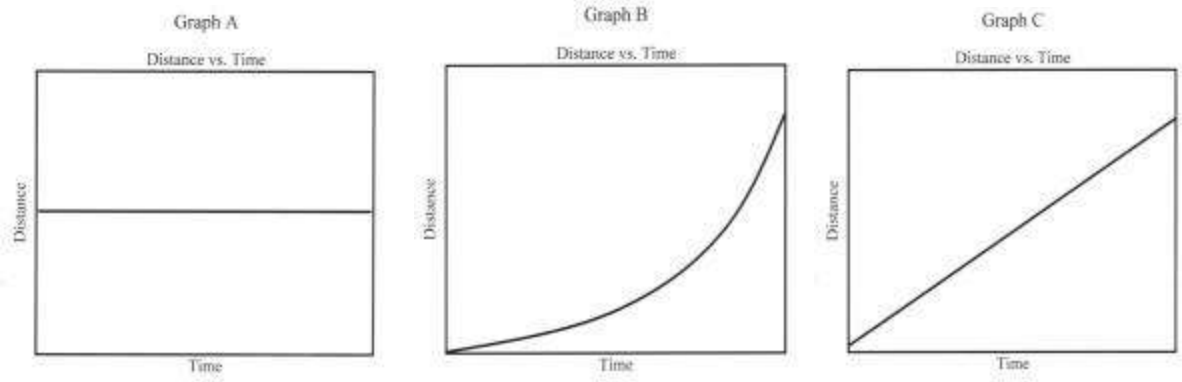
9th Grade Motion, Force, and Mechanical Energy
Performance Assessment Rubrics

1. Observe the motion of the bubble rising in the tube.



a. Which graph best represents the observed motion? _____.
b. Define the term speed using the words distance and time.
c. Explain why your graph choice illustrates the motion of the bubble using the words speed, distance, and time.

This item measures the students' understanding of the concept of speed and ability to relate the observed motion of the bubble to the graphical representation on a distance vs. time graph.

Criteria for a complete response:

1. Student identifies Graph C as the correct graph.
2. Student defines Speed in terms of Distance and Time is correctly used to describe the motion.
3. Student explains that Graph C shows that the speed of the bubble is constant because the constant slope indicates that the bubble travels equal distances in equal time intervals (i.e. constant speed).

Note: Students may use the word 'increase' in place of 'rise' to describe the ascending bubble.

Question 1 cont.

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Chooses graph C, correctly identifying constant speed, but does not correctly define speed using distance and time.
11	Chooses graph C, correctly uses distance, time, but does not use constant speed in the explanation.
19	Any other partially correct response.
	Incorrect Response
70	Chooses graph A, describes motion as constant speed, but does not correctly describe speed using distance and time.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

Design and conduct an investigation to describe the motion of the bubble using a distance vs. time graph.

2. Write a plan for your investigation. Your plan must include:

   a. Question you are testing
   b. Hypothesis (i.e. describe the expected results)
   c. Materials list
   d. Procedures (As part of your plan, choose an appropriate time interval.)
   e. Design for a data table

This item measures the student's ability to design and develop a plan for experimentation.

Criteria for a Complete Response:

1. Student includes a description of how the investigation will be conducted.
2. Student includes a description of how the variables will be measured (distance and time).
3. Student includes all components in question 2 above (a-e).

Code	**Response**
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Plan generally describes investigation but procedures incomplete or incoherent.
11	Omits one component of the plan but generally describes investigation.
19	Any other partially correct response.
	Incorrect Response
70	All components attempted, however, two or more components incomplete or insufficient.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

3. Now conduct your investigation and record your data in your data table. Record the color of the bubble tube you have been given on the line below:

_____

This item measures the student's ability to organize and represent data in a data table.

Scoring Criteria:

1. Student organizes data in a table with two variables (distance and time).
2. Student includes a data table which must contain appropriate labels and units for distance and time.

Example of Data Table:

Time Interval	Distance
s	cm
0-2	10
2-4	11
4-6	10
6-8	9
8-10	10

Total Time	Total Distance
s	cm
0	0
2	10
4	21
6	31
8	40
10	50

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Data table is correctly organized, but units are omitted or are inaccurate.
11	Data table is correctly organized, but the distance measurements are incorrectly correlated with the time measurements.
19	Any other partially correct response.
	Incorrect Response
70	Data is listed in only one column.
71	Data is not displayed in tabular form.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

4. Graph your data, using as much of the paper as possible. Draw a best-fit line or curve through the data points.

This item measures the student's ability to represent the data on a graph.

Criteria for a Complete Response:

1. Student graph must include an appropriate title (distance vs. time), label and units, and scaling.
2. Student must include a best-fit line or curve through the accurately plotted data.

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	All criteria met, except labels with units and a title are missing or incomplete.
11	All criteria met, except student connects data points with segments instead of best-fit line or smooth curve.
12	All criteria met, except student does not use appropriate scaling.
13	All criteria met, except one data point is plotted incorrectly.
19	Any other partially correct response.
	Incorrect Response
70	All criteria met, except distance vs. time data not plotted. (i.e. time vs. distance plotted.)
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
91	Graph is too small to interpret.
99	Blank

5. Use **experimental data** from your investigation to **describe the speed** of the bubble.

This item measures the student's ability to accurately describe the trend in the data table and/or graph and relate to the motion of the bubble.

Criteria for a Complete Response:

1. Student description should accurately describe the trend in the data using the evidence.
2. Student accurately incorporates distance and time data into the description.

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Accurately describes trend, but does not incorporate both distance and time data in response.
11	Accurately describes trend, but uses exclusively distance or time data in the explanation.
12	Describes speed correctly using distance and time data, but does not accurately describe the trend in the data.
19	Any other partially correct response.
	Incorrect Response
70	Data appears reasonable, but description does not accurately describe the trend in the data.
71	Data does not seem reasonable and description does not accurately describe the trend in the data.
72	Response only includes the formula (v = d/t).
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

6. Use data from your investigation to **calculate** the average speed of the bubble. Explain your answer using appropriate formulas and calculations.

This item measures the student's ability to use collected data to calculate the average speed.

Criteria for a Complete Response:

1. Student uses the formula (v = d/t), written or accurately described, in the response.
2. Student uses data accurately selected from data table or graphs.
3. Student shows evidence of calculations.
4. Student shows all measurements and calculations accompanied by units.
5. Student response is numerically correct.

Code	Response
	Complete Response
20	Meets above criteria.
21	Student correctly writes and applies a formula for slope to calculate average speed.
29	Any other correct response.
	Partially Correct Response
10	Meets all criteria, but units missing or incorrect.
11	Meets all criteria, but does not write formula.
12	Meets all criteria, but numerical answer incorrect.
13	Meets all criteria, but data not accurately selected from data table or graph.
19	Any other partially correct response.
	Incorrect Response
70	Correct numerical answer given, but explanation not provided or insufficient.
71	Incorrectly displays and/or uses formula (i.e. v =t/d).
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

7. Your teacher will supply you with a second bubble tube. Observe the motion of the bubble in the two tubes simultaneously. Record the color of the bubble tube you have been given on the line below:

_____

a. Compare the motion of the two bubbles and draw another line or curve on your distance vs. time graph which represents the motion of the second bubble. Label either lines (or curves) on the graph.

b. How did you decide where to draw the second line or curve?

This item measures the student's ability to apply their understanding of speed by observing motion and graphically representing the motion.

Criteria for a complete response:

1. Student correctly represents the speed of the second bubble tube on the graph.
2. Student conveys an understanding of how the slope of a distance vs. time graph represents speed. *(Example: A steeper slope indicates a faster speed as compared to a less steep slope.)*

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Graph line is drawn correctly, but does not include a complete description of how slope relates to speed.
11	Data from original bubble tube erroneously indicates changing speed. Student indicates observation of changing speed for second tube and accurately describes it.
12	Meets all criteria, but does not label lines on graph.
19	Any other partially correct response.
	Incorrect Response
70	The line or curve does not represent a faster or slower speed of the bubble. (i.e. horizontal line, reverses slope)
71	Data from original bubble tube indicates constant speed. Student graphically represents changing speed for second tube.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

8. Without opening the tube, is it possible to change the speed of the bubble in either tube? If possible, explain how the speed would change and why? If not, explain why?

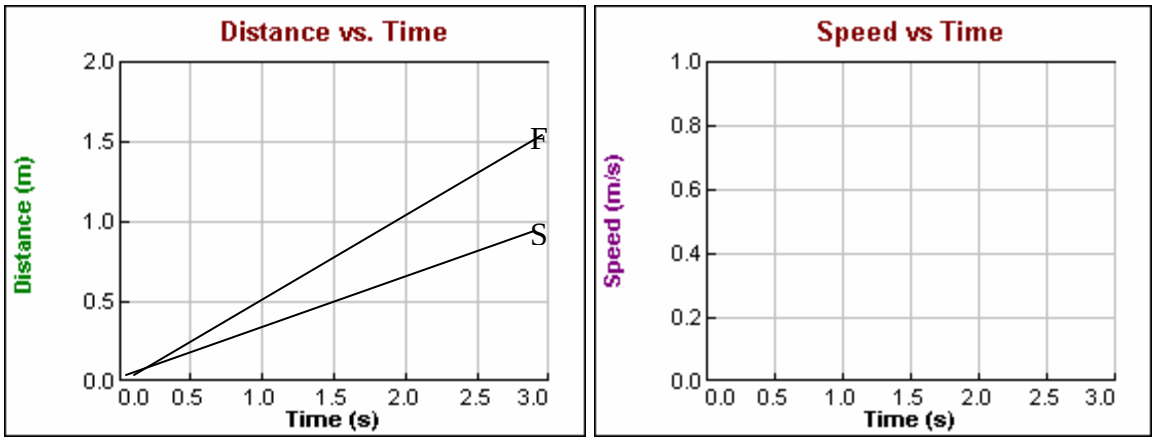
This item measures the students' ability to manipulate the bubble tube in order to identify factors that change the speed of the bubble in the tube.

Criteria for a complete response:

1. Student explains one reason (e.g. change of the tube slope, temperature, etc.)
2. Student explains reason for choice.

Code	Response
	Complete Response
20	Student meets above criteria.
29	Any other correct response.
	Partial Response
10	Student identifies one plausible reason with no explanation.
19	Any other partially correct response.
	Incorrect Response
70	Student indicates task not possible.
71	Student indicates task is possible, but does not give reason.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

9. Alison performs the previous experiment and obtains the following distance vs. time data for the slow bubble tube (S) and fast bubble tube (F).



a. **Calculate** the speeds from Alison's d vs. t graph.

b. **Display** the calculated speeds on the Speed vs. Time graph and **label** using (S) and (F).

c. What kind of motion is being displayed on the Speed vs. Time graph based on your calculations?

This item measures the students' ability to transfer the data from a distance vs. time graph to a speed vs. time graph.

Criteria for a Complete Response:

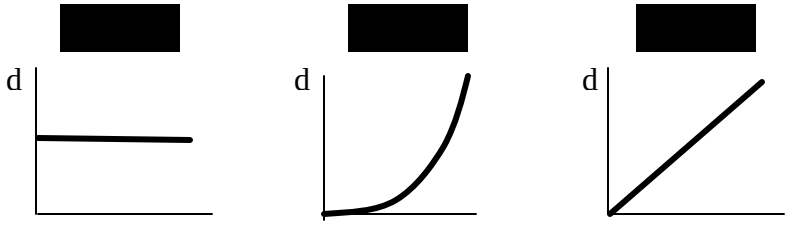
1. Student accurately calculates the speeds from the distance vs. time graph and appropriately positions the lines on the speed vs. time graph.
2. Student draws two horizontal lines indicating fast (F) and slow (S), by positioning the faster one higher than the slower one.
3. Student explains that the speed of each bubble is constant over time.

Item #9, cont.

Code	Response
	Complete Response
20	Meets above criteria.
29	Any other correct response.
	Partially Correct Response
10	Meets all criteria, except lines are drawn at incorrect speeds.
11	Meets all criteria, except explanation incorrect or incomplete.
12	Meets all criteria, except lines not labeled (F) and (S).
19	Any other partially correct response.
	Incorrect Response
70	Graph and data are incorrect, but sufficient explanation given.
71	Graph correct, but incorrect calculations and insufficient explanation given.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

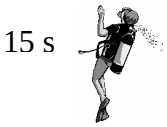
10. A diver is rising to the surface after examining the wreck of a cargo ship. The onboard monitor shows the position of the divers every three seconds as illustrated below.

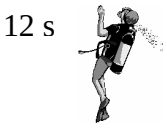
A. Which of the **distance vs. time** graphs below best illustrates the motion of the diver? _____



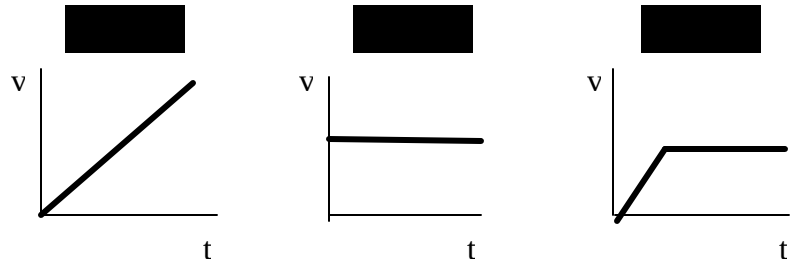
Graph 1 *Graph 2* *Graph 3*

B. Explain the reason for your choice.



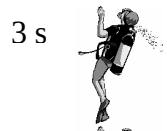


C. Which of the **speed vs. time** graphs below best illustrates the motion of the diver? _____



Graph 4 *Graph 5* *Graph 6*

D. Explain the reason for your choice.



This item measures the students' ability to identify motion at a constantly changing speed on a distance vs. time graph and speed vs. time graph.

Criteria for a Complete Response: (A & B)

1. Student identifies Graph 2 is the correct graph.
2. Student explains that the distance between each diver is increasing therefore the diver is accelerating.
3. Student shows understanding that Graph 2 demonstrates changing speed as opposed to constant speed in their explanation.
4. Student correctly uses the terms distance, time, and speed to describe the graph.

Code	Response
	Complete Response
20	Meets above criteria.
21	Meets above criteria but uses acceleration instead of changing speed.
29	Any other correct response.
	Partially Correct Response
10	Chooses Graph 2, but explanation is incorrect.
11	Chooses Graph 2, indicates acceleration or changing speed, but does not use distance or time in explanation.
12	Chooses Graph 3, but explanation is correct.
19	Any other partially correct response.
	Incorrect Response
70	Chooses Graph 3, indicates that diver accelerates, but distance, time and speed used incorrectly in explanation.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank

Criteria for a Complete Response: (C & D)

1. Student identifies Graph 4 is the correct graph.
2. Student explains that the speed is increasing over time.
3. Student shows understanding that Graph 4 demonstrates acceleration on a speed vs. time graph in their explanation.
4. Student uses the terms distance, time, and speed are correctly used to describe the graph.

Code	Response
	Complete Response
20	Meets above criteria.
21	Meets above criteria but uses acceleration instead of changing speed.
29	Any other correct response.
	Partially Correct Response
10	Chooses Graph 4, but explanation is incorrect.
11	Chooses Graph 4, indicates acceleration or changing speed, but does not use distance or time in explanation.
19	Any other partially correct response.
	Incorrect Response
70	Chooses Graph 6 and accurately describes the graph.
76	Repeats the stem of the question.
79	Any other incorrect response.
	Non Response
90	Crosses out, erases, illegible or impossible to interpret
99	Blank