Re-Imagined Time

Physics

Days 1 to 6

Instructions – Read ALL instructions carefully.

1. Please do the front and back of one page per day.
2. You will be asked to turn in the completed pages upon return to school.
3. If you need me you can contact me at
    a. vbale@k12.wv.us
    b. Through the live grades message board

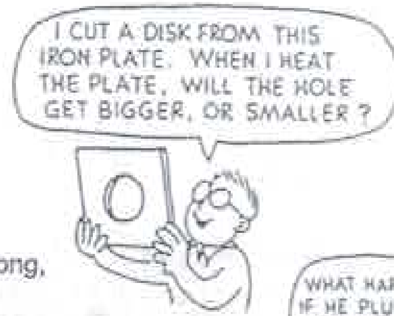
Name ______________________________ Date __________

CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 1 About Science
Making Hypotheses

The word *science* comes from Latin, meaning "to know." The word *hypothesis* comes from Greek, "under an idea." A hypothesis (an educated guess) often leads to new knowledge and may help to establish a theory.

Examples:

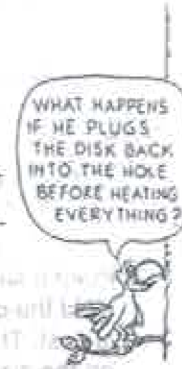


1. It is well known that things generally expand when heated. An iron plate gets slightly bigger, for example, when put in a hot oven. But what of a hole in the middle of the plate? Will the hole get bigger or smaller when expansion occurs? One friend says the size of the hole will increase, and another says it will decrease.

   a. What is your hypothesis about hole size, and if you are wrong, is there a test for finding out?

   ____

   ____



   b. There are often several ways to test a hypothesis. For example, you can perform a physical experiment and witness the results yourself, or you can use the library or internet to find the reported results of other investigators. Which of these two methods do you favor, and why?

   ____

2. Before the time of the printing press, books were hand-copied by scribes, many of whom were monks in monasteries. There is the story of the scribe who was frustrated to find a smudge on an important page he was copying. The smudge blotted out part of the sentence that reported the number of teeth in the head of a donkey. The scribe was very upset and didn't know what to do. He consulted with other scribes to see if any of their books stated the number of teeth in the head of a donkey. After many hours of fruitless searching through the library, it was agreed that the best thing to do was to send a messenger by donkey to the next monastery and continue the search there. What would be your advice?

   ____

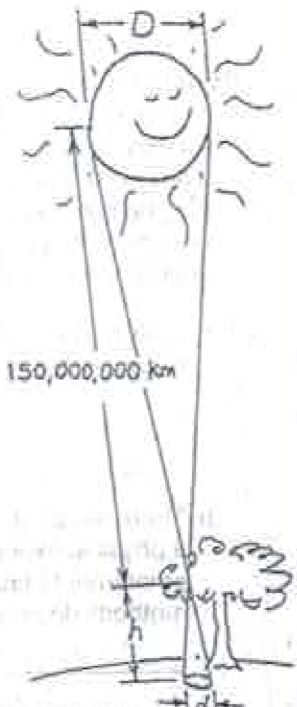
Making Distinctions

Many people don't seem to see the difference between a thing and the *abuse* of the thing. For example, a city council that bans skateboards may not distinguish between skateboarding and reckless skateboarding. A person who advocates that technology be banned may not distinguish between technology and the abuses of technology. There is a difference between a thing and the abuse of the thing.

On a separate sheet of paper, list other examples where use and abuse are often not distinguished. Compare your list with others in your class.

Chapter 1 About Science
Pinhole Formation

Look carefully at the round spots of light on the shady ground beneath trees. These are *sunballs*, and are actually images of the Sun. They are cast by openings between leaves in the trees that act as pinholes. Large sunballs, several centimeters in diameter or so, are cast by openings that are relatively high above the ground, while small ones are produced by closer "pinholes." The interesting point is that the ratio of the diameter of the sunball to its distance from the pinhole is the same as the ratio of the Sun's diameter to its distance from the pinhole. We know the Sun is approximately 150,000,000 km from the pinhole, so careful measurement of this ratio tells us the diameter of the Sun. That's what this page is about. Instead of finding sunballs under the shade of trees, make your own easier-to-measure sunballs.



1. Poke a small hole in a piece of cardboard (like with a sharp pencil). Hold the cardboard in the sunlight and note the circular image that is cast. This is an image of the Sun. Note that its size does not depend on the size of the hole in the cardboard, but only on its distance. The image will be a circle when cast on a surface that is perpendicular to the rays—otherwise it's "stretched out" as an ellipse.

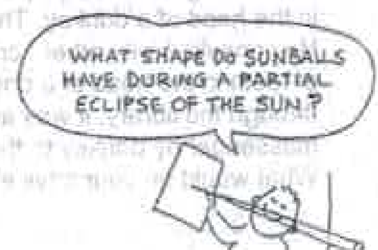
2. Try holes of different shapes—say a square hole, or a triangular hole.

   a. What is the shape of the image when its distance from the cardboard is large compared to the size of the hole?

   ____

   b. Does the shape of the "pinhole" make a difference?

   ____



3. If you were doing this when the Sun is partially eclipsed, what image shape would you expect to see?

   ____

4. Measure the diameter of a small coin. Then place the coin on a viewing area that is perpendicular to the Sun's rays. Position the cardboard with its small hole so the image exactly covers the coin. Carefully measure the distance between the coin and the small hole in the cardboard. Complete the following:

$$\frac{\text{Diameter of sunball}}{\text{Distance of pinhole}} = \underline{\qquad}$$

With this ratio, estimate the diameter of the Sun. Show your work on a separate piece of paper.

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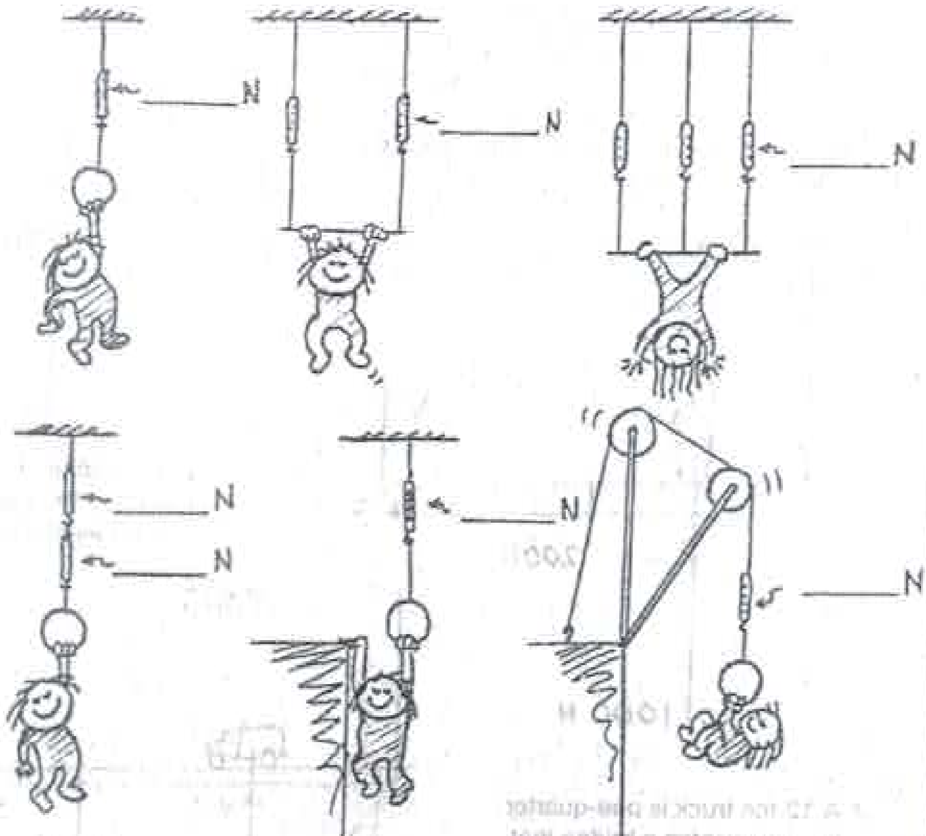
CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 2 Newton's First Law of Motion—Inertia
Static Equilibrium

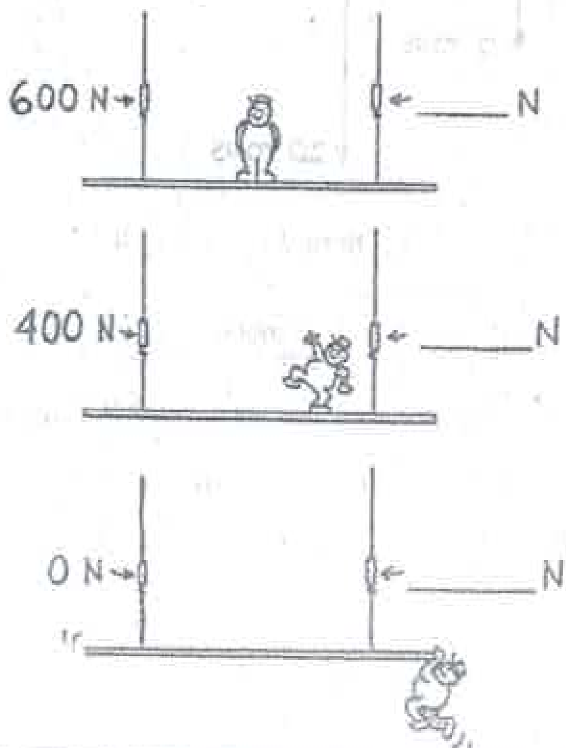
1. Little Nellie Newton wishes to be a gymnast and hangs from a variety of positions as shown. Since she is not accelerating, the net force on her is zero. That is, $\Sigma F = 0$. This means the upward pull of the rope(s) equals the downward pull of gravity. She weighs 300 N. Show the scale reading(s) for each case.



2. When Burl the painter stands in the exact middle of his scaffold, the left scale reads 600 N. Fill in the reading on the right scale. The total weight of Burl and staging must be ______ N.

3. Burl stands farther from the left. Fill in the reading on the right scale.

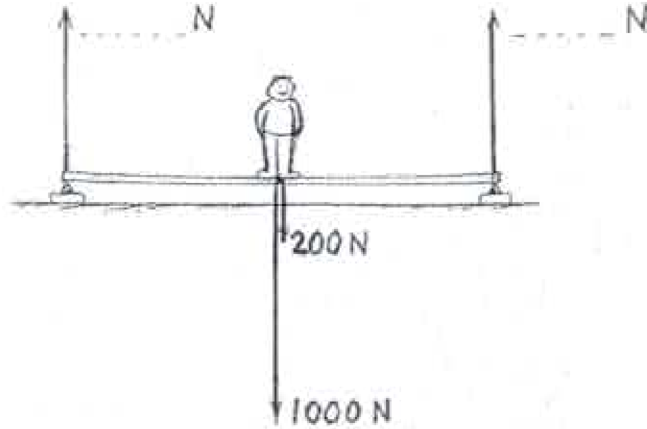
4. In a silly mood, Burl dangles from the right end. Fill in the reading on the right scale.

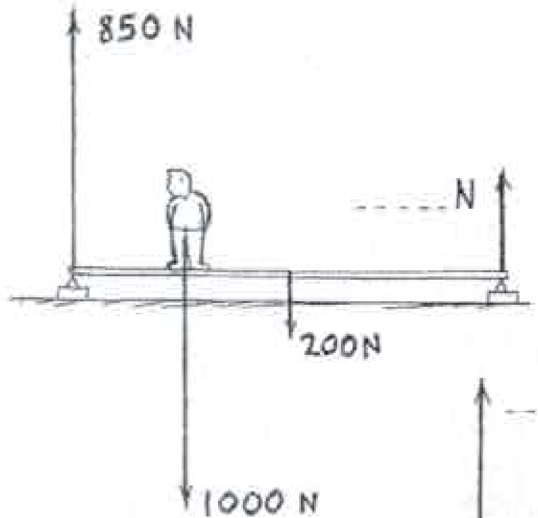


Chapter 2 Newton's First Law of Motion—Inertia

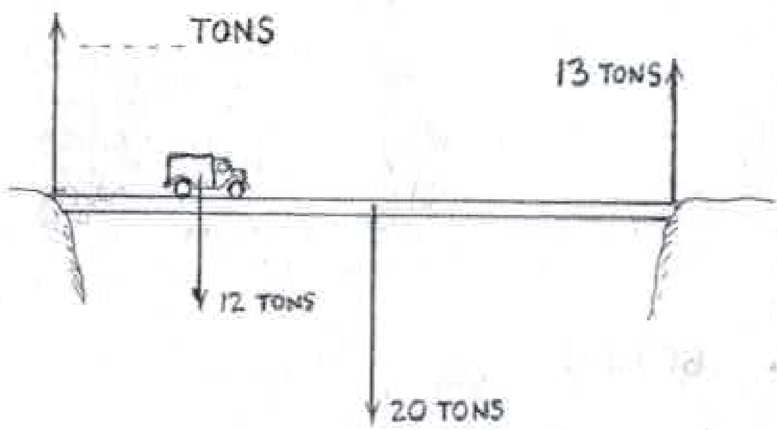
The Equilibrium Rule: $\Sigma F = 0$

1. Manuel weighs 1000 N and stands in the middle of a board that weighs 200 N. The ends of the board rest on bathroom scales. (We can assume the weight of the board acts at its center.) Fill in the correct weight reading on each scale.



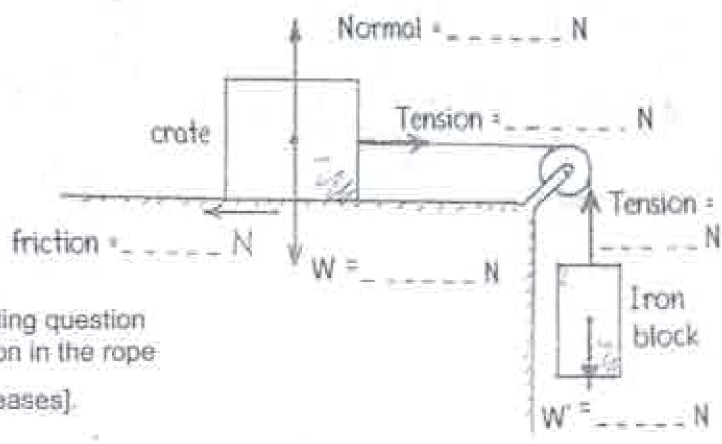


2. When Manuel moves to the left as shown, the scale closest to him reads 850 N. Fill in the weight for the far scale.



3. A 12-ton truck is one-quarter the way across a bridge that weighs 20 tons. A 13-ton force supports the right side of the bridge as shown. How much support force is on the left side?

4. A 1000-N crate resting on a surface is connected to a 500-N block through a frictionless pulley as shown. Friction between the crate and surface is enough to keep the system at rest. The arrows show the forces that act on the crate and the block. Fill in the magnitude of each force.



Circle the correct answers.

5. If the crate and block in the preceding question move at constant speed, the tension in the rope

[is the same] [increases] [decreases].

The sliding system is then in [static equilibrium] [dynamic equilibrium].

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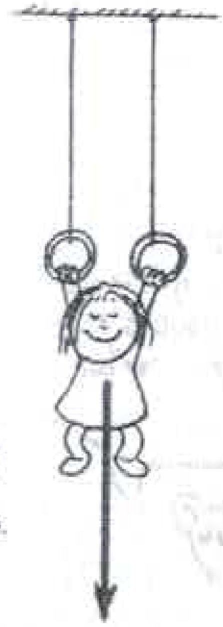
CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 2 Newton's First Law of Motion—Inertia

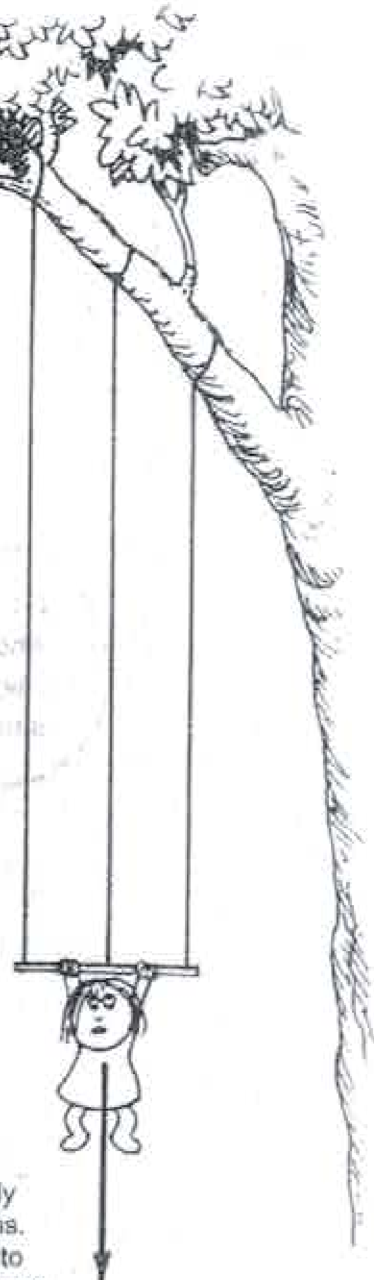
Vectors and Equilibrium

Nellie Newton dangles from a vertical rope in equilibrium: $\Sigma F = 0$. The tension in the rope (upward vector) has the same magnitude as the downward pull of gravity (downward vector).



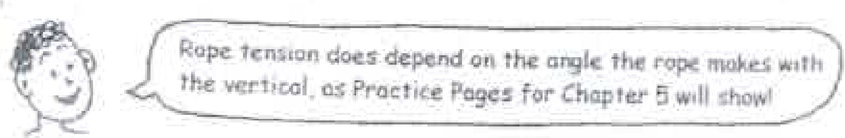
1. Nellie is supported by two vertical ropes. Draw tension vectors to scale along the direction of each rope.

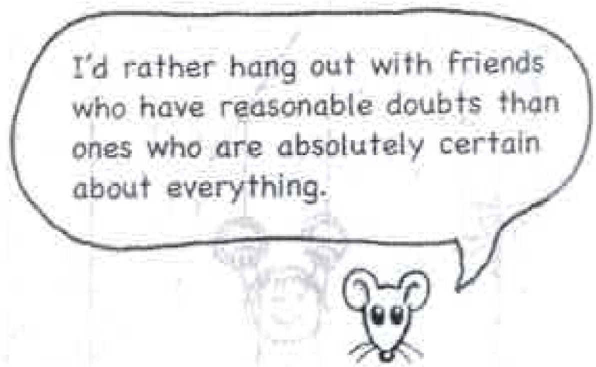
2. This time the vertical ropes have different lengths. Draw tension vectors to scale for each of the two ropes.



3. Nellie is supported by three vertical ropes that are equally taut but have different lengths. Again, draw tension vectors to scale for each of the three ropes.

4. We see that tension in a rope is [dependent on] [independent of] the length of the rope. So the length of a vector representing rope tension is [dependent on] [independent of] the length of the rope.




I'd rather hang out with friends who have reasonable doubts than ones who are absolutely certain about everything.

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CONCEPTUAL Physics PRACTICE PAGE

Chapter 3 Linear Motion
Free Fall Speed

1. Aunt Minnie gives you $10 per second for 4 seconds. How much money do you have after 4 seconds? ________

2. A ball dropped from rest picks up speed at 10 m/s per second. After it falls for 4 seconds, how fast is it going? ________

3. You have $20, and Uncle Harry gives you $10 each second for 3 seconds. How much money do you have after 3 seconds? ________

4. A ball is thrown straight down with an initial speed of 20 m/s. After 3 seconds, how fast is it going? ________

5. You have $50, and you pay Aunt Minnie $10/second. When will your money run out? ________

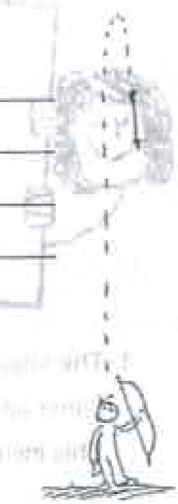
6. You shoot an arrow straight up at 50 m/s.

   a. In how many seconds will it run out of speed? ________

   b. What will be the arrow's speed 5 seconds after you shoot it? ________

   c. What will be the arrow's speed 6 seconds after you shoot it? ________

   d. What will be the arrow's speed 7 seconds after you shoot it? ________



Free Fall Distance

1. Speed is one thing; distance is another. How high is the arrow that you shoot up at 50 m/s when it runs out of speed? ________

2. How high will the arrow be 7 seconds after being shot up at 50 m/s? ________

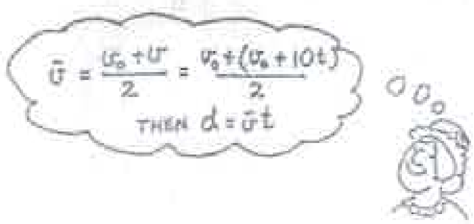
3. Aunt Minnie drops a penny into a wishing well, and it falls for 3 seconds before hitting the water.

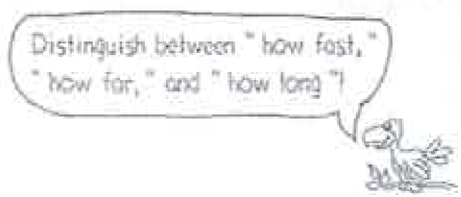
   a. How fast is it going when it hits? ________

   b. What is the penny's average speed during its 3-second drop? ________

   c. How far down is the water surface? ________

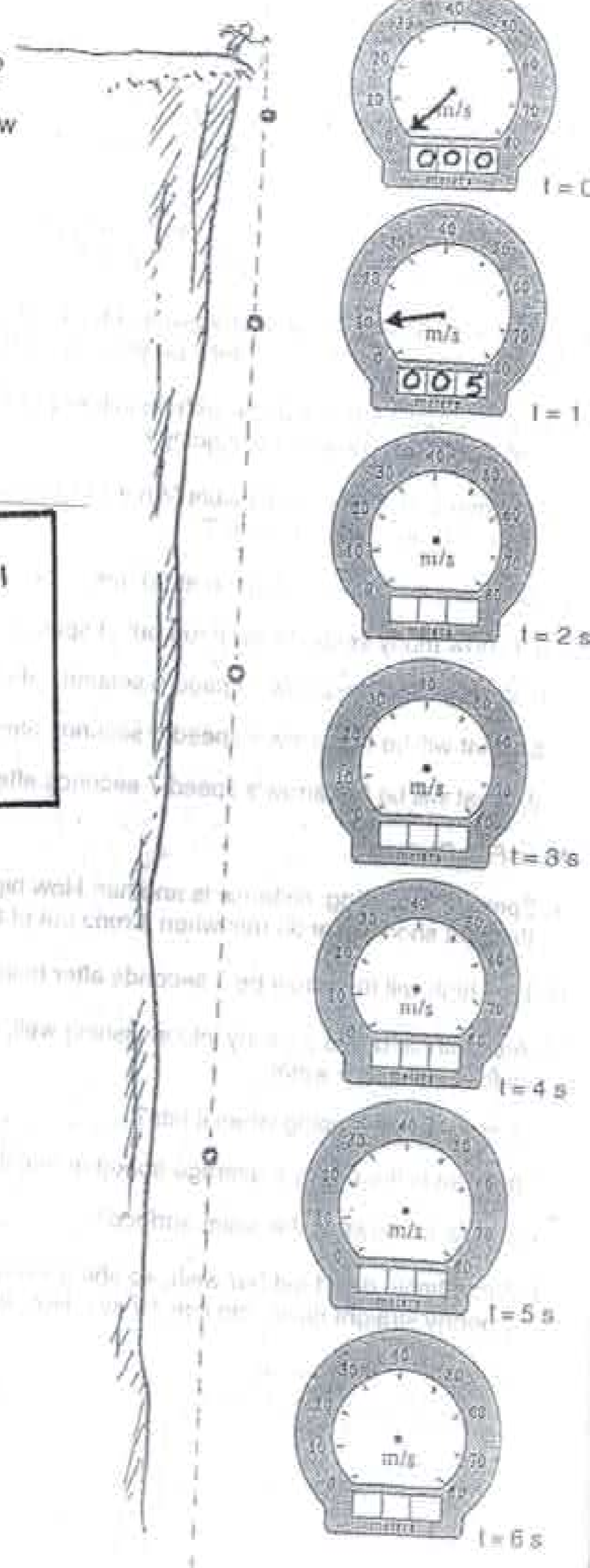
4. Aunt Minnie didn't get her wish, so she goes to a deeper wishing well and throws a penny straight down into it at 10 m/s. How far does this penny go in 3 seconds? ________





Chapter 3 Linear Motion
Acceleration of Free Fall

A rock dropped from the top of a cliff picks up speed as it falls. Pretend that a speedometer and odometer are attached to the rock to show readings of speed and distance at 1-second intervals. Both speed and distance are zero at time = zero (see sketch). Note that after falling 1 second, the speed reading is 10 m/s and the distance fallen is 5 m. The readings for succeeding seconds of fall are not shown and are left for you to complete.
Draw the position of the speedometer pointer and write in the correct odometer reading for each time. Use $g = 10\ m/s^2$ and neglect air resistance.



YOU NEED TO KNOW:
Instantaneous speed of fall from rest:

$$v = gt$$

Distance fallen from rest:

$$d = v_{average}t$$

or

$$d = \frac{1}{2}gt^2$$

1. The speedometer reading increased by the same amount, ________ m/s, each second. This increase in speed per second is called ____________.

2. The distance fallen increases as the square of the ________.

3. If it takes 7 seconds to reach the ground, then its speed at impact is ________ m/s, the total distance fallen is ________ m, and its acceleration of fall just before impact is ??________ m/s^2.

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CONCEPTUAL **Physics** PRACTICE PAGE

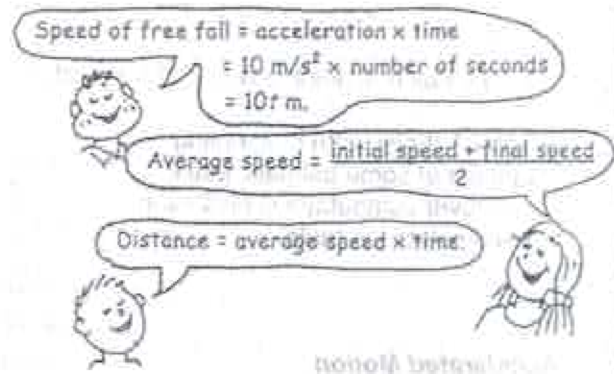
Chapter 3 Linear Motion
Hang Time

Some athletes and dancers have great jumping ability. When leaping, they seem to momentarily "hang in the air" and defy gravity. The time that a jumper is airborne with feet off the ground is called *hang time*. Ask your friends to estimate the hang time of the great jumpers. They may say 2 or 3 seconds. But surprisingly, the hang time of the greatest jumpers is most always less than 1 second! A longer time is one of many illusions we have about nature.

To better understand this, find the answers to the following questions:

1. If you step off a table and it takes one-half second to reach the floor, what will be the speed when you meet the floor?

____



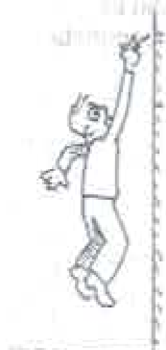
2. What will be your average speed of fall?

____

3. What will be the distance of fall?

____

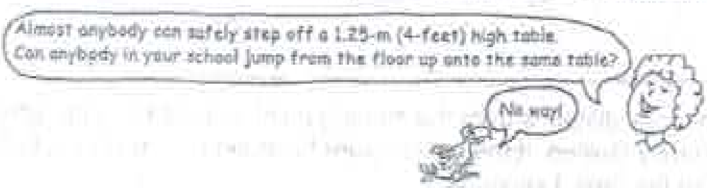
4. So how high is the surface of the table above the floor? ____________

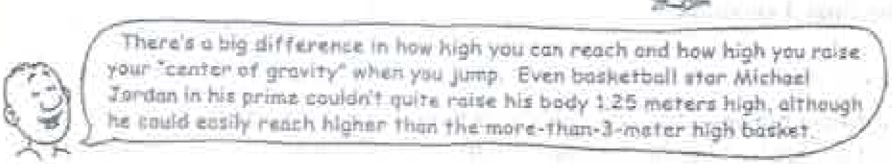


Jumping ability is best measured by a standing vertical jump. Stand facing a wall with feet flat on the floor and arms extended upward. Make a mark on the wall at the top of your reach. Then make your jump and at the peak make another mark. The distance between these two marks measures your vertical leap. If it's more than 0.6 meters (2 feet), you're exceptional.

5. What is your vertical jumping distance? ____________

6. Calculate your personal hang time using the formula $d = 1/2\ gt^2$. (Remember that hang time is the time that you move upward + the time you return downward.)





Here we're talking about vertical motion. How about running jumps? We'll see in Chapter 10 that the height of a jump depends only on the jumper's vertical speed at launch. While airborne, the jumper's horizontal speed remains constant while the vertical speed undergoes acceleration due to gravity. While airborne, no amount of leg or arm pumping or other bodily motions can change your hang time.

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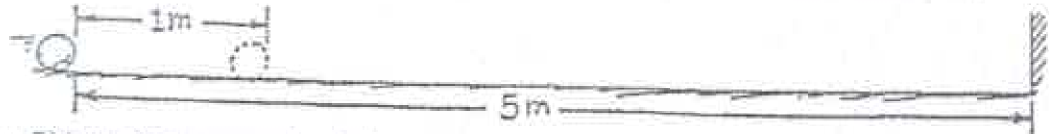
Physics PRACTICE PAGE

Linear Motion
elerated Motion

sketch shows a ball rolling at constant velocity along a level floor. The ball rolls from the rst position shown to the second in 1 second. The two positions are 1 meter apart. Sketch the ball at successive 1-second intervals all the way to the wall (neglect resistance).



a. Did you draw successive ball positions evenly spaced, farther apart, or closer together? Wh

b. The ball reaches the wall with a speed of _____ m/s and takes a time of ________ second

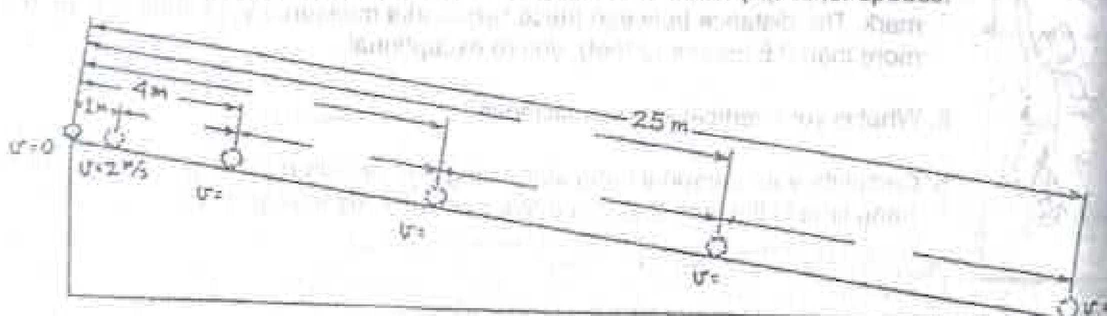
2. Table I shows data of sprinting speeds of some animals. Make whatever computations necessary to complete the table.

TABLE I

ANIMAL	DISTANCE	TIME	SPEED
CHEETAH	75 m	3 s	25 m/s
GREYHOUND	160 m	10 s	
GAZELLE	1 km		100 km/h
TURTLE		30 s	1 cm/s

Accelerated Motion

3. An object starting from rest gains a speed $v = at$ when it undergoes uniform acceleration. The distance it covers is $d = 1/2\ at^2$. Uniform acceleration occurs for a ball rolling down an inclined plane. The plane below is tilted so a ball picks up a speed of 2 m/s each second; then its acceleration $a = 2\ m/s^2$. The positions of the ball are shown for 1-second intervals. Complete the six blank spaces for distance covered and the four blank spaces for speeds.



a. Do you see that the total distance from the starting point increases as the square of the time? This was discovered by Galileo. If the incline were to continue, predict the ball's distance from the starting point for the next 3 seconds.

b. Note the increase of distance between ball positions with time. Do you see an odd-integer pattern (also discovered by Galileo) for this increase? If the incline were to continue, predict the successive distances between ball positions for the next 3 seconds.

Hewitt Drew it!

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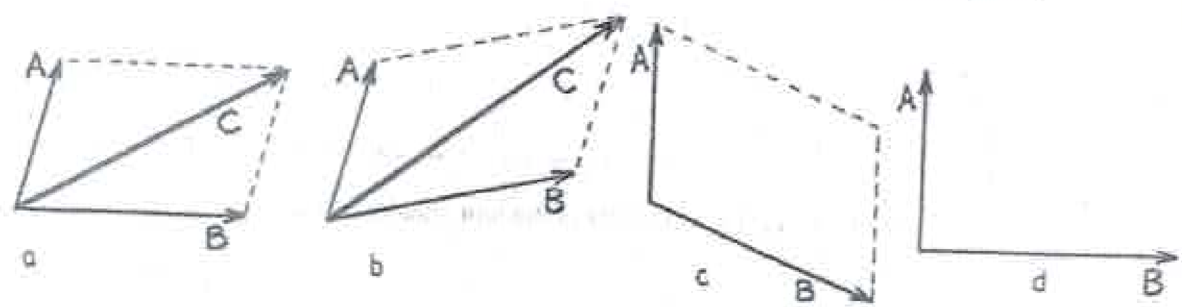
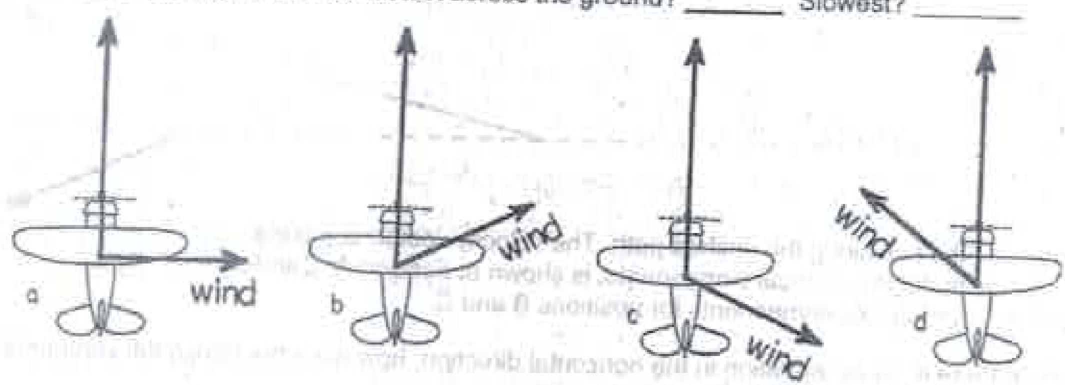
CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 3 Linear Motion
Vectors and the Parallelogram Rule

1. When two vectors **A** and **B** are at an angle to each other, they add to produce the resultant **C** by the *parallelogram rule*. Note that **C** is the diagonal of a parallelogram where **A** and **B** are adjacent sides. Resultant **C** is shown in the first two diagrams, *a* and *b*. Construct resultant **C** in diagrams *c* and *d*. Note that in diagram *d* you form a rectangle (a special case of a parallelogram).

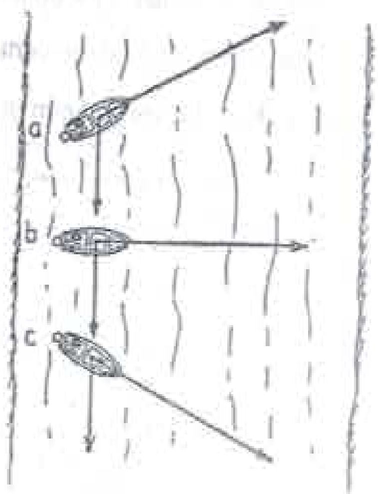


2. Below we see a top view of an airplane being blown off course by wind in various directions. Use the parallelogram rule to show the resulting speed and direction of travel for each case. In which case does the airplane travel fastest across the ground? ______ Slowest? ______



3. To the right we see the top views of 3 motorboats crossing a river. All have the same speed relative to the water, and all experience the same water flow.

Construct resultant vectors showing the speed and direction of the boats.



a. Which boat takes the shortest path to the opposite shore?

____

b. Which boat reaches the opposite shore first?

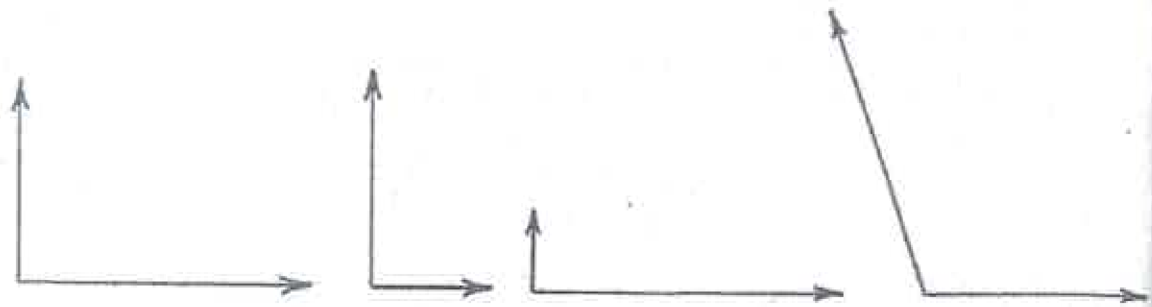
____

c. Which boat provides the fastest ride?

____

Chapter 3 Linear Motion
Velocity Vectors and Components

1. Draw the resultants of the four sets of vectors below.



2. Draw the horizontal and vertical components of the four vectors below.

3. She tosses the ball along the dashed path. The velocity vector, complete with its horizontal and vertical components, is shown at position A. Carefully sketch the appropriate components for positions B and C.

   a. Since there is no acceleration in the horizontal direction, how does the horizontal component of velocity compare for positions A, B, and C? ____________

   b. What is the value of the vertical component of velocity at position B? __________

   c. How does the vertical component of velocity at position C compare with that of position A?

   ____

   ____