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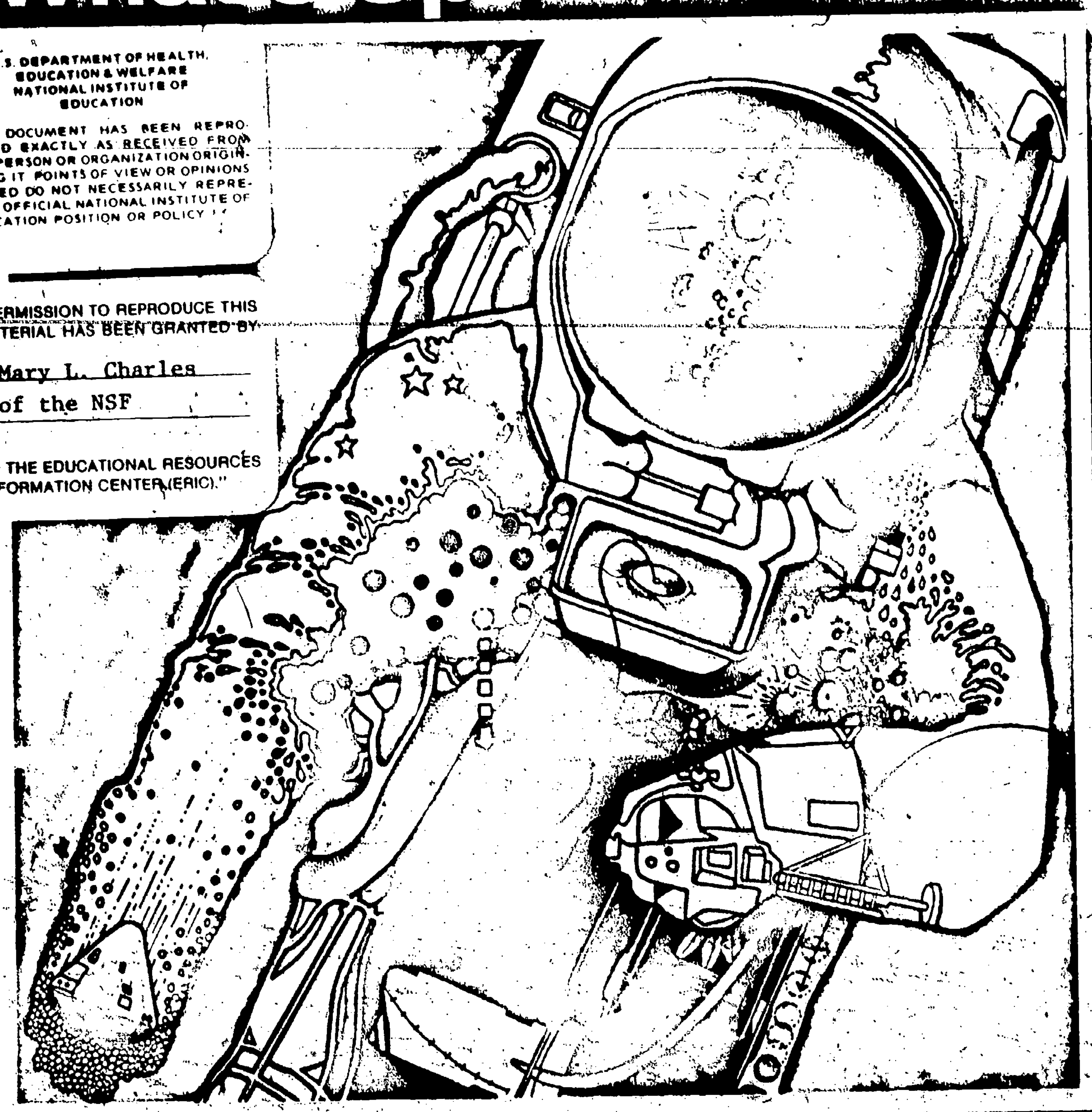
ABSTRACT

This is the student's edition of the Record Book for the unit "What's Up" of the Intermediate Science Curriculum Study (ISCS) for level III students (grade 9). Space is provided for answers to the questions from the student text as well as for the optional excursions and the self evaluation. An introductory note to the student explains how to use the book. (SA)

Record Book

What's Up?



Probing the Natural World/3

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Record Book
What's Up?

Probing the Natural World / Level III

SILVER BURDETT
GENERAL LEARNING CORPORATION
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Student Record Book / Volume 1 / with Teacher's Edition
Master Set of Equipment / Volume 1
Test Resource Booklet

LEVEL II
Probing the Natural World / Volume 2 / with Teacher's Edition
Record Book / Volume 2 / with Teacher's Edition
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LEVEL III
Why You're You / with Teacher's Edition
Record Book / with Teacher's Edition / **Master Set of Equipment**
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The genesis of some of the ISCS material stems from a summer writing conference in 1964. The participants were:

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Foreword

A pupil's experiences between the ages of 11 and 16 probably shape his ultimate view of science and of the natural world. During these years most youngsters become more adept at thinking conceptually. Since concepts are at the heart of science, this is the age at which most students first gain the ability to study science in a really organized way. Here, too, the commitment for or against science as an interest or a vocation is often made.

Paradoxically, the students at this critical age have been the ones least affected by the recent effort to produce new science instructional materials. Despite a number of commendable efforts to improve the situation, the middle years stand today as a comparatively weak link in science education between the rapidly changing elementary curriculum and the recently revitalized high school science courses. This volume and its accompanying materials represent one attempt to provide a sound approach to instruction for this relatively uncharted level.

At the outset the organizers of the ISCS Project decided that it would be shortsighted and unwise to try to fill the gap in middle school science education by simply writing another textbook. We chose instead to challenge some of the most firmly established concepts about how to teach and just what science material can and should be taught to adolescents. The ISCS staff have tended to mistrust what authorities believe about schools, teachers, children, and teaching until we have had the chance to test these assumptions in actual classrooms with real children. As conflicts have arisen, our policy has been to rely more upon what we saw happening in the schools than upon what authorities said could or would happen. It is largely because of this policy that the ISCS materials represent a substantial departure from the norm.

The primary difference between the ISCS program and more conventional approaches is the fact that it allows each student to travel at his own pace, and it permits the scope and sequence of instruction to vary with his interests, abilities, and background. The ISCS writers have systematically tried to give the student more of a role in deciding what he should study next and how soon he should study it. When the materials are used as intended, the ISCS teacher serves more as a "task easer" than a "task master." It is his job to help the student answer the questions that arise from his own study rather than to try to anticipate and package what the student needs to know.

There is nothing radically new in the ISCS approach to instruction. Outstanding teachers from Socrates to Mark Hopkins have stressed the need to personalize education. ISCS has tried to do something more than pay lip service to this goal. ISCS' major contribution has been to design a system whereby an average teacher, operating under normal constraints, in an ordinary classroom with ordinary children, can indeed give maximum attention to each student's progress.

The development of the ISCS material has been a group effort from the outset. It began in 1962, when outstanding educators met to decide what might be done to improve middle-grade science teaching. The recommendations of these conferences were converted into a tentative plan for a set of instructional materials by a small group of Florida State University faculty members. Small-scale writing sessions conducted on the Florida State campus during 1964 and 1965 resulted in pilot curriculum materials that were tested in selected Florida schools during the 1965–66 school year. All this preliminary work was supported by funds generously provided by The Florida State University.

In June of 1966, financial support was provided by the United States Office of Education, and the preliminary effort was formalized into the ISCS Project. Later, the National Science Foundation made several additional grants in support of the ISCS effort.

The first draft of these materials was produced in 1968, during a summer writing conference. The conferees were scientists, science educators, and junior high school teachers drawn from all over the United States. The original materials have been revised three times prior to their publication in this volume. More than 150 writers have contributed to the materials, and more than 180,000 children, in 46 states, have been involved in their field testing.

We sincerely hope that the teachers and students who will use this material will find that the great amount of time, money, and effort that has gone into its development has been worthwhile.

Tallahassee, Florida
February 1972

The Directors
INTERMEDIATE SCIENCE CURRICULUM STUDY

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Notes to the Student

This Record Book is where you should write your answers. Try to fill in the answer to each question as you come to it. If the lines are not long enough for your answers, use the margin, too.

Fill in the blank tables with the data from your experiments. And use the grids to plot your graphs. Naturally, the answers depend on what has come before in the particular chapter or excursion. Do your reading in the textbook and use this book only for writing down your answers.

☐ 1-1. ______________________________

____

☐ 1-2. ______________________________

☐ 1-3. ______________________________

____

☐ 1-4. ______________________________

☐ 1-5. ______________________________

☐ 1-6. ______________________________

Chapter 1
Up, Up, and Away

PROBLEM BREAK 1-1

Procedure:

Expected results:

Data:

Conclusions:

☐ 1-7. ______

☐ 1-8. ______

☐ 1-9. ______

Chapter 2
What a Reaction!

☐2-1. ____________________

☐2-2. ____________________

☐2-3. ____________________

☐2-4. ____________________

☐2-5. ____________________

☐2-6. ____________________

☐2-7. ____________________

____

☐2-8. ____________________

☐2-9. ____________________

PROBLEM BREAK 2-1

☐2-10. ____________________

☐2-11. ____________________

☐2-12. ____________________

☐2-13. ____________________

☐2-14. ____________________

☐2-15. ____________________

☐2-16. ____________________

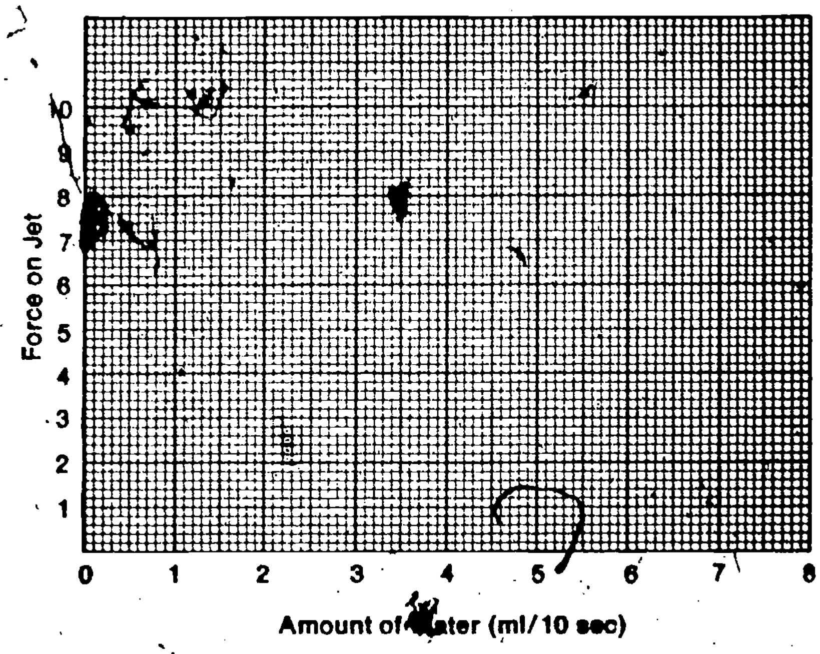
☐2-17. ____________________

PROBLEM BREAK 2-2

Procedure:

Data:

☐2-18. Figure 2-6



☐2-19. ____________________

PROBLEM BREAK 2-3

☐ 2-20. ____

☐ 2-21. ____

☐ 2-22. ____

____

☐ 2-23. ____

Chapter 3
How Much Is Needed?

☐ 3-1. ____

☐ 3-2. ____

☐ 3-3. ____

☐ 3-4. ____

☐ 3-5. ____

☐ 3-6. ____

☐ 3-7. ____

____

☐ 3-8. ____

____

☐ 3-9. ____

☐ 3-10. ____

____

Table 3-1

Interval	Distance Traveled (in cm)
1st	
2nd	
3rd	
4th	
5th	
6th	
7th	

☐ **3-11.** ____________________

____

☐ **3-12.** ____________________

____

Table 3-2

	Distance (in cm)			
Time interval	Total mass: 2.0 kg	Total mass: 1.5 kg	Total mass: 1.0 kg	Total mass: 0.5 kg
1st				
2nd				
3rd				
4th				
5th				
6th				

☐3-13. ______

☐3-14. ______

☐3-15. ______

☐3-16. ______

☐3-17. ______

Chapter 4
All Systems Are Go

Table 4-1

Trial No.	Force (in newtons)	Distance (in meters)
1	2	
2	4	
3	6	
4	8	
5	10	

☐4-1. ______

☐4-2. ______

☐4-3. ______

☐4-4. ______

☐4-5. ______

☐4-6. ______

☐4-7. ______

☐4-8. ______

☐4-9. ______

☐4-10. ______

PROBLEM BREAK 4-1

☐ 4-11. ____________________

____

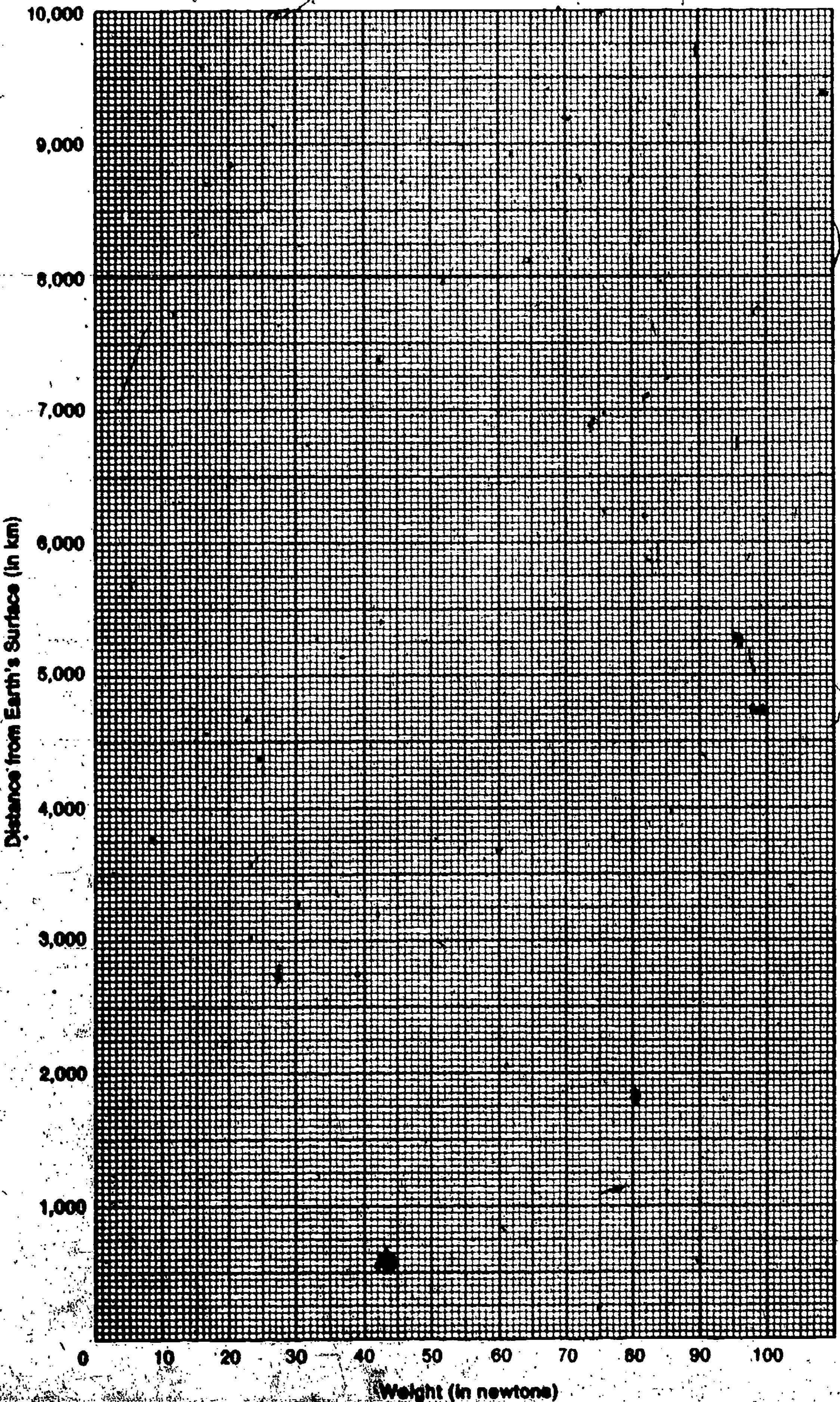
☐ 4-12. ____________________

Table 4-2

Height of Satellite Above Surface (in km)	Fraction of Speed at Surface of Earth	Orbiting Speed of Satellite (in m/sec)
0 (at surface)*	1.00	
160	0.99	
1,000	0.92	
2,000	0.86	
3,000	0.82	
4,000	0.78	
5,000	0.74	
6,000	0.71	
7,000	0.68	
8,000	0.66	
9,000	0.64	
10,000	0.63	
380,000	0.13	

*Consider this the same as 4.9 m above the surface.

□4-13. Figure 4-9



☐ 4-14. ____________________

☐ 4-15. ____________________

☐ 4-16. ____________________

☐ 4-17. ____________________

☐ 4-18. ____________________

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☐ 4-19. ____________________

☐ 4-20. ____________________

☐ 4-21. ____________________

☐ 4-22. ____________________

☐ 4-23. ____________________

☐ 4-24. ____________________

☐ 4-25. ____________________

☐ 4-26. ____________________

☐ 4-27. ____________________

☐ 4-28. ____________________

☐ 4-29. ____________________

Chapter 5 Creating Craters

☐ 5-1. ____________________

☐ 5-2. ____________________

☐ 5-3. ____________________

☐ 5-4.

☐ 5-5.

☐ 5-6.

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☐ 5-12.

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☐ 5-14.

☐ 5-15.

☐ 5-16.

☐ 5-17.

☐ 5-18.

☐ 5-19.

☐5-20. ____________________

☐5-21. ____________________

____

____

PROBLEM BREAK 5-1

Figure 5-17

☐5-22. ____________________

☐5-23. ____________________

____

☐5-24. ____________________

☐5-25. ____________________

☐5-26. ____________________

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☐ 5-27. ______________________________

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☐ 5-28. ______________________________

☐ 5-29. ______________________________

☐ 5-30. ______________________________

☐ 5-31. ______________________________

____

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Chapter 6 Peaks and Flows

☐ 6-1. ______________________________

____

☐ 6-2. ______________________________

☐ 6-3. ______________________________

☐ 6-4. ______________________________

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☐ 6-5. ______________________________

☐ 6-6. ______________________________

☐ 6-7. ______________________________

☐ 6-8. ______________________________

☐ 6-9. ______

☐ 6-10. ______

______

☐ 6-11. ______

PROBLEM BREAK 6-1

Chapter 7 A Day on the Moon

☐ 7-1. ______

______

☐ 7-2. ______

☐ 7-3. ______

☐ 7-4. ______

☐ 7-5. ______

☐ 7-6. ______

☐ 7-7. ______

☐7-8. ____________________

☐7-9. ____________________

☐7-10. ____________________

☐7-11. ____________________

☐7-12. ____________________

☐7-13. ____________________

☐7-14. ____________________

Excursions

Excursion 2-1 Newtons of Force

☐ 1. ____________________

☐ 2. ____________________

____

☐ 3. ____________________

☐ 4. ____________________

☐ 5. ____________________

☐ 6. ____________________

☐ 7. ____________________

☐ 8. ____________________

☐ 9. ____________________

☐ 10. ____________________

☐ 11. ____________________

☐ 12. ____________________

____

____

☐ 13. ____________________

Excursion 3-1
The Big Push

- [ ] 1. ____________________
- [ ] 2. ____________________
- [ ] 3. ____________________
- [ ] 4. ____________________
- [ ] 5. ____________________
- [ ] 6. ____________________
- [ ] 7. ____________________

Excursion 3-2
One Stage at a Time

- [ ] 1. ____________________
- [ ] 2. ____________________
- [ ] 3. ____________________
- [ ] 4. ____________________
- [ ] 5. ____________________
- [ ] 6. ____________________
- [ ] 7. ____________________
- [ ] 8. ____________________
- [ ] 9. ____________________
- [ ] 10. ____________________
- [ ] 11. ____________________

☐12. ____

____

☐13. ____

____

☐14. ____

☐15. ____

Excursion 4-1
Time to Fall

☐1. ____

☐2. ____

☐3. ____

☐4. ____

☐5. ____

☐6. ____

☐7. ____

☐8. ____

☐9. ____

Excursion 4-2
The Falling Apple

☐1. ____

☐2. ____

☐3. ____________________

☐4. ____________________

☐5. ____________________

Excursion 4-3 Orbiting Syncom

☐1. ____________________

☐2. ____________________

☐3. ____________________

☐4. ____________________

☐5. ____________________

☐6. ____________________

Excursion 4-4 Losing Heat

☐1. ____________________

☐2. ____________________

☐3. ____________________

Excursion 5-1
Less Force

☐1. ____________________

☐2. ____________________

☐3. ____________________

____

____

____

Excursion 7-1
An Excursion to the Far Side

☐1. ____________________

☐2. ____________________

☐3. ____________________

☐4. ____________________

☐5. ____________________

How Well Am I Doing?

You probably wonder what you are expected to learn in this science course. You would like to know how well you are doing. This section of the book will help you find out. It contains a Self-Evaluation for each chapter. If you can answer all the questions, you're doing very well.

The Self-Evaluations are for your benefit. Your teacher will not use the results to give you a grade. Instead, you will grade yourself, since you are able to check your own answers as you go along.

Here's how to use the Self-Evaluations. When you finish a chapter, take the Self-Evaluation for that chapter. After answering the questions, turn to the Answer Key that is at the end of this section. The Answer Key will tell you whether your answers were right or wrong.

Some questions can be answered in more than one way. Your answers to these questions may not quite agree with those in the Answer Key. If you miss a question, review the material upon which it was based before going on to the next chapter. Page references are frequently included in the Answer Key to help you review.

On the next to last page of this booklet, there is a grid, which you can use to keep a record of your own progress.

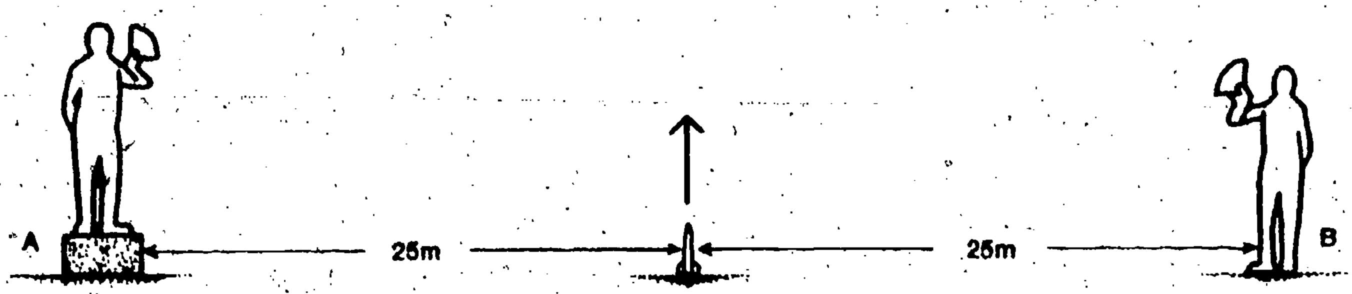
If you did any excursions for this chapter, write their numbers here. **SELF-EVALUATION 1**

____

☐**1-1.** If you were interested in comparing the performance of two water rockets, which of the following would be the best factor to measure in making the comparison? Check the best answer.

____**a.** The weight of the rockets
____**b.** The length of the rockets
____**c.** The height reached by the rockets
____**d.** The angle at which the rockets are launched

☐**1-2.** Two students observe a rocket launched from the positions shown in the diagram below.



When the rocket is launched, will both students record the same height for the rocket? Explain your answer.

____

____

____

□**1-3**. Use the table below to answer the questions that follow.

Height Converter for Observer at 25 Meters

Angle	0°	5°	10°	15°	20°	25°	30°	35°	40°
Height	0 m	2.2 m	4.4 m	6.9 m	9.1 m	11.7 m	14.4 m	17.5 m	21.0 m
Angle	**45°**	**50°**	**55°**	**60°**	**65°**	**70°**	**75°**	**80°**	**85°**
Height	25.0 m	29.8 m	35.7 m	43.3 m	53.6 m	68.7 m	93.3 m	141.8 m	285.8 m

a. If an observer 25 m from the launch site measured an angle of 60° for the height of a rocket, how high did the rocket go?

______

b. Two observers were 25 m from the launch site of a rocket. One observer measured an angle of 40° for the height of the rocket, and the other observer measured an angle of 35°. What height should be reported for the rocket?

______

c. Why doesn't the table include a height measurement for an angle of 90°?

______

______

d. Ask your teacher's permission to go outside. Take your quadrant and a meterstick outside and measure the height of the school building in degrees. Use the Height Converter Table to change your measurement to meters.

______

□**1-4.** Each member of your team measured the height reached by the model rocket. Then you averaged the heights measured by all the team members. What advantage is there, if any, in averaging several measurements instead of using a single measurement?

______

______

______

☐1-5. a. What variables influenced how high your water rocket went?

____

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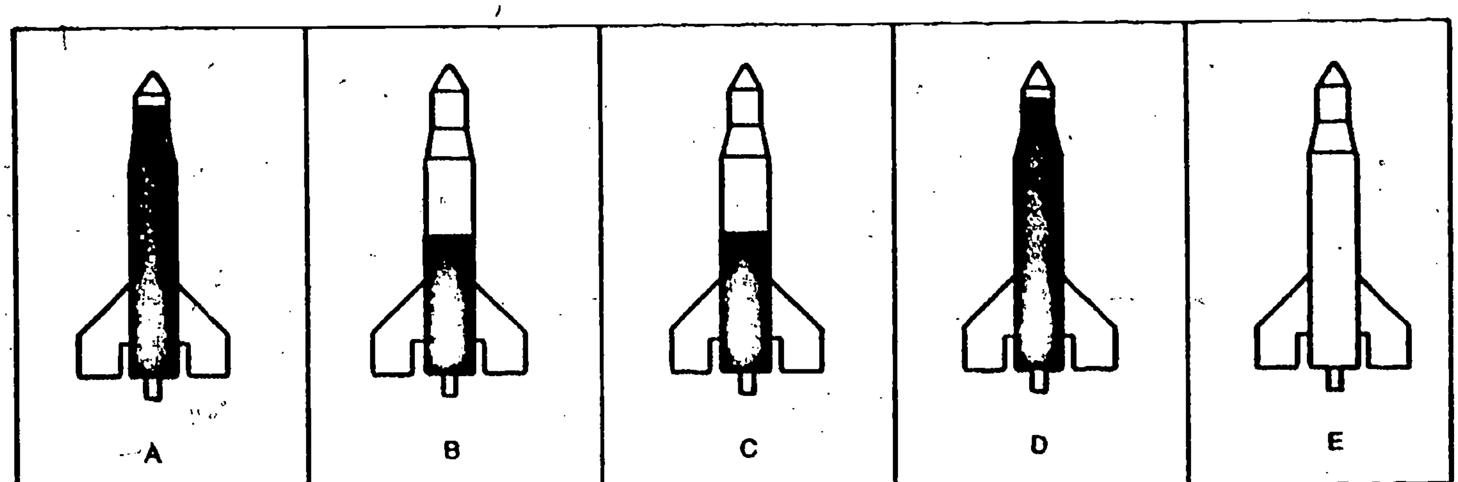
b. Which of the rockets shown in the chart below will reach the greatest height when launched?

____



	A	B	C	D	E
Pressure	8 strokes	8 strokes	6 strokes	6 strokes	8 strokes
Water level	Almost full	½ full	½ full	Almost full	No water

☐1-6. Design an experiment to determine if using liquids other than water would affect the performance of your rocket. Outline your procedure here.

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If you did any excursions for this chapter, write their numbers here.

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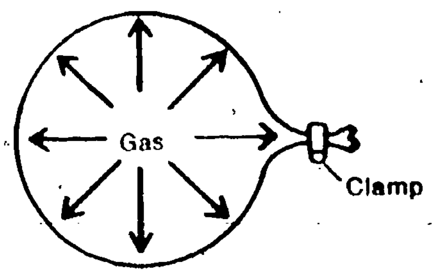
☐2-1. Using an arrow, indicate on the diagram below the direction that the balloon would move if the clamp were released.



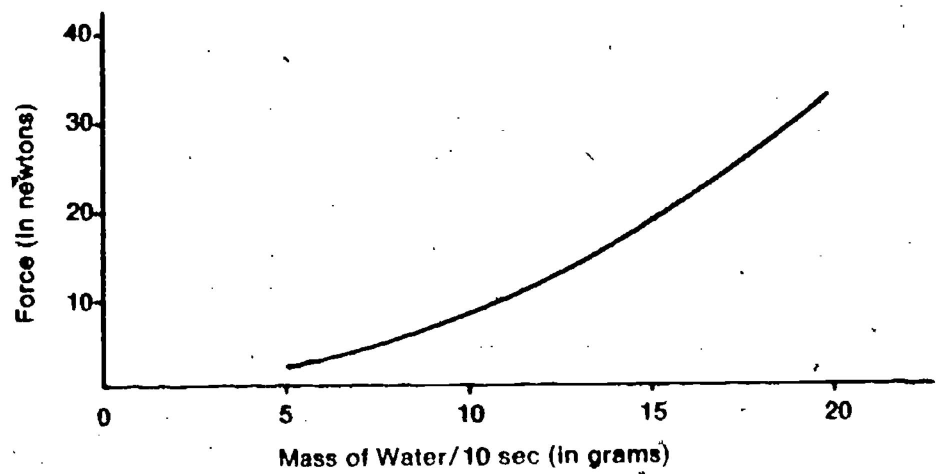
☐2-2. Check the correct answer. If you increase the mass of matter rushing out through a rocket nozzle each second, the thrust of the rocket will

____a. decrease.
____b. increase.
____c. stay the same.

☐2-3. Check the correct answer. If you decrease the speed of the matter rushing out through a rocket nozzle, the thrust of the rocket will

____a. decrease.
____b. increase.
____c. stay the same.

☐2-4. Use the graph below to answer the following questions.



a. When 10 grams of water rush from the jet in 10 seconds, what is the force in newtons on the jet?

b. How many grams of water would have to rush from the jet in 10 seconds to produce a force of 30 newtons on the jet?

c. Predict what the force on the jet will be when 25 grams of water rush from the jet in 10 seconds.

☐**2-5.** A water rocket was launched straight up from a submarine on the bottom of the ocean. An identical water rocket was launched straight up on land. Which of the rockets produced the greater upward thrust during the first second after launch? Explain your answer.

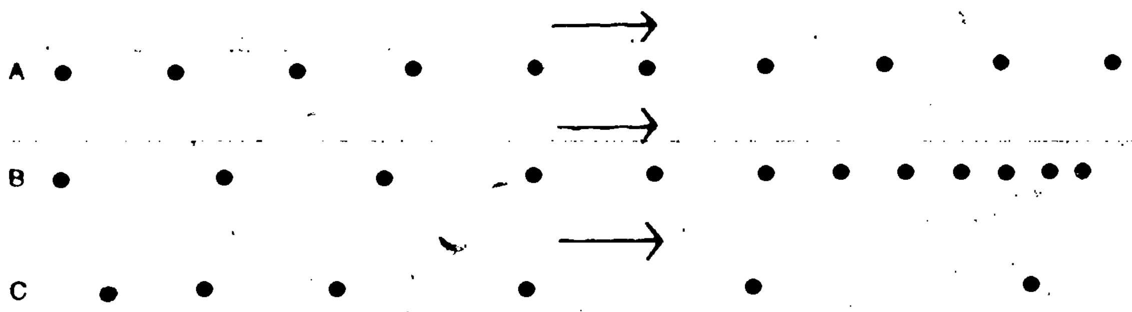
If you did any excursions for this chapter, write their numbers here.

SELF-EVALUATION 3

☐**3-1.** The weight of an unfueled spacecraft is 28,500,000 newtons. The weight of its fuel and oxygen is 21,000,000 newtons. What is the total weight that must be lifted by the thrust of the rocket engines?

☐**3-2.** A rocket is resting on its launch pad. If the upward thrust of its engines were equal to the downward force on the rocket, would the rocket rise off the launch pad? Explain your answer.

☐3-3. Use the diagram and information below to answer the questions that follow. The drop patterns shown below were obtained from an experiment with a water-clock cart. The arrows indicate the direction in which the cart was moving.



a. Which pattern indicates an increasing speed for the cart?

b. Which pattern indicates a decreasing speed for the cart?

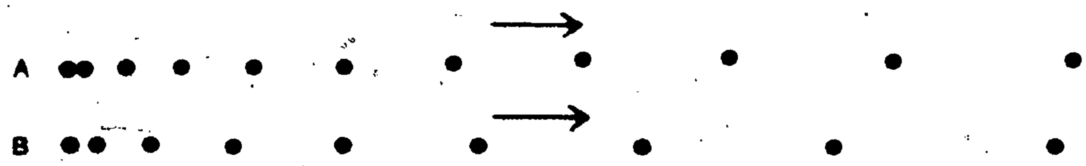
c. Which pattern indicates a constant speed for the cart?

d. What is the average distance in millimeters between the drops in pattern C?

e. Which pattern indicates that the cart is being pushed or pulled by a constant unbalanced force acting in the same direction as the cart is traveling?

☐3-4. If an unbalanced force, in the direction of motion, is continuously applied to a rocket in space, what happens to the speed of the rocket?

☐3-5. Use the diagram and information on the next page to answer the questions that follow. The drop patterns were obtained from an experiment with a water-drop cart. The arrows indicate the direction in which the cart was moving.



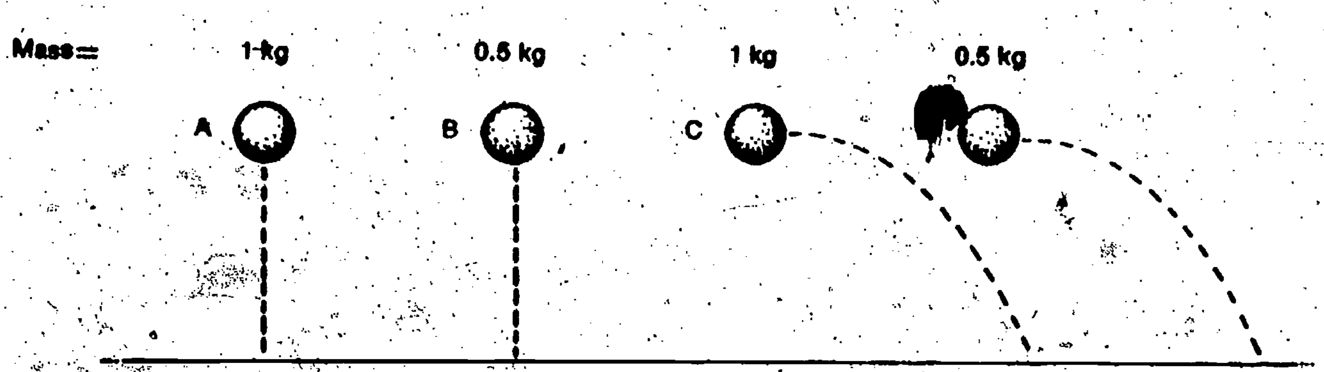
a. The student who performed the experiment exerted the same unbalanced force of 0.2 newton during each run. However, he did change the mass of the cart between runs. He forgot to write down which mass was which. During which run was the mass larger?

b. Explain your answer to part a.

If you did any excursions for this chapter, circle or write their numbers here.

SELF-EVALUATION 4

☐**4-1.** Four balls of different masses are equally distant from the earth. Balls A and B are allowed to fall freely to the earth. Balls C and D are projected sideways with equal speeds. The path of each ball is shown below.



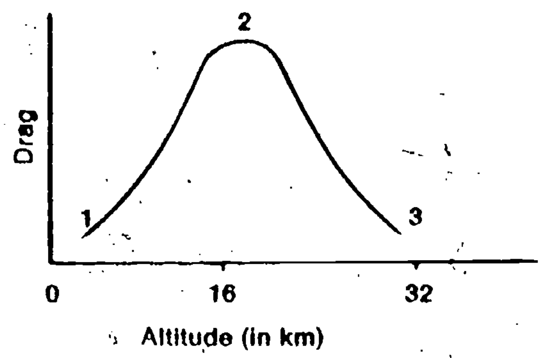
a. If all the balls were released or projected at the same time, which ball(s) would hit the ground first?

b. Explain your answer.

c. Which ball(s) would travel farthest?

d. Explain your answer.

☐ 4-2. The graph below shows the change in air frictional drag on a rocket as its altitude increases.



a. Why does the air frictional drag increase so rapidly during the first 16 km?

b. The drag force on the rocket reaches a maximum at a point called max-Q. Which point (1, 2, or 3) on the graph is max-Q?

c. At which point (1, 2, or 3) is the speed of the rocket greatest?

d. Why does the drag force decrease so rapidly after the first 16 km?

☐**4-3.** Many of the satellites that have been put into orbit recently have been for the purpose of sending back pictures of the earth's surface. Most of these satellites have been put in orbits about 160 km above the earth's surface. Since the pictures would be sharper and show more detail if they were taken from a lower orbit, why don't they put these satellites in orbits about 40 km above the surface?

☐**4-4.** What is meant by the period of a satellite?

Use the information on page 36 to answer questions **4-5** through **4-7**. Assume that there is a planet called Hercules in our solar system. Hercules is similar to the planet Earth except Hercules has a radius of 2,000 km while Earth's radius is 6,400 km. The following data have been obtained about Hercules.

Distance from the Center of Hercules in Hercules radii (r)	Weight of Object That Exerts a 200-N Force at Surface (in N)
1	200
2	50
3	22
4	12.6
5	8
6	5.6
7	4
8	3.2
9	2.4
10	2

☐ **4-5.** Using the data above and the grid on page 37, plot a graph of the weight of the object as a function of its distance from the center of Hercules as measured in Hercules radii.

☐ **4-6.** At what distance from the center of Hercules does an object's weight become $\frac{1}{4}$ of its weight at the surface?

____

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☐ **4-7.** An object that is located at 5 radii has what fraction of the weight of the same object on the surface of Hercules.

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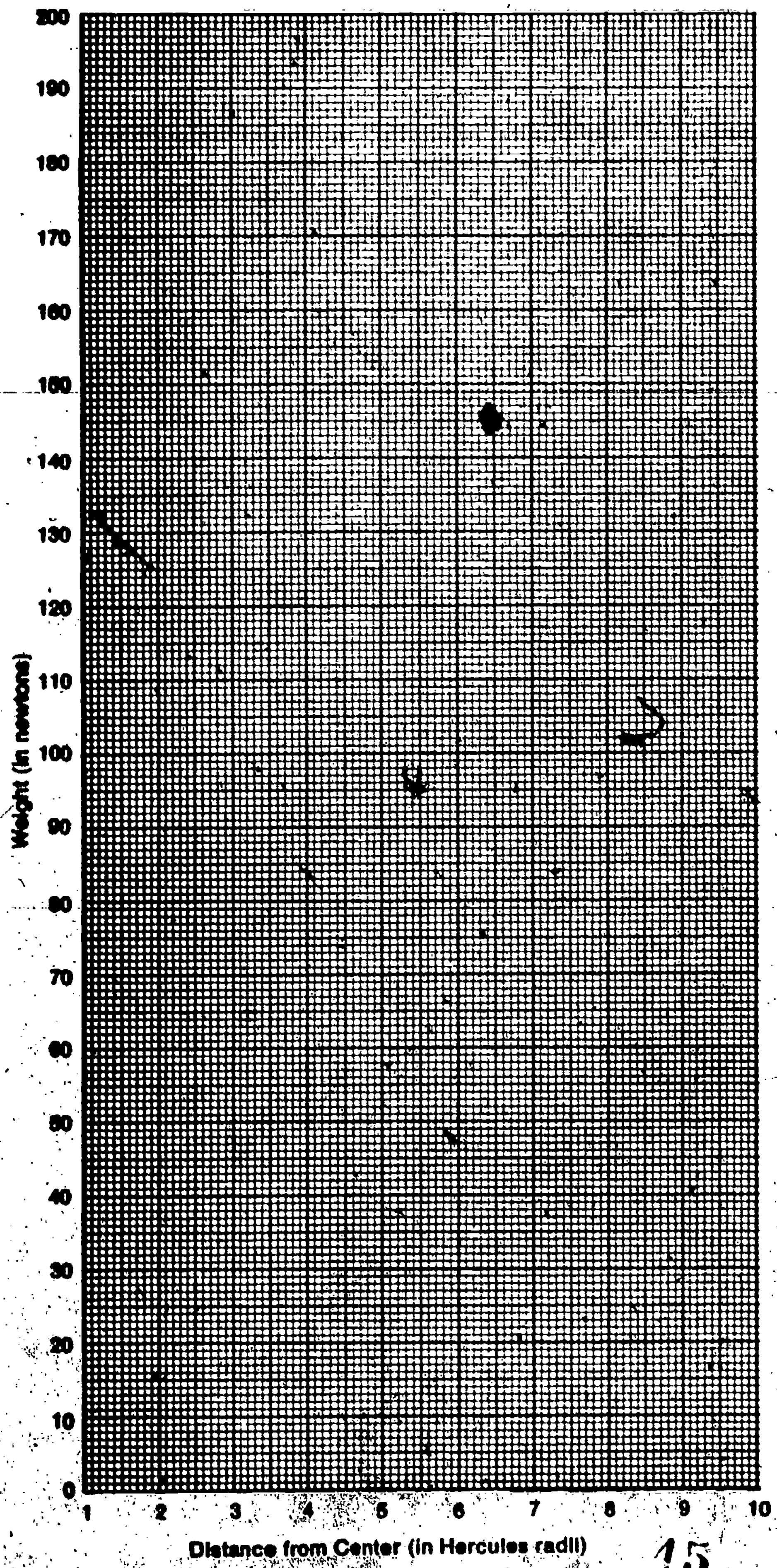


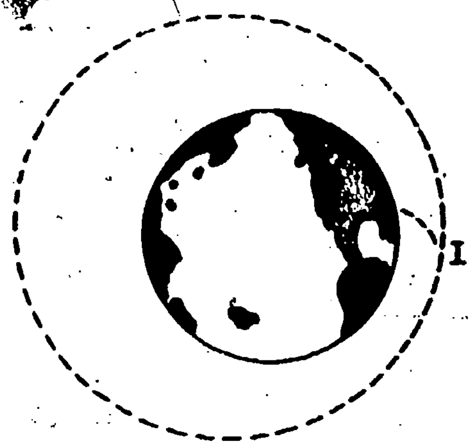
Weight (in newtons)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Distance from Center (in Hercules radii)

□4-8. Two satellites of equal mass are orbiting the earth. The radius of the orbit of satellite A is twice that of satellite B.

a. Is the period of satellite A less than, greater than, or equal to the period of satellite B?

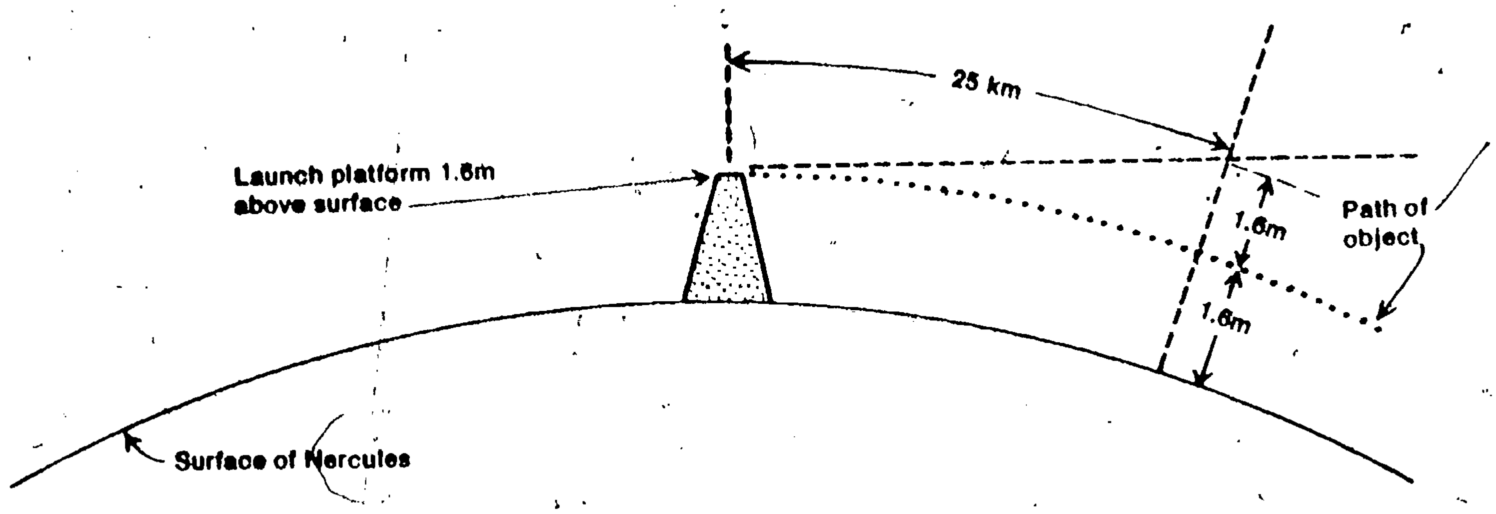
b. Is the gravitational pull of the earth on satellite A less than, greater than, or equal to the gravitational pull of the earth on satellite B?

□4-9. The diagram below shows the path of a rocket that was launched and point L and injected into orbit at point I.



Was the speed of the rocket when it was injected into orbit less than, equal to, slightly greater than, or much greater than the speed necessary to put the satellite into a circular orbit around the earth?

□4-10. At the surface of Hercules, an object falls 1.6 m in the first second after its launch. For every 2.5 km of distance, Hercules curves downward 1.6 m at the surface. Use this information and the diagram on the next page to answer the questions that follow.



a. What would be the orbiting speed for an object on Hercules?

b. At a height of 10,000 km above Hercules, would the orbiting speed be faster than, the same as, or slower than the speed at a height of 1.6 m?

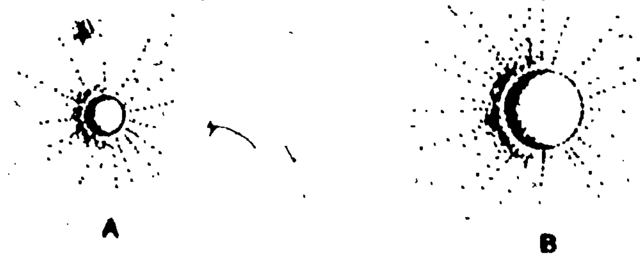
If you did any excursions for this chapter, write their numbers here.

SELF-EVALUATION 5

☐**5-1.** Most professional photographers prefer to take pictures in the early morning or in the late afternoon. On the basis of your experiences while studying this chapter, explain why they prefer these times.

☐**5-2.** What two variables affect the amount of energy that a moving object has?

☐5-3. Use the diagram below, which shows two craters formed in sand by falling objects, to answer the questions that follow.



a. Suppose the craters were formed by two steel balls that had the same mass. Which crater was formed by the ball that had fallen farther?

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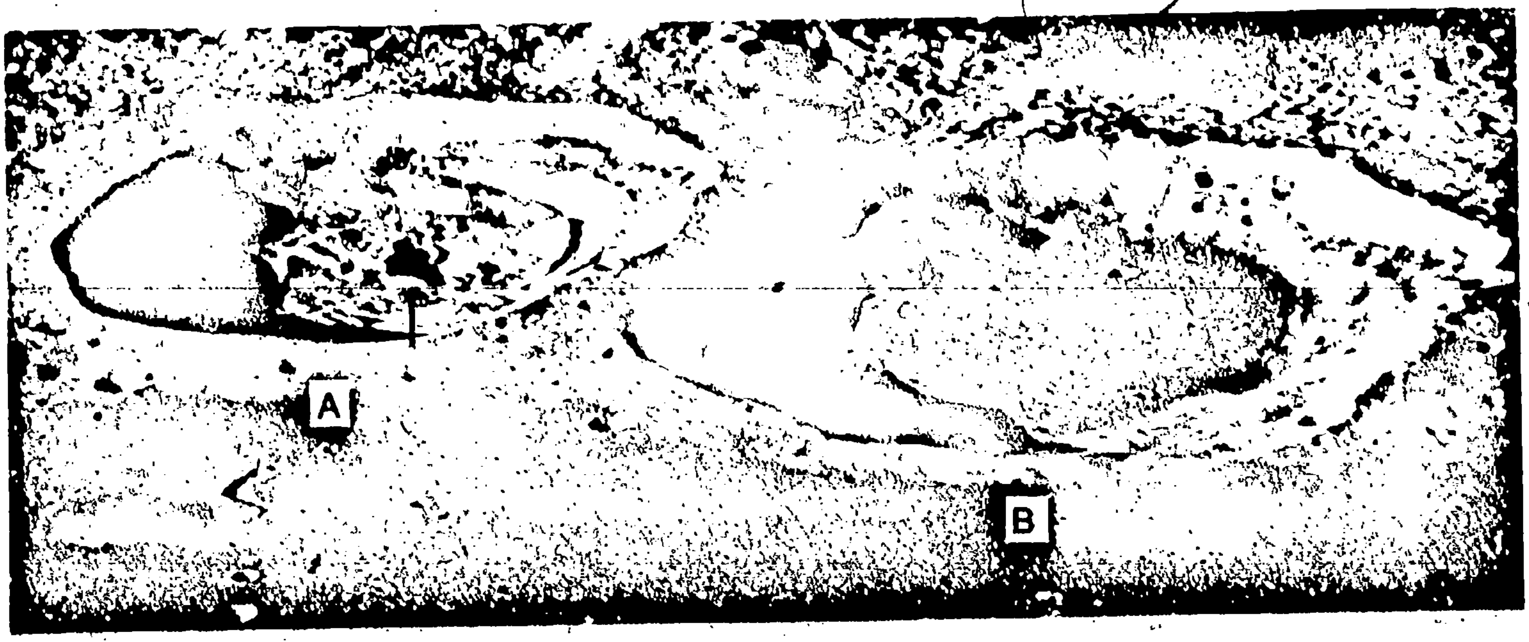
b. Suppose the two craters were formed by dropping balls of different masses from the same height. Which crater was the one that would have been formed by the heavier ball?

☐5-4. On the moon photo below, label the hills with a small h and the craters with a small c.

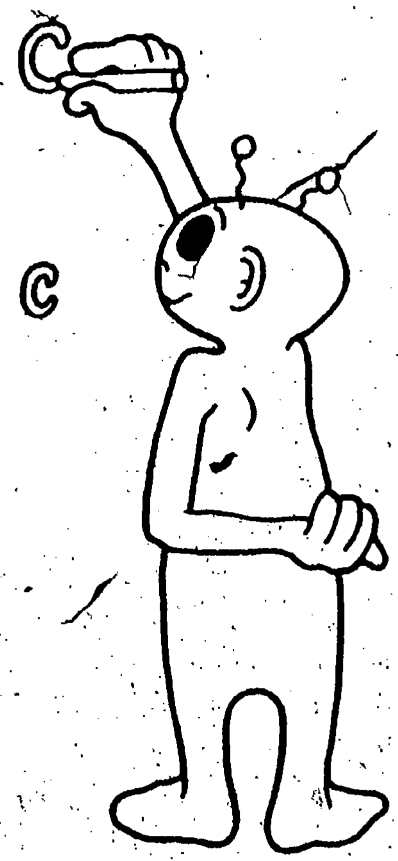
□5-5. Use the picture below to answer the questions that follow.



a. Which crater is older?

b. Explain your answer.

□5-6. What are two characteristics of impact craters that would help you distinguish them from other types of craters?



□5-7. What is a possible cause of the rays on the surface of the moon?

SELF-EVALUATION 6 If you did any excursions for this chapter, write their numbers here.

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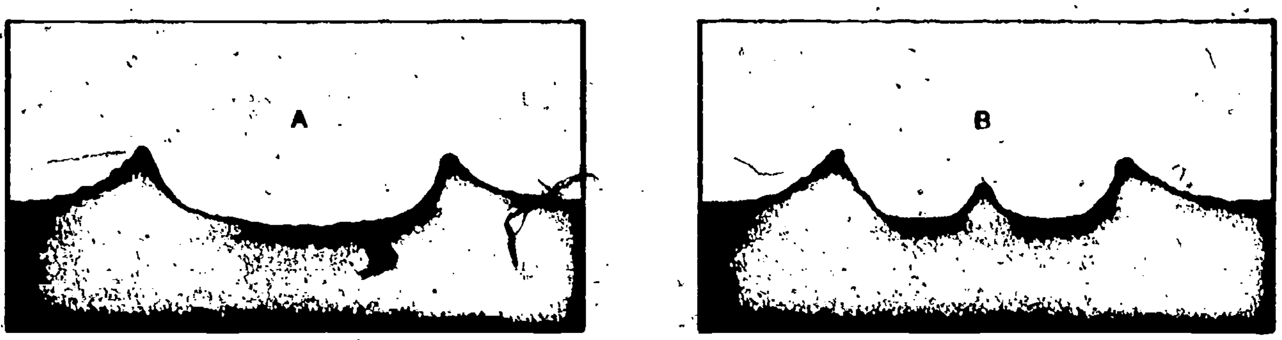
☐**6-1.** Use the diagram below, which shows a cross-sectional view through two impact craters, to answer the questions that follow.



a. Which crater was formed by the impact of an object that caused both the surface and the object to become molten when it hit?

____

b. Explain your answer.

____

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☐**6-2.** What things would you look for in a picture of a crater if you were asked to determine whether the crater was a cinder-cone crater formed by a volcano or whether it was an impact crater?

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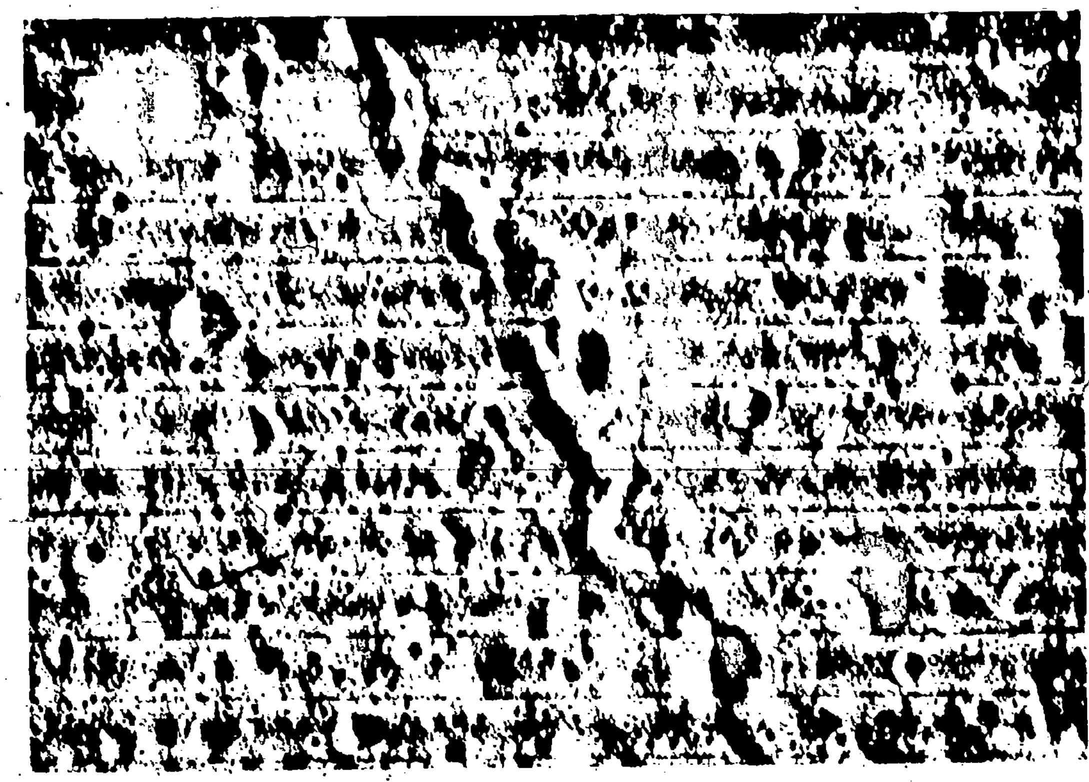
☐**6-3.** Use the photograph to answer the question that follows.



The photograph shows a ridge of rock on the surface of the moon. What is a possible cause of this bulge in the surface?

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If you did any excursions for this chapter, write their numbers here.

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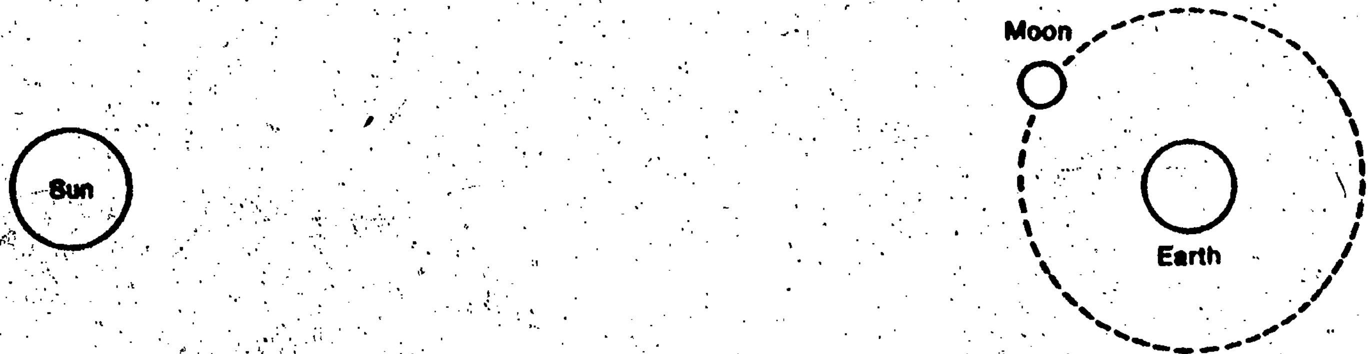
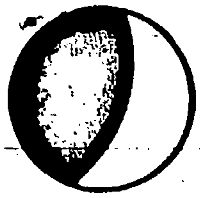
SELF-EVALUATION 7

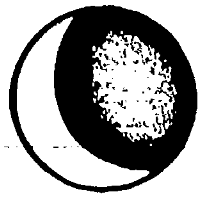
☐7-1. Use the diagram below, which shows the positions of the earth, moon, and sun, to answer the questions that follow.



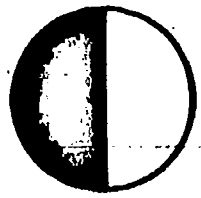
Check the picture below that best represents what the moon would look like to an observer on the earth. (The shaded part of the diagrams is the dark part of the moon that the observer would not see clearly.)



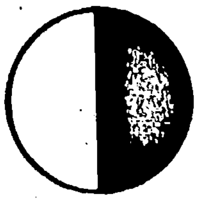
A_____



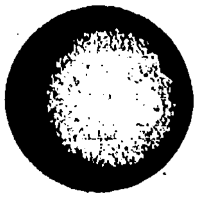
B_____



C_____

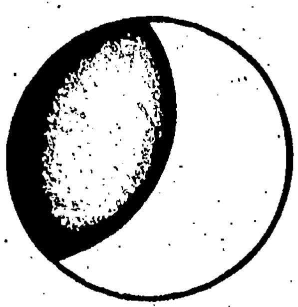


D_____



E_____

☐**7-2.** On the diagram of the moon shown below, draw an arrow to point to the terminator.



☐**7-3.** Why doesn't a person on the earth ever see the far side of the moon?

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Self-Evaluation Answer Key

SELF-EVALUATION 1

1-1. c. The height reached by the rockets. Remember that these are water rockets and you want to compare their performance.

1-2. No. They won't measure the same height because student A is holding his quadrant higher than student B's. Since A and B are the same distance from the launch site but A's quadrant is higher, he will most likely measure a smaller angle. When A consults the Height Converter Table he will then record a smaller height. If the student who is launching the rocket sends it off so that the flight is not straight up, no one can predict any of the angles. If you aren't sure about this, you should take a look at text pages 6 and 7 again.

1-3. a. You should have found the height to be 43.3 m. Take another look at the table if you had problems.

b. The calculated height should be about 19.25 m, which is the average of the two heights of 21.0 m and 17.5 m found by the two observers. If you stop to think about how you measured the angles, you might agree that it would be pretty reasonable to round off the answer to 19.3 m or even 19 m.

c. As long as the rocket went straight, it is unlikely that you would ever get a sighting angle of 90° unless you were standing right at the launching site. The rocket never gets high enough to give you the effect that it is directly overhead when you stand 25 m away from the launching site.

d. Compare your answer with the answers that other students got. If your answer seems to be different from theirs, review text pages 7 and 8 and check your answer with your teacher.

1-4. The average of the height found by two or more observers generally gives a more reliable measurement than that obtained by a single observer. You are assuming, of course, that all the observers are equally reliable and have equally good eyesight. If all the observers are equally unreliable and have equally bad eyesight, this technique is known as a pooling of ignorance.

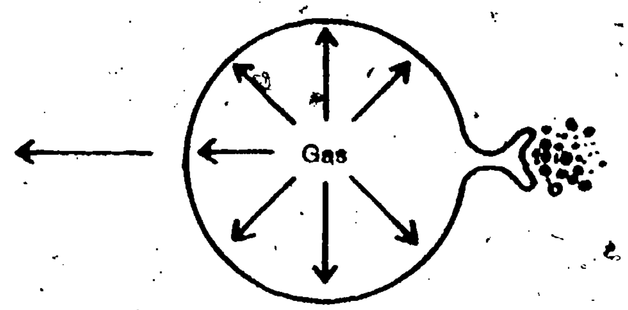
1-5. a. Your answer should have included the amount of water you poured into the rocket and the amount of air that you pumped in. You may also have included other variables, such as the angle at which the rocket was launched. If you did not include the first two variables mentioned, you should take another look at Problem Break 1-1.

b. Rocket B is the one you should have chosen. If you picked the wrong one, you should take another look at your data from Problem Break 1-1. Perhaps you might even want to try the various combinations pictured to make sure.

1-4. Your experimental design should have specified that you would use at least one liquid other than water. You should have included the idea that you keep all the variables constant except one. For example, you might vary the liquid that the rocket contains while keeping the number of strokes on the air pump, the launching angle, etc., constant. This idea of changing only one thing at a time is perhaps the most important thing to keep in mind when doing any experiment. Here's something to think about: Since the same volume of two different liquids may have different weights, should you keep the weight, or the volume, constant or does it matter?

SELF-EVALUATION 2

2-1. As the air rushes out of the balloon in one direction, the balloon moves in the opposite direction. If you have never tried this, you may want to try it out at home. Maybe you can even come up with an explanation as to why the balloon does not travel in a nice straight path like the rocket does. Do tail fins help?



2-2. b. increase. Take another look at Problem Break 2-2 if you missed this one. You might even want to try to devise an experiment that uses a liquid other than water to see what happens when you keep the rate of flow constant but change the mass of the liquid that emerges from the jet each second.

2-3. a. decrease. Think about what would happen if the water emerged slower and slower from your water rocket. How much thrust would there be if the water stopped emerging? Take another look at Problem Break 2-2 if you are still having difficulty.

2-4. a. The force should be about 8 newtons. If you were off by a small amount, don't worry about it. However, if your answer was smaller than 6 newtons or greater than 10 newtons, you had better take another look at the graph.

b. To get a force of 30 newtons, you need a water flow of about 18 grams/10 sec.

c. You should have predicted a force of around 50 newtons. This process of extending the curve to predict what will happen is called "extrapolation." It is useful but it can get you into trouble. For example, suppose we tried to increase the water flow to 25 grams/10 sec and found that the pressure broke the plastic nozzle. Our prediction of 50 newtons would be all wrong.

2-5. The water rocket that is launched on land will have a much greater thrust. Your work on Problem Break 2-3 should have shown you that as you increase the pressure outside the nozzle, the thrust decreases. The pressure outside reduces the amount of mass ejected/10 sec and the speed at which it is ejected. At the bottom of the ocean the pressure outside the rocket would be so great that it would be unlikely for any water to be ejected from the rocket at all. If you had difficulty with this question, read over Problem Break 2-3 again and check your data.

SELF-EVALUATION 3

3-1. The rocket's thrust must be enough to lift both the spacecraft and the fuel it contains. 28,500,000 newtons plus 21,000,000 newtons equals the total weight of 49,500,000 newtons. Read over text pages 23 and 24 again if you had a different answer.

3-2. No. The rocket would not lift off unless there was an upward unbalanced force acting on it. If the thrust of the engines just equaled the weight of the rocket, the forces would be balanced, and the rocket would not move. The thing to remember is that unless an unbalanced force acts on an object, it moves with a constant speed (which might be a speed of zero) in a straight line. If you had problems with this, do Activities 3-1 to 3-3 again and read over page 26.

3-3. a. Pattern C shows an increasing speed. The drops are getting farther and farther apart.

b. Pattern B indicates a decreasing speed. As the cart travels along, the drops are getting closer and closer together.

c. Pattern A indicates that the cart is traveling at a constant speed. The cart is traveling the same distance between each drop.

d. The average distance between drops is 18 mm. This is the average of measurements of 5, 11, 15, 21, 25, and 31 mm. If your measurements do not agree, make sure that you measured from the center of one dot to the center of the next dot.

e. Pattern C indicates a cart that is being pushed or pulled by a constant unbalanced force. If you chose pattern B, you were almost right. In pattern B there is a constant unbalanced force, but this time it is acting in the opposite direction of the motion of the cart. If you had difficulty with these questions, you should take another look at your data from Activities 3-4 to 3-9. You might read over pages 27 to 30 in the text as well.

3-4. As long as there is an unbalanced force acting in the same direction the rocket is traveling, the speed of the rocket will increase.

3-5. a. The mass was larger for run A. If you look at the dot patterns for the two runs, you can see that the dots are closer together in run A, which means that the speed is not increasing as rapidly.

b. Your explanation should include the idea that since the speed of the cart is not increasing as rapidly during run A as during run B, even though the same force is acting, the mass must be larger during run A. Try Activity 3-10 again if your answer did not include the ideas suggested above.

SELF-EVALUATION 4

4-1. a. All the balls will hit the ground at the same time.

b. Your answer should indicate that the time of fall is determined only by the vertical distance from the ground and *not* by the mass of the object or its horizontal speed. Try Activities 4-1 to 4-7 again if you had difficulty with this question.

c. Balls C and D will travel farthest.

d. Since C and D have a horizontal speed when they start to fall, the path they travel is longer than the paths of A and B. Remember they travel farther but it takes them the same amount of time because their speed is faster.

4-2. a. During the first 16 km the rocket is picking up speed quite rapidly and since the air friction depends on the speed, the air frictional drag increases quite rapidly. Read over page 44 in the text for a more complete explanation.

b. Point 2 is max-Q. At point 2 the drag reaches its peak, and this means this must be the point of max-Q.

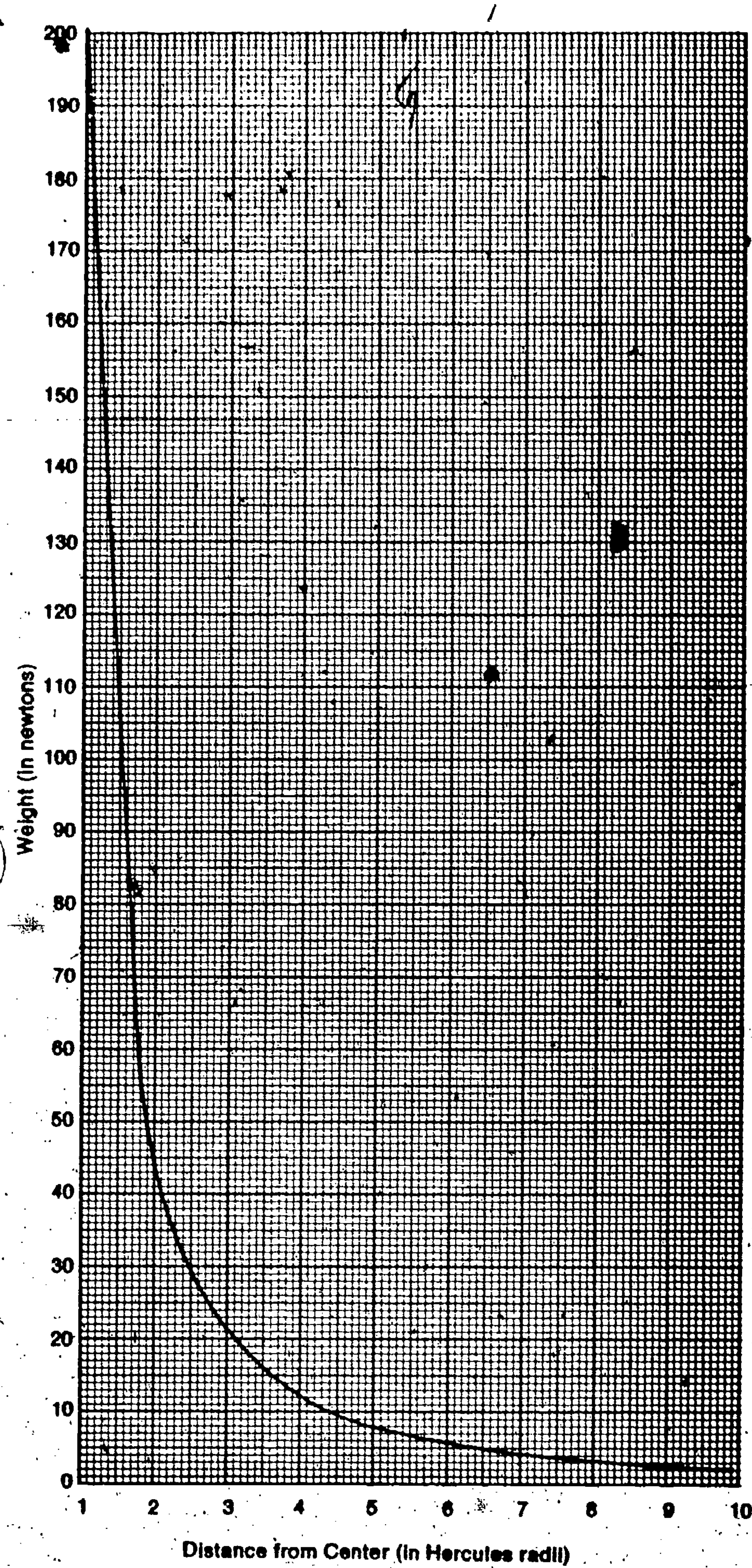
c. The rocket is traveling most rapidly at point 3. Remember that a large rocket's speed increases steadily as it climbs through the atmosphere.

d. As you get higher and higher in the atmosphere, the air gets thinner and thinner. This means that there are fewer air particles to rub against the rocket surface to produce air friction.

4-3. You may have had to think about this question a little. It sounds like a nice idea, doesn't it? The problem of course is that the air friction at 40 km would be too large and the satellite would slow down and return to the earth's surface.

4-4. The period of a satellite is the amount of time required for a satellite to make one complete orbit. For satellites in parking orbit, the period is about 88 minutes. You might take another look at page 48 if you didn't remember the answer to this question.

4-5. The graph is shown on the next page.


Weight (in newtons)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
Distance from Center (in Hercules radii)

4-6. When an object is at 2 radii, its weight is $\frac{1}{4}$ that of a similar object on the surface of Hercules. You should have been looking for the distance where the object's weight was 200 N × ($\frac{1}{4}$) = 50 N. Read over page 47 again if you missed this question.

4-7. At 5 radii its weight will be $\frac{1}{25}$ of what it would be at the surface. Take a look at your graph. The object weighs 200 N at the surface. Out at 5 radii the same object has a weight of 8 N. Thus its weight is $\frac{8}{200}$, or $\frac{1}{25}$, as large as it would be at the surface.

4-8. a. The period of satellite A is greater than the period of satellite B. If you had difficulty with this question, take another look at pages 48 and 49.

b. The gravitational pull on satellite A is less than the pull on satellite B. Take another look at the graph you drew for question 4-5 if you had problems answering this question.

4-9. Slightly greater than. Take a second look at the possible paths of a satellite shown on text pages 50 and 51 if you missed this one.

4-10. a. The orbiting speed at the surface would be 2.5 km/sec. This is similar to the calculation shown on text pages 41 and 42.

b. The orbiting speed would be slower. Remember that the farther it is above the surface, the slower the satellite has to travel.

SELF-EVALUATION 5

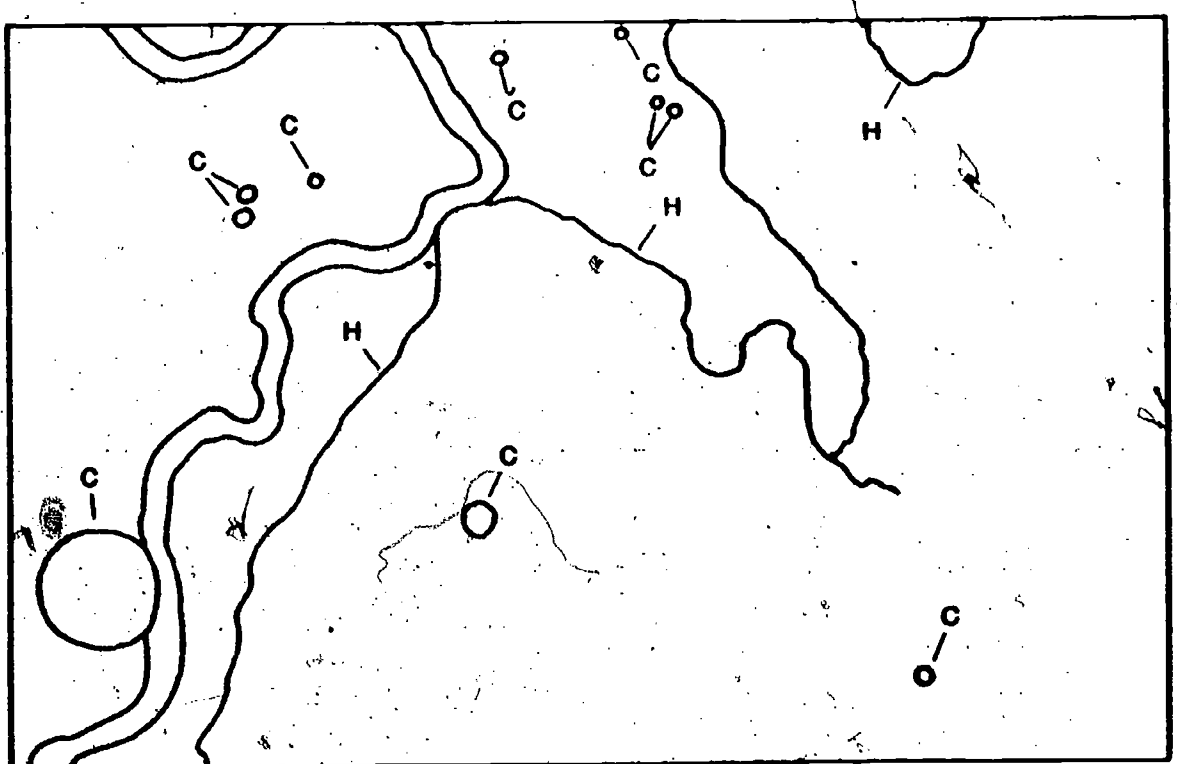
5-1. They prefer these times because the longer shadows cast by the sun in the early morning or late afternoon reveal more detail and texture in surfaces than the short shadows cast around noon. If you take photos, this is something to keep in mind and try out. If you missed this question, you should try Activities 5-7 and 5-8 again.

5-2. You should have indicated that the mass and the speed affect the energy of a moving object.

5-3. a. Crater B was formed by the steel ball that had fallen farther. Try Activity 5-6 again if you had problems answering this question.

b. Crater B was formed by the heavier mass. You should review your data for Activity 5-5 if you had difficulty answering this question.

5-4. The diagram below shows the relative positions of the hills and craters.



5-5. a. You should have identified crater B as being the older crater.

b. You should have noticed that crater A seems to cut into crater B at the nearest point and that crater B contains debris that was thrown out of crater A when it was formed. Also, the edges of crater A are sharper than those of crater B.

5-6. Your answer may have included such characteristics as a bowl-shaped crater with its floor a little below the level of the surrounding land, a round shape with a raised rim, and ejecta scattered on the surrounding landscape.

5-7. Your answer should include the idea that the falling object ejected some of the lighter material from below the surface of the moon and splashed it across the darker material of the surface. You may have also mentioned that the surface may have been darkened by radiation from the sun. Review Activities 5-11 through 5-13 in your text if you had difficulty with this question.

SELF-EVALUATION 6

6-1. a. Crater B was formed by an object that caused both the surface and the object to become molten when it hit.

b. Your answer should have included the idea that the central peak of crater B was formed by an inflow of material during the later part of the impact. Review pages 79 through 81 in the text if you are unsure of your answer.

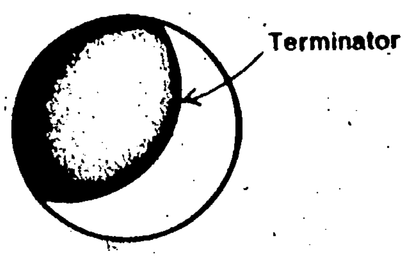
6-2. You should have looked for such things as a bowl-shaped (impact) or cone-shaped (volcanic) crater, the floor of the crater below level at the surrounding ground (impact) or above the level of the surroundings (volcanic), and evidence of a lava flow (volcanic) or widely scattered ejecta (impact).

6-3. One possible cause might be an underground flow of magma that would have lifted the surface rock. A large flow might have caused a large enough bulge to produce a mountain range. Review text pages 85 through 87.

SELF-EVALUATION 7

7-1. You would see the moon as in diagram B. If you had difficulty visualizing the situation, you may want to set up your model of the earth-moon-sun system as you did for Activity 7-3 and see what it looks like.

7-2. The diagram below shows the position of the terminator.



Check over text page 95 if you forgot what the terminator was.

7-3. Your answer should have included the idea that the moon rotates on its axis in the same amount of time that it takes to make one revolution around the earth. As a result the same side of the moon always faces the earth and we can never see the far side. See text page 97.

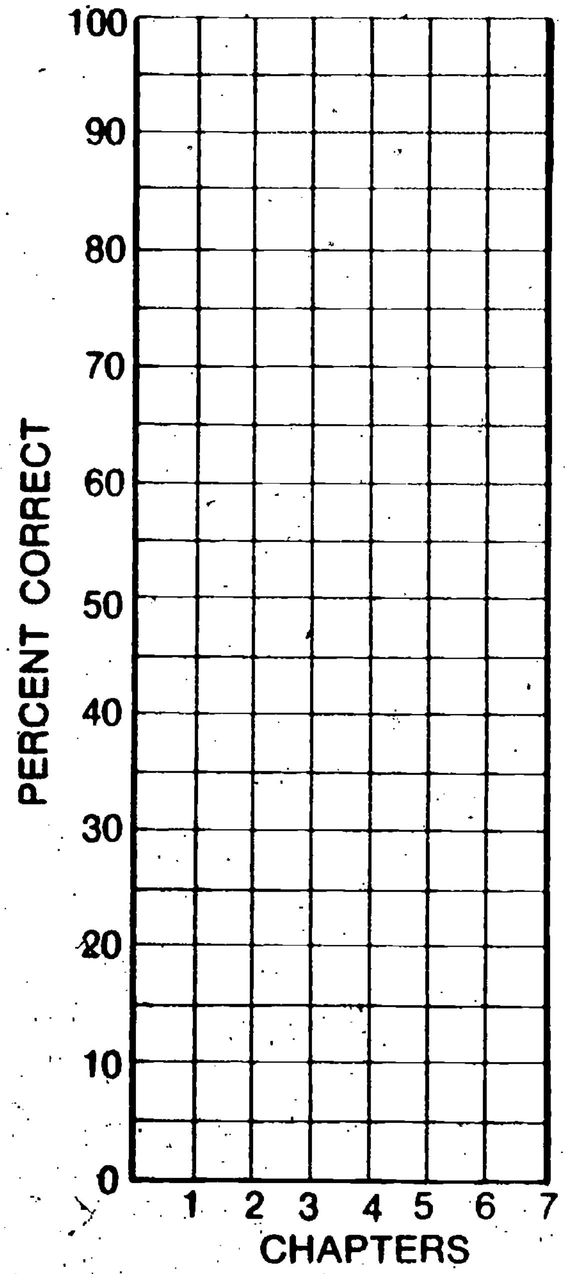
My Progress

Keep track of your progress in the course by plotting the percent correct for each Self Evaluation as you complete it.

$$\text{Percent correct} = \frac{\text{Number correct}}{\text{Number of questions}} \times 100$$

To **find** how you are doing, draw lines connecting these points. After you've tested yourself on all chapters, you may want to draw a best-fit line. But in the meantime, unless you always get the same percent correct, your graph will look like a series of mountain peaks.

RECORD OF MY PROGRESS



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