I. Motion with constant speed

Each person in your group should obtain a ruler and at least one ticker tape segment from the staff. All the tape segments were generated using the same ticker timer. Do not write on or fold the tapes. If a ticker timer is available, examine it so that you are familiar with how it works.

A. Describe the motion represented by your segment of tape. Explain your reasoning.

B. Compare your tape segment with those of your partners.

How does the time taken to generate one of the short tape segments compare to the time taken to generate one of the long tape segments? Explain your answer.

Describe how you could use your answer above to arrange the tape segments in order by speed.

C. Suppose the ticker timer that made the dots strikes the tape every $1/60^{th}$ of a second.

How far did the object that generated your tape segment move in: $1/60^{th}$ of a second? $2/60^{th}$ of a second? $3/60^{th}$ of a second? Explain your answer.

Predict how far the object would move in: 1 second, $1/120^{th}$ of a second. Explain the assumption(s) you used to make your predictions.

D. In your own words, describe a procedure you could use to calculate the speed of an object.

E. Determine the speed of the object that generated each of your tapes. Record your answers below.

Give an interpretation of the speed of the object, i.e., explain the meaning of the number you just calculated. Do not use the word “speed” in your answer. (Hint: Which of the distances that you calculated in part C is numerically equal to the speed?)

Write the speed of the object that generated each tape on a small piece of paper and attach the paper to the tape. Express your answer in terms of centimeters and seconds.
F. A motion that generates a sequence of evenly-spaced dots on a ticker tape is called motion with constant speed. Explain the assumption about the motion that is being made when this phrase is applied.

Discuss with your partners whether the object that generated your tape was moving with constant velocity.

G. A model train moving with constant velocity travels 60 cm for every 1.5 s that elapses. Answer the questions below and discuss your reasoning with your partners.

1. Is there a name that is commonly given to the quantity represented by the number 40? (40 = 60/1.5) If so, what is the name?

To denote the quantity completely, what additional information must be given besides the number 40?

How would you *interpret* the number 40 in this instance? (*Note:* A name is *not* an interpretation. Your response should be in terms of centimeters and seconds.)

Use your interpretation (not algebra) to find the distance the train moves in 2.5 s.

2. Is there a name that is commonly given to the quantity represented by the number 0.025? (0.025 = 1.5/60) If so, what is the name?

How would you *interpret* the number 0.025?

Use your interpretation (not algebra) to find the time it takes the train to move 90 cm.
II. Motion with varying speed
A. In the space below, sketch a possible ticker tape resulting from motion with varying speed and write a description of the motion.

How can you tell from your diagram that the motion has varying speed?

B. Together with your classmates, take your ticker tape segments and arrange yourselves in a line, ranked according to the speed of the segments. Discuss the following questions as a class.

Compare your segment of ticker tape to neighboring tape segments. What do you observe?

Compare the smallest and largest speeds. What do you observe?

C. Based on your observations of your tape segment and the tape segments of other members of your class, answer the following questions.

Is each small tape segment a part of a motion with constant or varying speed?

Did your examination of a single, small tape segment reveal whether the entire motion that generated the tape had constant or varying speed?
D. Review your earlier interpretation of the speed for your small tape segment. (See section I.) Is that interpretation valid for the entire motion that generated the tape?

Based on the speed for your piece of tape, could you successfully predict how far the object would move in: $1/60^{th}$ s? $2/60^{th}$ s? 1 s?

How can you modify the interpretation of the speed so that it applies even to motion with varying speed?

What name is given to a speed that is interpreted in this way?

E. Suppose you selected two widely separated dots on the ticker tape assembled in part B. What would you call the number you would obtain if you divided the distance between the dots by the time it took the object to move between the dots?

How would you interpret this number?