Description of the PLAN Tests

The English Test (50 questions — 30 minutes)

The English Test measures your students' understanding of the conventions of standard written English and of rhetorical skills. The test consists of several prose passages, each accompanied by a number of multiple-choice test items.

Usage/Mechanics

Punctuation. The items in this category test the student's knowledge of the conventions of internal and end-of-sentence punctuation, with emphasis on the relationship of punctuation to meaning.

Grammar and Usage. The items in this category test the student's understanding of agreement between subject and verb, between pronoun and antecedent, and between modifiers and the words modified; verb formation; pronoun case; formation of comparative and superlative adjectives and adverbs; and idiomatic usage.

Sentence Structure. The items in this category test the student's understanding of relationships between and among clauses, placement of modifiers, and shifts in construction.

Rhetorical Skills

Strategy. The items in this category test the student's ability to choose expressions appropriate to an essay's audience and purpose; to gauge the effect of adding, revising, or deleting supporting material; and to judge the relevancy of statements in context.

Organization. The items in this category test the student's ability to organize ideas and to choose effective opening, transitional, and closing sentences.

Style. The items in this category test the student's ability to select precise and appropriate words and images, to maintain the level of style and tone in an essay, to manage sentence elements for rhetorical effectiveness, and to avoid ambiguous pronoun references, wordiness, and redundancy.

The Mathematics Test (40 questions — 40 minutes)

The Mathematics Test measures your students' mathematics achievement. It emphasizes the solution of practical quantitative problems that require skills encountered in many first- and second-year high school courses (pre-algebra, elementary algebra, and plane geometry). While some material from second-year courses is included on the test, most items, including geometry items, emphasize content presented before the second year of high school. The test focuses on quantitative reasoning rather than on memorization of formulas, knowledge of techniques, or computation skill.

Pre-Algebra. Items in this category are based on operations with whole numbers, integers, decimals, and fractions. The topics covered include prime factorization, comparison of fractions, conversions, scientific notation, square roots, percent, absolute value, positive integer exponents, data representation, elementary counting and probability, mean, median, and mode.

Elementary Algebra. Items in this category are based on operations with algebraic expressions. The operations include substituting to evaluate algebraic expressions; simplifying algebraic expressions; adding, subtracting, and multiplying polynomials; factoring polynomials; and factoring to solve quadratic equations.

Geometry

Coordinate Geometry. Items in this category cover topics on graphing in the standard coordinate plane. The topics include graphs of linear equations, measurement of lines, and determination of the slope of a line.

Plane Geometry: Items in this category cover such topics as measurement of plane surfaces, properties of polygons, properties of triangles, the Pythagorean theorem, and relationships involving circles.

The Reading Test (25 questions — 20 minutes)

The Reading Test measures reading comprehension and requires your students to derive meaning from several reading passages by (1) referring to what is explicitly stated and (2) reasoning to determine implicit meanings and to draw conclusions, comparisons, and generalizations. The test includes three prose passages based on topics in prose fiction, the humanities, and the social sciences. The test focuses on the kinds of skills that readers must use in studying written materials across a range of subject areas, rather than on information from outside the passages, rote recall of facts, isolated vocabulary items, or rules of formal logic.

Prose Fiction. Intact short stories or excerpts from short stories or novels.

Social Sciences. Anthropology, archaeology, biography, business, economics, education, geography, history, political science, psychology, sociology.

Humanities. Passages from memoirs and personal essays and in the content areas of architecture, art, dance, ethics, film, language, literary criticism, music, philosophy, radio, television, and theater.

The Science Test (30 questions — 25 minutes)

The Science Test measures your students' scientific reasoning skills with respect to information that is typically encountered in general, introductory science courses. The content of the Science Test includes biology, chemistry, physics, and the Earth/space sciences. Advanced knowledge in these subject areas is not required, but knowledge that is typically covered in early high school general science courses is needed to answer some of the questions.

The items require your students to recognize and understand the basic features of, and concepts related to, the information provided; to examine critically the relationships between the information provided and the conclusions drawn or hypotheses developed; and to generalize from the given information to gain new information, draw conclusions, or make predictions.

The test presents five sets of scientific information, each conveyed in one of three different formats.

Data Representation. This format presents students with graphic and tabular material similar to that found in science journals and texts. The items measure skills such as graph reading, interpretation of scatterplots, and interpretation of information presented in tables.

Research Summaries. This format provides students with descriptions of one or more related experiments. The items focus on the design of experiments and the interpretation of experimental results.

Conflicting Viewpoints. This format presents students with expressions of several hypotheses or views that, being based on differing premises or on incomplete data, are inconsistent with one another. The items focus on the understanding, analysis, and comparison of alternative viewpoints or hypotheses.

SECTION A

TABLE 1: Item-Response Summary for English

SECTION B Item Number	Percent of report group selecting each option, by response position Asterisk marks correct response A / F	B / G	C / H	D / J	Omit	REFERENCE group percentage correct	Percentage difference (report group minus reference group percentage correct) Report group responded correctly Less often	As often	More often	Item Number
Usage/Mechanics: Punctuation										
2	*71	3	10	16	0	60			11	2
14	14	1	14	*71	0	56			15	14
17	8	4	10	*77	0	62			15	17
29	*71	14	8	7	1	54			17	29
33	*72	12	13	2	1	59			13	33
35	3	*74	20	3	0	60			14	35
39	18	5	23	*54	0	41			13	39
Avg. % Correct			70			56				
Usage/Mechanics: Grammar and Usage										
1	2	16	*80	2	0	72		8		1
3	9	*89	0	2	0	75			14	3
21	9	38	3	*50	0	47		3		21
31	23	12	*55	10	0	40			15	31
32	8	6	16	*69	1	78		-9		32
37	17	*80	1	2	0	62			18	37
40	5	14	*78	2	1	58			20	40
4	6	*86	6	2	1	63			23	4
15	5	*75	8	12	1	77		-2		15
Avg. % Correct			74			64				
Usage/Mechanics: Sentence Structure										
6	2	11	7	*80	0	67			13	6
7	1	12	3	*84	0	76		8		7
11	4	23	4	*69	0	52			17	11
16	*79	18	3	0	0	71		8		16
18	13	16	*61	10	0	71	-10			18
20	*87	6	4	3	0	76			11	20
22	5	11	3	*81	0	72		9		22
25	17	17	*63	2	1	68		-5		25
27	8	10	9	*73	1	65		8		27
28	2	24	*70	4	0	54			16	28
30	7	*80	4	8	1	67			13	30
34	14	12	*53	21	1	64	-11			34
38	*62	27	9	2	0	44			18	38
9	10	11	4	*74	1	42			32	9
Avg. % Correct			73			64				

SECTION C

SECTION D

SECTION E

KEY

Section A | Section B | Section C | Section D | Section E

SECTION A. Identify your report group and reference group (top of first page of report for each subject area).

? Does your report group represent your entire 10th-grade class or some portion of your 10th-grade class? (Note: Only the records of students tested in standard-time test administrations are included.)

- If your report group represents only a portion of your class, your results may not apply to your entire class.

SECTION B. Study the items within each content area (PLAN test booklet).

? What differences are there between your curriculum and the skills and knowledge covered by each PLAN content area?

- Use the descriptions of the tests given on the back page of this guide to determine the skills and knowledge tested within each content area. Use the items themselves to identify more specific skills or knowledge required to answer correctly the items in each content area. Identify the skills and knowledge you emphasize in your curriculum, and determine the similarities and differences between your curriculum and the test contents.
- PLAN test items represent skills and knowledge from broader content domains. Focus on each domain of skills and knowledge, rather than the contents of specific items. Specific items will not be used again on future forms of PLAN.

SECTION C. Evaluate your report group performance in each content area (percentage selecting each response option).

? Given your curriculum, is the percentage of your report group answering each item correctly consistent with your expectations? (The correct response is indicated by an asterisk.)

- Determine whether your students tended to respond correctly to items in a content area that you emphasize in your curriculum.

? Is a large percentage of your report group choosing incorrect response options?

- Incorrect options may represent common misconceptions related to the skill or knowledge measured by the item. If your students did not perform as well as you expected on some items, the incorrect options can help you identify the source of errors being made.

? Is a large percentage of your report group omitting responses to items?

- If you have high omit rates at the end of the test, you may want to consider other factors, such as general test-taking skills, that can influence your students' performance.
- High omit rates near the beginning of the test or on difficult items may indicate that your students did not know the answer.

SECTION D. Compare the performance of your report group with that of a national reference group.

In order to give you an idea of how well your students did on PLAN compared to other students from across the nation, ACT has included test results from a national reference group. This group consists of several thousand fall 10th graders who had previously taken the same test form as your students as part of a special study.

? Is there a consistent pattern of your report group responding correctly less often, as often, or more often than the reference group in a content area?

- Differences in percentage correct that occur in the "Less often" and "More often" columns are likely to reflect real differences between the report and reference groups. When differences across items in a content area consistently fall in these columns, your report group is more or less prepared than the reference group in that content area. Some individual items may appear in these columns solely due to chance and should be interpreted cautiously, however. Look for consistent patterns of difference between your report group and the reference group performance.
- Differences in percentage correct between your report group and the reference group that occur in the "As often" column are likely not to be significant.

SECTION E. Examine the overall performance of your report group in each content area (average percentage correct).

? Is your report group's average percentage correct similar to that of the reference group?

- If consistent patterns of item-level performance occur in a content area, comparing report and reference group average percentage correct will help confirm your report group's strengths and weaknesses in that content area. Where no consistent pattern is apparent, differences between the report and reference group average percentage correct are likely due to chance.
- Report and reference group comparisons of average percentage correct (as well as patterns of item-level performance) should always be interpreted relative to the skills and knowledge emphasized in your curriculum.

TABLE 4: Item-Response Summary for Science

Item Number	Percent of report group selecting each option, by response position. Asterisks mark correct responses. A / F %	B / G %	C / H %	D / J %	Omit %	REFERENCE group percentage	Percentage difference (report group minus reference group percentage correct). Report group responded correctly: Less often	As often	More often	Item Number
Data Representation: Biology										
1	*96	1	2	1	0	84			12	1
2	5	5	5	*85	0	74			11	2
3	3	8	*86	2	0	72			14	3
4	35	*51	9	4	0	45		6		4
5	49	11	11	*27	1	24		3		5
Avg. % Correct			69%			60%				
Data Representation: Chemistry										
26	14	13	*55	8	10	40			15	26
27	*46	25	11	7	10	37		9		27
28	12	23	21	*31	14	23		8		28
29	17	22	*36	12	14	30		6		29
30	14	*25	27	20	14	20		5		30
Avg. % Correct			39%			30%				
Research Summaries: Earth/Space Science										
12	7	*86	5	2	1	65			21	12
13	*87	5	3	4	1	72			15	13
14	9	*77	10	3	1	55			22	14
15	19	11	6	*63	1	47			16	15
16	25	14	15	*45	1	30			15	16
17	20	13	*56	10	1	39			17	17
18	16	16	24	*43	2	33			10	18
Avg. % Correct			65%			49%				
Research Summaries: Physics										
19	*68	11	11	8	3	51			17	19
20	*66	9	12	9	3	46			20	20
21	9	33	*47	5	5	38		9		21
22	17	26	*42	10	6	36		6		22
23	13	*48	13	19	6	38			10	23
24	*33	21	23	14	8	25		8		24
25	19	18	22	*33	8	20			13	25
Avg. % Correct			48%			36%				
Conflicting Viewpoints: Earth/Space Science										
6	7	*66	11	15	1	58		8		6
7	5	17	3	*74	1	55			19	7
8	10	*68	12	10	1	53			15	8
9	*62	11	18	7	1	47			15	9
10	16	17	*53	14	1	41			12	10
11	20	14	*58	7	0	43			15	11
Avg. % Correct			64%			50%				

4

SCIENCE TEST

25 Minutes—30 Questions

DIRECTIONS: There are five passages in this test. Each passage is followed by several questions. After reading a passage, choose the best answer to each question and fill in the corresponding oval on your answer folder. You may refer to the passages as often as necessary.

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

Passage I

Photosynthesis (the process through which plants convert light energy to chemical energy) can be summarized by the equation

$$6CO_2 + 6H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

As plants photosynthesize, a gas is produced. To determine whether the distance of a plant from a light source affects the rate of photosynthesis, students found the *gas production rate* (volume of gas produced in 1 hr) of a piece of *Elodea* (a water plant) when it was located at 6 different distances from a lamp that emitted light at a constant intensity. The experiment took place in a room lit by an overhead light. The results are shown in the figure.

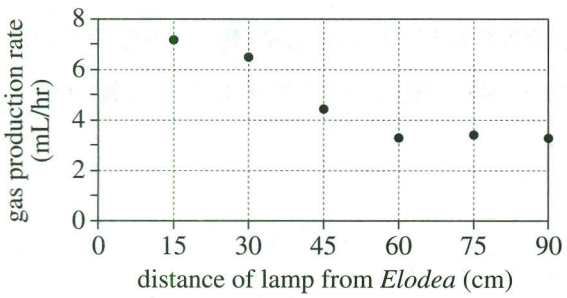


Figure adapted from Neil A. Campbell, Lawrence G. Mitchell, and Jane B. Reece, *Biology Concepts & Connections*, 2nd ed. ©1997 by The Benjamin/Cummings Publishing Company.

1. Based on the figure, the rate of photosynthesis was greatest when the lamp was located at which of the following distances from the *Elodea* ?

   A. 15 cm
   B. 30 cm
   C. 45 cm
   D. 75 cm

2. According to the figure, when the lamp distance was doubled from 15 cm to 30 cm, the rate of gas production was:

   F. doubled.
   G. increased, but not doubled.
   H. halved.
   J. decreased, but by less than half.

3. If a trial had been conducted with the lamp 22.5 cm from the *Elodea*, the gas production rate would most likely have been closest to which of the following?

   A. 2 mL/hr
   B. 4 mL/hr
   C. 7 mL/hr
   D. 9 mL/hr

4. Based on the passage, the gas produced by the *Elodea* through the process of photosynthesis was:

   F. carbon dioxide.
   G. oxygen.
   H. hydrogen.
   J. nitrogen.

5. Suppose that when the lamp was 60 cm from the *Elodea*, the students measured the volume of gas produced during a period of 8 hr. Based on the figure, the volume of gas produced was most likely closest to which of the following?

   (Note: Assume the gas production rate was constant.)

   A. 4 mL
   B. 8 mL
   C. 15 mL
   D. 25 mL

Passage II

Introduction

Upheaval Dome was formed between 30 million and 100 million years ago in the sedimentary rocks at a location in the western U.S. The circular structure, 5.5 km across, is a central peak surrounded by a ring depression that is lined with folded and faulted rocks. Figure 1 shows a cross section through the structure and the flat-lying rock layers around it. Two scientists discuss the creation of Upheaval Dome.

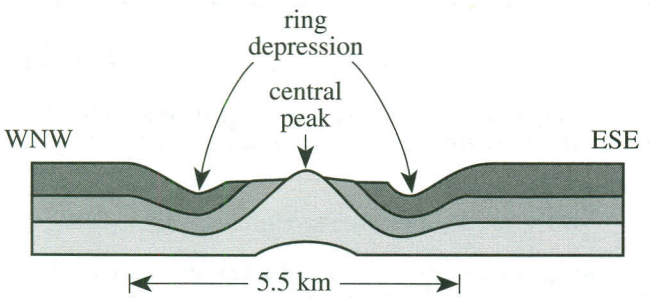


Figure 1

Scientist 1

Upheaval Dome was created when a large salt column rose to near the surface from a deeply buried salt layer. The area that includes Upheaval Dome was covered by a shallow sea from 320 million years ago to 285 million years ago. The sea then dried up, leaving behind a 0.5 km thick salt layer. Rocks that were deposited on top of the salt layer produced enough pressure to change the salt to fluid. Once a sufficient mass of rock and sediment had been eroded from above the salt layer, the salt began to rise through surrounding rock.

Over a million years, the rising salt column pushed up the rock layers above it, creating a dome. Before the salt reached the surface, the column stopped rising and then settled downward. During the settling some of the rocks were folded into a U shape, forming the ring depression (see Figure 2). Since the salt column never reached the surface, no salt is exposed. Salt columns have created similar domes at other locations in this area, and at other places on Earth.

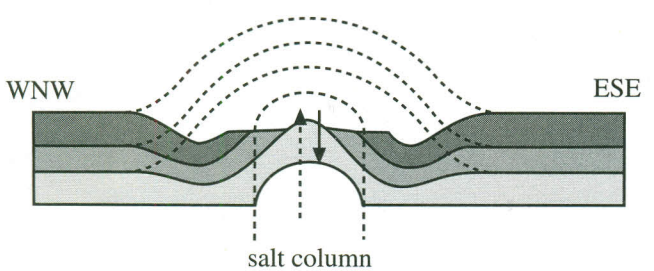


Figure 2

Scientist 2

Upheaval Dome was created by the impact of a 0.3 km diameter meteorite. The initial impact excavated a bowl-shaped crater, 1.5 km deep, out of the sediment and rock. Seconds after the impact, the material in the center of the crater rebounded upward, creating a raised peak in the center. Within hours, the rocks around the edge of the crater had collapsed into the cavity around the central peak, creating the ring depression (see Figure 3).

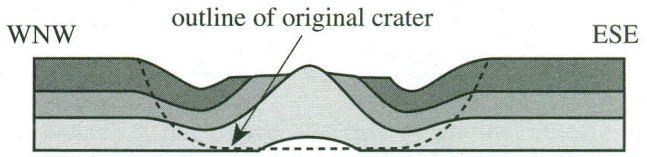


Figure 3

The rocks in the central peak contain certain minerals that are formed from other minerals only under the high pressures associated with a meteorite impact. The faulting of the rocks in the ring depression occurred when rock layers slid down into the cavity around the central peak. No salt column exists beneath the structure.

6. According to Scientist 1, how did the now-buried salt layer form?

- **F.** Seawater evaporated, causing the salt to dissolve.
- **G.** Seawater evaporated, leaving behind the salt.
- **H.** Seawater condensed from water vapor, causing the salt to dissolve.
- **J.** Seawater condensed from water vapor, leaving behind the salt.

7. According to Scientist 1 and Scientist 2, how long did it take Upheaval Dome (central peak and ring depression) to form?

	Scientist 1	Scientist 2
A.	a hundred years	a million years or more
B.	a million years or more	a hundred years
C.	less than a day	a million years or more
D.	a million years or more	less than a day

8. Suppose it were discovered that a sea had never covered the area where Upheaval Dome is located. This discovery would weaken the viewpoint of:

   F. Scientist 1, because the flat-lying rock layers adjacent to the structure would have been thicker.
   G. Scientist 1, because the salt column beneath the structure would not have existed.
   H. Scientist 2, because the flat-lying rock layers adjacent to the structure would have been thicker.
   J. Scientist 2, because the salt column beneath the structure would not have existed.

9. Assume the rock layers shown in Figure 1 are sandstone and siltstone. Is this assumption consistent with information provided in the introduction?

   A. Yes, because both sandstone and siltstone are sedimentary rocks.
   B. Yes, because both sandstone and siltstone are igneous rocks.
   C. No, because both sandstone and siltstone are sedimentary rocks.
   D. No, because both sandstone and siltstone are igneous rocks.

10. A present-day examination of the subsurface beneath the central peak of the dome has shown that there is no salt column within 500 m of the surface. Which of the following statements would Scientist 1 most likely offer to explain this result? Beneath the central peak, the salt column has:

    F. risen to the surface from a depth of 500 m.
    G. risen to a depth of 500 m from a much greater depth.
    H. settled downward to a depth of more than 500 m.
    J. settled downward to a depth of less than 500 m.

11. Scientist 2 states that during the creation of Upheaval Dome, certain minerals in the rocks in the central peak were formed from other minerals. This process is an example of:

    A. erosion.
    B. weathering.
    C. metamorphism.
    D. volcanism.

Passage III

Air pressure is the force on a surface, per unit area, exerted by the weight of air above that surface. Air pressure at different elevations is usually measured with a barometer. The air pressure can also be indirectly measured using a thermometer and boiling water. As air pressure decreases, the boiling point of water or any other liquid decreases. At sea level (0 m elevation) the boiling point of distilled water is approximately 100°C.

Three studies involving air pressure were performed in a mountainous region.

Study 1

At 5 locations (A–E), each at a different elevation, distilled water was heated until it boiled. The temperature of the boiling water, in °C, was measured using a thermometer. The air pressure, in millibars (mb), was also measured. The results are shown in Table 1.

Table 1

Location	Boiling point of distilled water (°C)	Air pressure (mb)
A	94.6	812.7
B	93.1	778.9
C	91.9	745.0
D	90.5	711.1
E	89.7	677.3

Study 2

At 4 locations (A, C, F, and G), rainwater was heated until it boiled and the temperature at boiling was recorded. These measurements were taken at the same time of day as the measurements in Study 1, but were taken 1 day later. No barometer readings were taken. The elevation, in meters (m), was measured at each location. The results are shown in Table 2.

Table 2

Location	Boiling point of rainwater (°C)	Elevation (m)
A*	95.2	1,700
C*	92.4	2,200
F	90.3	3,000
G	89.3	3,500

*Locations A and C are the same as Locations A and C in Study 1.

Study 3

At Location A, air pressure readings were taken continuously over a 24-hour period. The data showed that maximum air pressure was recorded at 10 A.M. and at 10 P.M. Minimum air pressure was recorded at 4 A.M. and at 4 P.M.

12. According to the results of Study 2, as elevation increased, the boiling point of rainwater:

F. increased only.
G. decreased only.
H. increased, then decreased.
J. remained the same.

13. Which of the following was directly measured *both* in Study 1 and in Study 2 ?

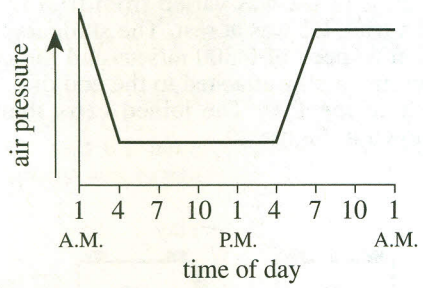
A. Boiling point
B. Air temperature
C. Air pressure
D. Elevation

14. The studies were performed in a mountainous region most likely because:

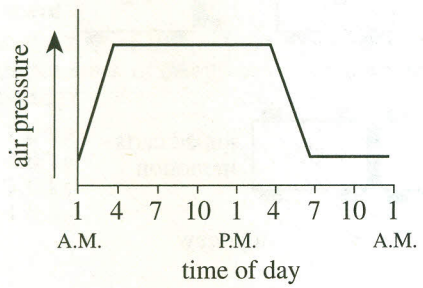
F. the area had to have temperatures that changed significantly during a 24-hour period.
G. a wide range of elevations could be found within a relatively small area.
H. strong mountain winds are necessary for accurate readings of air pressure.
J. barometers can only function above an elevation of 1,000 m.

15. Which of the following graphs best fits the description of the changes in air pressure in Study 3 ?

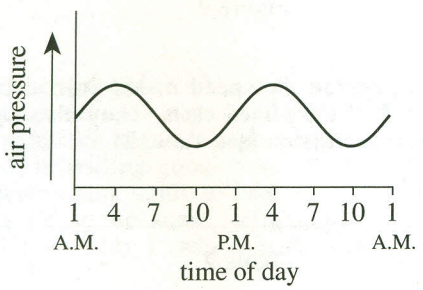
A.



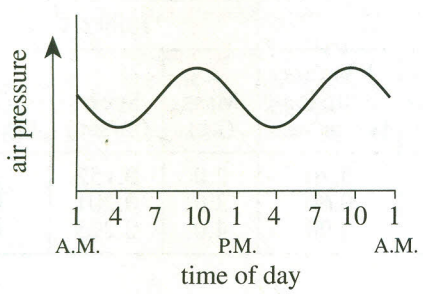
B.



C.



D.



16. Suppose an additional trial had been performed in Study 1 in a chamber that replicated the conditions at 2,000 m *below* sea level. The boiling point of distilled water would most likely have been:

F. less than 90°C.
G. between 90°C and 95°C.
H. between 95°C and 100°C.
J. greater than 100°C.

17. Were Study 1 and Study 2, taken together, designed to show that air temperature varies with elevation?

A. Yes, because boiling point increased with elevation in both studies.
B. Yes, because air temperature was higher at higher elevations in both studies.
C. No, because air temperature readings were not taken in either study.
D. No, because barometer readings were not taken in either study.

18. Assuming that the air pressure was the same at a given elevation and time of day in Studies 1 and 2, which of the following statements about the relationship between the boiling points of distilled water and rainwater is supported by the data?

F. Distilled water and rainwater have the same boiling point at any given elevation.
G. Distilled water and rainwater have the same boiling point only at sea level.
H. Distilled water has a higher boiling point than rainwater at a given elevation.
J. Distilled water has a lower boiling point than rainwater at a given elevation.

4

Passage IV

The *amount of momentum*, P, of an object equals the object's mass multiplied by its speed. Some physics students found P for 2 carts, C1 and C2, under a variety of conditions. (Assume that frictional forces were insignificant.)

Study 1

For all 3 trials of Study 1, C1 had a mass of 1.0 kg. However, the mass of C2 was varied from trial to trial. At the start of each trial, C1 and C2 were at rest, separated only by a spring that was compressed. The amount of compression was the same for each trial. When the spring was released, the expanding spring caused the carts to move in opposite directions (see Figure 1).

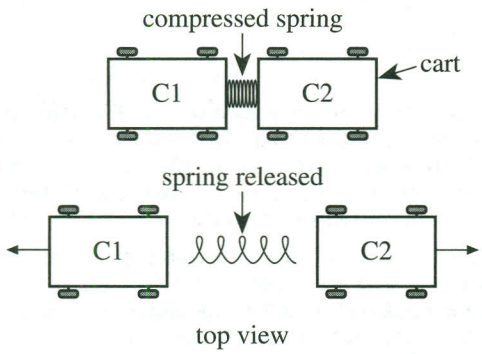


Figure 1

The students measured the speed, in m/sec, of each cart, and then calculated P of each cart (see Table 1).

Table 1

Trial	Mass of C2 (kg)	Speed (m/sec)		P (kg m/sec)	
		C1	C2	C1	C2
1	1.0	0.104	0.104	0.10	0.10
2	2.0	0.116	0.062	0.12	0.12
3	3.0	0.120	0.041	0.12	0.12

Study 2

For all 3 trials of Study 2, C1 had a mass of 1.0 kg. However, the mass of C2 was varied from trial to trial. At the start of each trial, C1 was at rest. The students launched C2 toward C1 at a speed of 0.300 m/sec, and the carts collided. Small lumps of clay attached to the end of C2 caused the 2 carts to join together. The joined carts then moved together, as shown in Figure 2.

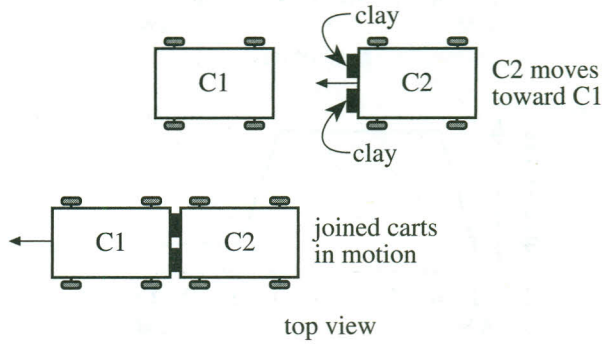


Figure 2

The students measured the speed of the joined carts and then calculated P of the joined carts. They also calculated P of C2 before the collision (see Table 2).

Table 2

Trial	C2		Joined carts		
	Mass (kg)	P before collision (kg m/sec)	Mass (kg)	Speed (m/sec)	P (kg m/sec)
4	1.0	0.30	2.0	0.152	0.30
5	2.0	0.60	3.0	0.201	0.60
6	3.0	0.90	4.0	0.225	0.90

19. In Study 1, when did C1 and C2 each have an amount of momentum equal to zero?

- **A.** Before the spring was released, because both C1 and C2 were at rest.
- **B.** Before the spring was released, because both C1 and C2 were in motion.
- **C.** When the spring was expanding, because both C1 and C2 were at rest.
- **D.** When the spring was expanding, because both C1 and C2 were in motion.

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20. In Study 1, under what conditions, if any, did C1 and C2 have the same speed when the spring was expanding?

F. When the mass of C2 was equal to the mass of C1
G. When the mass of C2 was 2 times as great as the mass of C1
H. When the mass of C2 was 3 times as great as the mass of C1
J. C1 and C2 never had the same speed when the spring was expanding.

21. In Study 2, P of the joined carts equaled 0.60 kg m/sec when the mass of the joined carts equaled which of the following?

A. 1.0 kg
B. 2.0 kg
C. 3.0 kg
D. 4.0 kg

22. Suppose that Sphere A, a 2 kg sphere, and Sphere B, a 1 kg sphere, are separated by an explosive device. Both spheres are at rest. The explosive device is detonated, providing equal amounts of momentum to the 2 spheres and sending them flying in opposite directions along the same horizontal line. Based on the results of Study 1, which of the spheres is most likely flying faster?

(Note: Assume that air resistance is insignificant.)

F. Sphere A, because it is less massive than Sphere B.
G. Sphere A, because it is more massive than Sphere B.
H. Sphere B, because it is less massive than Sphere A.
J. Sphere B, because it is more massive than Sphere A.

23. Consider 2 identical toy cars, Car A and Car B. Car A is at rest. A child gives Car B a shove, so that the 2 toys collide head-on, stick together, and continue rolling in the same direction as that of Car B before the collision. Based on Study 2, compared to the speed of Car B before the collision, the speed of the joined cars is most likely:

A. less, because the mass of the joined cars is less than the mass of Car B.
B. less, because the mass of the joined cars is greater than the mass of Car B.
C. greater, because the mass of the joined cars is less than the mass of Car B.
D. greater, because the mass of the joined cars is greater than the mass of Car B.

24. In each of Trials 4–6, how did the amount of momentum of C2 before its collision with C1 compare to the amount of momentum of the joined carts?

F. The amount of momentum of C2 before its collision with C1 was equal to the amount of momentum of the joined carts.
G. The amount of momentum of C2 before its collision with C1 was less than the amount of momentum of the joined carts.
H. The amount of momentum of C2 before its collision with C1 was greater than the amount of momentum of the joined carts.
J. Cannot be determined from the given information

25. In each trial of Study 1, the source of the kinetic energy of C1 was which of the following?

A. The kinetic energy stored in C2 before the spring was released
B. The potential energy stored in C2 before the spring was released
C. The kinetic energy stored in the spring before the spring was released
D. The potential energy stored in the spring before the spring was released

Passage V

An *antifreeze* is a substance that is added to a liquid to keep the liquid from freezing under cold conditions. Figures 1 and 2 show data for 2 liquids—ethanol and ethylene glycol. Each liquid acts as an antifreeze when added to H_2O. Figure 1 shows how freezing point varies with the concentration of antifreeze in H_2O. Antifreeze concentration is measured as *% AF*, the percent antifreeze by mass in H_2O:

$$\%\ \text{AF} = \frac{\text{mass of antifreeze}}{\text{mass of antifreeze} + \text{mass of } H_2O} \times 100$$

Figure 2 shows how density varies with % AF at 20°C for solutions of ethanol in H_2O and of ethylene glycol in H_2O.

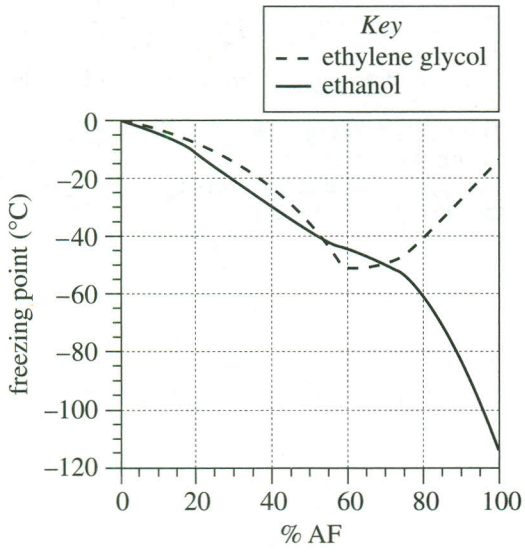


Figure 1

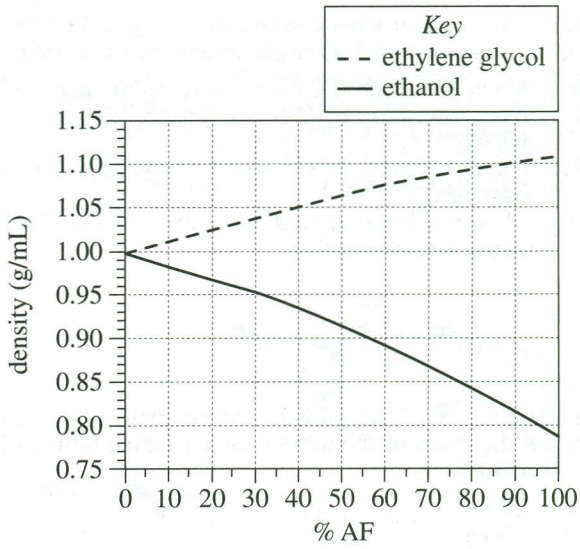
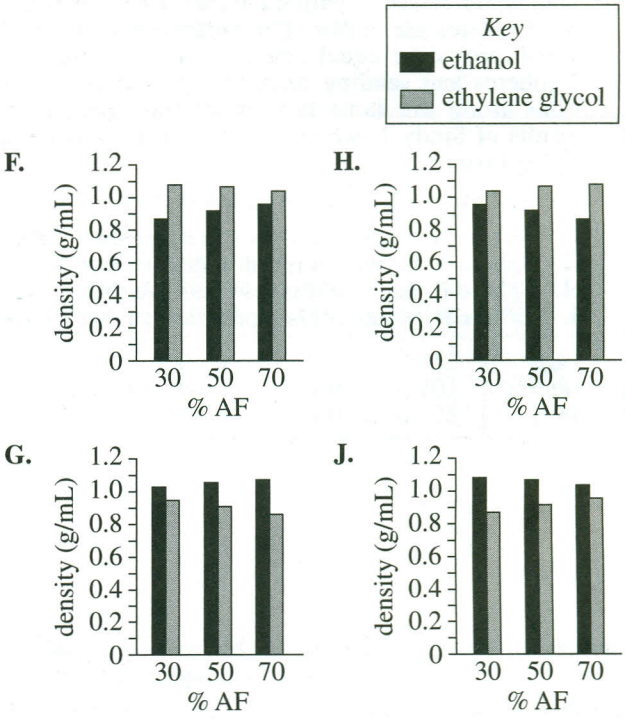


Figure 2

26. Which of the following graphs best shows the data in Figure 2 for % AF values of 30%, 50%, and 70% ?



4

27. According to Figure 1, a solution that is 80% ethanol by mass in H_2O will have a freezing point closest to which of the following?

A. −60°C
B. −40°C
C. 0°C
D. 0.85°C

28. Consider a solution of ethanol in H_2O and a solution of ethylene glycol in H_2O that are each 50% AF. Based on Figure 2, which will have a greater mass at 20°C, 20 mL of the ethanol solution or 20 mL of the ethylene glycol solution?

F. The ethanol solution, because it is less dense than the ethylene glycol solution.
G. The ethanol solution, because it is more dense than the ethylene glycol solution.
H. The ethylene glycol solution, because it is less dense than the ethanol solution.
J. The ethylene glycol solution, because it is more dense than the ethanol solution.

29. Consider a solution composed of 20 g of ethanol and 80 g of H_2O. According to Figure 1, the freezing point of the solution would be closest to which of the following?

A. −60°C
B. −50°C
C. −10°C
D. 0°C

30. At 20°C, a sphere having a density of 1.05 g/mL will most likely float in which of the liquids listed below?

I. Pure H_2O
II. 55% AF ethanol in H_2O
III. 55% AF ethylene glycol in H_2O

F. I only
G. III only
H. I and II only
J. II and III only

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.