RVIEW FOR GRADE 10 GENRAL: Chapter 1: A Physics Toolkit

Vocabulary:

- Physics
- Dimensional analysis
- Scientific method
- Hypothesis
- Scientific law
- Scientific theory

L1: What is Science?

Science means knowledge.

What is pseudoscience?

-Pseudo – comes from Greek meaning false, pretend, or unreal.

- A claim, belief or practice which is presented as scientific, but does not adhere to a valid scientific method. It lacks supporting evidence or plausibility, cannot be reliably tested, or otherwise lacks scientific status.

L2: What is Physics?

Physics is a branch of science that involves the study of natural things: energy, matter, and how they interact.

L3:SI Units

The Système International d'Unités, or SI, uses seven base quantities:

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

L4:SI Units

The most commonly used SI prefixes

Prefixes Used with SI Units				
Prefix	**Symbol**	**Multiplier**	**Scientific Notation**	**Example**
femto-	f	0.000000000000001	10^{-15}	femtosecond (fs)
pico-	p	0.000000000001	10^{-12}	picometer (pm)
nano-	n	0.000000001	10^{-9}	nanometer (nm)
micro-	μ	0.000001	10^{-6}	microgram (μg)
milli-	m	0.001	10^{-3}	milliamps (mA)
centi-	c	0.01	10^{-2}	centimeter (cm)
deci-	d	0.1	10^{-1}	deciliter (dL)
kilo-	k	1000	10^{3}	kilometer (km)
mega-	M	1,000,000	10^{6}	megagram (Mg)
giga-	G	1,000,000,000	10^{9}	gigameter (Gm)
tera-	T	1,000,000,000,000	10^{12}	terahertz (THz)

L5: Dimensional Analysis:

Dimensional analysis also is used in choosing conversion factors.

Method of treating units as algebraic quantities, which can be cancelled.

Conversion Factor: is a multiplier that is equal to one

Example: 1 kg = 1000 g

$$1 = \frac{1\,\text{kg}}{1000\,\text{g}} \qquad 1 = \frac{1000\,\text{g}}{1\,\text{kg}}$$

For example, to convert 1.34 kg of iron ore to grams, do as shown:

$$1.34\ \text{kg}\left(\frac{1000\ \text{g}}{1\ \text{kg}}\right) = 1340\ \text{g}$$

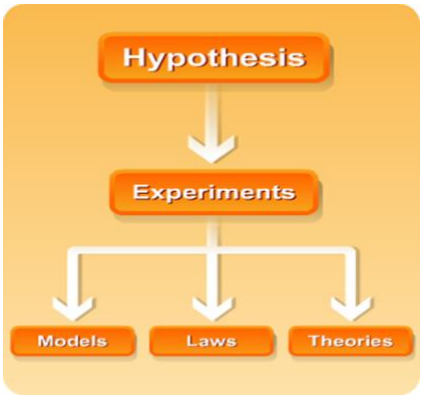
L6: Significant Digits

1. A meter stick is used to measure a pen and the measurement is recorded as 14.3 cm.
2. This measurement has three valid digits: two you are sure of, and one you estimated.
3. The valid digits in a measurement are called significant digits.
4. However, the last digit given for any measurement is the uncertainty digit.
5. All nonzero digits in a measurement are significant, but not all zeros are significant.
6. Consider a measurement such as 0.0860 m. Here the first two zeros serve only to locate the decimal point and are not significant.
7. The last zero, however, is the estimated digit and is significant.

L7.A: Scientific Methods

- Making observations, doing experiments, and creating models or theories to try to explain your results or predict new answers form the essence of a scientific method.
- All scientists, including physicists, obtain data, make predictions, and create compelling explanations that quantitatively describe many different phenomena.
- The experiments and results must be reproducible; that is, other scientists must be able to recreate the experiment and obtain similar data.
- A scientist often works with an idea that can be worded as a hypothesis, which is an educated guess about how variables are related.

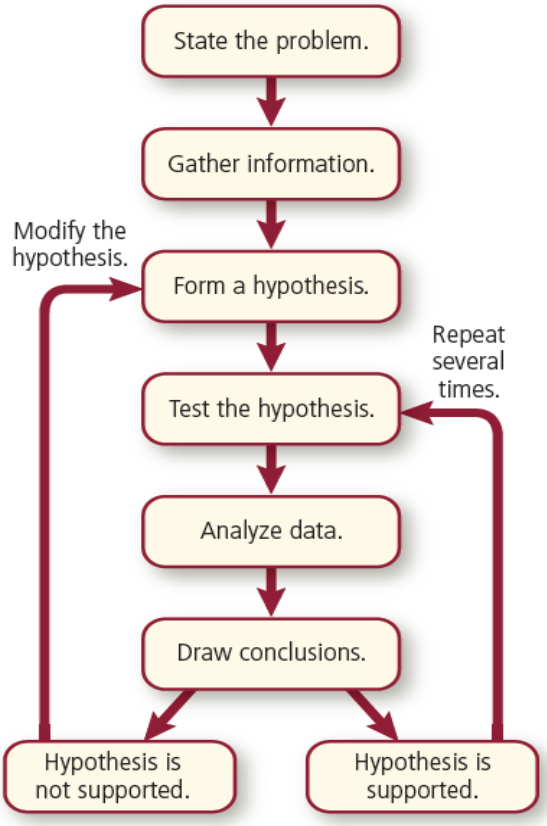
- A hypothesis can be tested by conducting experiments, taking measurements, and identifying what variables are important and how they are related. Based on the test results, scientists establish models, laws, and theories.



L7.B:Scientific Methods:

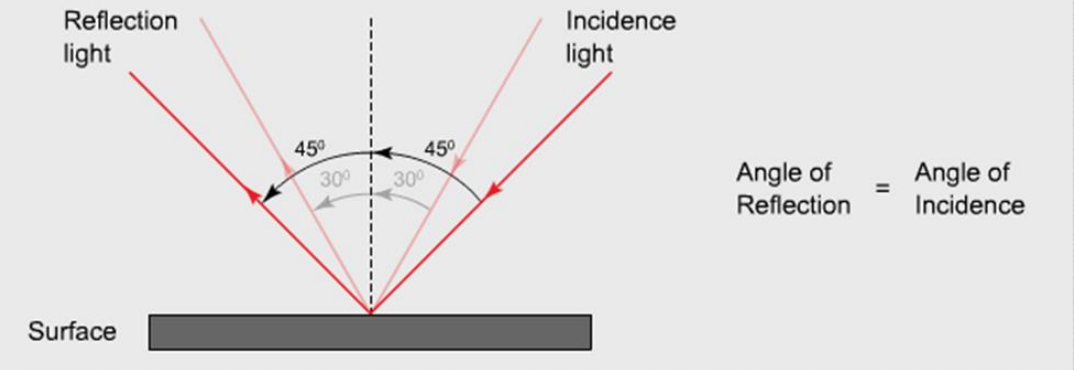
- **Although physicists do not always follow a rigid set of steps, investigations often follow similar patterns called scientific methods.**
- **Depending on the investigation, a scientist might add new steps, repeat some steps or skip steps altogether.**
- **Many investigations begin when someone observes an event in nature and wonders *why* or *how* it occurs.**
- **The question of "why" or "how" is the *problem.***
  - **Many questions have been asked throughout history: why objects fall to Earth, what causes day and night, how to generate electricity…**
  - **Often the investigation into one problem may lead to more questions and more investigations.**
  - **Researching already known information about a problem, helps to fine-tune the question and form it into a hypothesis.**
  - **Hypothesis is a possible explanation for a problem using what you know and have observed.**
  - **Hypotheses can be tested by different means:**
  - **Observations**
  - **Models**
  - **Experiments**
  - **Test the effect of one thing on another,**

  using a control.



L8: Models, Laws, and Theories:

- A scientific law is a rule of nature that sums up related observations to describe a pattern in nature.



- Laws do not explain why these phenomena happen, they simply describe them.

L9: Models, Laws, and Theories

- A scientific theory is an explanation based on many observations supported by experimental results.
- A theory is the best available explanation of why things work as they do.
- Theories may serve as explanations for laws.
- Laws and theories may be revised or discarded over time.
- Theories are changed and modified as new experiments provide insight and new observations are made.

Question 1:

The potential energy, PE, of a body of mass, m, raised to a height, h, is expressed as PE = mgh, where g is the gravitational constant. If m is measured in kg, g in m/s2, h in m, and PE in joules, then what is 1 joule described in base unit? (Hint: Substitute units and cancel.)

A. 1 kg·m/s

B. 1 kg·m/s²

C. 1 kg·m²/s

D. 1 kg·m²/s²

Answer: D $PE = mgh$ $\therefore 1J = 1kg \times \frac{m}{s^2} \times m$ $\therefore 1J = 1kg \cdot \left(\frac{m}{s}\right)^2$

Question 2:

A car is moving at a speed of 90 km/h. What is the speed of the car in m/s? (Hint: Use Dimensional Analysis)

A. 2.5×10^{1} m/s

B. 1.5×10^{3} m/s

C. 2.5 m/s

D. 1.5×10^{2} m/s

Answer: A

$$\left(\frac{90\text{ km}}{1\text{h}}\right)\left(\frac{1000\text{ m}}{1\text{km}}\right)\left(\frac{1\text{h}}{60\text{ min}}\right)\left(\frac{1\text{min}}{60\text{ s}}\right)=25\text{ m/s}$$

Question 3:

Which of the following representations is correct when you solve 0.030 kg + 3333 g using scientific notation?

A. 3.4×10^{3} g

B. 3.36×10^{3} g

C. 3×10^{3} g

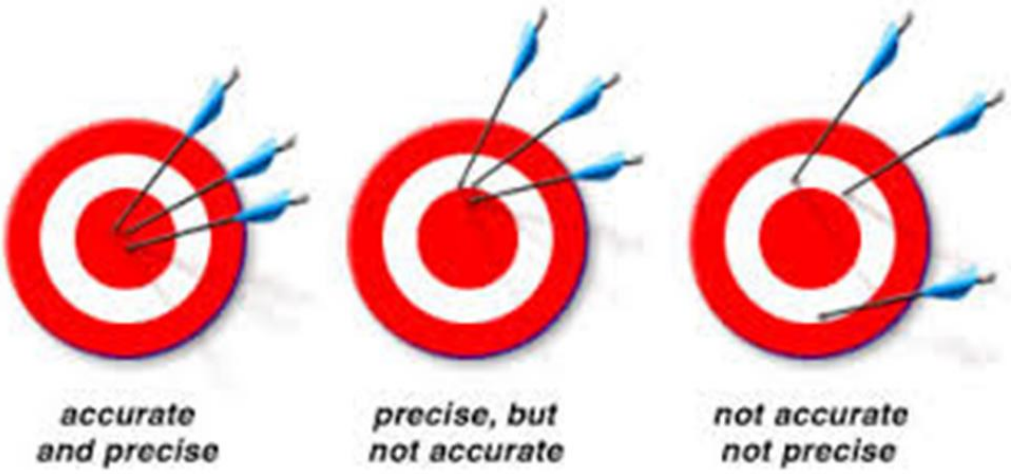
D. 3363 g

Answer: A

Reason: 0.030 kg can be written as 3.0 ⍰101 g which has 2 significant digits, the number 3 and the zero after 3.
In number 3333 all the four 3's are significant hence it has 4 significant digits. So our answer should contain 2 significant digits.

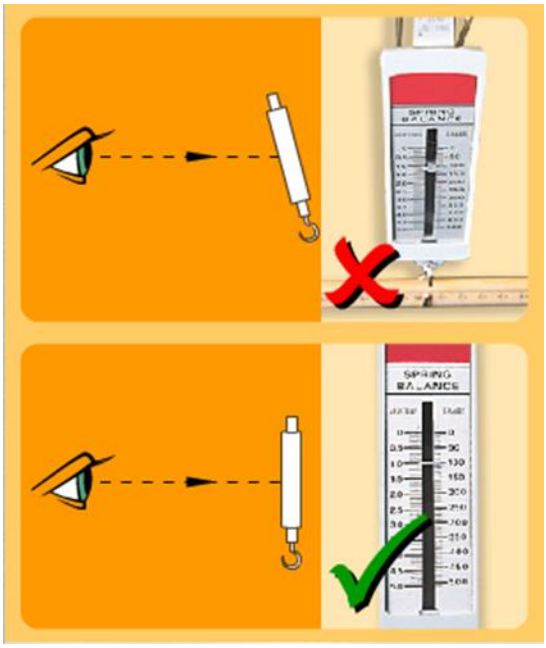
L10: Measurement

Precision Versus Accuracy



Techniques of Good Measurement

- To assure precision and accuracy, instruments need to be used correctly.
- The difference in the readings is caused by parallax, which is the apparent shift in the position of an object when it is viewed from different angles.
- Precision is ½ the smallest scale on the instrument. Where you guess or have uncertainty.



L11: Percent Error vs Percent Difference

- **Error - Used to calculate the error between the accepted value and any experimental value**

$$\%\ \text{error} = \frac{|(\text{accepted value}) - (\text{measured value})|}{(\text{accepted value})} * 100$$

Question 4

Ronald, Kevin, and Paul perform an experiment to determine the value of acceleration due to gravity on the Earth (980 cm/s^2). The following results were obtained: Ronald - 961 ± 12 cm/s^2, Kevin - 953 ± 8 cm/s^2, and Paul - 942 ± 4 cm/s^2.
Justify who gets the most accurate vs precise value.

A. **Kevin got the most precise and accurate value.**
B. **Ronald's value is the most accurate, while Kevin's value is the most precise.**
C. **Ronald's value is the most accurate, while Paul's value is the most precise.**
D. **Paul's value is the most accurate, while Ronald's value is the most precise.**

Answer: C.

Reason: Ronald's answer is closest to 980 cm/s^2 and hence his result is the most accurate. Paul's measurement is the most precise within 4 cm/s^2.

Question 5:

What is the precision of an instrument?

A. **The smallest division of an instrument.**
B. **The least count of an instrument.**
C. **One-half of the least count of an instrument.**

One-half of the smallest division of an instrument

Answer: D

Reason: Precision depends on the instrument and the technique used to make the measurement. Generally, the device with the finest division on its scale produces the most precise measurement. The precision of a measurement is one-half of the smallest division of the instrument.

Question 6:

A 100-cm long rope was measured with three different scales. The answer obtained with the three scales were:

1st scale - 99 ± 0.5 cm, 2nd scale - 98 ± 0.25 cm, and 3rd scale - 99 ± 1 cm. Which scale has the best precision?

A. 1st scale

B. 2nd scale

C.3rd scale

D. Both scale 1 and 3

Answer: B

Reason: Precision depends on the instrument. The measurement of the 2nd scale is the most precise within 0.25 cm.

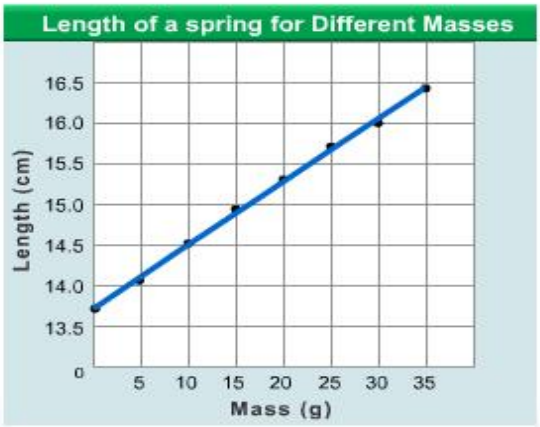
L13: Graphing Data

- Graph the relationship between independent and dependent variables.
- Interpret graphs.
- Recognize common relationships in graphs.

L14:Identifying Variables

- A variable is any factor that might affect the behavior of an experimental setup.
- The independent variable is the factor that is changed or manipulated during the experiment. The X axis.
- The dependent variable is the factor that depends on the independent variable. Typically the measured outcome. The Y axis.

L15:Graphing Data



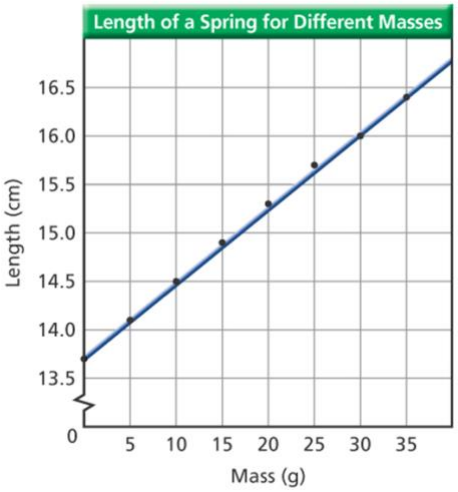
Length of a spring for Different Masses

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

L16:Linear Relationships

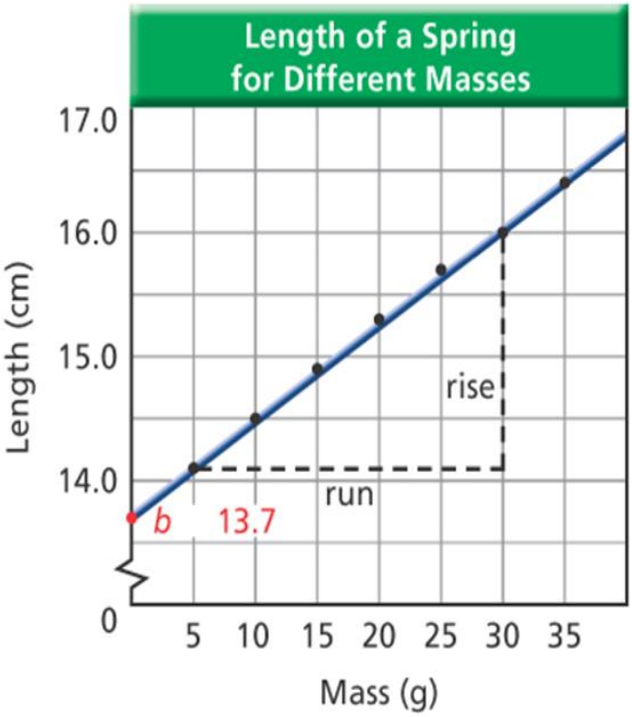
- When the line of best fit is a straight line the dependent variable varies linearly with the independent variable. This relationship between the two variables is called a **linear relationship**.
- The relationship can be written as an equation.

$$y = mx + b$$

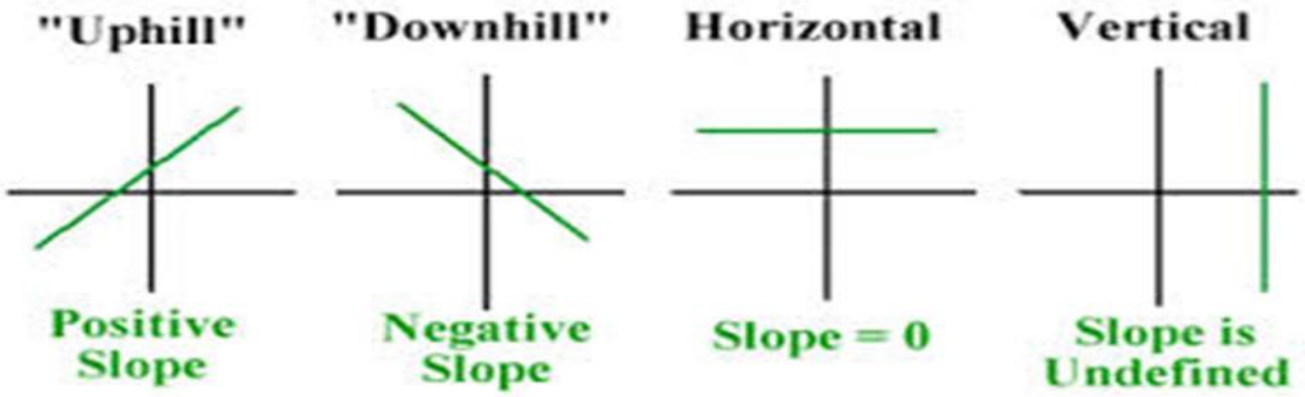


The slope is the ratio of the vertical change to the horizontal change. To find the slope, select two points, A and B, on the line. The vertical change, or rise, Δy, is the difference between the vertical values of A and B. The horizontal change, or run, Δx, is the difference between the horizontal values of A and B.

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



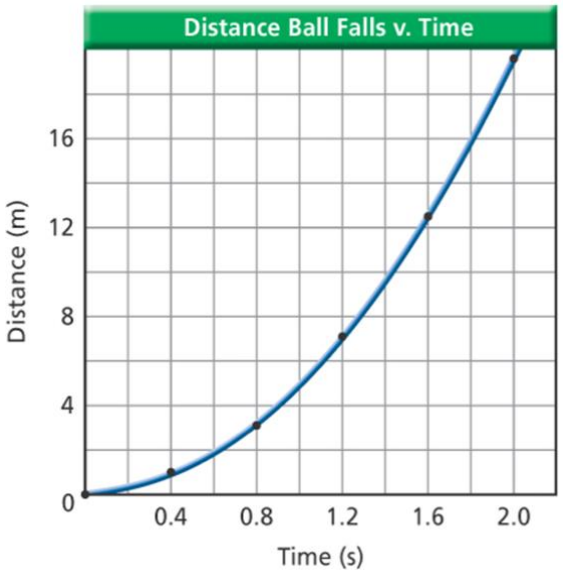
- **The slope of a line is equal to the rise divided by the run, or the change in *y* divided by the change in *x*.**
- **If *y* gets smaller as *x* gets larger, then Δ*y*/Δ*x* is negative, and the line slopes downward.**
- **The *y*-intercept, *b*, is the point at which the line crosses the *y*-axis, and it is the *y*-value when the value of *x* is zero.**



L17: Nonlinear Relationships

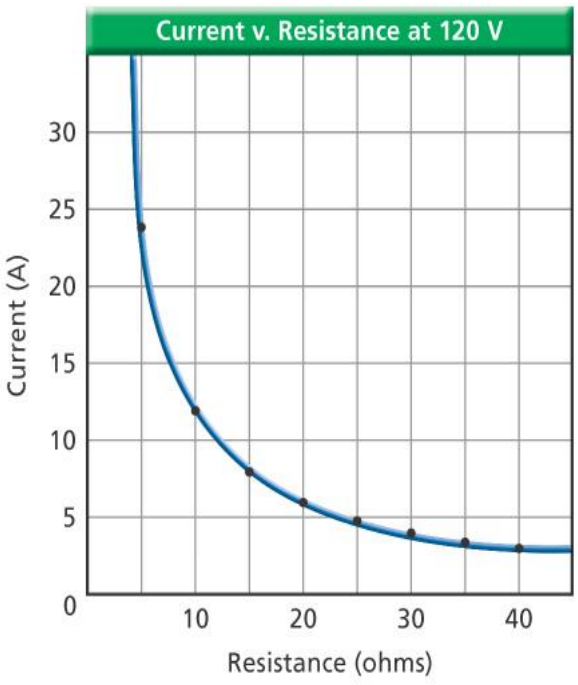
- **The graph shown in the figure is a quadratic or exponential relationship.**
- **A quadratic relationship exists when one variable depends on the square of another.**
- **A quadratic relationship can be represented by the following equation:**

$$y = ax^2 + bx + c$$

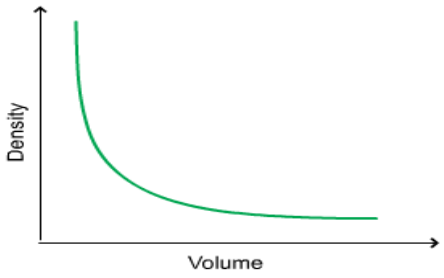


L18: Nonlinear Relationships

- The graph in the figure shows how the current in an electric circuit varies as the resistance is increased. This is an example of an inverse relationship.
- In an **inverse relationship**, a hyperbola (hi-per-bola) results when one variable depends on the inverse of the other.
- $$y = \frac{a}{x}$$



Question 7: Which type of relationship is shown following graph?



A. **Linear**
B. **Inverse**
C. **Parabolic**
D. **Quadratic**

Answer: B

Reason: In an inverse relationship a hyperbola results when one variable depends on the inverse of the other.

Question 8: What is line of best fit?

A. **The line joining the first and last data points in a graph.**
B. **The line joining the two center-most data points in a graph.**
C. **The line drawn close to all data points as possible.**
D. **The line joining the maximum data points in a graph.**

Answer: C

Reason: The line drawn closer to all 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 or two points that help to determine the line.

Question 9: Which relationship can be written as $y = mx$?

A. **Linear relationship**
B. **Quadratic relationship**
C. **Parabolic relationship**
D. **Inverse relationship**

Answer: A

Reason: Linear relationship is written as $y = mx + b$, where b is the y intercept. If y-intercept is zero, the above equation can be rewritten as $y = mx$.