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M 1, 2	Revision	Term 1

Part1/ MCQ

1.1

1	-Differentiate between scientific theory and scientific law -Explain why a scientific theory cannot become a scientific law	Student Textbook	7-8

Scientific Theories and Laws

**** A scientific theory:- is an explanation based on knowledge gained from many observations and investigations.**

**** It is not a guess. If scientists repeat an investigation and the results always support the hypothesis, the hypothesis can be called a theory.**

**** As new information becomes available, theories can be modified.**

**** A scientific law:- is a statement about what happens in nature and that seems to be true all the time.**

**** Laws describe specific relationships under given conditions.**

**** They don't explain why or how some-thing happens.**

**** Gravity is an example of a scientific law.**

**** The law of gravity states that any one mass will attract another mass.**

**** A theory can be used to explain a law, but theories do not become laws.**

**** For example, many theories have been proposed to explain how the law of gravity works.**

**** Even so, there are few accepted theories in science and even fewer laws.**

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Greek philosophers proposed that objects fall because they seek their natural places. The more massive the object, the faster it falls.

Revision

Galileo showed that the speed at which an object falls depends on the amount of time for which that object has fallen and not on the object's mass.

Revision

Newton provided an explanation for why objects fall. Newton proposed that objects fall because the object and Earth are attracted by a force. Newton also stated that there is a force of attraction between any two objects with mass.

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Einstein suggested that the force of attraction between two objects is due to mass causing the space around it to curve.

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1.2

2	**Express the derived units for common quantities (like velocity, acceleration, force, pressure, volume, density) in terms of their SI base units**	**Student Textbook**	**9**

Mathematics in Physics

**** Physicists often use the language of mathematics.**

**** In physics, equations are important tools for modeling observations and for making predictions.**

**** Equations are one way of representing relationships between measurements.**

**** Physicists rely on theories and experiments with numerical results to support their conclusions.**

** For example, you can predict that if you drop a penny, it will fall, but car you predict how fast it will be going when it strikes the ground?

- Different models of falling objects give different answers to how the speed of the object changes as it falls or on what the speed depends.
- By measuring how an object falls, you can compare the experimental data with the results predicted by different models.
- This tests the models, allowing you to pick the best one or to develop a new model.

International System of Units

** Measurement requires a number and a unit.

** Units such as the foot, gallon, and pound are part of the English system of measurement.

** Most nations use the metric system, which is based on multiples of ten. The International System of Units (SI) is a version of the metric system.

** Sl standards are universally accepted.

** All Sl units are based on fundamental physical constants that are the same throughout the universe.

** Each type of SI measurement has a base unit. The base unit for length is the meter.

** The names and symbols for the seven base units are in the table below.

** All other SI units come from these seven base units.

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SI Base Units

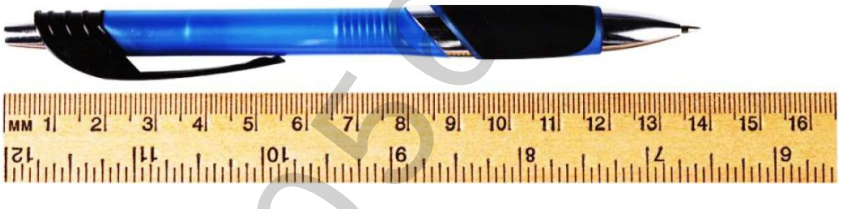
Quantity Measured	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Intensity of light	candela	cd

3	Use dimensional analysis to validate equations and to choose the appropriate conversion factor when converting units	Student Textbook Example problem1	11 12

4	-Identify the significant digits in a given number -Use appropriate significant figures to record answers from a mathematical operation, with the correct number of digits	Student Textbook Check your progress (8)	11 12

Significant Figures:-

** Suppose you measure a pen and find that the end of the pen is just past 138 mm.



** You estimate that the pen is one-tenth of a millimeter past the last tick mark on the ruler and record the pen as being 138.1 mm long.

** This measurement has four valid digits: The first three digits are certain, and the last one is uncertain.

***** Significant figures:-** are the valid digits in a measurement.

** The last digit given for any measurement is the uncertain digit.

** All nonzero digits in a measurement are significant.

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***** Are all zeros significant?***

- **No. For example, in the measurement 0.0860 m, the first two zeros serve only to locate the decimal point and are not significant.**
- **The last zero, however, is the estimated digit and is significant.**

**** The measurement 172,000 m could have 3, 4, 5, or 6 significant figures.**

**** This ambiguity is one reason to use scientific notation.**

**** It is clear that the measurement 1.7200×10^5 m has five significant figures.**

Arithmetic with significant figures

**** When you do any arithmetic operation, remember that the result never can be more precise than the least-precise measurement.**

**** To add or subtract measurements, first do the operation, then round off the result to correspond to the least-precise value involved.**

**** For example, 3.86 m +2.4 m = 6.3 m, not 6.26 m, because the least-precise measure is to one-tenth of a meter.**

**** To multiply or divide measurements, first do the calculation, and then round to the same number of significant figures as the leastprecise measurement.**

**** For example,** $\frac{409.2\ \text{km}}{11.4\ \text{L}} = \frac{35.9\ \text{km}}{\text{L}}$ **because the least-precise measurement has three significant figures.**

**** Some calculators display several additional digits, while others round at different points.**

**** Be sure to record your answers with the correct number of digits.**

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Solving Problems:-

EXAMPLE Problem 1

USING DISTANCE AND TIME TO FIND SPEED When a car travels 434 km in 4.5 h, what is the car's average speed?

1 ANALYZE AND SKETCH THE PROBLEM

The car's speed is unknown. The known values include the distance the car traveled and the time. Use the relationship among speed, distance, and time to solve for the car's speed.

Known
distance = 434 km
time = 4.5 h

Unknown
speed = ?

2 SOLVE FOR THE UNKNOWN

distance = **speed** × time — State the relationship as an equation.

speed = $\frac{\text{distance}}{\text{time}}$ — Solve the equation for speed.

speed = $\frac{434\ \text{km}}{4.5\ \text{h}}$ — Substitute distance = 434 km and time = 4.5 h.

speed = 96.4 km/h — Calculate, and specify the units.

3 EVALUATE THE ANSWER

Check your answer by using it to calculate the distance the car traveled.

distance = speed × time = 96.4 km/~~h~~ × 4.5 ~~h~~ = 434 km

The calculated distance matches the distance stated in the problem. This means that the calculated average speed is correct.

THE PROBLEM

1. Read the problem carefully.
2. Be sure you understand what is being asked.

ANALYZE AND SKETCH THE PROBLEM

1. Read the problem again.
2. Identify what you are given, and list the known data. If needed, gather information from graphs, tables, or figures.
3. Identify and list the unknowns.
4. Determine whether you need a sketch to help solve the problem.
5. Plan the steps you will follow to find the answer.

SOLVE FOR THE UNKOWN

1. If the solution is mathematical, write the equation and isolate the unknown factor.
2. Substitute the known quantities into the equation.
3. Solve the equation.
4. Continue the solution process until you solve the problem.

EVALUATE THE ANSWER

1. Reread the problem. Is the answer reasonable?
2. Check your math. Are the units and significant figures correct?

9/ Significant Figures Solve the following problems, using the correct number of significant figures each time.

a. 10.8 g-8.264 g = 2.536 g = 2.5 g

b. 4.75 m-0.4168 m = 4.3332 m = 4.33 m

c. 139 cm x 2.3 cm = 319.7 cm^2 = 320 cm^2

d. 13.78 g/11.3 mL = 1.219469 g/mL = 1.22 g/mL

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e. 1.6 km +1.62 m + 1200 cm

** 1.6 Km = 1.6*1000 =1600 m

** 1200 cm = 1200/ 100 = 12.00 m

- 1600m +1.62 m + 12.00 = 1613.62 m = 1600m or $1.6*10^3$ m

1.3

5	Compare and contrast precision and accuracy with examples	Student Textbook	14

Comparing Results:-



** Scientists share their results.

** Before new data are fully accepted, other scientists examine the experiment, look for posible sources of error, and try to reproduce the results.

** Results often are reported with an uncertainty.

** A new measurement that is within the margin of uncertainty is in agreement with the old measurement.

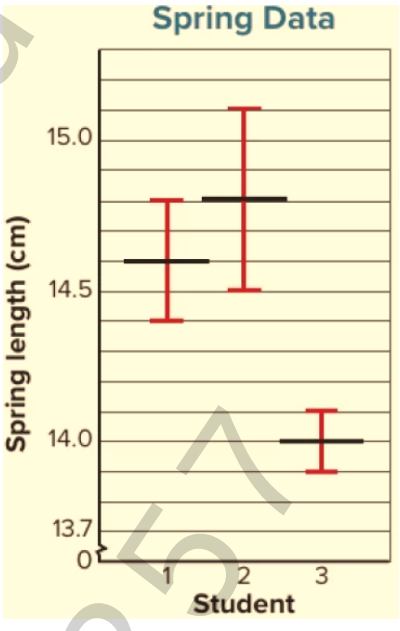
** For example, archaeologists use radiocarbon dating to deter mine the age of cave paintings, such as those from the Niaux cave in France and the Chauvet cave, also in France.

** Each radiocarbon date is reported with an uncertainty Three radiocarbon ages from a panel in the Chauvet cave are 30,940 ± 610 years, 30,790 ± 600 years, and 30,230 ± 530 years.

** While none of the measurements matches, the uncertainties in all three overlap, and the measurements agree with each other.

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** Suppose three students performed an experiment several times starting with springs of the same length.

** With two washers on the spring, **student 1** made repeated measurements, which ranged from **14.4 cm** to **14.8 cm**.

** The average of student 1's measurements was 14.6 cm.

** This result was reported as (14.6 ± 0.2) cm.

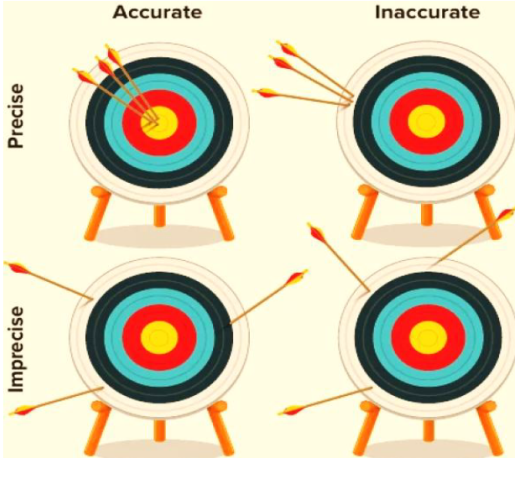
** **Student 2** reported finding the spring's length to be (14.8 ± 0.3) cm.

** **Student 3** reported a length of (14.0 ± 0.1) cm.

***** Could you conclude that the three measurements are in agreement? Is student 1's result reproducible?***

- The ranges of the results of students 1 and 2 overlap between 14.5 cm and 14.8 cm.
- However, there is no overlap and, therefore, no agreement, between their results and the result of student 3.

Precision Versus Accuracy



** Both precision and accuracy are characteristics of measured values.

***** How precise and accurate are the measurements of the three students above?***

***** Precision:-** is the degree of exactness of a measurement.

** In the example above, student 3's measurements are the most precise, within ± 0.1 cm.

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** Both the measurements of student 1 and student 2 are less precise because they have a larger uncertainty (student 1±0.2 cm, student 2= ±0.3 cm).

** Precision depends on:-

- The instrument and technique used to make the measurement.

** Generally, the device that has the finest division on its scale produces the most precise measurement.

** The precision of a measurement:- is one-half the smallest division of the instrument

** For example, suppose a graduated cylinder has divisions of 1 mL You could measure an object to within 0.5 ml. with this device.

** However, if the smallest division on a beaker is 50 ml, how precise would your measurements be compared to those taken with the graduated cylinder?

**BThe significant figures in an answer show its precision.

**BA measure of 67.100 g is precise to the nearest thousandth of a gram.

** Say you add 1.2 ml. of acid to a beaker containing $2.4x10^2$ ml. of water-you cannot say you now have $2.412x10^2$ ml. of fluid because the Volume of water was not measured to the nearest tenth of a milliliter, but to the nearest 10ml.

** Accuracy:- describes how well the results of a measurement agree with the "real" value, that is, the accepted value as measured by competent experimenters.

** If the length of the spring that the three students above measured had been 14.8 cm, then student 2 would have been most accurate and student 3 least accurate.

1.4

6	Define and identify independent and dependent variables for a given data set	Student Textbook	17-18
7	Represent data in graphical form, draw the best fit line, and identify from the shape of the graph if the relationship between the variables is linear	Student Textbook	17-18

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What is measurement?

** When you perform an experiment, it is important to change only one factor at a time.

** For example, Table 3 gives the length of a spring with different masses attached.

** Only the mass varies, if different masses were hung from different types of springs, you wouldn't know how much of the difference between two data pairs was due to the different masses and how much was due to the different springs.

Independent and dependent variables:-

** A variable:- is any factor that might affect the behavior of an experimental setup.

** The Independent variable:- is the factor that is manipulated during an investigation.

** In the experiment that gave the data in Table 3, the mass was the independent variable.

Table 3 Length of a Spring for Different Masses

Mass Attached to Spring (g)	Length of Spring (cm)
0	13.7
5	14.1
10	14.5
15	14.9
20	15.3
25	15.7
30	16.0
35	16.4

** The dependent variable:- is the factor that depends on the independent variable.

** In this investigation, the amount the spring stretched depended on the mass, so the amount of stretch was the dependent variable.

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Line of best fit:-

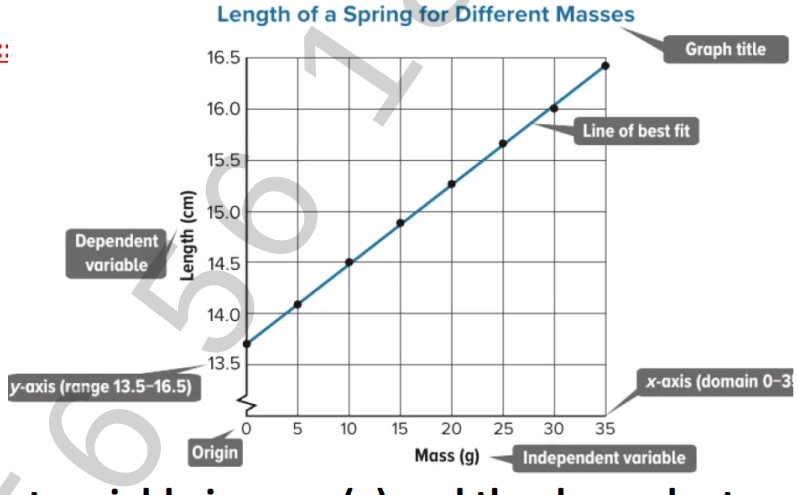
**** A line graph:-** shows how the dependent variable changes with the independent variable.

** The line in blue, drawn as close to all the data points as possible, is called a line of best fit.

**** The line of best fit:-** is a better model for predictions than any one point along the line.

** A well-designed graph allows patterns that are not immediately evident in a list of numbers to be seen quickly and simply.

** The graph in Figure 15 shows that the length of the spring increases as the mass suspended from the spring increases.



**** Steps for Drawing a Scientific Graph:-**

1. Identify the independent variable and the dependent variable in your data.

** In this example, the independent variable is mass (g) and the dependent variable is length (cm).

** The independent variable is plotted on the horizontal axis, the x-axis.

** The dependent variable is plotted on the vertical axis, the y-axis.

2. Determine the range of the independent variable to be plotted.

** In this case the range is 0-35

3. Decide whether the origin (0, 0) is a valid data point.

4. Spread the data out as much as possible.

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** Let each division on the graph paper stand for a convenient unit.

** This usually means units that are multiples of 2, 5, or 10.

5. Number and label the horizontal axis.

** The label should include the name of the variable and its units, for example, Mass (g).

6. Repeat steps 2-5 for the dependent variable.

7. Plot the data points on the graph.

8. Draw the best-fit straight line or smooth curve that passes through as many data points as possible.

** This is sometimes called eyeballing.

** Do not use a series of straight-line segments that connect the dots.

** The line that looks like the best fit to you may not be exactly the same as someone else's.

** There is a formal procedure, which many graphing calculators use, called the least squares technique, that produces a unique best-fit line, but that is beyond the scope of this textbook

9. Give the graph a title that clearly tells what the graph represents.

8	Identify the mathematical equation for linear relations	Student Textbook	18-19

** Scatter plots of data take many different shapes, suggesting different relationships.

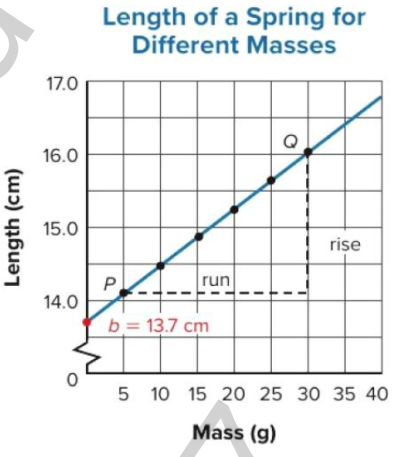
Three of the most common relationships:-

- 1/ Linear relationships
- 2/ quadratic relationships
- 3/ inverse relation-ships

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Linear Relationships:-



** When the line of best fit is a straight line there is a linear relationship between the variables.

** In a linear relationship:- the dependent variable varies linearly with the independent variable.

** The relationship can be written as the following equation.

Linear Relationship Between Two Variables

$$y = mx + b$$

** m:- is the slope of the line, or the ratio of the vertical change to the horizontal change, and b is the y-intercept, the point at which the line crosses the vertical axis.

** To find the slope, select two points, P and Q, far apart on the line-they may or may not be data points.

** The vertical change, or rue (Δy), is the difference between the vertical values of P and Q.

** The horizontal change, or run (Δa), is the difference between the horizontal values of P and Q.

Slope

The slope of a line is equal to the rise divided by the run, which also can be expressed as the vertical change divided by the horizontal change.

$$m = \frac{rise}{run} = \frac{\Delta y}{\Delta x}$$

In Figure 16: $m = \frac{(16.0\text{ cm} - 14.1\text{ cm})}{(30\text{ g} - 5\text{ g})} = 0.08\text{ cm/g}$

** If y gets smaller as x gets larger, then $\frac{\Delta y}{\Delta x}$ is negative, and the line slopes downward from left to right.

** The y-intercept, or the y-value when the value of x is zero, in this example is b = 13.7 cm .

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** So, when no mass is suspended by the spring, it has a length of 13.7 cm.

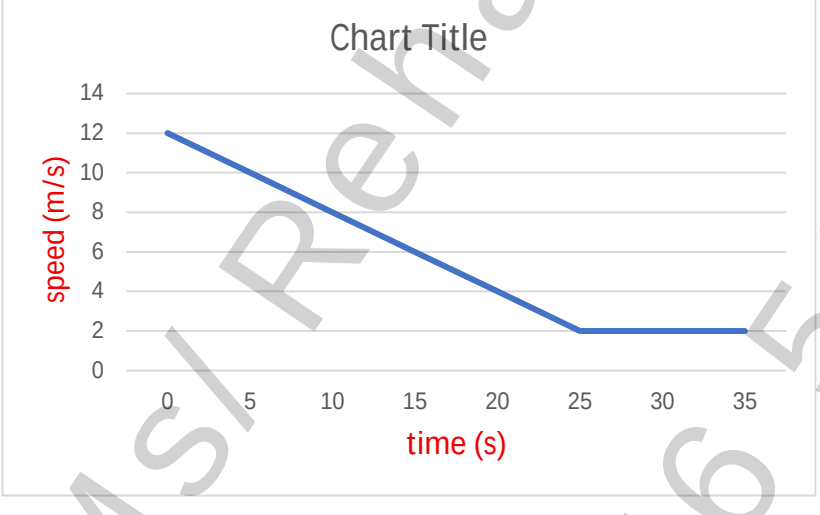
** When b=0, or y=mx, y is said to vary directly with x.

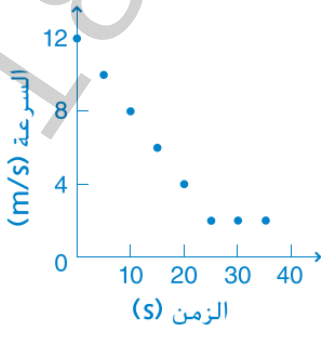
** In physics, the slope of the line and the y-intercept always contain information about the physical system that is described by the graph.

9	Predict the unknown values in a linear relation using the slope and the intercept with the vertical axis	Check your progress (19,20,22)	22

19. **Make a Graph** Graph the following data. Time is the independent variable.

Time (s)	0	5	10	15	20	25	30	35
Speed (m/s)	12	10	8	6	4	2	2	2





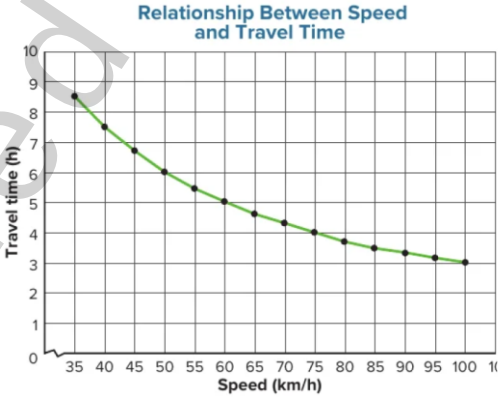
20. **Interpret a Graph** What would be the meaning of a nonzero y-intercept in a graph of total mass versus volume?

** A non-zero total mass exists when the volume of a substance is zero.

**This can occur if the mass value of the substance is zero, including the container.

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22. **Predict** Use the relationship shown in **Figure 18** to predict the travel time when speed is 110 km/h.



d= 300 km s= 110 km/h t=?

t= $\frac{d}{s} = \frac{300}{110} = 2.7\ h$ y= $\frac{a}{x}$

1. A variable whose value changes as a result of changes to other variables is a(n)

a) independent variable. b) dependent variable.

c) control. d) constant.

3. A factor that is a quantity that can have more than one value is a

a) constant. b) method.

c) model. d) variable.

5. The variable you change to see how it affects another variable

a) Bias b) Control

c) Independent variable d) Dependent variable

6. The general pattern of investigational procedures

a) Hypothesis b) Scientific Law

c) Scientific Method d) Theory

7. A possible explanation or prediction of a problem based on observation and prior knowledge that can be tested by experimentation

a) Problem b) Conclusion

c) Hypothesis d) Experiment

8. An explanation of things, events, or natural phenomena using observations and knowledge gained from multiple investigations or large amounts of data

a) Scientific law b) Theory

c) Experiment d) Hypothesis

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9. A statement about what happens in nature that seems to be true all the time

a) Theory
b) Scientific Law
c) Standard
d) Experiment

1. What SI Unit is used for Length?

a) Meter
b) Gram
c) Liter
d) Foot

2. How many centimeters are in a meter?

a) 100
b) 10
c) 1
d) 1000

3.  The SI unit for time is the __?__.

a) liter (L)
b) meter (m)
c) gram (g)
d) second (s)

4. Convert 12 km to m

a) 1,200 m
b) 120,000 m
c) 120 m
d) 12,000 m

5. Convert 0.25 m to mm

a) 25
b) 2.5
c) 0.025
d) 250

7. What SI unit is used to measure electric current?

a) amperes
b) seconds
c) Kelvin
d) mole

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6. 

The SI unit for temperature is __?__.

a) degree celsius (° C)

b) degree fahrenheit (° F)

c) degree centigrade (°C)

d) kelvin (K)

8. SI stands for ___.

a) Instructional System (of measurements)

b) International System (of measurements)

c) Sports Illustrated

d) Scientific Notation

9. What is the base unit for amount of substance?

a) mole

b) second

c) kilogram

d) candela

10. What is unit conversion in physics?

a) Process of converting a quantity from one unit to another unit of a different physical quantity.

b) Process of converting a quantity from one unit to another unit of a different physical dimension.

c) Process of converting a quantity from one unit to another unit of the same physical quantity.

d) Process of converting a quantity from one unit to another unit of a different physical property.

11. A car travels $150\,\text{km}$ in $3\,\text{hours}$. What is its average speed in m/s?

a) $13.89\,\text{m/s}$

b) $5\,\text{m/s}$

c) $15\,\text{m/s}$

d) $50\,\text{m/s}$

3. It is a measure of how close measurements come to each other when they are made in the same way

a) Accuracy

b) Precision

c) Extrapolation

d) Error

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4. How close a measurement is to the accepted value is called..

a) Estimate
b) Precision
c) Accuracy
d) Significant

5.  This bullseye demonstrates...

a) High Accuracy & Low Precision
b) Low Accuracy & Low Precision
c) Low Accuracy & High Precision
d) High Accuracy & High Precision

6.  ?

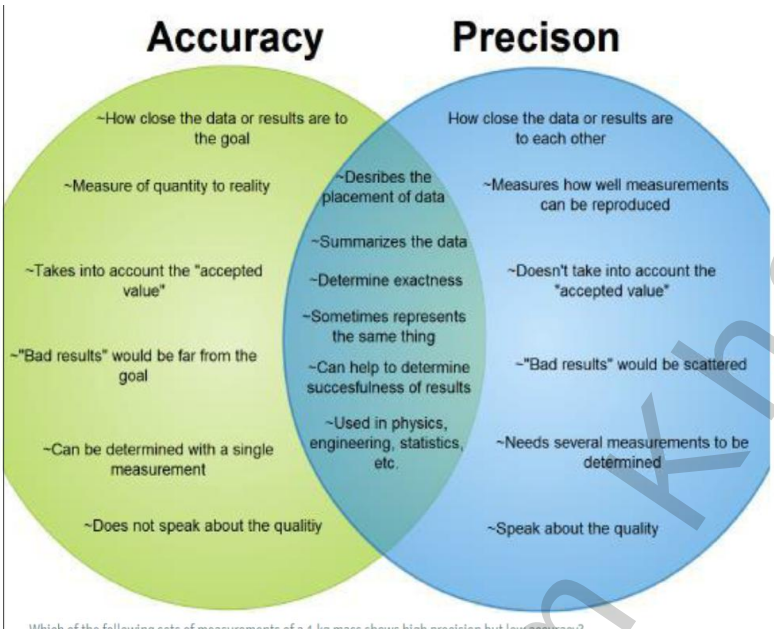
a) Low Accuracy & Low Precision
b) High Accuracy & High Precision
c) High Accuracy & Low Precision
d) Low Accuracy & High Precision

7. Describe the accuracy and precision of the image 

a) Accurate and Precise
b) Not Accurate and Precise
c) Accurate and not precise
d) not accurate and not precise

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Each Student within the group will analyze one set of data (A, B, C, D) and decide whether the data are Precise, accurate, both or neither.

Student A's results are:
A. Precise
B. Accurate
C. Precise and accurate
D. Neither

Student C's results are:
A. Precise
B. Accurate
C. Precise and accurate
D. Neither

Student B's results are:
A. Precise
B. Accurate
C. Precise and accurate
D. Neither

Student D's results are:
A. Precise
B. Accurate
C. Precise and accurate
D. Neither

Actual Measurement: 100 °c

Student	Measurement 1 (°C)	Measurement 2 (°C)	Measurement 3 (°C)	Average (°C)
A	99.5	95	85.5	93.3
B	99.6	100.1	100.4	100.0
C	101.0	101.1	101.0	101.0
D	100.1	100.0	100.2	100.1

Which of the following sets of measurements of a 1 kg mass shows high precision but low accuracy?

- 0.92 kg 0.91 kg 0.90 kg 0.92 kg ✓
- 0.88 g 0.88 g 0.87 g 0.87 g
- 1.00 kg 1.01 kg 1.02 kg 1.00 kg
- 1.01 kg 1.11 kg 1.23 kg 0.96 kg

High precision means that the measurements are close to each other, low accuracy means that the readings are not close to the true value.

1. If a person measures the same object several times and gets nearly the same result each time, what is this called?
a) Accuracy
b) Precision
c) Length
d) Distance

2. How close a measurement is to the true value is called:
a) Accuracy
b) Precision
c) Significant
d) Estimate

Your uncle says he is the tallest member of the family and that his height is 194 cm. What can you say about the range of your uncle's height in this statement if the meter he used to measure his height reads to the closest 1 cm?

ATTEMPT 1

- between 193 cm and 195 cm
- between 193.5 cm and 194.5 cm ✓
- 194 cm exactly - no uncertainty
- between 193.0 cm and 195.0 cm

The smallest scale division on the used meter is 1 cm. The uncertainty in the measurement is ± one-half the smallest scale division, that is 0.5 cm.
So your uncle's height is 194.0 cm ± 0.5 cm. This gives a range of height between **193.5 cm and 194.5 cm**.

This thermometer reading is precise to the nearest

1. 0.01°C. ✓

0.05°C. 0.1°C. 0.005°C.



You weigh yourself on the scales that reads to the nearest one kilogram. The reading is 61 kg. The possible range of values for this reading is between 1. 60.5 kg and 61.5 kg ✓.

1. 60.5 kg and 61.5 kg ✓

The smallest division is 1 kg. The range will be ± one-half of that value added to the measured value. So the range of that measurement is between 60.5 kg and 61.5 kg.

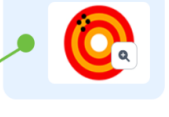
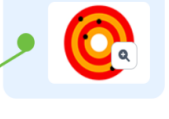
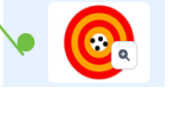
The higher the resolution of a measuring tool, the 1. more precise ✓ it is.

Fill in each blank with the correct word.

Complete the sentence by typing ***high*** or ***low***.

These measurements have 1. low ✓ precision and 2. high ✓ accuracy.



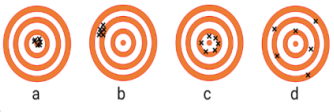
Description	Image
It is accurate and precise.	
It is precise, but not accurate.	
It is neither accurate nor precise.	

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Accuracy is how close are the measurements to 1. a true value ✓. Whereas precision is how close are the measurements to 2. each other ✓.

Choose the correct answer.

The diagrams in the given figure represent the different measurements taken with different instruments at different instants. Which diagram(s) show that measurements have high precision?



- a, b, and c
- b and d
- only a
- a and b ✓

Match the items correctly.

1.01, 1.03, 1.02	It is accurate, but not precise.
0.788, 0.779, 0.755	It is precise, but not accurate.
1.3, 1.5, 0.8	It is neither accurate nor precise.
0.9, 1.1, 1.0	It is accurate and precise.

Theory vs. law

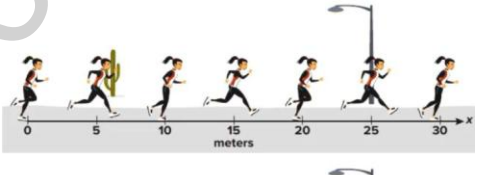
Scientific theory	Scientific law
An explanation of events based on knowledge gained from many observations	**A statement** about what happens in nature and seems to be true all the time.
Gives explanations of how or why things happen	Does not give explanations of how or why things happen
Can be changed and modified	Cannot be changed or modified
Examples: theory of relativity big bang theory	Examples: Newton's laws law of conservation

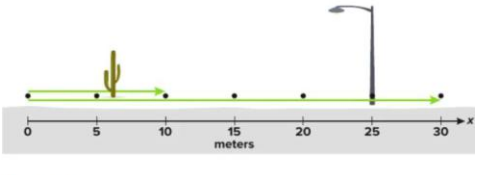
2.2

10	**Differentiate between distance travelled and displacement**	**Student Textbook**	**32-33**
11	**Classify physical quantities into vector and scalar quantities (distance, mass, displacement, speed, velocity, acceleration, force, work, energy, pressure**	**Student Textbook**	**33**

Coordinate Systems:-

***** Is it possible to measure distance and time on a motion diagram?***





** Before photographing a runner, you could place a long measuring tape on the ground to show where the runner is in each image.

** A stop-watch within the camera's view could show the time.

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Position and distance:-

** It is useful to identify a system in which you have chosen where to place the zero point of the measuring tape and when to start the stopwatch.

***** A coordinate system:-** gives the location of the zero point of the variable you are studying and the direction in which the values of the variable increase.

***** The origin:-** is the point at which all variables in a coordinate system have the value zero.

** In the example of the runner shown in Figure 6, the origin, which is the zero point of the measuring tape, could be 6 m to the left of the cactus.

** Because the motion is in a straight line, your measuring tape should lie along this line.

***** The straight line:-** is an axis of the coordinate system.

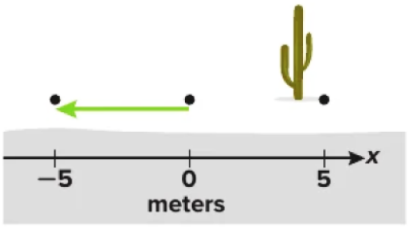
** You can indicate how far the runner in Figure 6 is from the origin at a certain time on the motion diagram by drawing an arrow from the origin to the point that represents the runner, shown at the bottom of Figure 6.

** This arrow represents ***the runner's position:-*** the distance and direction from the origin to the object.

***** Distance:-** is the entire length of an object's path, even if the object moves in many directions.

** Because the motion in Figure 6 is in one direction, the arrow lengths represent distance.

Negative position:-



***** Is there such a thing as a negative position?**

- Suppose you chose the coordinate system just described but this time placed the origin 4 m left of the cactus with the x-axis extending in a

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positive direction to the right.

- A position 9 m left of the cactus, or 5 m left of the origin, would be a negative position.

Vectors and Scalars

** Many quantities in physics have both size (also called magnitude) and direction.

** A vector:- is a quantity that has both magnitude and direction.

** You can represent a vector with an arrow.

** The length of the arrow represents the magnitude of the vector, and the direction of the arrow represents the direction of the vector.

** A scalar:- is a quantity that is just a number without any direction, such as distance, time, or temperature.

** we will use boldface letters to represent vector quantities and regular letters to represent scalars.

** Displacement:- equals final position minus initial position.

Displacement

Displacement is the change in position from initial position to final position.

$$\Delta x = x_f - x_i$$

2.3

12	Plot a position-time graph given position-time value.	Student Textbook Practice problems (10) Example problem1	37-38 39 40
14	Interpret a position-time graph that represents the motion of multiple objects	Example problem2	40

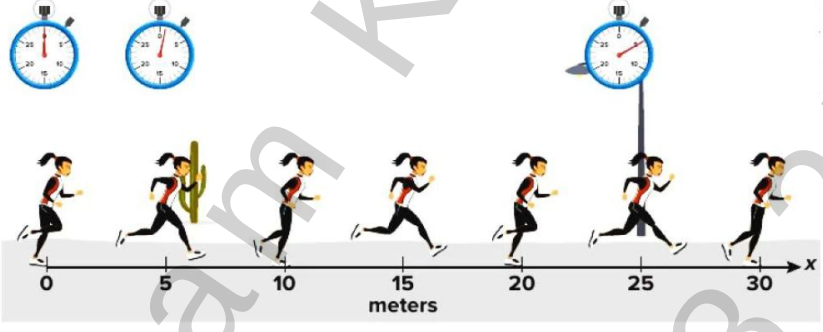
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Finding Positions:-

** When analyzing complex motion, it often is useful to represent the motion in a variety of ways.

** A motion diagram contains information about an object's position at various times.



** Tables and graphs can also show this same information.

Plotting data:-

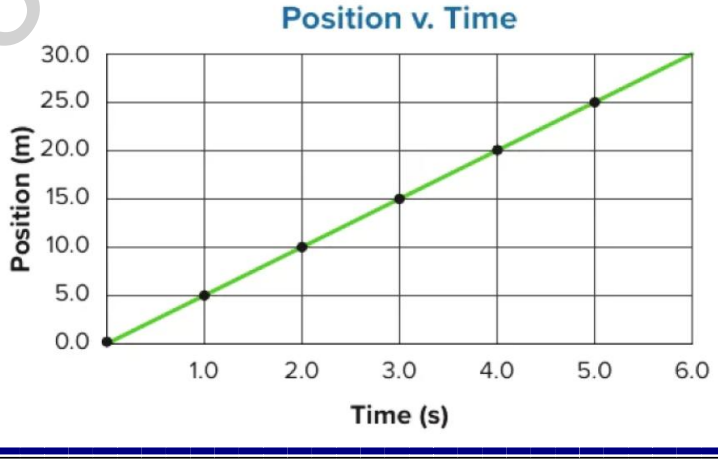
** The data listed in Table 1 can be presented on a position-time graph.

** A position-time graph:- in which the time data is plotted on a horizontal axis and the position data is plotted on a vertical axis.

** To draw this graph, first plot the runner's positions. Then, draw a line that best fits the points.

Table 1 Position v. Time

Time (s)	Position (m)
0.0	0.0
1.0	5.0
2.0	10.0
3.0	15.0
4.0	20.0
5.0	25.0



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Estimating time and position:-

** Notice that the graph is not a picture of the runner's path-the graphed line is sloped, but the runner's path was horizontal.

** Instead, the line represents the most likely positions of the runner at the times between the recorded data points.

** Even though there is no data point exactly when the runner was 12.0 m beyond her starting point or where she was at 14.5 s, you can use the graph to estimate the time or her position.

Instantaneous position:-

** How long did the runner spend at any location?

- Each position has been linked to a time, but how long did that time last?

** You could say "an instant," but how long is that?

** If an instant lasts for any finite amount of time, then the runner would have stayed at the same position during that time, and she would not have been moving.

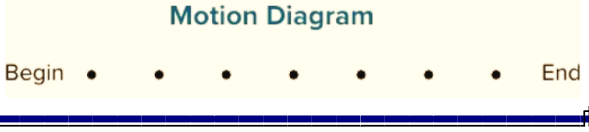
** An instant is not a finite period of time, however.

** It lasts zero seconds.

** The symbol x represents the runner's instantaneous position-the position at a particular instant.

** Instantaneous position is usually simply called position.

Equivalent representations:-



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The different ways to describe motion:-

- Words
- Pictures (or pictorial representations)
- Motion diagrams
- Data tables
- position-time graphs

** All of these representations contain the same information about the runner's motion.

** However, depending on what you want to learn about an object's motion, some types of representations will be more useful than others.

EXAMPLE Problem 1

ANALYZE A POSITION-TIME GRAPH When did the runner whose motion is described in **Figure 11** reach 12.0 m beyond the starting point? Where was she after 4.5 s?



1 ANALYZE THE PROBLEM

Restate the questions.

Question 1: At what time was the magnitude of the runner's position (x) equal to 12.0 m?

Question 2: What was the runner's position at time $t = 4.5$ s?

2 SOLVE FOR THE UNKNOWN

Question 1

Examine the graph to find the intersection of the best-fit line with a horizontal line at the 12.0 m mark. Next, find where a vertical line from that point crosses the time axis. The value of t there is 2.4 s.

Question 2

Find the intersection of the graph with a vertical line at 4.5 s (halfway between 4.0 s and 5.0 s on this graph). Next, find where a horizontal line from that point crosses the position axis. The value of x is approximately 22.5 m.

10. The graph in **Figure 13** represents the motion of a car moving along a straight highway. Describe in words the car's motion.

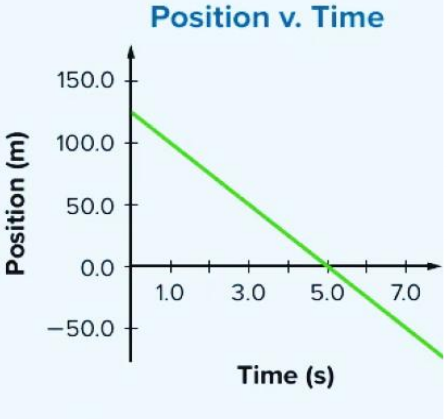


Figure 13

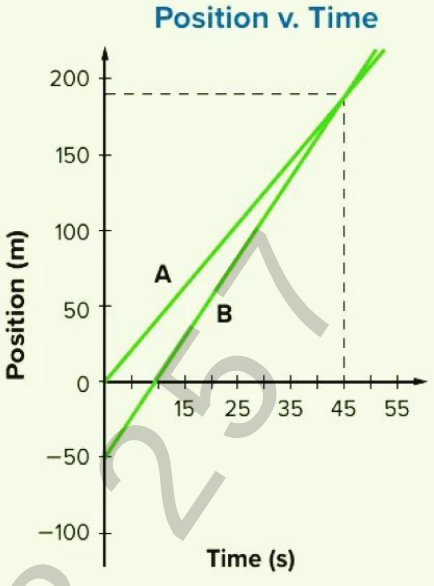
** The car is moving in the negative direction at a constant speed.

** It starts at a position of 150 meters and its position decreases over time.

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EXAMPLE Problem 2

INTERPRETING A GRAPH The graph to the right describes the motion of two runners moving along a straight path. The lines representing their motion are labeled A and B. When and where does runner B pass runner A?



1 ANALYZE THE PROBLEM

Restate the questions.

Question 1: At what time are runner A and runner B at the same position?

Question 2: What is the position of runner A and runner B at this time?

2 SOLVE FOR THE UNKNOWN

Question 1

Examine the graph to find the intersection of the line representing the motion of runner A with the line representing the motion of runner B. These lines intersect at time 45 s.

Question 2

Examine the graph to determine the position when the lines representing the motion of the runners intersect. The position of both runners is about 190 m from the origin.

Runner B passes runner A about 190 m beyond the origin, 45 s after A has passed the origin.

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13	Convert a particle model to a position time graph and vice-versa	Check your progress	41

20. **Particle Diagram** Using the particle model motion diagram in **Figure 16** of a baby crawling across a kitchen floor, plot a position-time graph to represent the motion. The time interval between dots on the diagram is 1 s.

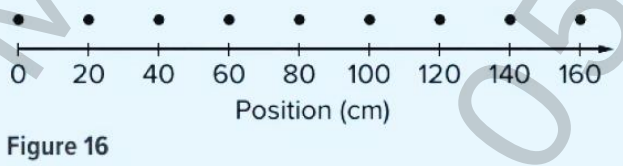
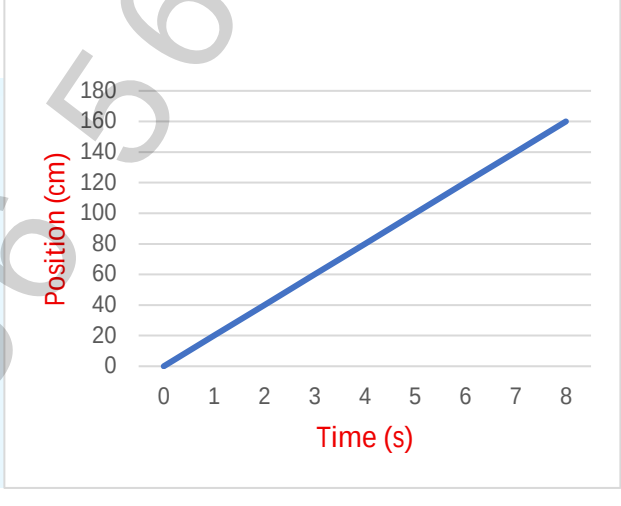


Figure 16



*For problems 21–24, refer to **Figure 17.***

21. **Particle Model** Create a particle model motion diagram from the position-time graph of a hockey puck gliding across the ice.

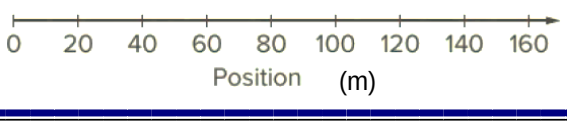




Figure 17

22. **Time** Use the hockey puck's position-time graph to determine the time when the puck was 10.0 m beyond the origin.

t = 0.5 s

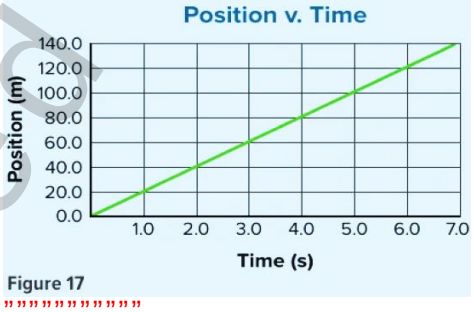


Figure 17

23. **Distance** Use the position-time graph to determine how far the hockey puck moved between 0.0 s and 5.0 s.

d = 100 m

24. **Time Interval** Use the position-time graph for the hockey puck to determine the time it took for the puck to go from 40.0 m beyond the origin to 80.0 m beyond the origin.

$\Delta t = 4 - 2 = 2s$

25. **Critical Thinking** Look at the diagram and graph shown in **Figure 18**. Do they describe the same motion? Explain. The time intervals in the particle model diagram are 2 s.

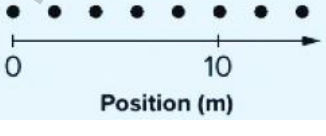




Figure 18

** No, because they do not show the same motion. Although both objects are moving in the positive direction, one is moving faster than the other. Students can cite a number of different examples from the diagram and the particle model to support this principle.

** For example, the particle model shows the position of 2 s 2 m after 2 m, but the diagram shows the position of 2 s 8 m after 2 m.

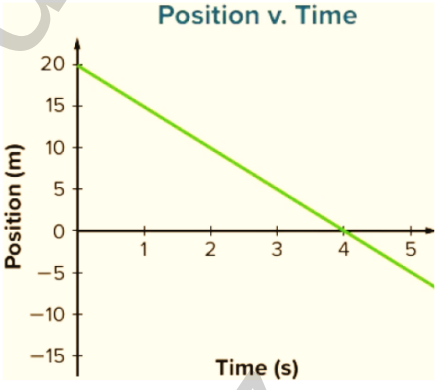
2.4

15	**Apply the equation of motion, ($x_f = v_{avg}\, t + x_i$) or ($x_f - x_i = v_{avg}\, t$), in numerical problems to calculate the position or other physical quantities**	**Student Textbook Example problem**	**46 47**

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Equation of Motion:-



** Often it is more efficient to use an equation, rather than a graph, to solve problems.

** Any time you graph a straight line, you can find an equation to describe it.

** The object moving with a constant velocity of -5.0 m/s.

** Recall that you can represent any straight line with the equation y=mx+b.

- where y is the quantity plotted on the vertical axis.
- m is the line's slope.
- x is the quantity plotted on the horizontal axis.
- b is the line's y-intercept.

** The quantity plotted on the vertical axis is position, represented by the variable x.

** The line's slope is -5.0 m/s, which is the object's average velocity ($\bar{V}$).

** The quantity plotted on the horizontal axis is time (t).

** The y-intercept is 20.0 m.

***** What does this 20.0 m represent?***

- This shows that the object was at a position of 20.0 m when 10.0 s.
- This is called the initial position of the object and it is designated x_i.

***** The mathematical equation for the line graphed is as follows:-***

$$y = (-5.0\ \text{m/s})x + 20.0\ \text{m}$$

You can rewrite this equation, using x for position and t for time.

$$x = (-5.0\ \text{m/s})t + 20.0\ \text{m}$$

** It might be confusing to use y and x in math but use x and t in physics.

** You do this because there are many types of graphs in physics, including position v. time graphs, velocity v. time graphs, and force v. position graphs. Fo a position v. time graph.

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** The math equation y=mx+b can be rewritten as follows:-

Position

An object's position is equal to the average velocity multiplied by time plus the initial position.

$$x = \bar{v}t + x_i$$

CONNECTING MATH to Physics

Lines and Graphs Symbols used in the point-slope equation of a line relate to symbols used for motion variables on a position-time graph.

General Variable	Specific Motion Variable	Value in Figure 20
y	x	
m	$\bar{v}$	−5.0 m/s
x	t	
b	x_i	20.0 m

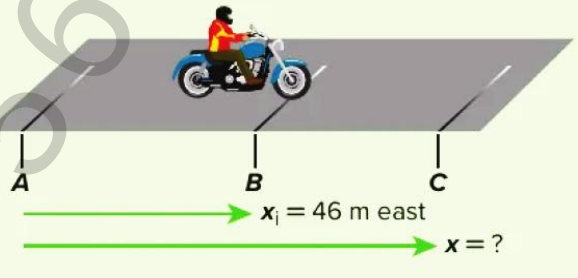
EXAMPLE Problem 4

POSITION The figure shows a motorcyclist traveling east along a straight road. After passing point ***B***, the cyclist continues to travel at an average velocity of 12 m/s east and arrives at point ***C*** 3.0 s later. What is the position of point ***C***?

1 ANALYZE THE PROBLEM

Choose a coordinate system with the origin at ***A***.

KNOWN	UNKNOWN
$\bar{v} = 12$ m/s east	$x = ?$
$x_i = 46$ m east	
$t = 3.0$ s	



2 SOLVE FOR THE UNKNOWN

$x = \bar{v}t + x_i$ Use magnitudes for the calculations.

$= (12 \text{ m/s})(3.0 \text{ s}) + 46 \text{ m}$ Substitute $\bar{v} = 12$ m/s, $t = 3.0$ s, and $x_i = 46$ m.

$= 82$ m

$x = 82$ m east

3 EVALUATE THE ANSWER

- **Are the units correct?** Position is measured in meters.
- **Does the direction make sense?** The motorcyclist is traveling east the entire time.

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1. 1. What is a magnitude?

   a) .A direction.
   b) A numeric value

2. A scalar is a magnitude _____.

   a) Without direction.
   b) With direction

3. The height of wall 10 m .Vector or scalar?

   a) scalar
   b) vector

4. Distance and direction of an object's change in position from a starting point

   a) point
   b) distance
   c) displacement
   d) motion reference

5. . A deer running 15 meters per second due west.Vector or scalar?

   a) vector
   b) scalar

6. Amy runs 2 miles south, then turns around and runs 3 miles north. What is displacement?

   a) 2 miles south
   b) 5 miles
   c) 1 mile north
   d) 1 mile

7. Which of the following is always positive?

   a) scalar
   b) direction
   c) vector
   d) magnitude

8. The _____ of two or more vectors is the sum of the vectors.

   a) resultant
   b) scalar
   c) magnitude
   d) components

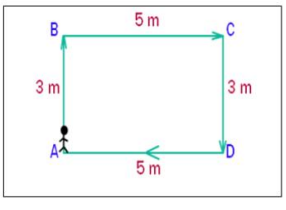
9. Which one of the following is not the property of a vector quantity?

   a) Direction
   b) Magnitude
   c) Unit
   d) Location

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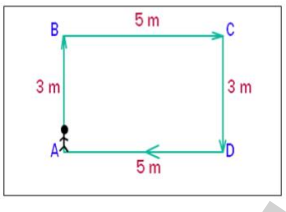
10. Which symbol is used to show vector quantities?

a) Circle
b) Triangle
c) Line
d) Arrow

11. 

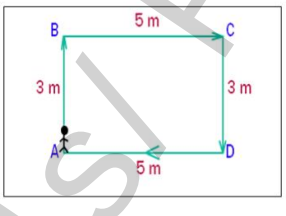
Sara walks from Point A to Point B. Which is true?

a) Distance is less than displacement
b) Distance and displacement are EQUAL

12. 

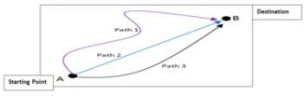
Find the distance Sara walks from A to B, B to C then C to D?

a) 3 m
b) 5 m
c) 8 m
d) 11 m

13. 

Michael walks in the following order: from Point A, to Point B, and finally to Point C. Which is true?

a) Distance and displacement are EQUAL
b) Distance is less than displacement
c) Displacement is less than distance.

14. 

Which driver has an equal distance and displacement at B?

a) 2
b) 1
c) 3

15. Vector addition is the same as scalar addition.

a) False
b) True

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16. Coordinate systems are not important when solving problems with vectors as long as the proper scalars are used.

a) False
b) true

17. Scott travels north 5 miles and then goes west 3 miles before coming straight back south 2 miles. What is his distance?

a) 8
b) 10
c) 6
d) 7

18. Distance and direction of an object's change in position from a starting point

a) displacement
b) motion
c) reference point
d) distance

19. Jermaine runs exactly 2 laps around a 400 meter track. What is the displacement?

a) 400
b) 800
c) 0
d) 200

20. David walks 3 km north, and then turns east and walks 4 km. What is the distance?

a) 7 km
b) 1 km
c) 4 km
d) 3 km

21. Bill runs 400 meters to Andy's house, turns around, and runs 400 meters back home. What is Bill's distance?

a) 1600 meters
b) 0 meters
c) 400 meters
d) 800 meters

1. Final position minus the initial position is called

a) distance
b) magnitude
c) displacement
d) time interval

2. _____ is an objects position at a particular instant.

a) new position
b) final position
c) real position
d) instantaneous position

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3. What is the resultant of two displacement vectors having the same direction?

a) The resultant is the sum of the two displacements having the direction opposite to the direction of the original vectors.

b) The resultant is the difference of the two displacements having the same direction as the original vectors.rs

c) The resultant is the sum of the two displacements having the same direction as the original vectors.

d) The resultant is the sum of the two displacements having the direction perpendicular to the direction of the original vectors.

4. A car is moving with a uniform speed of 15.0m/s along a straight path. What is the distance covered by the car in 12.0 minutes?

a) .180km

b) 108km

c) 10,800km

d) 10.8km

5. A racehorse is running with a uniform speed of 69 km/hr along a straightaway. What is the time it takes for the horse to cover 400 meters?

a) 2.1 minutes

b) 21 seconds

c) 27.6 hours

d) 0.35 hours

7. Which of the following quantities can be determined from a position vs time graph? (3 correct choices)

a) the cardinal direction the object was moving in

b) the mass of the object

c) where the object is in relation to the origin

d) how much time it took to get to a certain location

e) average velocity of the object

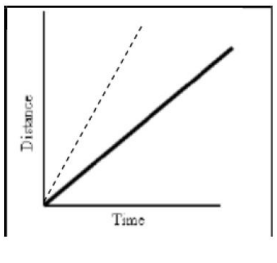
8. Which of the following statements describe constant motion? (2 correct choices)

a) the position vs time graph is linear

b) an object changes its postion the same amount between each time interval

c) an object changes its postion more between each time interval

d) the position vs time graph is parabolic

10. 

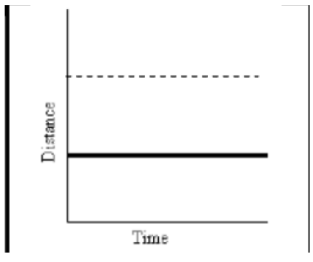
What does this graph represent?

a) Not moving

b) Constant Speed

c) Acceleration

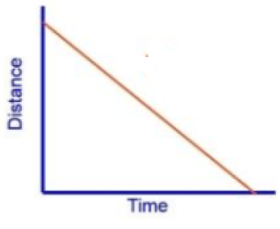
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11. 

What does this graph represent?

a) Constant speed
b) Not moving
c) Acceleration

12. What is this line of this graph showing?



a) moving away from starting point at a constant speed
b) deceleration (getting slower)
c) moving back towards the starting point at a constant speed
d) acceleration (getting faster)

13. 

A runner races in the 100 meter dash. It takes her 10 seconds to finish. What is her average speed?

a) 100 seconds
b) 1000 m/s
c) 10 m/s
d) 10 seconds

14. 

Shona cycles at an average speed of 8km/h. How far has she travelled if she cycles for 4 hours?

a) 32km
b) 55km
c) 43km
d) 32miles

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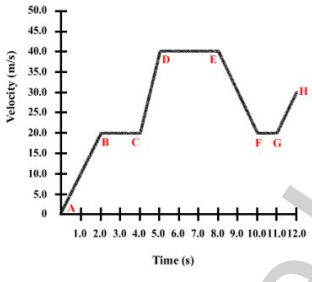
15. 

Bob runs from 4:50 pm until 5:20pm at an average speed of 7km/h. How far did he go?

a) 14km
b) 3.5km
c) 4.5km
d) 2.5km

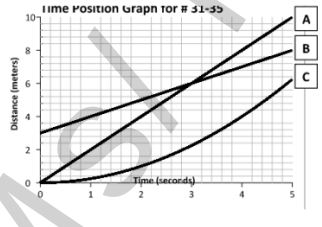
16. On a distance vs. time graph, the steeper the slope _____

a) less acceleration
b) greater acceleration
c) the faster the speed
d) the slower the speed

17. 

During which interval is the object speeding up?

a) E to F
b) D to E
c) A to B
d) B to C

19. 

At what time did runner A pass runner B?

a) 0 seconds
b) 1 second
c) 3 seconds
d) 2 seconds

1. What is the equation of speed?

a) Displacement/Time
b) Rise/Run
c) Meter/Second
d) Distance/Time

2. What is the equation of slope?

a) Rise/Run
b) All of the above
c) Distance/time
d) Meter/Second

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3. What is the equation of velocity?

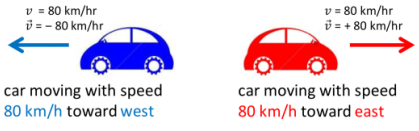
a) Distance/time

b) Rise/Run

c) Mass x acceleration

d) Displacement/Time

4. Speed and Velocity



a) Both cars have the same velocity and the same speed

b) Both cars have different speed but same velocity

c) All of the above

d) Both cars have the same speed but different velocity

5. A man jogs for a distance of 1600 m to south in 400 s at constant velocity. Calculate:
a) The speed of the man.
b) The velocity of the man.

a) B = 4m/s to south

b) B = 4m/s to East

c) A = 6m/s

d) A= 4m/s

6. A biker travels 120 km to north in 2 hours at constant velocity. Calculate:
a) The speed of the biker.
b) The velocity of the biker.

a) B = 60 km/hr to East

b) B = 60km/hr to north

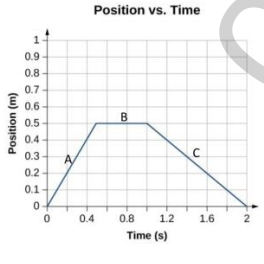
c) A = 60 m/s

d) A = 60km/hr

7. 1. What is the instantaneous velocity at A?

2. What is the average velocity for A and B?

3. What is the average speed for the whole journey (A-B-C)?



What is the answer of 1?

a) 1.5 m/s

b) 1 m/s

c) 0.5 m/s

d) -1m/s

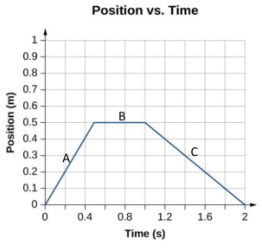
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8.

1. What is the instantaneous velocity at A?

2. What is the average velocity for A and B?

3. What is the average speed for the whole journey (A-B-C)?



What is the answer of 2?

a) -1m/s

b) -0.5m/s

c) +1m/s

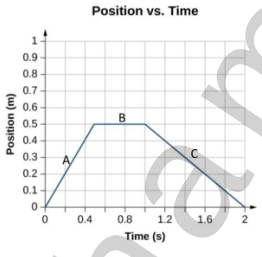
d) +0.5m/s

9.

1. What is the instantaneous velocity at A?

2. What is the average velocity for A and B?

3. What is the average speed for the whole journey (A-B-C)?



What is the answer for 3?

a) +1m/s

b) -1m/s

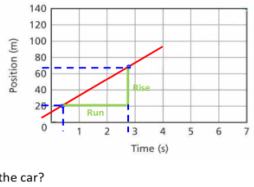
c) +0.5m/s

d) -0.5m/s

10.

EX: The opposite position-time graph represents the motion of a car. Use the graph to answer the following:

(a) The slope of the line:



(b) What is the average velocity of the car?

(c) What is the average speed of the car?

(d) What is the initial position of the car?

What is the answer of question A?

a) 2m/s

b) 20km/hour

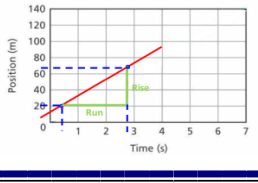
c) 50m/s

d) 20m/s

11.

EX: The opposite position-time graph represents the motion of a car. Use the graph to answer the following:

(a) The slope of the line:



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(b) What is the average velocity of the car?

(c) What is the average speed of the car?

(d) What is the initial position of the car?

What is the answer of B?

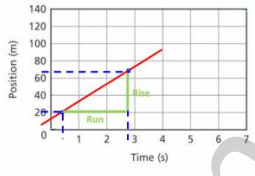
a) 20m/s abject moves down

b) 20m/s abject moves to the left

c) 20 m/s object moves to the right

d) 20m/s object moves up

12. EX: The opposite position-time graph represents the motion of a car. Use the graph to answer the following:



(a) The slope of the line:

(b) What is the average velocity of the car?

(c) What is the average speed of the car?

(d) What is the initial position of the car?

What is the answer of C?

a) 19m/s

b) 15m/s

c) 20m/s

d) 25m/s

3.1

16	Recognize uniform or non-uniform motion from a motion diagram or a particle model.	Student Textbook	53,58
17	Describe the motion of an object if its velocity and acceleration are either in the same direction or opposite directions, hence state if an object is slowing down or speeding up	Student Textbook	56

Nonuniform Motion Diagrams:-

** An object in uniform motion moves along a straight line with an unchanging velocity, but few objects move this way all the time.

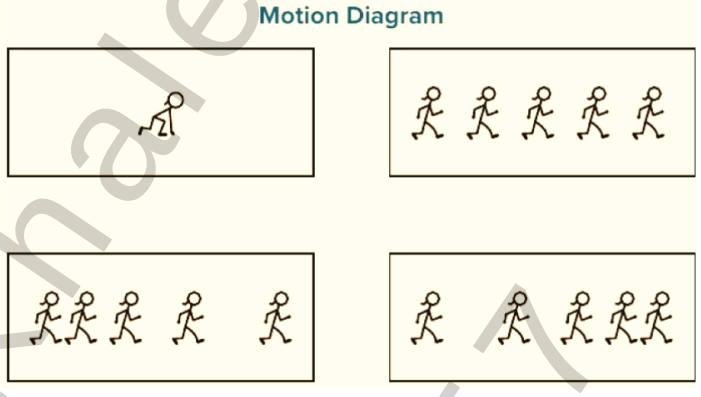
** More common is nonuniform motion, in which velocity is changing.

** Examples include balls rolling down won hills, cars braking to a stop, and falling objects.

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Describing nonuniform motion:-



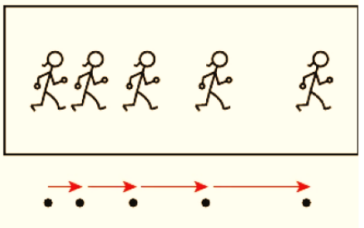
** In the first diagram in Figure 1, the single image indicates that the person is motionless, like a runner waiting for the signal at the start of a race.

** In the other diagrams, the distances between successive positions change in different ways.

** In the second diagram, the distances are the same, which indicates that the jogger is in uniform motion at a constant velocity.

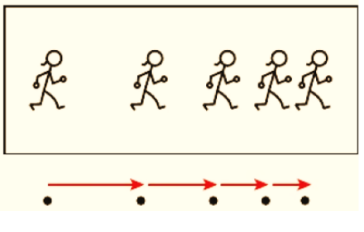
** In the third diagram, the distance increases because the jogger speeds up.

** In the fourth diagram, the distance decreases because the jogger slows down.



Particle model diagram:-

***** What does a particle model motion diagram look like for an object with changing velocity?**



** The change in the spacing of the dots and the differences in the lengths of the velocity vectors indicate the changes in velocity.

** If an object speeds up, each subsequent velocity vector is longer, and the spacing between dots increases.

** If the object slows down, each vector is shorter than the previous one, and the spacing between dots decreases.

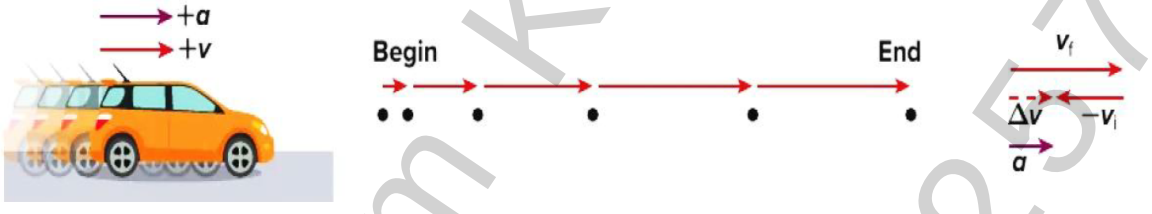
** Both types of motion diagrams indicate how an object's velocity is changing.

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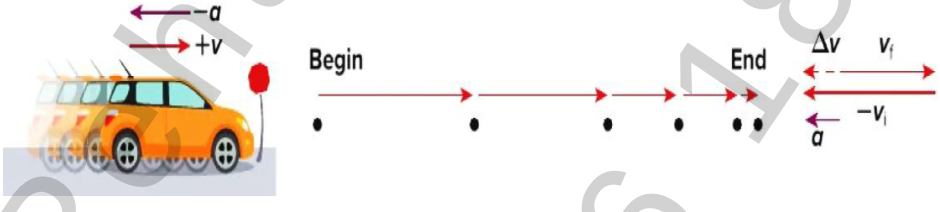
Direction of Acceleration:-

** Consider the four situations shown in Figure 4 in which an object can accelerate by changing speed.

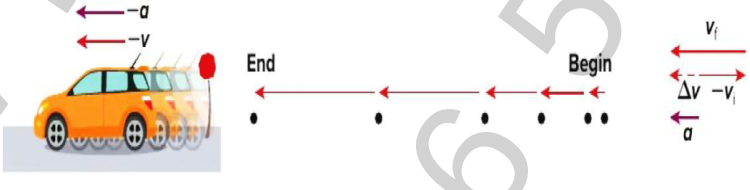
** The first motion diagram shows the car moving in the positive direction and speeding up.



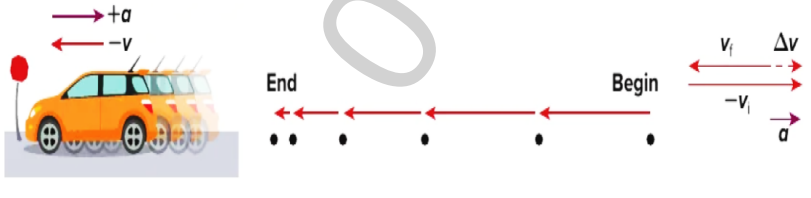
** The second motion diagram shows the car moving in the positive direction and slowing down.



** The third shows the car speeding up in the negative direction.



** The fourth shows the car slowing down as it moves in the negative direction.



** The figure also shows the velocity vectors for the second time interval of each diagram, along with the corresponding acceleration vectors.

** Note that Δt is equal to 1 s.

** In the first and third situations, when the car is speeding up, the velocity and acceleration vectors point in the same direction.

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** In the other two situations, in which the acceleration vector is in the opposite direction from the velocity vectors, the car is slowing down.

** When the car's-acceleration is in the same direction as its velocity, the car's speed increases.

** When they are in opposite directions, the speed of the car decreases.

** Both the direction of an object's velocity and its direction of acceleration are needed to determine whether it is speeding up or slowing down.

** An object has a positive acceleration:- - When the acceleration vector points in the positive direction.

** An object has a negative acceleration:- - When the acceleration vector points in the negative direction.

** It is important to notice that the sign of acceleration alone does not indicate whether the object is speeding up or slowing down.

Average and Instantaneous Acceleration:-

** The acceleration of most moving objects continually changes.

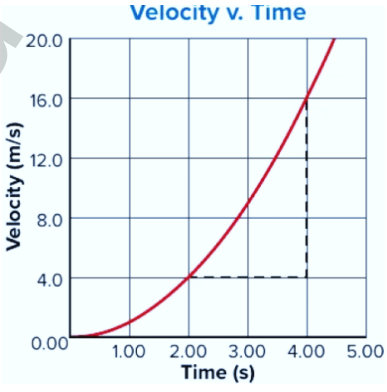
**** The average acceleration of an object:-*** is its change in velocity during some measurable time interval divided by that time interval.

** Average acceleration is measured in meters per second per second (m/s/s), or simply meters per second squared (m/s^2).

** An average velocity depends only on the starting and ending displacement.

** An average acceleration depends only on the starting and ending velocity during a time interval.

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** Figure 7 shows a graph of motion in which the acceleration is changing.

** Notice, however, that because the line is curved, the average acceleration in this graph varies depending on the time interval that you choose.

** ***Instantaneous acceleration:-*** is the change in an object's velocity at an instant of time.

** You can determine the instantaneous acceleration of an object by drawing a tangent line on the velocity-time graph at the point of time in which you are interested.

** ***A tangent line:-*** is a line that intersects the graph at one and only one point.

** The slope of this line is equal to the instantaneous acceleration.

** When the acceleration is the same at all points during a time interval, the average acceleration and the instantaneous accelerations are equal.

18	Explain how an object can accelerate while moving at a constant speed	Student Textbook Check your progress	62

Acceleration with Constant Speed:-

** Think again about running wind sprints across the gym.

** You first run at a speed of 4.0 m/s toward the wall.

** Then, 10.0 s later, you are running away from the wall and your speed is 4.0 m/s.

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** Notice that your speed is the same as you move toward the wall of the gym and as you move away from it. In both cases, you are running at a speed of 4.0 m/s.

** How is it possible for you to be accelerating?

** Acceleration can occur even when speed is constant.

** The average acceleration for the entire trip you make toward the wall of the gym and back again is -0.80 m/s².

** The negative sign indicates that the direction of your acceleration is away from the wall because the positive direction was chosen as toward the wall.

** The velocity changes from positive to negative when the direction of motion changes.

** A change in velocity results in acceleration.

** Thus, acceleration can also be associated with a change in the direction of motion.

11. **Describing Motion** What are three ways an object can accelerate?

1/ Speed increases. 2/ speed decreases. 3/ direction changes

12. **Position-Time and Velocity-Time Graphs** Two joggers run at a constant velocity of 7.5 m/s east. **Figure 10** shows the positions of both joggers at time $t = 0$.

a. What would be the difference(s) in the position-time graphs of their motion?



Figure 10

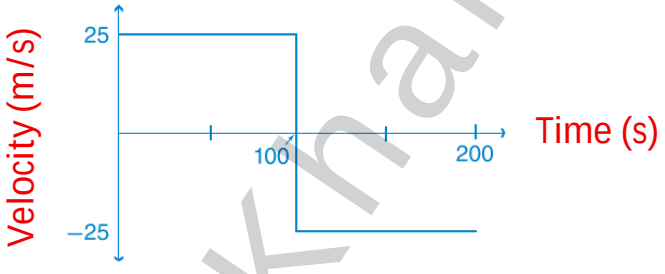
- Both lines will have the same slope but will rise –15 m, +15 m, at different points on the x-axis.

b. What would be the difference(s) in their velocity-time graphs?

Their velocity-time graphs will be identical.

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13. **Velocity-Time Graph** Sketch a velocity-time graph for a car that goes east at 25 m/s for 100 s, then west at 25 m/s for another 100 s.



14. **Average Velocity and Average Acceleration** A canoeist paddles upstream at a velocity of 2.0 m/s for 4.0 s and then floats downstream at 4.0 m/s for 4.0 s.

a. What is the average velocity of the canoe during the 8.0-s time interval?

1 m/s down

b. What is the average acceleration of the canoe during the 8.0-s time interval?

-0.75 m/s2 down

15. **Critical Thinking** A police officer clocked a driver going 32 km/h over the speed limit just as the driver passed a slower car. When the officer stopped the car, the driver argued that the other driver should get a ticket as well. The driver said that the cars must have been going the same speed because they were observed next to each other. Is the driver correct? Explain with a sketch and a motion diagram.

No; the two cars had the same position, not the same velocity. To have the same velocity, they had to have the same relative position for a period of time.

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1. Acceleration is

a) when you speed up only
b) the change in velocity
c) the rate of change
d) the rate at which velocity changes.

2. Velocity has two components
(pick 2 below)

a) slow down
b) speed up
c) change in speed
d) direction

3. In science, acceleration refers to

a) increasing speed
b) changing direction
c) decreasing speed
d) increasing speed only

4. What does it mean when a change in velocity is negative?

a) The object is speeding up.
b) The object is falling down.
c) The object is slowing down.
d) The object is changing direction.

5. In each of the following cases, determine where the car has no acceleration ?

a) A car shortly after a stoplight turns green.
b) A car approaching a red light
c) A car turning a curve at a constant speed
d) A car with the cruise control set at 80 km/h

6. Which of the following is a unit for acceleration?

a) ft
b) km/s
c) mi/hr
d) m/s^2

20. The light turns red, and you ease to a halt. Checking your stopwatch, you see that you stopped in 4.5 seconds. Your acceleration was 1.23×10^{-3} miles per $second^2$ in a direction opposite to your original velocity. What was your original speed in miles per hour?

a) 39.0 mi/h
b) 19.9 mi/h
c) 34 mi/h
d) 29 mi/h

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14. If you are test-driving a Bugatti Veyron and you go from 0 km/s to 124 km/s in 3.7 seconds, what was your acceleration?

a) 33.5 m/s^2 b) -33.5 m/s^2

c) 0.03 m/s^2 d) -0.03 m/s^2

15. A plane lands on the runway and slows from 758 km/hr to 30 km/hr in 0.013 hours. What is the plane's acceleration in m/s^2?

a) 56,000 m/s^2 b) -17857 m/s^2

c) -56,000 m/s^2 d) 17857 m/s^2

16. What is the final velocity of a rocket that travels for 4 seconds, has an initial velocity of 12 km/s and an acceleration of 2 km/s^2?

a) 10 km/s b) -10 km/s

c) 20 km/s d) -4 km/s

17. 

A golf ball accelerates off a tee at 15m/s^2, changing its velocity from 0m/s to 50 m/s down the fairway. How long did it take the golf ball to accelerate?

a) 3.3 seconds b) 35 seconds

c) 750 seconds d) 0.3 seconds

18. The building with the highest occupiable floor is currently the Sears Tower in Chicago. The top floor of the Sears Tower is 110 stories (436 m) above street level, and the roof of the tower is 442 m above the street. Assume a golf ball is thrown downward from the roof of the Sears Tower. Neglecting air resistance, the golf ball accelerates at 9.8 m/s2 and lands on the pavement after 9.2 s. If the ball's final speed is 93.0 m/s, what was the speed with which the ball was initially thrown?

a) 3 m/s b) 12 m/s

c) 19.9 m/s d) 34.2 m/s

19. Which of the following is not accelerating?

a) a satellite circling Earth b) a braking cyclist

c) a ball being juggled d) a woman walking at 2.5 m/s along a straight road

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3.2

19	Apply the equation of motion relating the final velocity of an object to its initial velocity, uniform acceleration, and time ($v_f = v_i + at$).	Practice problems (16, 17,18)	65

Velocity with Average Acceleration:-

** You can rewrite the definition of average acceleration ($\bar{a} = \frac{\Delta v}{\Delta t}$) as follows:

$$\Delta v = \bar{a}\Delta t$$

$$v_f - v_i = \bar{a}\Delta t$$

** The equation for final velocity with average acceleration can be written:

Final Velocity with Average Acceleration

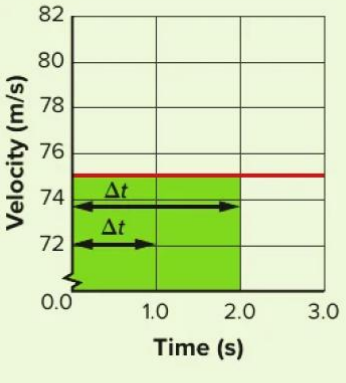
The final velocity is equal to the initial velocity plus the product of the average acceleration and the time interval.

$$v_f = v_i + \bar{a}\Delta t$$

** In cases when the acceleration is constant, the average acceleration ($\bar{a}$) is the same as the instantaneous acceleration (a) at any point within the time interval.

EXAMPLE Problem 3

FINDING DISPLACEMENT FROM A VELOCITY-TIME GRAPH The velocity-time graph at the right shows the motion of an airplane. Find the displacement of the airplane for $\Delta t = 1.0$ s and for $\Delta t = 2.0$ s. Let the positive direction be forward.



1 ANALYZE AND SKETCH THE PROBLEM

- The displacement is the area under the *v*-*t* graph.
- The time intervals begin at $t = 0.0$ s.

KNOWN	UNKNOWN
$v = +75$ m/s	$\Delta x = ?$
$\Delta t = 1.0$ s	
$\Delta t = 2.0$ s	

2 SOLVE FOR THE UNKNOWN

Use the relationship among displacement, velocity, and time interval to find Δx during $\Delta t = 1.0$ s.

$\Delta x = v\Delta t$

$= (+75 \text{ m/s})(1.0 \text{ s})$ Substitute $v = +75$ m/s, $\Delta t = 1.0$ s.

$= +75$ m

Use the same relationship to find Δx during $\Delta t = 2.0$ s.

$\Delta x = v\Delta t$

$= (+75 \text{ m/s})(2.0 \text{ s})$ Substitute $v = +75$ m/s, $\Delta t = 2.0$ s.

$= +150$ m

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16. A golf ball rolls up a hill toward a miniature-golf hole. Assume the direction toward the hole is positive.

a. If the golf ball starts with a speed of 2.0 m/s and slows at a constant rate of 0.50 m/s², what is its velocity after 2.0 s?

1.0 m/s

b. What is the golf ball's velocity if the constant acceleration continues for 6.0 s?

−1.0 m/s

c. Describe the motion of the golf ball in words and with a motion diagram.

- In the first case, the ball's vector velocity decreased.
- In the second case, the ball's velocity decreased until it stopped and then began to move down the inclined plane.

17. A bus traveling 30.0 km/h east has a constant increase in speed of 1.5 m/s². What is its velocity 6.8 s later?

67 km/h east

18. If a car accelerates from rest at a constant rate of 5.5 m/s² north, how long will it take for the car to reach a velocity of 28 m/s north?

5.1 s

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Galileo's Discovery:-

** Do heavier objects accelerate more as they fall?

** If you release a paper and a book, the book hits the ground first.

** But if you put the paper flat on the book, they fall together.

** Collisions with particles of air have a greater effect on the paper.

** To understand falling objects, first consider the case in which air does not have an appreciable effect on motion.

** *Gravity:-* is an attraction between objects.

** *Free fall:-* is the motion of an object when gravity is the only significant force acting on it.

** About 400 years ago, Galileo Galilei discovered that, neglecting the effect of the air, all objects in free fall have the same acceleration.

** It doesn't matter what they are made of or how much they weigh.

** *Free-fall acceleration:-* is the acceleration of an object due only to the effect of gravity.

** Figure 19 depicts the results of a 1971 free-fall experiment on the Moon in which astronauts verified Galileo's results.

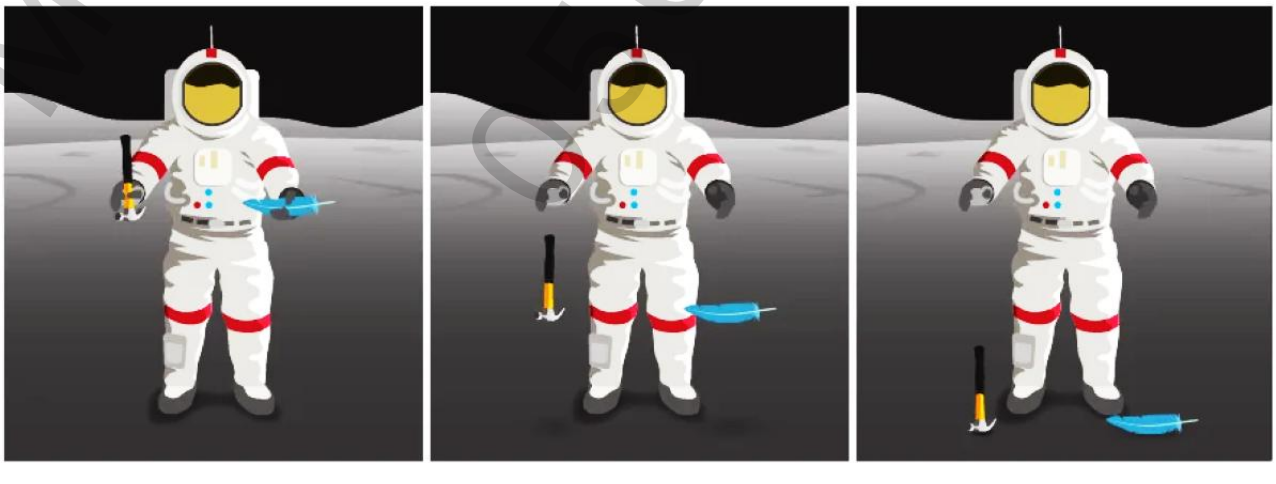


Figure 19 In 1971, astronaut David Scott dropped a hammer and a feather at the same time from the same height above the Moon's surface. The hammer's mass was greater, but both objects hit the ground at the same time because the Moon has gravity but no air.

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** Near Earth's surface, free-fall acceleration is about 9.8 m/s² downward (which is equal to about 22 mph/s downward).

** Think about skydivers. Each second skydivers fall, their downward velocity increases by 9.8 m/s.

** When analyzing free fall, whether you treat the acceleration as positive or negative depends on the coordinate system you use.

** If you define upward as the positive direction, then the free-fall acceleration is negative.

** If you decide that downward is the positive direction, then free-fall acceleration is positive.

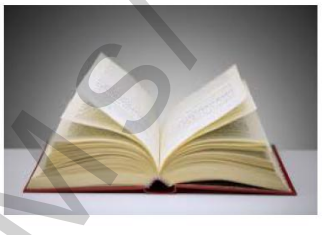
1. 

A textbook is dropped from a second floor window and falls to the ground. What happens to the velocity as the book falls to the ground

a) the velocity remain constant

b) the velocity decreases

c) the velocity increases

2. 

A textbook is dropped from a second floor window and falls to the ground. What happens to the acceleration as the book falls to the ground

a) the acceleration decreases

b) the acceleration remains constant

c) the acceleration increases

3. 

A baseball is thrown up into the air. What direction is the velocity of the ball?

a) upward

b) downward

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4.  A baseball is thrown up into the air. What direction is the acceleration of the ball?

a) upward b) downward

5. **The acceleration of a freely falling body on Earth is**

a) 9.8 s. b) 9.8 m/s^2.

c) 9.8 m. d) 9.8 m/s.

6. Heavier objects free fall faster than lighter objects.(in the absence of the air resistance)

a) True b) False

7. The state that exists when the only force acting on an object is gravity is called

a) free fall b) acceleration

c) momentum d) inertia

10. why does a bungee jumper feel weightless on their way down?

a) because they are really weightless b) because they are falling at constant velocity

c) Because of Lack of support force as they fall d) because their mass is negligible as they fall

Part2/ FRQ

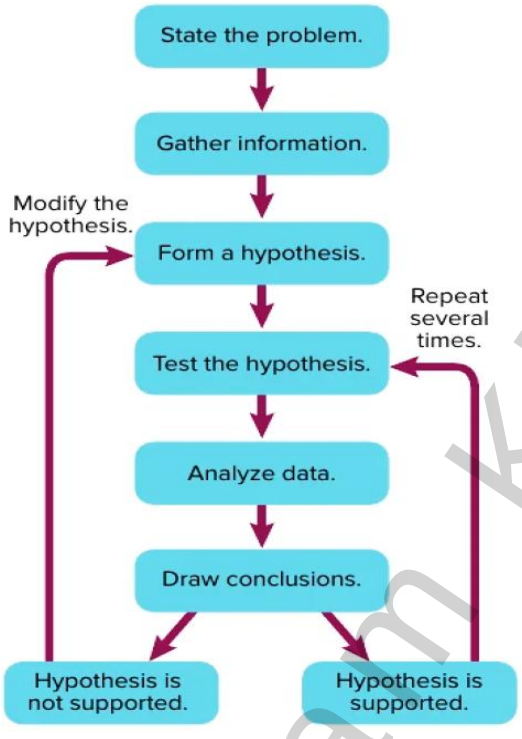
1.1-1.2

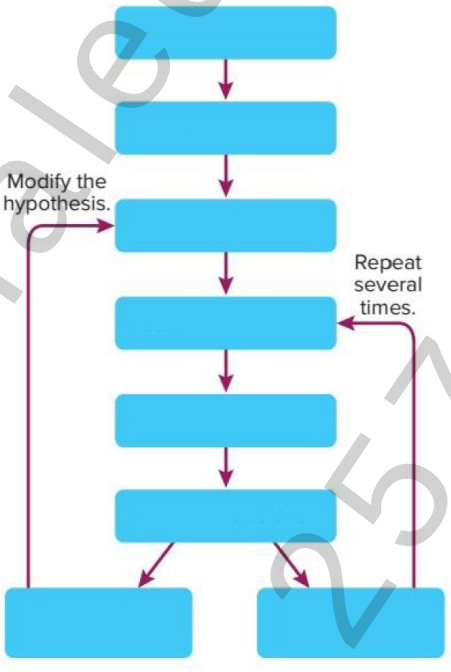
21	**List the common steps of scientific methods used in investigations** **Classify common quantities into base and derived quantities with their SI units**	**Student Textbook**	**4** **9**

*** A scientific method:-* is a set of steps that scientists follow to solve problems depending on investigation.

** Physicists often adjust, repeat, or even skip steps depending on the situation.

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Match each term with its description:

3	**Hypothesis**	1) Scientist who discovered microwave cooking by accident.
5	**Peer review**	2) Careful organization of observations into tables and graphs.
4	**Bias**	3) A testable explanation for a problem.
1	**Percy Spencer**	4) Personal expectations affecting results.
2	**Analyze data**	5) Evaluation of research by scientists in the same field.

Table 1 SI Base Units

Base Quantity	Base Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of a substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

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Match the **SI base quantity** with its **unit**:

6	**Length**	**1)**	Second (s)
3	**Mass**	**2)**	Candela (cd)
1	**Time**	**3)**	Kilogram (kg)
5	**Temperature**	**4)**	Mole (mol)
4	**Amount of substance**	**5)**	Kelvin (K)
7	**Electric current**	**6)**	Meter (m)
2	**Luminous intensity**	**7)**	Ampere (A)

2.2-2.4

22	**-Interpret the motion represented by motion diagrams and particle models.** **-Determine displacement using vector addition or subtraction in one dimension** **-Define and calculate the average speed using a suitable mathematical representation** **-Define and calculate the average velocity using a suitable mathematical representation**	**Student Textbook** **Example problem 3** **Practice problems (26,29)**	**32-35** **36** **45**

EXAMPLE Problem 3

AVERAGE VELOCITY The graph at the right describes the straight-line motion of a student riding her skateboard along a smooth, pedestrian-free sidewalk. What is her average velocity? What is her average speed?

1 ANALYZE AND SKETCH THE PROBLEM

Identify the graph's coordinate systems.

UNKNOWN

$\bar{v} = ?$ $\bar{v} = ?$

2 SOLVE FOR THE UNKNOWN

Find the average velocity using two points on the line.

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

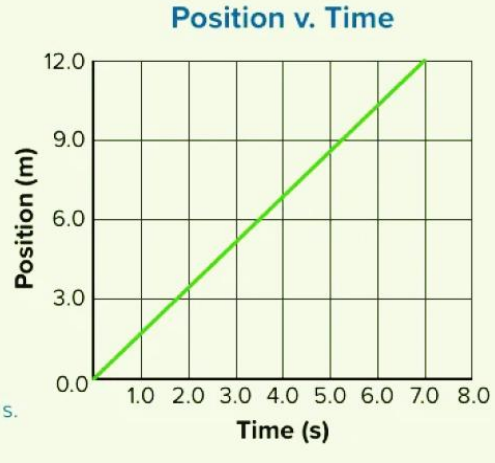
$$= \frac{x_f - x_i}{t_f - t_i}$$

$$= \frac{12.0\text{ m} - 0.0\text{ m}}{7.0\text{ s} - 0.0\text{ s}}$$

Substitute $x_f = 12.0$ m, $x_i = 0.0$ m, $t_f = 7.0$ s, $t_i = 0.0$ s.

$\bar{v} = 1.7$ m/s in the positive direction

The average speed ($\bar{v}$) is the absolute value of the average velocity, or 1.7 m/s.



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26. The graph in **Figure 22** describes the motion of a cruise ship drifting slowly through calm waters. The positive *x*-direction (along the vertical axis) is defined to be south.

a. What is the ship's average speed?

0.3 m/s

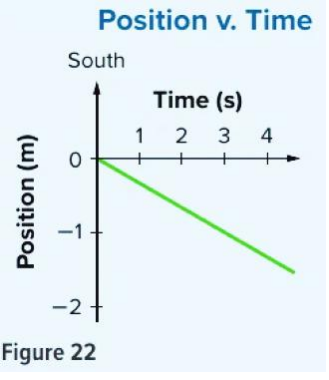


Figure 22

b. What is its average velocity?

- The average vector velocity represents the slope of the line, including the sign, so that it is -0.3 m/s or 0.3 m/s north.

.....

29. The graph in **Figure 23** represents the motion of a bicycle.

a. What is the bicycle's average speed?

0.7 km/min



Figure 23

b. What is its average velocity?

0.7 km/min In the positive direction.

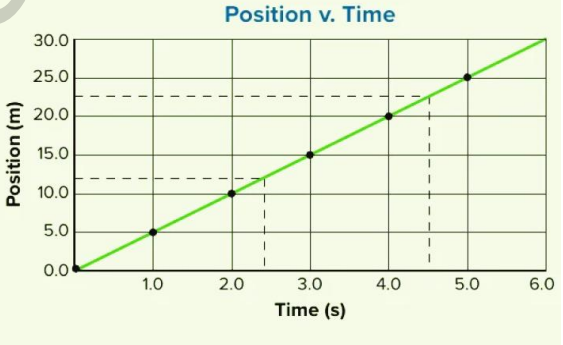
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2.3

23	**-Analyze a position-time graph to describe an object's motion -Calculate average velocity (magnitude and direction) from the slope of a position-time graph during a certain time interval and instantaneous velocity from the slope of a position-time graph at a certain instant**	**Student Textbook Example Problem 1 Practice problems (10, 12) Check your progress (25)**	**37-39 41**

EXAMPLE Problem 1

ANALYZE A POSITION-TIME GRAPH When did the runner whose motion is described in **Figure 11** reach 12.0 m beyond the starting point? Where was she after 4.5 s?



1 ANALYZE THE PROBLEM

Restate the questions.

Question 1: At what time was the magnitude of the runner's position (*x*) equal to 12.0 m?

Question 2: What was the runner's position at time $t = 4.5$ s?

2 SOLVE FOR THE UNKNOWN

Question 1

Examine the graph to find the intersection of the best-fit line with a horizontal line at the 12.0 m mark. Next, find where a vertical line from that point crosses the time axis. The value of *t* there is 2.4 s.

Question 2

Find the intersection of the graph with a vertical line at 4.5 s (halfway between 4.0 s and 5.0 s on this graph). Next, find where a horizontal line from that point crosses the position axis. The value of *x* is approximately 22.5 m

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For problems 10–12, refer to ***Figure 13.***

10. The graph in **Figure 13** represents the motion of a car moving along a straight highway. Describe in words the car's motion.

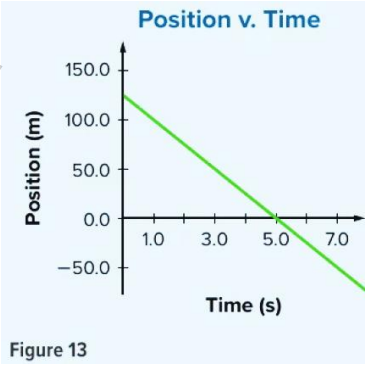
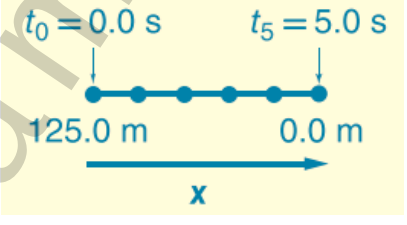


Figure 13

- The car starts from position 125.0 m and moves toward the origin in 5.0 s. Therefore, it reaches the origin after 5.0 s from the start of its movement.
- The car passes the origin.

11. Draw a particle model motion diagram that corresponds to the graph.



12. Answer the following questions about the car's motion. Assume that the positive *x*-direction is east of the origin and the negative *x*-direction is west of the origin.

a. At what time was the car's position 25.0 m east of the origin? 4.0 s

b. Where was the car at time $t = 1.0$ s? 100.0 m

c. What was the displacement of the car between times $t = 1.0$ s and $t = 3.0$ s? 50.0 m

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25. **Critical Thinking** Look at the diagram and graph shown in **Figure 18**. Do they describe the same motion? Explain. The time intervals in the particle model diagram are 2 s.

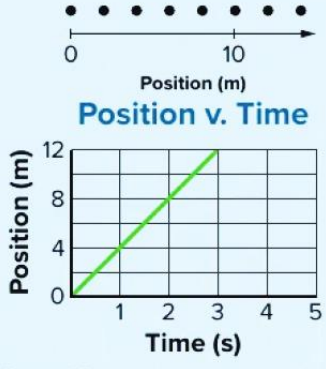


Figure 18

** No, because they do not show the same motion. Although both objects are moving in the positive direction, one is moving faster than the other.

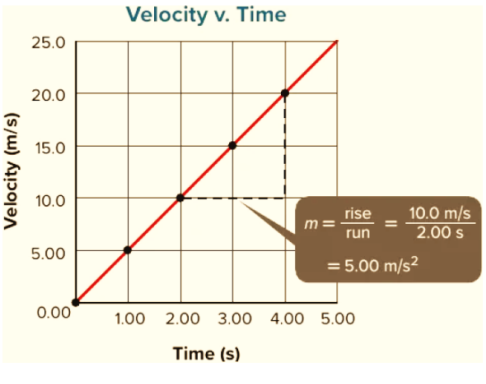
** For example, the particle model shows the position of 2 s 2 m after 2 m, but the diagram shows the position of 2 s 8 m after 2 m.

3.1

24	-Interpret the velocity-time graph for a single or multiple objects in motion -Find the slope and y-intercept of a velocity-time graph to describe the motion of an object	Student Textbook Example problem 1 Practice problems (1,2,3,4)	57 60

Velocity-Time Graphs:-

**** On a velocity-time graph, or v-t graph:-** velocity is plotted on the vertical axis and time is plotted on the horizontal axis.



Slope:-

** The velocity-time graph for a car that started at rest and sped up along a straight stretch of road is shown in Figure 5.

** The positive direction has been chosen to be the same as that of the car's motion.

** Notice that the graph is a straight line.

** This means the car sped up at a constant rate.

** The rate at which the car's velocity changed can be found by calculating the slope of the velocity-time graph.

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** The graph shows that the slope is 5.00 (m/s)/s, which is often written as 5.00 m/s^2.

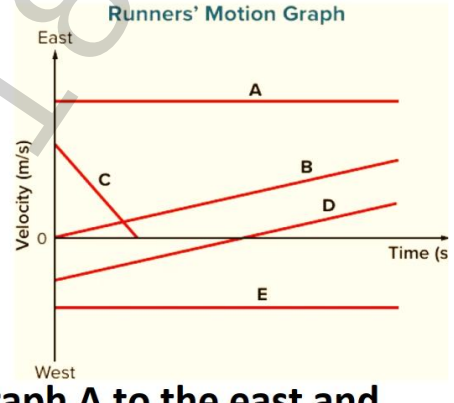
** Consider the time interval between 4.00 s and 5.00 s. At 4.00 s, the car's velocity was 20.0 m/s in the positive direction.

** At 5.00 s, the car was traveling at 25.0 m/s in the same direction.

** Thus, in 1.00 s, the car's velocity increased by 5.0 m/s in the positive direction.

** When the velocity of an object changes at a constant rate, it has a constant acceleration.

Reading velocity-time graphs:-



** The motions of five runners are shown in Figure 6.

** Assume that the positive direction is east.

** The slopes of Graphs A and E are zero.

** Thus, the accelerations are zero.

** Both graphs show motion at a constant velocity-Graph A to the east and Graph E to the west.

** Graph B shows motion with a positive velocity eastward.

- Its slope indicates a constant, positive acceleration.
- You can infer that the speed increases because velocity and acceleration are positive.

** Graph C has a negative slope.

- It shows motion that begins with a positive velocity, slows down, and then stops.
- This means the acceleration and the velocity are in opposite directions.

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**** The point at which Graphs C and B cross shows that the runners' velocities are equal at that time.**

**** It does not, however, identify their positions.**

**** Graph D indicates motion that starts out toward the west, slows down, for an instant has zero velocity, and then moves east with increasing speed.**

- **The slope of Graph D is positive. Because velocity and acceleration are initially in opposite directions, the speed decreases to zero at the time the graph crosses the r-axis.**
- **After that time, velocity and acceleration are in the same direction, and the speed increases.**

EXAMPLE Problem 1

VELOCITY AND ACCELERATION How would you describe the sprinter's velocity and acceleration as shown on the graph?



1 ANALYZE AND SKETCH THE PROBLEM

From the graph, note that the magnitude of the sprinter's velocity starts at zero, increases rapidly for the first few seconds, and then, after reaching about 10.0 m/s, remains almost constant.

KNOWN	UNKNOWN
v = varies	a = ?

2 SOLVE FOR THE UNKNOWN

Draw tangents to the curve at two points. Choose $t = 1.00$ s and $t = 5.00$ s. Solve for the magnitude of the instantaneous acceleration at 1.00 s:

$$a = \frac{\text{rise}}{\text{run}}$$ The slope of the line at 1.00 s is equal to the acceleration at that time.

$$= \frac{10.0 \text{ m/s} - 6.00 \text{ m/s}}{2.4 \text{ s} - 1.00 \text{ s}}$$

$$= 2.9 \text{ m/s/s} = 2.9 \text{ m/s}^2$$

Solve for the magnitude of the instantaneous acceleration at 5.00 s:

$$a = \frac{\text{rise}}{\text{run}}$$ The slope of the line at 5.00 s is equal to the acceleration at that time.

$$= \frac{10.3 \text{ m/s} - 10.0 \text{ m/s}}{10.0 \text{ s} - 0.00 \text{ s}}$$

$$= 0.030 \text{ m/s/s} = 0.030 \text{ m/s}^2$$

The acceleration is not constant because its magnitude changes from 2.9 m/s^2 at 1.00 s to 0.030 m/s^2 at 5.00 s.

The acceleration is in the direction chosen to be positive because both values are positive.

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1. The velocity-time graph in **Figure 8** describes Steven's motion as he walks along the midway at the state fair. Sketch the corresponding motion diagram. Include velocity vectors in your diagram.

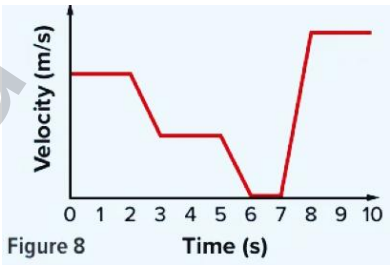
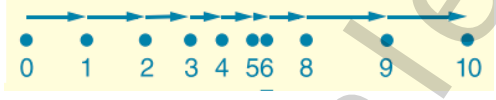


Figure 8

Time (s)



2. Use the *v-t* graph of the toy train in **Figure 9** to answer these questions.

   a. When is the train's speed constant?

5.0 s to 15.0 s



Figure 9

   b. During which time interval is the train's acceleration positive?

0.0 to 5.0 s

   c. When is the train's acceleration most negative?

15.0 s to 20.0 s

3. Refer to **Figure 9** to find the average acceleration of the train during the following time intervals.

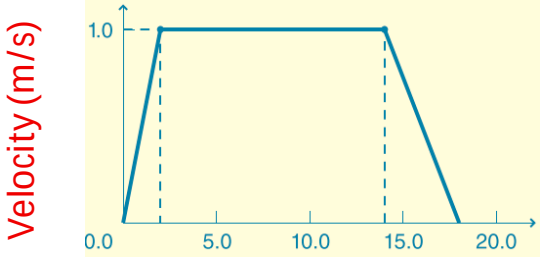
   a. 0.0 s to 5.0 s **b.** 15.0 s to 20.0 s **c.** 0.0 s to 40.0 s

2.0 m/s^2 .a

−1.2 m/s^2 .b

0.0 m/s^2 .c

4. **CHALLENGE** Plot a *v-t* graph representing the following motion: An elevator starts at rest from the ground floor of a three-story shopping mall. It accelerates upward for 2.0 s at a rate of 0.5 m/s^2, continues up at a constant velocity of 1.0 m/s for 12.0 s, and then slows down with a constant downward acceleration of 0.25 m/s^2 for 4.0 s as it reaches the third floor.



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1. Define displacement and explain how it differs from distance.

Displacement is the straight-line distance and direction from start to end point, while distance is the total path length.

2. Describe how to determine if motion is uniform or non-uniform using a position–time graph.

Uniform motion appears as a straight line with constant slope on a position–time graph.

3. Explain the difference between precision and accuracy in scientific measurements with an example.

Precision = repeatability; accuracy = closeness to true value.
Example: hitting same wrong spot vs. bullseye.

4. A car starts from rest and accelerates at 3 m/s² for 4 seconds. Calculate its final velocity.

$v_f = v_i + a \cdot t = 0 + 3 \times 4 = 12$ m/s.

5. Sketch or describe the shape of a velocity–time graph for an object that is slowing down.

A line sloping downwards (negative slope) on a velocity–time graph.

6. Explain why an object moving at constant speed in a circular path is said to be accelerating.

Because its velocity direction is continuously changing, indicating centripetal acceleration.

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Work hard, for the future is made by those with high aspirations 🌟.

We wish you continued success and excellence in your studies. 🙂

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