SCIENCE TEST

35 Minutes—40 Questions

DIRECTIONS: There are seven 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 document. You may refer to the passages as often as necessary.

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

Passage I

Table 1 lists 4 genes found in *Pisum sativum* (a garden pea), the possible alleles of each gene, and the possible genotypes for each gene.

Table 1

Gene	Alleles	Genotypes
A	*A, a*	*AA, Aa, aa*
B	*B, b*	*BB, Bb, bb*
D	*D, d*	*DD, Dd, dd*
E	*E, e*	*EE, Ee, ee*

Table 2 lists various garden pea genotypes and the phenotype associated with each genotype. Each gene affects only 1 of the 4 phenotypic traits listed.

Table 2

Genotype	Phenotype: flower color	pod color	seed shape	stem length
AABBDDEE	purple	green	round	tall
AABBDDEe	purple	green	round	tall
AABBDDee	purple	green	round	short
AABBDdEE	purple	green	round	tall
AABBddEE	purple	green	wrinkled	tall
AABbddee	purple	green	wrinkled	short
AabbddEE	purple	yellow	wrinkled	tall
AabbDDee	purple	yellow	round	short
aabbddee	white	yellow	wrinkled	short
aaBBddEE	white	green	wrinkled	tall
aaBBDDEE	white	green	round	tall
AaBbDdEe	purple	green	round	tall

Table 3 lists 4 garden pea crosses, the genotypes of the parents, and the percent of offspring that displayed each phenotype for the 4 traits listed in Table 2. In each cross, each parent donated 1 allele to each offspring at each gene.

Table 3

Cross*	Genotype of: female parent	male parent	Offspring phenotype: flower color	pod color	seed shape	stem length
1	*AABBDDEE*	*AABBDDEE*	100% purple	100% green	100% round	100% tall
2	*aaBbddEe*	*aaBbddEe*	100% white	75% green 25% yellow	100% wrinkled	75% tall 25% short
3	*aaBbDdee*	*AabbddEe*	50% purple 50% white	50% green 50% yellow	50% round 50% wrinkled	50% tall 50% short
4	*AabbDdee*	*AabbDdee*	75% purple 25% white	100% yellow	75% round 25% wrinkled	100% short

*For each cross, multiple matings were performed.

1. Based on Table 2, which of the 4 genes affects seed shape?

   A. Gene A
   B. Gene B
   C. Gene D
   D. Gene E

2. Based on Table 2, a *P. sativum* plant with 1 dominant allele for each of the 4 genes will have which of the following phenotypes?

   F. White flowers, yellow pods, wrinkled seeds, tall stems
   G. White flowers, yellow pods, wrinkled seeds, short stems
   H. Purple flowers, green pods, round seeds, short stems
   J. Purple flowers, green pods, round seeds, tall stems

3. In 1 of the crosses listed in Table 3, for each trait, the offspring were split evenly between the 2 possible phenotypes. In this cross, the genotypes of the female parent and the male parent were, respectively:

   A. *AABBDDEE* and *AABBDDEE*.
   B. *aaBbDdee* and *aaBbDdee*.
   C. *aaBbDdee* and *AabbddEe*.
   D. *aabbDdee* and *AabbddEe*.

4. Based on the information presented, all of the offspring of Cross 4 had yellow pods because each received:

   F. Allele *A* from its female parent and Allele *a* from its male parent.
   G. Allele *b* from its female parent and Allele *b* from its male parent.
   H. Allele *d* from its female parent and Allele *D* from its male parent.
   J. Allele *E* from its female parent and Allele *e* from its male parent.

5. In Cross 3, what percent of the offspring had Genotype *BB* ?

   A. 0%
   B. 25%
   C. 50%
   D. 75%

Passage II

Figure 1 shows the life cycle of the malaria parasite. *Gametocytes* and *sporozoites* are 2 forms of the parasite.

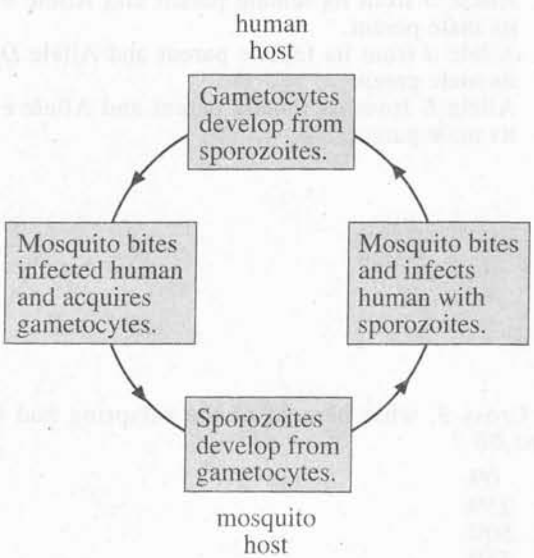


Figure 1

For the parasite to survive, mosquitoes must bite humans infected with gametocytes. Therefore, 2 studies were conducted to determine whether mosquitoes are most attracted to humans infected with gametocytes.

Study 1

Three groups (Groups X, Y, and Z), each with 12 human subjects (Subjects 1–12), were identified (see Table 1).

Table 1

Group	Malaria infection status of subjects
X	Uninfected
Y	Sporozoites present
Z	Gametocytes present

Three subjects—one from each group—rested in separate, but identical, tents of mosquito netting attached to the same central chamber. A mosquito trap was inserted between the chamber and each tent to capture any mosquitoes trying to enter the tent (see Figure 2).

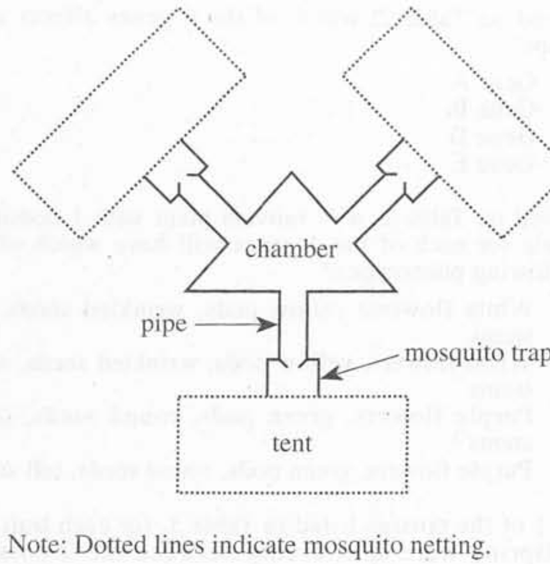


Figure 2

In the first trial 100 uninfected mosquitoes were released into the chamber. Thirty minutes later the number of mosquitoes attracted to each subject was determined. This procedure was repeated in 11 more trials until all subjects had been tested. Then, for each group, the average number of mosquitoes attracted to a subject was calculated (see Figure 3). All infected subjects were then treated to cure their sporozoite or gametocyte infections.

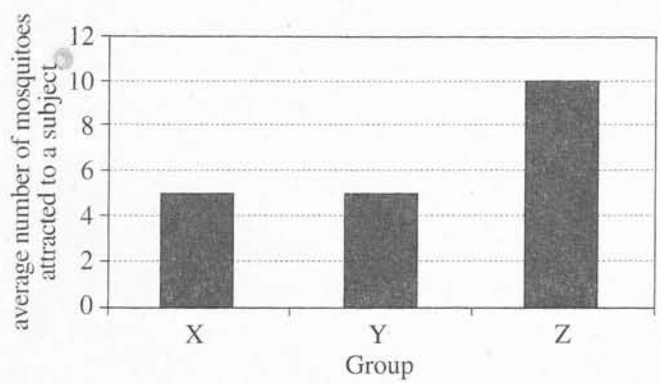


Figure 3

Study 2

The procedure from Study 1 was repeated with Group X subjects and the cured subjects from Groups Y and Z. Figure 4 shows the proportion of *responsive* mosquitoes (those caught in a trap) that were attracted to the Group Z subjects before treatment and after being cured of their gametocyte infections.

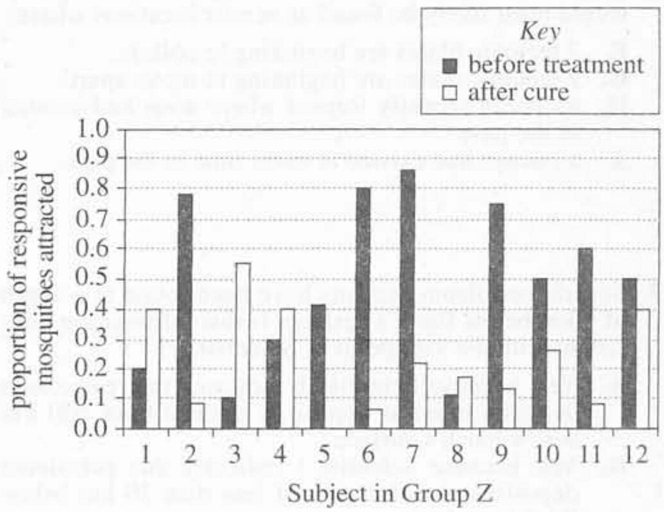


Figure 4

Figures adapted from Renaud Lacroix et al., "Malaria Infection Increases Attractiveness of Humans to Mosquitoes." ©2005 by Renaud Lacroix et al.

6. Assume that a subject's attractiveness to mosquitoes depends on body temperature. Based on Figure 4, the body temperature of which of the following Group Z subjects, with which treatment status, was most attractive to mosquitoes?

   F. Subject 1, before treatment
   G. Subject 1, after cure
   H. Subject 9, before treatment
   J. Subject 9, after cure

7. Do the results of Study 1 support the hypothesis that mosquitoes are more attracted to human subjects infected with gametocytes than to human subjects infected with sporozoites or to uninfected human subjects?

   A. Yes; on average, more mosquitoes were attracted to subjects from Group X than to subjects from Group Y or Z.
   B. Yes; on average, more mosquitoes were attracted to subjects from Group Z than to subjects from Group X or Y.
   C. No; on average, more mosquitoes were attracted to subjects from Group X than to subjects from Group Y or Z.
   D. No; on average, more mosquitoes were attracted to subjects from Group Z than to subjects from Group X or Y.

8. Based on Figure 4, how many of the subjects in Group Z attracted a greater proportion of the responsive mosquitoes *after* their infections were cured than before they were treated?

   F. 0
   G. 4
   H. 8
   J. 12

9. Which of the following is the most likely reason that subjects infected with gametocytes were tested both before and after their infections were cured?

   A. To determine whether mosquitoes were attracted to these subjects because of the subjects' infections
   B. To make sure that gametocytes were found in the red blood cells of the subjects
   C. To determine how many gametocytes were present in the subjects
   D. To make sure that the mosquitoes were not killed by the drugs used to treat malaria

10. In Studies 1 and 2, which group—Group X or Group Y—more likely served as the standard of comparison allowing the researchers to compare the results for Group Z from Study 1 to the results for Group Z from Study 2 ?

   F. Group X, because the infection status of the Group X subjects was different in Study 1 and Study 2.
   G. Group X, because the infection status of the Group X subjects was the same in Study 1 and Study 2.
   H. Group Y, because the infection status of the Group Y subjects was different in Study 1 and Study 2.
   J. Group Y, because the infection status of the Group Y subjects was the same in Study 1 and Study 2.

11. Which of the following procedures was most likely employed to ensure that the mosquitoes were attracted to a specific subject rather than to a specific tent?

   A. Releasing the same number of mosquitoes into each tent in each trial
   B. Releasing a different number of mosquitoes into each tent in each trial
   C. Assigning the subjects to tents in a random manner in each trial
   D. Assigning the gametocyte subject to the same tent in each trial

Passage III

Petroleum (crude oil) is brought to Earth's surface from large underground deposits that are mostly 0.5–0.7 km below Earth's surface. Two scientists discuss the origin of petroleum.

Scientist 1

All of Earth's current supply of petroleum formed within the last 600 million years from once-living matter. Petroleum formation began when the remains of microscopic marine organisms accumulated on the seafloor over a long period. Fine-grained ocean sediments buried the remains. Beneath the ocean floor, at depths of less than 10 km below Earth's surface, heat and pressure over millions of years changed the remains into petroleum.

After forming, the petroleum migrated upward to depths where it accumulated in large deposits at specific locations in Earth's crust. Petroleum contains *biomarkers*, compounds that can be produced only through the breakdown of once-living matter. Fossils of the marine organisms that provided the raw material for petroleum are found in rocks brought to the surface from locations where petroleum is known to have formed.

Because of the unique conditions and time necessary for petroleum formation, there is a limited supply available in Earth's crust.

Scientist 2

All of Earth's petroleum has formed from simple, inorganic carbon compounds at depths from 100 km to 200 km below Earth's surface. Petroleum formation has been occurring constantly since shortly after Earth's formation. The process begins as water reacts with simple, inorganic carbon compounds to form simple hydrocarbons such as methane. Those simple hydrocarbons then combine under pressure to produce petroleum.

After forming, the petroleum migrates upward to much shallower depths where it accumulates in large deposits at specific locations in Earth's crust. Most petroleum deposits exist along tectonic plate boundaries, where the petroleum can rise from depths greater than 100 km through deep fractures in Earth's crust. A helium isotope, commonly found associated with petroleum, originates only at depths greater than 100 km and is brought up from those depths by the rising petroleum.

Since petroleum is constantly forming and rising toward the surface, there is an unlimited supply available.

12. Based on Scientist 1's discussion, petroleum deposits would most likely be found at or near locations where:

F. 2 tectonic plates are beginning to collide.
G. 2 tectonic plates are beginning to move apart.
H. an ocean recently formed where none had existed in the past.
J. an ocean had existed at some time in the past.

13. Several petroleum deposits have been found at a depth of 5 km below Earth's surface. Is this information consistent with the viewpoint of Scientist 1 ?

A. Yes, because Scientist 1 indicates that petroleum deposits exist at depths of greater than 100 km below Earth's surface.
B. Yes, because Scientist 1 indicates that petroleum deposits exist at depths of less than 10 km below Earth's surface.
C. No, because Scientist 1 indicates that petroleum deposits exist at depths of greater than 100 km below Earth's surface.
D. No, because Scientist 1 indicates that petroleum deposits exist at depths of less than 10 km below Earth's surface.

14. Which scientist indicates that petroleum has formed in the higher pressure environment?

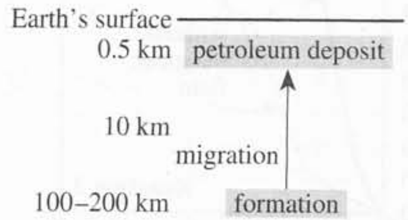
F. Scientist 1, because that scientist states that petroleum has formed at depths of less than 10 km below Earth's surface.
G. Scientist 1, because that scientist states that petroleum has formed at depths of greater than 100 km below Earth's surface.
H. Scientist 2, because that scientist states that petroleum has formed at depths of less than 10 km below Earth's surface.
J. Scientist 2, because that scientist states that petroleum has formed at depths of greater than 100 km below Earth's surface.

15. An experiment demonstrated that petroleum can be formed through a reaction of carbon dioxide and water. Which scientist would most likely use this demonstration to support his/her viewpoint?

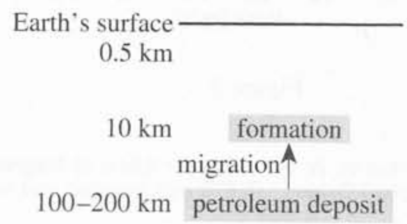
A. Scientist 1, because it would demonstrate how marine organisms can be changed into petroleum.
B. Scientist 1, because it would demonstrate how simple carbon compounds can be changed into petroleum.
C. Scientist 2, because it would demonstrate how marine organisms can be changed into petroleum.
D. Scientist 2, because it would demonstrate how simple carbon compounds can be changed into petroleum.

16. Which of the following diagrams is most consistent with Scientist 2's description of the formation and migration of petroleum? (Note: Diagrams are not to scale.)

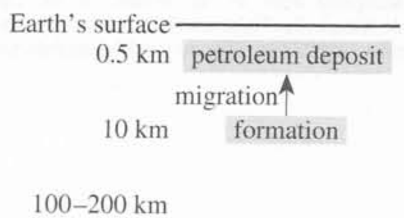
F.



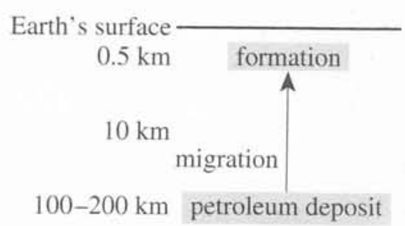
G.



H.



J.



17. Based on the scientists' discussions, which of the following statements describes the 2 physical properties of petroleum that are most important in facilitating its movement from the location at which it forms to the location at which it accumulates in a large deposit? Petroleum is a:

A. fluid that is more dense than the material that it moves through.
B. fluid that is less dense than the material that it moves through.
C. solid that is more dense than the material that it moves through.
D. solid that is less dense than the material that it moves through.

18. Based on Scientist 2's discussion, which of the following compounds is involved in the formation of petroleum?

I. CH_4
II. N_2
III. NaCl

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

Passage IV

If a metal oxide sample at high temperature is exposed to a stream of H_2 gas, it may be converted to a pure metal. Reactions 1–3 are examples of this process for a cobalt oxide and 2 different iron oxides, respectively.

Reaction 1: $CoO + H_2 \rightarrow Co + H_2O$

Reaction 2: $FeO + H_2 \rightarrow Fe + H_2O$

Reaction 3: $Fe_3O_4 + 4H_2 \rightarrow 3Fe + 4H_2O$

During the reaction, the H_2 stream carries away H_2O, so the resulting sample is composed of metal oxide and pure metal only.

Figures 1–3 show how the *percent of pure metal*, % PM, in metal oxide samples changed over time as they underwent Reactions 1–3, respectively, with and without a magnetic field present.

$$\% \text{ PM} = \frac{\text{mass of metal}}{\text{mass of metal oxide} + \text{mass of metal}} \times 100$$

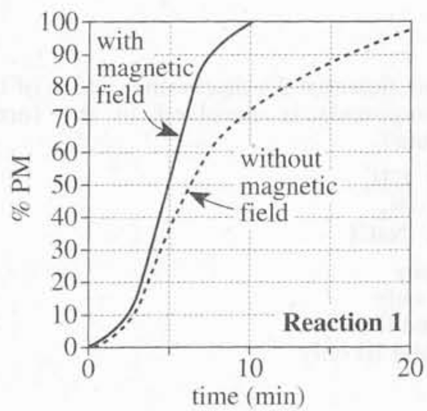


Figure 1

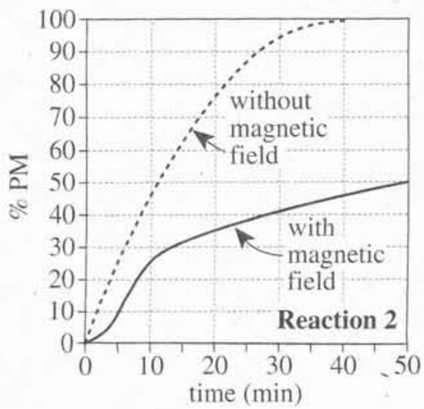


Figure 2

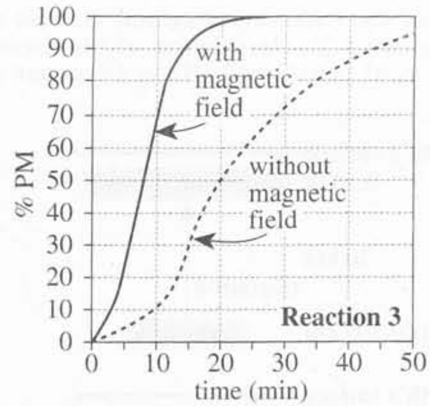


Figure 3

19. According to Figure 2, during Reaction 2 without a magnetic field, the % PM at 10 min was approximately:

    A. 25%.
    B. 35%.
    C. 45%.
    D. 55%.

20. Suppose that during Reaction 2 with a magnetic field, the magnetic field had been removed at time = 10 min. Five minutes later, at time = 15 min, the % PM would most likely have been:

    F. less than 30%.
    G. between 30% and 60%.
    H. between 60% and 90%.
    J. greater than 90%.

21. According to Figure 3, in Reaction 3, how did the addition of a magnetic field affect the yield of pure Fe metal? At 20 min, the yield obtained with a magnetic field was about:

A. $\frac{1}{4}$ the yield obtained without a magnetic field.

B. $\frac{1}{2}$ the yield obtained without a magnetic field.

C. the same as the yield obtained without a magnetic field.

D. 2 times the yield obtained without a magnetic field.

22. A chemist claimed that the conversion of a metal oxide to a pure metal using H_2 gas will always occur faster with a magnetic field than without a magnetic field. Do Figures 1–3 confirm this claim?

F. Yes; the % PM reached 0% sooner with a magnetic field than it did without a magnetic field in all 3 reactions.

G. Yes; the % PM reached 100% sooner with a magnetic field than it did without a magnetic field in all 3 reactions.

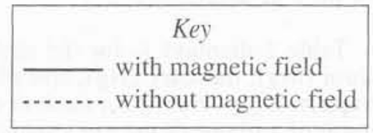
H. No; the % PM reached 0% sooner without a magnetic field than it did with a magnetic field in Reaction 2.

J. No; the % PM reached 100% sooner without a magnetic field than it did with a magnetic field in Reaction 2.

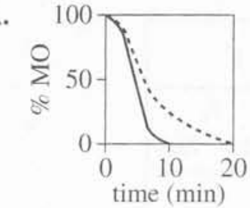
23. Suppose that Figure 1 had instead been plotted as *percent of metal oxide* (% MO) versus time:

$$\% \text{ MO} = \frac{\text{mass of metal oxide}}{\text{mass of metal oxide} + \text{mass of metal}} \times 100$$

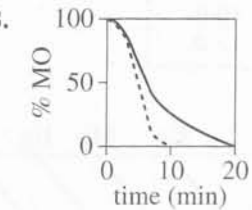
Which of the following graphs best shows how Figure 1 would have appeared?



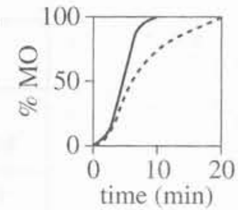
A.



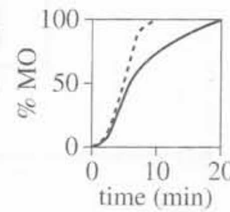
B.



C.



D.



Passage V

For a photon to free an electron from a metal, the photon's frequency, f, must equal or exceed the *threshold frequency*, f_T, for the metal. If $f > f_T$, the photon has extra energy that is transferred to the electron as kinetic energy, resulting in the ejection of the electron from the metal. K_{max} is the highest kinetic energy an ejected electron can have for a given f.

Table 1 displays f_T for the metals calcium (Ca), magnesium (Mg), mercury (Hg), and platinum (Pt). Figure 1 is a graph of K_{max} versus f for each of the 4 metals. Figure 2 is a graph of a photon's energy versus its f.

Table 1

Metal	f_T (10^{14} Hz)
Ca	6.55
Mg	8.84
Hg	10.9
Pt	13.0

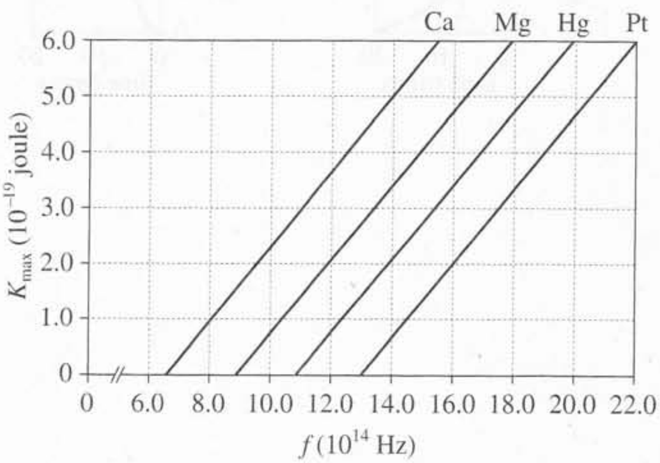


Figure 1

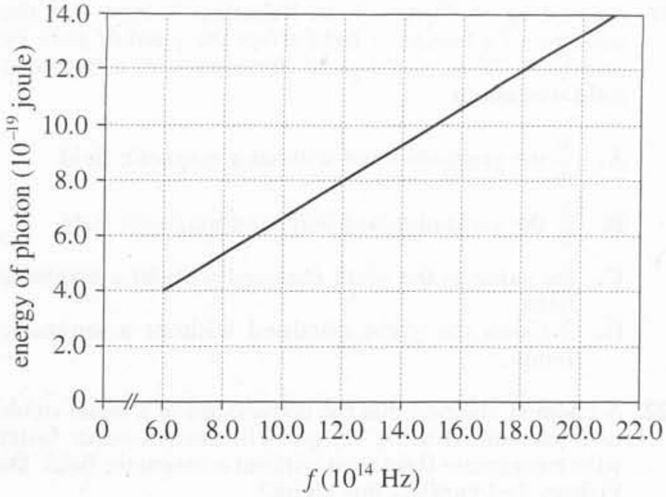


Figure 2

24. For a photon to free an electron from Ca, the photon's frequency must be at least:

F. 1.15×10^{14} Hz.
G. 2.45×10^{14} Hz.
H. 6.55×10^{14} Hz.
J. 9.45×10^{14} Hz.

25. Based on Figure 1, which of the following correctly ranks Ca, Mg, and Pt in order of increasing K_{max} at $f = 16.0 \times 10^{14}$ Hz ?

A. Pt, Mg, Ca
B. Pt, Ca, Mg
C. Mg, Pt, Ca
D. Mg, Ca, Pt

26. Based on Table 1 and Figure 2, the *threshold energy*, E_T, for Hg is closest to which of the following?

F. 3×10^{-19} joule
G. 5×10^{-19} joule
H. 7×10^{-19} joule
J. 9×10^{-19} joule

27. Based on Figure 1, for electrons ejected from Pt by photons having $f = 28.0 \times 10^{14}$ Hz, K_{max} would be:

A. less than 1.0×10^{-19} joule.
B. between 1.0×10^{-19} joule and 4.0×10^{-19} joule.
C. between 4.0×10^{-19} joule and 7.0×10^{-19} joule.
D. greater than 7.0×10^{-19} joule.

28. Photons having $f = 11.8 \times 10^{14}$ Hz and photons having $f = 13.3 \times 10^{14}$ Hz are shone separately upon a new metal, Metal X, resulting in ejected electrons with the following K_{max} :

f (10^{14} Hz)	K_{max} (10^{-19} joule)
11.8	2.5
13.3	3.5

Based on Figure 1 and Table 1, the f_T of Metal X is most likely closest to which of the following?

F. 6.0×10^{14} Hz
G. 8.0×10^{14} Hz
H. 10.0×10^{14} Hz
J. 12.0×10^{14} Hz

Passage VI

At constant temperature and pressure, the ratio in which the volumes of gases react and form products is indicated by the balanced chemical equation for the reaction. For example, consider the balanced chemical equation for hypothetical Gases A, B, and C:

$$A + 2B \rightarrow C$$

At constant temperature and pressure, 1 L of Gas A will react with 2 L of Gas B to form 1 L of Gas C.

Students did experiments at constant room temperature and pressure to determine the ratio in which nitric oxide (NO) and O_2 (either pure, or from air) react to form nitrogen dioxide (NO_2).

Experiment 1

Two glass syringes (Syringes I and II) were lubricated so their plungers would move freely. Then, 20 mL of NO was introduced into empty Syringe I through its tip and the tip was closed. Next, 20 mL of O_2 was introduced into empty Syringe II through its tip and the tip was closed. The syringes were then attached to each other and the tips were opened. The plunger of Syringe II was pushed to the bottom (emptying its content into Syringe I) and its tip was closed. After the reaction was complete, the final volume of gas in Syringe I was recorded and its contents were analyzed (see Figure 1).

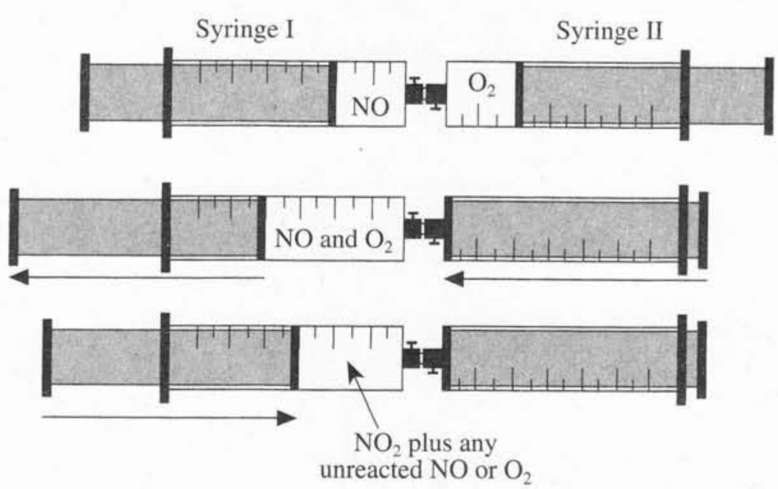


Figure 1

Figure 1 adapted from Donald D. DuPré, "A Simple Demonstration of the Law of Combining Volumes." ©1993 by Division of Chemical Education, Inc., American Chemical Society.

The same procedure was used with various initial volumes of NO and O_2 (see Table 1).

Table 1

Trial	Volume of NO (mL)	Volume of O_2 (mL)	Final volume (mL)	Syringe I contents (mL)		
				NO	O_2	NO_2
1	20	20	30	0	10	20
2	40	20	40	0	0	40
3	20	40	50	0	30	20
4	30	10	30	10	0	20

Experiment 2

The procedure from Experiment 1 was used to test 20 mL of air (instead of O_2) mixed with various amounts of NO (see Table 2).

Table 2							
				Syringe I contents (mL)			
Trial	Volume of NO (mL)	Volume of air (mL)	Final volume (mL)	NO	O_2	NO_2	Other gases
5	4	20	22	0	2	4	16
6	8	20	24	0	0	8	16
7	16	20	32	8	0	8	16
8	32	20	48	24	0	8	16

29. In Experiment 2, from trial to trial, as the volume of NO was increased, the volume of NO_2 produced:

A. increased only.
B. decreased only.
C. increased, then remained constant.
D. decreased, then remained constant.

30. In which of the trials of Experiments 1 and 2 were all of the gases in the syringes completely converted to NO_2 ?

F. Trial 1
G. Trial 2
H. Trial 5
J. Trial 6

31. The reactant that is used up first in a reaction is called the *limiting reagent*. What was the limiting reagent in Trial 1 ?

A. NO
B. O_2
C. NO_2
D. Air

32. Based on Experiment 1, the balanced chemical equation for the reaction of NO and O_2 to form NO_2 is:

F. $NO + 2O_2 \rightarrow NO_2$
G. $2NO + O_2 \rightarrow NO_2$
H. $NO + 2O_2 \rightarrow 2NO_2$
J. $2NO + O_2 \rightarrow 2NO_2$

33. NO_2 readily dissolves in H_2O to form a strong acid, while NO and O_2 do not. Suppose the final contents of Syringe I from each of Trials 1–4 had been injected into one of four 5 mL samples of pure H_2O. The pH would have been *lowest* in the sample injected with the Syringe I contents from:

A. Trial 1.
B. Trial 2.
C. Trial 3.
D. Trial 4.

34. Which of the following best describes what occurred to the plunger of Syringe I during Trial 2 ? When O_2 was injected from Syringe II into Syringe I, the distance between the end of the plunger and the syringe tip:

F. increased; then, as the reaction occurred, the distance decreased.
G. increased; then, as the reaction occurred, the distance increased more.
H. decreased; then, as the reaction occurred, the distance decreased more.
J. decreased; then, as the reaction occurred, the distance increased.

Passage VII

A *physical pendulum* is an object that is suspended vertically from a rigid support (see example in Figure 1).

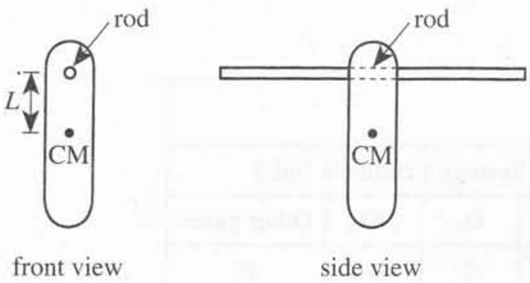


Figure 1

L is the distance between the rod (the rigid support) and the pendulum's center of mass (CM). When the pendulum is displaced from its equilibrium position and then released, it *oscillates* (swings back and forth) about the rod, which acts as the axis of rotation.

Students tested several types of physical pendulums. In each trial, first, they computed the *moment of inertia*, I, in kilogram meters^2 (kg m^2), of a pendulum. (I is a measure of the mass of a pendulum and how the mass is distributed.) Next, they displaced the pendulum slightly from its equilibrium position, released it, and measured the time, in seconds, it took the pendulum to oscillate through 20 *cycles* (1 cycle is 1 round-trip back and forth). Finally, they computed the pendulum's average *period*, P (the average time it took to complete 1 cycle).

Study 1

In Trials 1–5, each pendulum was a 1.0 kg solid sphere with a diameter, D, of 0.20 m (see Figure 2).

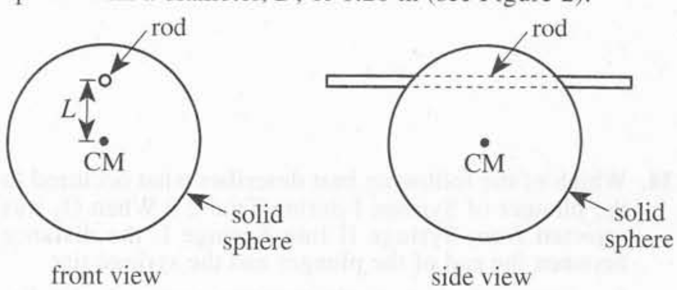


Figure 2

Each pendulum, however, had a different L. The results are shown in Table 1.

Table 1

Trial	L (m)	I (10^{-3} kg m^2)	P (sec)
1	0.020	4.40	0.94
2	0.040	5.60	0.75
3	0.060	7.60	0.71
4	0.080	10.4	0.72
5	0.090	12.1	0.74

Study 2

In Trials 6–10, each pendulum was a 1.0 kg thin, flat circular plate with $D = 0.20$ m (see Figure 3).

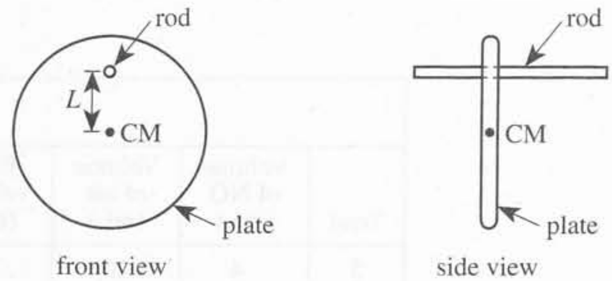


Figure 3

Each pendulum had a different L (see Table 2).

Table 2

Trial	L (m)	I (10^{-3} kg m^2)	P (sec)
6	0.020	5.40	1.04
7	0.040	6.60	0.82
8	0.060	8.60	0.76
9	0.080	11.4	0.76
10	0.090	13.1	0.77

Study 3

In Trials 11–15, each pendulum was a 1.0 kg thin, spherical shell with $D = 0.20$ m (see Figure 4).

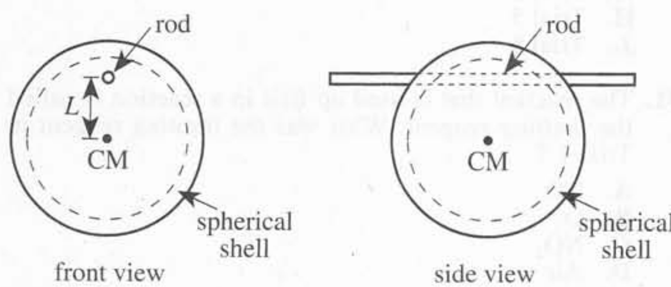


Figure 4

Each pendulum had a different L (see Table 3).

Table 3

Trial	L (m)	I (10^{-3} kg m^2)	P (sec)
11	0.020	7.07	1.19
12	0.040	8.27	0.91
13	0.060	10.3	0.83
14	0.080	13.1	0.81
15	0.090	14.8	0.81

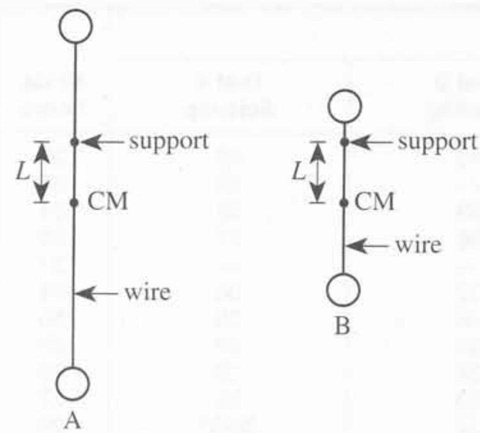
35. If an additional trial had been conducted in Study 1 with $L = 0.030$ m, P for this additional trial would most likely have been:

A. less than 0.71 sec.
B. between 0.71 sec and 0.75 sec.
C. between 0.75 sec and 0.94 sec.
D. greater than 0.94 sec.

36. In each study, as the distance between the CM and the horizontal rod increased, the moment of inertia:

F. increased only.
G. decreased only.
H. varied, but with no general trend.
J. remained the same.

37. Object A and Object B each consists of a pair of spheres connected by a rigid wire of insignificant mass. The 4 spheres are identical to each other. Each object is suspended vertically from a support at a distance L above the object's CM, as shown in the figure below.



L is the same for the 2 objects. Based on Studies 1 and 3, which object has the greater moment of inertia?

A. Object A, because the average distance of matter from the support is greater for Object A than for Object B.
B. Object A, because the average distance of matter from the support is less for Object A than for Object B.
C. Object B, because the average distance of matter from the support is greater for Object B than for Object A.
D. Object B, because the average distance of matter from the support is less for Object B than for Object A.

38. In which of the following trials in Study 3 was the *frequency* of the pendulum's oscillation the greatest?

F. Trial 11
G. Trial 12
H. Trial 13
J. Trial 14

39. Prior to the studies, 4 students made predictions about which of the 3 types of physical pendulums, if any, would have the shortest P for a given L. Student W predicted that it would be the solid sphere, Student X predicted that it would be the circular plate, and Student Y predicted that it would be the spherical shell. Student Z predicted that the 3 types of physical pendulums would have the same P. Which student's prediction was correct?

A. Student W's
B. Student X's
C. Student Y's
D. Student Z's

40. In Trial 4, approximately how long did it take the pendulum to complete 20 cycles?

F. 0.70 sec
G. 1.4 sec
H. 14 sec
J. 70 sec

END OF TEST 4

STOP! DO NOT RETURN TO ANY OTHER TEST.

Explanation of Procedures Used to Obtain Scale Scores from Raw Scores

On each of the four tests on which you marked any responses, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale scores. For each test, locate and circle your raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale score that corresponds to that raw score. As you determine your scale scores, enter them in the blanks provided on the right. The highest possible scale score for each test is 36. The lowest possible scale score for any test on which you marked any responses is 1.

Next, compute the Composite score by averaging the four scale scores. To do this, add your four scale scores and divide the sum by 4. If the resulting number ends in a fraction, round it off to the nearest whole number. (Round down any fraction less than one-half; round up any fraction that is one-half or more.) Enter this number in the blank. This is your Composite score. The highest possible Composite score is 36. The lowest possible Composite score is 1.

ACT Test 68A	Your Scale Score
English	_______
Mathematics	_______
Reading	_______
Science	_______
Sum of scores	_______
Composite score (sum ÷ 4)	_______

NOTE: If you left a test completely blank and marked no items, do not list a scale score for that test. If any test was completely blank, do not calculate a Composite score.

	Raw Scores				
Scale Score	**Test 1 English**	**Test 2 Mathematics**	**Test 3 Reading**	**Test 4 Science**	**Scale Score**
36	75	60	40	40	**36**
35	74	59	—	39	**35**
34	73	58	39	38	**34**
33	72	56-57	38	37	**33**
32	71	55	—	—	**32**
31	70	54	37	36	**31**
30	68-69	53	36	35	**30**
29	67	51-52	35	34	**29**
28	65-66	49-50	34	33	**28**
27	64	47-48	33	32	**27**
26	61-63	44-46	32	30-31	**26**
25	59-60	41-43	31	28-29	**25**
24	56-58	38-40	29-30	27	**24**
23	54-55	36-37	28	25-26	**23**
22	51-53	34-35	26-27	24	**22**
21	48-50	32-33	24-25	22-23	**21**
20	45-47	30-31	22-23	20-21	**20**
19	42-44	28-29	21	18-19	**19**
18	40-41	26-27	20	16-17	**18**
17	38-39	22-25	18-19	15	**17**
16	35-37	18-21	16-17	14	**16**
15	32-34	14-17	15	13	**15**
14	30-31	11-13	13-14	12	**14**
13	28-29	9-10	11-12	10-11	**13**
12	26-27	7-8	10	9	**12**
11	23-25	6	8-9	8	**11**
10	21-22	5	7	7	**10**
9	18-20	4	6	6	**9**
8	15-17	3	5	5	**8**
7	13-14	—	4	4	**7**
6	10-12	2	—	3	**6**
5	8-9	—	3	2	**5**
4	6-7	1	2	—	**4**
3	4-5	—	—	1	**3**
2	2-3	—	1	—	**2**
1	0-1	0	0	0	**1**

Explanation of Procedures Used to Obtain Scale Subscores from Raw Scores

For each of the seven subscore areas, the total number of correct responses yields a raw score. Use the table below to convert your raw scores to scale subscores. For each of the seven subscore areas, locate and circle either the raw score or the range of raw scores that includes it in the table below. Then, read across to either outside column of the table and circle the scale subscore that corresponds to that raw score. As you determine your scale subscores, enter them in the blanks provided on the right. The highest possible scale subscore is 18. The lowest possible scale subscore is 1.

If you left a test completely blank and marked no items, do not list any scale subscores for that test.

ACT Test 68A		Your Scale Subscore
English		
	Usage/Mechanics	______
	Rhetorical Skills	______
Mathematics		
	Pre-Algebra/Elementary Algebra	______
	Intermed. Algebra/Coord. Geometry	______
	Plane Geometry/Trigonometry	______
Reading		
	Social Studies/Sciences	______
	Arts/Literature	______

	Raw Scores							
	Test 1 English		Test 2 Mathematics			Test 3 Reading		
Scale Subscore	Usage/ Mechanics	Rhetorical Skills	Pre-Algebra/ Elem. Algebra	Inter. Algebra/ Coord. Geometry	Plane Geometry/ Trigonometry	Social Studies/ Sciences	Arts/ Literature	**Scale Subscore**
18	39-40	35	24	18	18	20	20	**18**
17	38	—	22-23	—	—	19	—	**17**
16	37	33-34	21	16-17	17	18	19	**16**
15	35-36	31-32	20	15	16	16-17	18	**15**
14	34	29-30	19	13-14	14-15	15	17	**14**
13	32-33	27-28	18	12	12-13	14	16	**13**
12	30-31	24-26	16-17	10-11	11	12-13	15	**12**
11	28-29	22-23	15	9	9-10	11	14	**11**
10	25-27	20-21	13-14	7-8	8	10	13	**10**
9	22-24	17-19	12	5-6	7	8-9	12	**9**
8	20-21	15-16	10-11	4	5-6	7	10-11	**8**
7	17-19	13-14	7-9	3	—	5-6	9	**7**
6	15-16	12	5-6	—	4	4	7-8	**6**
5	13-14	10-11	4	2	3	3	5-6	**5**
4	10-12	8-9	3	—	—	—	4	**4**
3	8-9	5-7	2	1	2	2	3	**3**
2	5-7	3-4	1	—	1	1	1-2	**2**
1	0-4	0-2	0	0	0	0	0	**1**