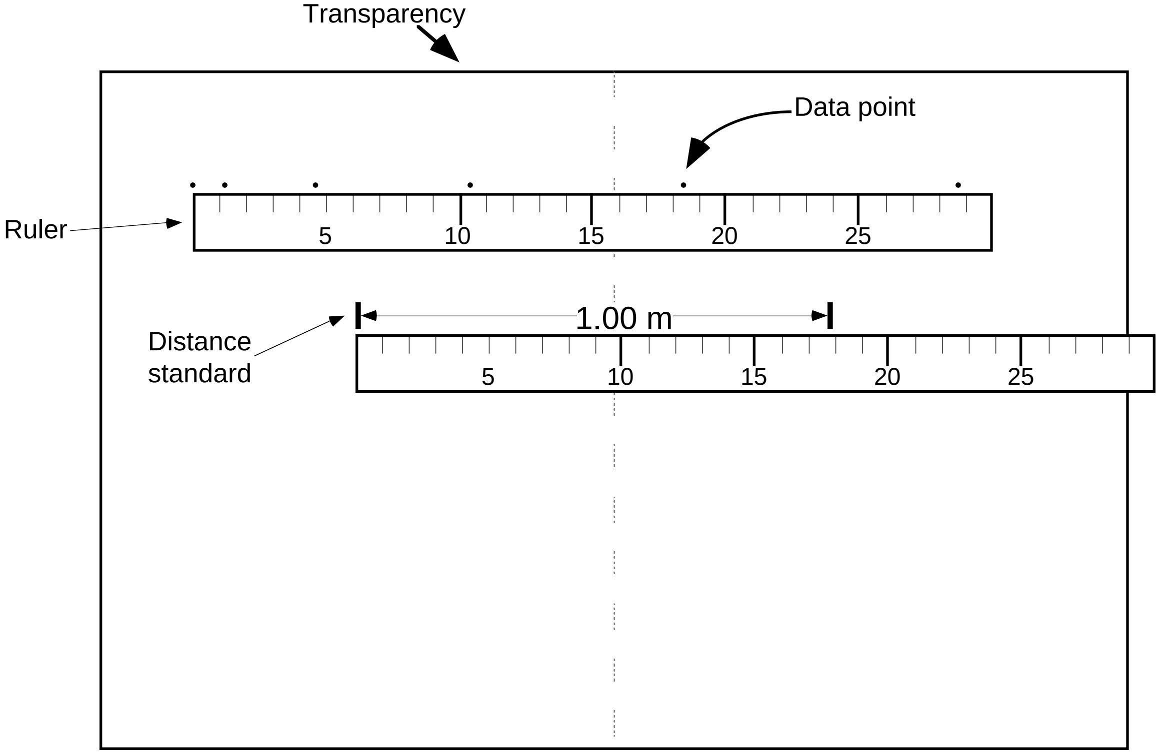
# Video Motion Analysis
## Important Notes

1. Make sure that your videotape is fully rewound before you put it in the camcorder.
2. Be sure that all of what you want to capture on video tape is visible in the view finder of the camcorder.
3. Make sure that you let the tape run in the "record" mode for at least 10 seconds before your experiment begins. This will ensure that you are recording on the magnetic tape.
4. The red button both starts and stops recording on the camcorder. When the tape is being recorded, you should see a flashing red light on the front of the camcorder, and REC in the view finder.
5. Give yourself a voice cue before the part of the motion you wish to analyze begins. "Ready, set, go" works well as a voice cue. Be sure to release the object on "go." When you analyze the data, this will save you time by allowing you to find the beginning of your data.
6. Stop recording when you have recorded all of the motion you wish to analyze. Eject the tape with the blue EJECT button on the left side of the camcorder.
7. Take your tape to the nearest VCR/Television combination. Make sure the power strip for your VCR/TV is on. Turn on the TV and VCR. Turn the TV to channel 3.
8. Rewind your tape to the beginning. Press play. When the video starts to play, make sure the volume on the TV is high enough that you can hear your voice cue. Press pause, either on the remote or on the VCR to "freeze" the frame as soon as you hear ready.
9. Attach a transparency to the television screen such that the full range of the motion of the object will be covered by the transparency. Use **masking tape** to secure the corners of the transparency to the TV screen. Make sure that the transparency is as flat as possible against the screen.
10. Using the meter stick in the background of your video, make marks which represent a known distance. Be sure to mark the ends of the meter stick and label the distance. Be sure that you are using the proper type of marking pen. This process requires a non-permanent overhead projection pen. If you are not sure that you are using the proper type of pen, ask your instructor.
11. Using the frame advance button on the remote control, advance frames one at a time until you reach the frame which contains the starting point for your experiment.
12. Mark the position of the object for your first data point. This will be zero time. It is important when you mark the position of the object that you make your mark as small as possible. A dot works best. Careful attention to accurate marking will pay off with much better lab results. To mark the position as precisely as possible, you need to make sure that you are directly in front of the video image you are marking so that the line of sight from the video image to your eye is perpendicular to the TV screen. You might want to make sure that you close one eye and use your dominant eye to locate the image you are marking.
13. Advance the video one frame (or more if your instructor suggests this) and mark the position of the object. Be sure to mark the same position on the object each time!
14. Continue marking the successive positions of the object, each time advancing the video the same number of frames as you did between the first and second positions.
15. If you have a different data run that you want to mark on the same transparency, be sure to reposition the transparency higher or lower so that the dots from one data run don't get mixed up with those from another data run. Be sure to label each data run so that you know which is which.
16. When you have finished marking the transparency for each of your data runs, turn off all of the video equipment and remove the transparency from the television screen. Remove all masking tape from the transparency and write the names of your lab group members legibly on the transparency. Rewind your tape. Eject your tape.
17. Give your completed transparency to your instructor who will then make photocopies of your transparency for each of your lab group members.
18. When your instructor returns with your photocopy of your video data, immediately clean your transparency. This should be done by running water over the transparency until all of the ink has dissolved and has been washed away. Dry the transparency thoroughly before putting the transparency back where you got it.
19. All equipment for this experiment should be returned to its original location as soon as you are done with it. Return it in at least as orderly an arrangement as you found it.
20. The back of this sheet gives details on how to analyze the transparency.

## Analysis of the Video Data

Below is an example of the transparency that a student might create for a video motion experiment.




Since the standard video frame rate is 30 frames per second, the time elapsed between two successive frames of video is 1/30 second. Assume that the student for this experiment marked the position of the object for each successive frame. To create a data table which has actual distances traveled by the object corresponding to the times, one should do the following:

1. Measure the distance between the end points of your distance standard. In the example, the distance standard was a meter stick in the background of the video. You can see, using the ruler shown in the diagram, that the length of the meter stick as it shows up in the video is about 17.8 cm. This allows you to create a video distance to actual distance conversion factor: 17.8 cm (video) = 100 cm (actual).

2. If the student were to measure the positions from the transparency using the ruler shown, they might find the successive positions of the object to be 0.0 cm, 1.2 cm, 4.8 cm, 10.3 cm, 18.4 cm, and 28.8 cm.

3. The conversion factor determined previously can be applied to any video measurement as shown in the following example:

   Let us apply the conversion factor to the fourth position value. $10.3\text{ cm (video)} \cdot \frac{100\text{ cm (actual)}}{17.8\text{ cm (video)}}$

   Doing the calculations for this problem yields 57.9 cm (actual).
   In other words, this object actually traveled 57.9 cm from the first mark to the last mark on the transparency.

4. The time between frames is 1/30th of a second which in decimal form is 0.033 s.

5. The resulting data table for this experiment would therefore look like the example below.

| time (s) | $x_{video}$ (cm) | $x_{actual}$ (cm) |
|---|---|---|
| 0.000 | 0.0 | 0.0 |
| 0.033 | 1.2 | 6.7 |
| 0.067 | 4.8 | 27.0 |
| 0.100 | 10.3 | 57.9 |
| 0.133 | 18.4 | 103.4 |
| 0.167 | 28.8 | 161.8 |