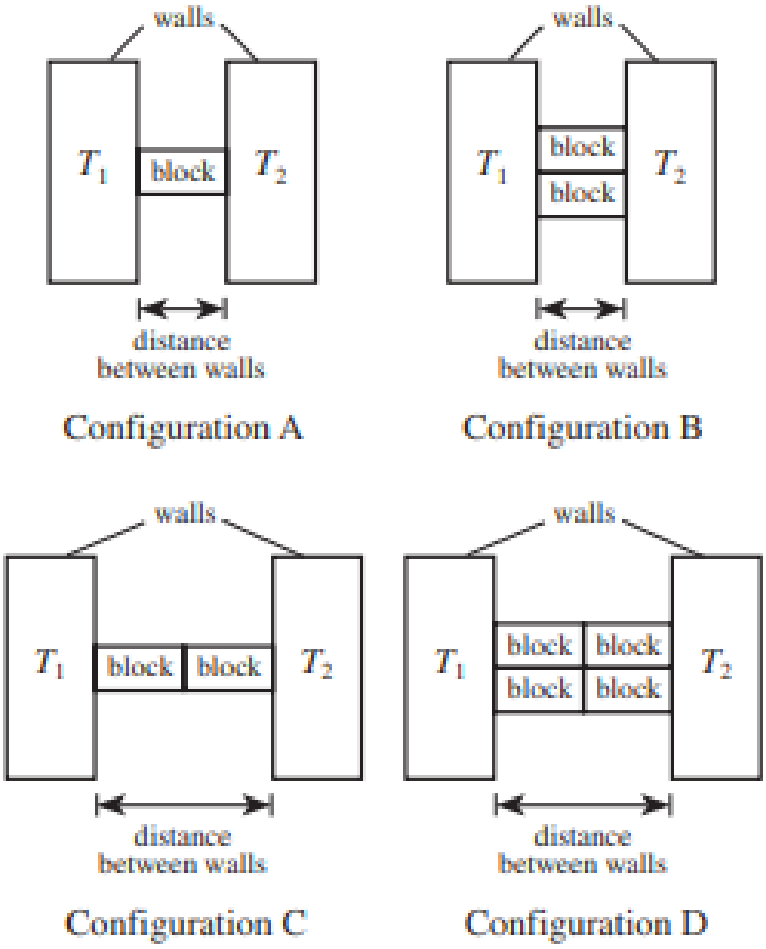

Figure 1

Figure 1

Table 1

Trial	Block material	Configuration	T_1 (°C)	T_2 (°C)	Heat flow (J/sec)
1	glass wool	A	50	20	0.025
2	glass wool	B	50	20	0.050
3	glass wool	C	50	20	0.013
4	glass wool	D	50	20	0.025
5	glass wool	A	100	70	0.025
6	glass wool	A	20	50	0.025
7	wood	A	50	20	0.072
8	brick	A	50	20	0.500
9	concrete	A	50	20	0.540
10	steel	A	50	20	31
11	aluminum	A	50	20	140
12	aluminum	A	60	20	190
13	aluminum	A	70	20	240

Questions:

1. According to the information provided, heat flowed from the wall at temperature T2 to the wall at temperature T1 in which trial?

A. Trial 4
B. Trial 6
C. Trial 10
D. Trial 12

2. Insulators are materials that are poor heat conductors. According to Trials 7 through 10, a wall of a given thickness built of which of the following materials would provide the best insulation between a room and the outdoors?

F. Wood
G. Brick
H. Concrete
J. Steel

3. The results of Trials 1 and 5 are consistent with the hypothesis that heat flow from a hotter wall to a cooler wall is dependent on the:

A. temperature of the hotter wall only.
B. temperature of the cooler wall only.
C. sum of the wall temperatures.

D. difference between the wall temperatures.

4. Materials differ in their thermal conductivities: the higher the thermal conductivity, the greater the heat flow through the material. According to Trials 6 through 11, which of the following statements about relative thermal conductivities is NOT true?
F. Brick has a higher thermal conductivity than glass wool.
G. Brick has a higher thermal conductivity than wood.
H. Steel has a higher thermal conductivity than aluminum.
J. Steel has a higher thermal conductivity than concrete.

5. Trials 1 and 3 provide evidence that heat flow depends on which of the following factors?
A. Distance between walls
B. Contact area
C. Temperature of the hotter wall
D. Temperature of the cooler wall