

حل مراجعة نهائية شاملة وفق منهج انسباير



تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف التاسع المتقدم ← فيزياء ← الفصل الأول ← حلول ← الملف

تاريخ إضافة الملف على موقع المناهج: 16:08:47 2026-06-06

ملفات اكتب للمعلم اكتب للطالب | اختبارات الكترونية | اختبارات | حلول | عروض بوربوينت | أوراق عمل
منهج انجليزي | ملخصات وتقارير | مذكرات وبنوك | الامتحان النهائي | للمدرس

المزيد من مادة
فيزياء:

إعداد: Marey Ahmed

التواصل الاجتماعي بحسب الصف التاسع المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف التاسع المتقدم والمادة فيزياء في الفصل الأول

حل تجميعية اختبارات وزارية سابقة منهج بريدج وانسباير

1

تجميعية اختبارات وزارية سابقة منهج بريدج وانسباير بدون الحل

2

حل مراجعة شاملة وفق الهيكل الوزاري الجديد منهج بريدج

3

حل كراسة تدريبية مراجعة وفق الهيكل الوزاري الجديد منهج بريدج

4

تجميعية أسئلة الكتاب وفق الهيكل الوزاري الجديد منهج بريدج

5



A PHYSICS TOOLKIT

LESSON 1 METHODS OF SCIENCE

What is physics?

Physics is a branch of science that study physical world: energy, matter and how they are related.

Scientific Methods

The pattern of investigation procedures.

1-The problem the question of "why" ,"what" or "how"

2- Gather information by Researching

3- Hypothesis /is a possible explanation for a problem using what you know and have observed

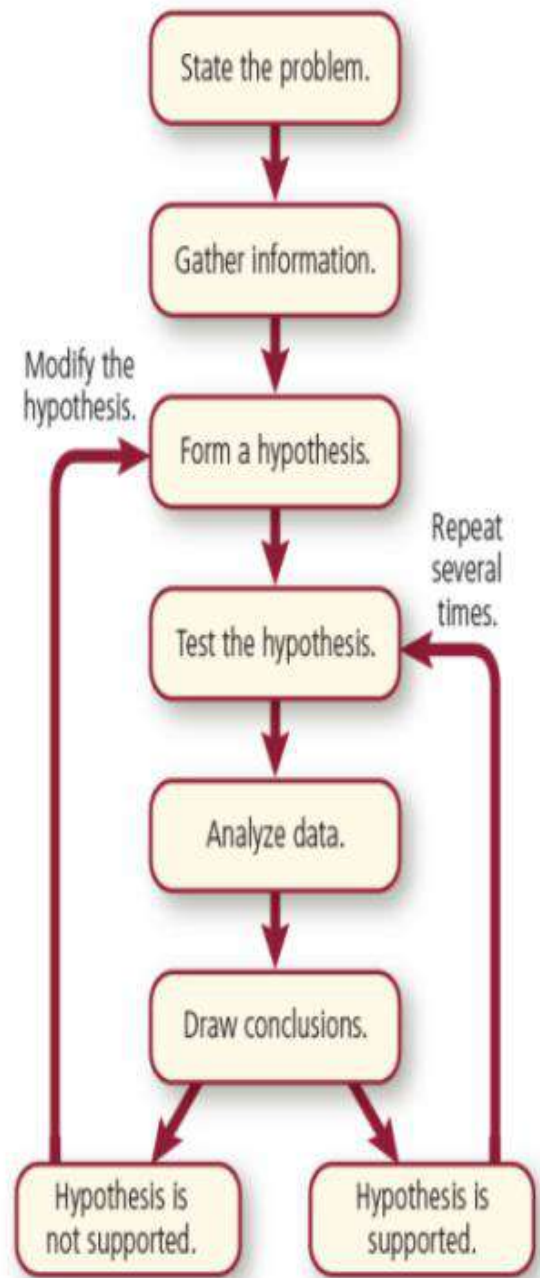
4- Test hypothesis: A hypothesis is a possible explanation for a problem using what you know and have observed.

- Hypotheses can be tested by different means:
 - Observations
 - Models
 - Experiments (investigation)

5- Analyze the data includes recording observations and organizing data into easy-to-read tables and graphs

6- Conclusion to decide whether the hypothesis is supported.

If the experiment does not support the hypothesis, the hypothesis must be reconsidered.



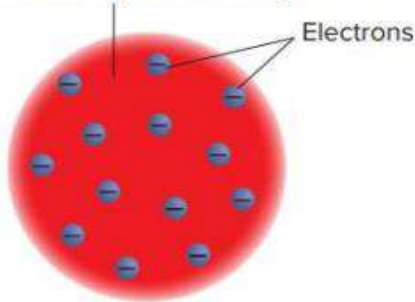
Models

A **model** is a representation of an idea, event, structure, or object that helps people better understand it.

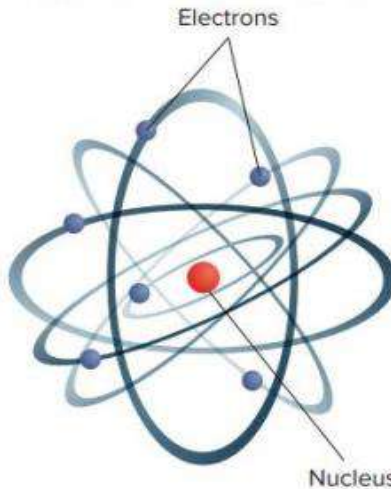
Ex. Earth model, engine, bridge, and high-tech models (computer simulation)

Thomson's Model (1904)

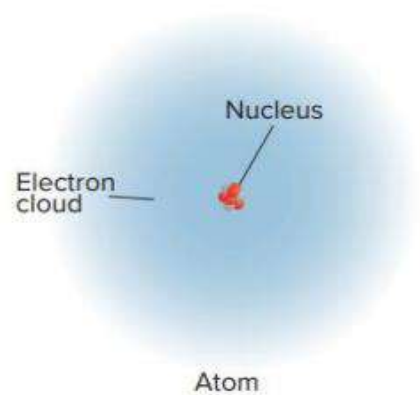
Matter containing evenly distributed positive charge



Rutherford's Model (1911)



Electron Cloud Model (Present-day)



Scientific Theories and Laws

- A **scientific theory** is an explanation of things or events based on knowledge gained from many observations and investigations.
- A **scientific law** is a statement about what happens in nature and seems to be true all the time.
- A scientific law is simply an observation of the phenomenon that the theory attempts to explain
- Laws does not explain why or how something happens

• Practice Questions

Choose the correct answer:

- 1) Which of the following is an explanation supported by experimental results?
☒ a) Scientific theory
b) Scientific method
c) Scientific law
d) Hypothesis
- 2) What is the field of science that studies mass and energy relationships?
a) Biology
b) Chemistry
☒ c) Physics
d) Astronomy
- 3) In a closed system, "mass is always conserved" is an example of which of the following?
☒ a) Scientific law
b) Scientific theory
c) Hypothesis
d) Model
- 4) Which is the way that an investigation is carried out?
a) Hypothesis
☒ b) Scientific method
c) Scientific theory
d) Scientific law
- 5) An educated guess about a question that a scientist asks is called a _____.
a) model
b) scientific theory
c) scientific method
☒ d) hypothesis



معهد رواد التعليمية

و

مركز النخبة المتميزة

Maths and Physics

We use math to express concepts in physics

The **SI (Système International d'Unités or SI.)** system of measurement uses seven base quantities.

The **base quantities** were originally defined in terms of direct measurements.

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

Other units, called **derived units**, are created by combining the base units in various ways .

• Practice Questions

Multiple Choice

1. Which of the following is a base unit?

- A. Grams
- B. Kelvin**
- C. Minutes
- D. Newton

2. Which of the following is a base unit?

- A. Ampere**
- B. Volt
- C. Newton
- D. Joule

3. Which of the following is not an SI unit of measurement?

- A. Meter
- B. Second
- C. Kilogram
- D. Kilometer**

4. The SI base unit used to measure mass is the ____.

- A. gram
- B. meter
- C. kilogram**
- D. milligram

How to Derive Units

1. Write down the formula
2. Substitute in the SI base units

E.g. working out the derived unit for Density:

$$\text{Density} = \text{Mass} / \text{Volume}$$

$$\text{Density} = \text{kg} / \text{m}^3$$

You can also write this as kg m^{-3}

Derived Units

Derived Quantity	Derived Unit	Base Units
Area	Type text here	
Volume		
Density		
Velocity		
Acceleration		
Force		
Pressure		

EX.

Classify each of the following as a base or derived unit.

Unit	Base/ derived
m	Base
m/s	derived
kg	Base
$kg \cdot m/s^2$	derived
m^2	derived
s	Base

Dimensional Analysis

Table 2 Prefixes Used with SI Units

Prefix	Symbol	Multiplier	Scientific Notation	Example
femto–	f	0.0000000000000001	10^{-15}	femtosecond (fs)
pico–	p	0.0000000000001	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)

Express the following using only SI units, without prefixes:

$$220 \mu\text{g} \quad 220 \times 10^{-6} = 2.2 \times 10^{-7}$$

$$800 \text{ ms} \quad 800 \times 10^{-3} = 0.8 \text{ s}$$

$$400 \text{ Kg} \quad 400 \times 10^3 = 4.0 \times 10^5 \text{ g}$$

$$2 \text{ ms} \quad 2 \times 10^{-3} \text{ s}$$

$$12 \text{ cm} \quad 12 \times 10^{-2} \text{ m}$$

• Practice Questions

Convert 57.7 kg to grams.

- ☐ $5.77 \times 10^5 \text{ g}$
A) $5.77 \times 10^3 \text{ g}$
B) $5.77 \times 10^4 \text{ g}$
C) $5.77 \times 10^6 \text{ g}$
D)
- $57.7 \times 10^3 = 5.77 \times 10^4$

Convert 243 ng to its equivalent in kilograms.

- ☐ $2.43 \times 10^{-10} \text{ kg}$
A) $2.43 \times 10^{-11} \text{ kg}$
B) $2.43 \times 10^9 \text{ kg}$
C) $2.43 \times 10^{-7} \text{ kg}$
D)

Convert 1.45 km to meters.

- ☐ $14.5 \times 10^3 \text{ m}$
A) $1.45 \times 10^{-3} \text{ m}$
B) $0.145 \times 10^{-3} \text{ m}$
C) $1.45 \times 10^3 \text{ m}$
D)

The multiplier for SI units with the prefix *pico* is _____.

- ☐ 10^{-15}
A) 10^{-12}
B) 10^{-9}
C) 10^{-6}
D)



) Convert the following measurements to the units shown.

❖ 52 km/h to m/s:

$$\frac{52 \cancel{\text{km}}}{1 \cancel{\text{h}}} \left(\frac{1000 \cancel{\text{m}}}{1 \cancel{\text{km}}} \right) \left(\frac{1 \cancel{\text{h}}}{60 \cancel{\text{min}}} \right) \left(\frac{1 \cancel{\text{min}}}{60 \cancel{\text{s}}} \right) = 14.4$$
$$= 14 \text{ m/s}$$

❖ 741.3 g to kg:

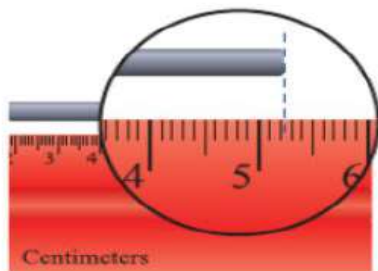
$$741.3 \times 10^{-3} = 7.413 \times 10^{-1} = 0.7413 \text{ kg}$$

❖ 3.2 h to min:

$$3.2 \times 60 = 192 \text{ min}$$

Significant Figures

Figure 7 Since the ruler is divided into tenths, you know the rod is between 5.2 cm and 5.3 cm. You can estimate that the rod is 5.25 cm.



Here, they have rounded from 2 significant digits to 3 significant digits.

Rules

1. All nonzero numbers are significant.
2. Zeros between nonzero digits are significant.
3. Final zeros used after the decimal point are significant.
4. Zeros used solely for spacing the decimal point are not significant. The zeros indicate only the position of the decimal point.

Significant figures.

Number	Number of s.f.	Reason	Scientific notation
504	3	in an integer all digits count (if last digit is not zero)	5.04×10^2
608 000	3	zeros at the end of an integer do not count	6.08×10^5
200	1	zeros at the end of an integer do not count	2×10^2
0.000 305	3	zeros in front do not count	3.05×10^{-4}
0.005 900	4	zeros at the end of a decimal count, those in front do not	5.900×10^{-3}



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number	<u>123</u>	<u>400</u>	<u>50001</u>	0.00 <u>56</u>	<u>3.000</u>	0.01 <u>230</u>	<u>9.0053</u>	<u>4</u> $\times 10^2$	<u>1.2</u> $\times 10^{-4}$
significant figures	3	1	5	2	4	4	5	1	2

How many Significant Digits?

- a) 100 1
- b) 12 2
- c) 0.05 1
- d) 0.0003 1
- e) 0.500 3
- f) 14.0030 6

! - How many significant figures are in each figure?

2000	1.9002	0.0055	8.00	321	1.2×10^3	1.33×10^{-6}
<u>1</u>	<u>5</u>	<u>2</u>	<u>3</u>	<u>3</u>	<u>2</u>	<u>3</u>

Math with Significant figures

- Addition and Subtraction**

- For addition and subtraction, look at the places to the decimal point.
- Add or subtract in the normal fashion, then round the answer to the LEAST number of places to the decimal point of any number in the problem.

$$\underbrace{3.21}_{2 \text{ d.p.}} + \underbrace{4.1}_{1 \text{ d.p.}} = 7.32 \approx \underbrace{7.3}_{1 \text{ d.p.}} \quad (\text{the least number of d.p. is shown in red})$$

$$\underbrace{12.367}_{3 \text{ d.p.}} - \underbrace{3.15}_{2 \text{ d.p.}} = 9.217 \approx \underbrace{9.22}_{2 \text{ d.p.}}$$

- Multiplication and Division**

- The LEAST number of significant figures in any number of the problem determines the number of significant figures in the answer.
- This means you must know how to recognize significant figures in order to use this rule.

$$\underbrace{23}_{2 \text{ s.f.}} \times \underbrace{578}_{3 \text{ s.f.}} = 13294 \approx \underbrace{1.3 \times 10^4}_{2 \text{ s.f.}} \quad (\text{the least number of s.f. is shown in red})$$

$$\frac{\underbrace{6.244}_{4 \text{ s.f.}}}{\underbrace{1.25}_{3 \text{ s.f.}}} = 4.9952... \approx \underbrace{5.00 \times 10^0}_{3 \text{ s.f.}} = 5.00$$



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

a. $10.8 \text{ g} - 8.264 \text{ g}$

b. $4.75 \text{ m} - 0.4168 \text{ m}$

c. $\underline{139} \text{ cm} \times 2.3 \text{ cm}$

d. $13.78 \text{ g} / 11.3 \text{ mL}$

e. $1.6 \text{ km} + 1.62 \text{ m} + 1200 \text{ cm}$ $1600 \text{ m} + 1.62 \text{ m} + 12 \text{ m}$

a. 2.536 round to the nearest tenth 2.5 g

b. 4.3332 round to the nearest hundredth 4.33 m

c. 319.7 only take 2 significant numbers 32 cm

d. 1.219 only take 3 significant numbers 1.22 g/ml

e. 1613.62 round to the least precise decimal place 1600 m

- Do arithmetic operation on significant figures

$$2.111 + 3.11 = \dots 5.22 \dots$$

$$24.2 - 10.111 = \dots 14.1 \dots$$

$$1.22 \times 3.2 = \dots 3.9 \dots$$

$$800 \div 4.2 = \dots 200 \dots$$



Measurement: A measurement is a comparison between an **unknown quantity** and a **standard**.

Accuracy and Precision

Accurate



An arrow in the center indicates high accuracy.

Precise but not accurate



Arrows far from the center indicate low accuracy. Arrows close together indicate high precision.

Accurate and precise



Arrows in the center indicate high accuracy. Arrows close together indicate high precision.

Not accurate or precise



Arrows far from the center indicate low accuracy. Arrows far apart indicate low precision.

Accuracy – How close a measurement is to the accepted or true value.

Precision – How similar or close the measurements are to each other.



High Accuracy
High Precision



Low Accuracy
High Precision



High Accuracy
Low Precision



Low Accuracy
Low Precision

The three arrows represent **three** measurements for an experiment. Depending on the picture, which of the following statements is correct regarding to **precision** and **accuracy**?

- a. Measurements are accurate but not precise
- b. Measurements are precise but not accurate**
- c. Measurements are neither accurate nor precise
- d. Measurements are accurate and precise



Below is a data table produced by four groups of students who were measuring the mass of a paper clip which had a known mass of **1.04 g**, which group got a properly **accurate and precise** measurement of the mass of the paper clip?

قامت أربع مجموعات من الطلاب بقياس كتلة مشبك ورقي له كتلة معروفة تساوي **1.04 g**. إذا دون الطلاب نتائجهم في الجدول التالي، فأأي المجموعات كان قياسها **دقيقاً ومضبوطاً** لكتلة مشبك الورق؟

		Group 1	Group 2	Group 3	Group 4
Trial 1	محاولة 1	1.03 g	1.13 g	1.04 g	0.99 g
Trial 2	محاولة 2	1.05 g	1.10 g	1.41 g	1.00 g
Trial 3	محاولة 3	1.02 g	1.11 g	1.52 g	1.19 g

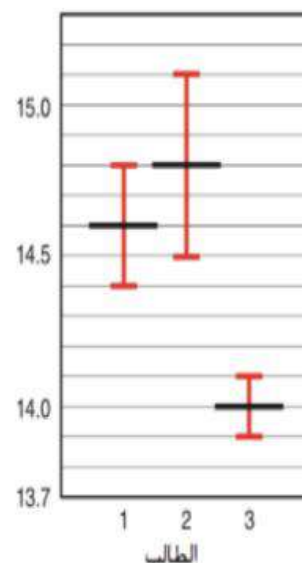
Ex. In an experiment done by 3 students

- Student1. (14.4cm ,14.8cm) average=14.6cm.

→Result1:(14.6 ± 0.2)cm

- Student2 : →Result2:(14.8 ± 0.3)cm

- Student3 : →Result4:(14.0 ± 0.1)cm

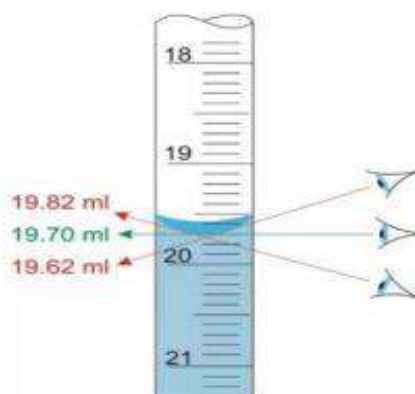


Student1, and 2 are less precise because they have large uncertainty (0.2 , 0.3),but student3 is the most precise.

Error in measurement comes from

1- instrument (zero ,scales, not working well ..)

2- Human (parallax, reading, reporting, way of measuring)



Parallax error

Generally, the device with the finest division on its scale produces the most precise measurement.

The precision of a measurement is one-half (0.5) of the smallest division of the instrument.

Give the measurement shown on the meter in **Figure 21** as precisely as you can. Include the uncertainty in your answer.



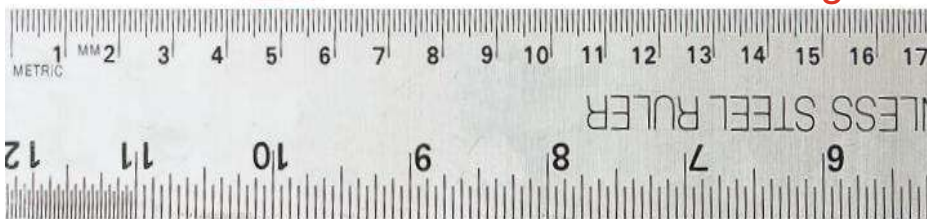
measurement = 3.6 A

precision = 0.2

uncertainty : $0.2/2 = \pm 0.1$

range 3.5 A to 3.7 A

How long is the leaf in **Figure 25**? Include the uncertainty in your measurement.

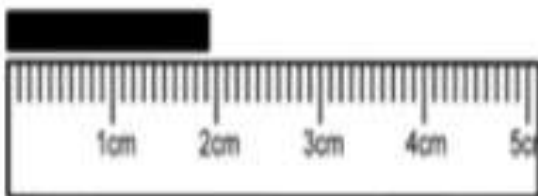


measurement = 8.3 cm

precision = 0.1

uncertainty $0.1/2 = \pm 0.05$

range 8.25 cm to 8.35 cm



Multiple Choice

1. ____ is the apparent shift of an object when it is viewed from different angles.

- A. Accuracy
- B. Double vision
- C. Measurement
- D. Parallax**

2. ____ describes how well the results of a measurement agree with the real value.

- A. Precision
- B. Accuracy**
- C. Error
- D. Measurement

3. The degree of exactness of a measurement is called ____.

- A. Precision**
- B. Accuracy
- C. Error
- D. Measurement

4. A device with very small divisions on its scale can measure with ____.

- A. agreement
- B. precision**
- C. scientific notation
- D. fundamental units

5. Four students reported results from an experiment.

Mass of Unknown Liquid			
Student A	Student B	Student C	Student D
52.3 g	52.35 g	52.353 g	53 g

Which student is more precise?

- A. Student A
- B. Student B
- C. Student C**
- D. Student D



LESSON 4

GRAPHING DATA

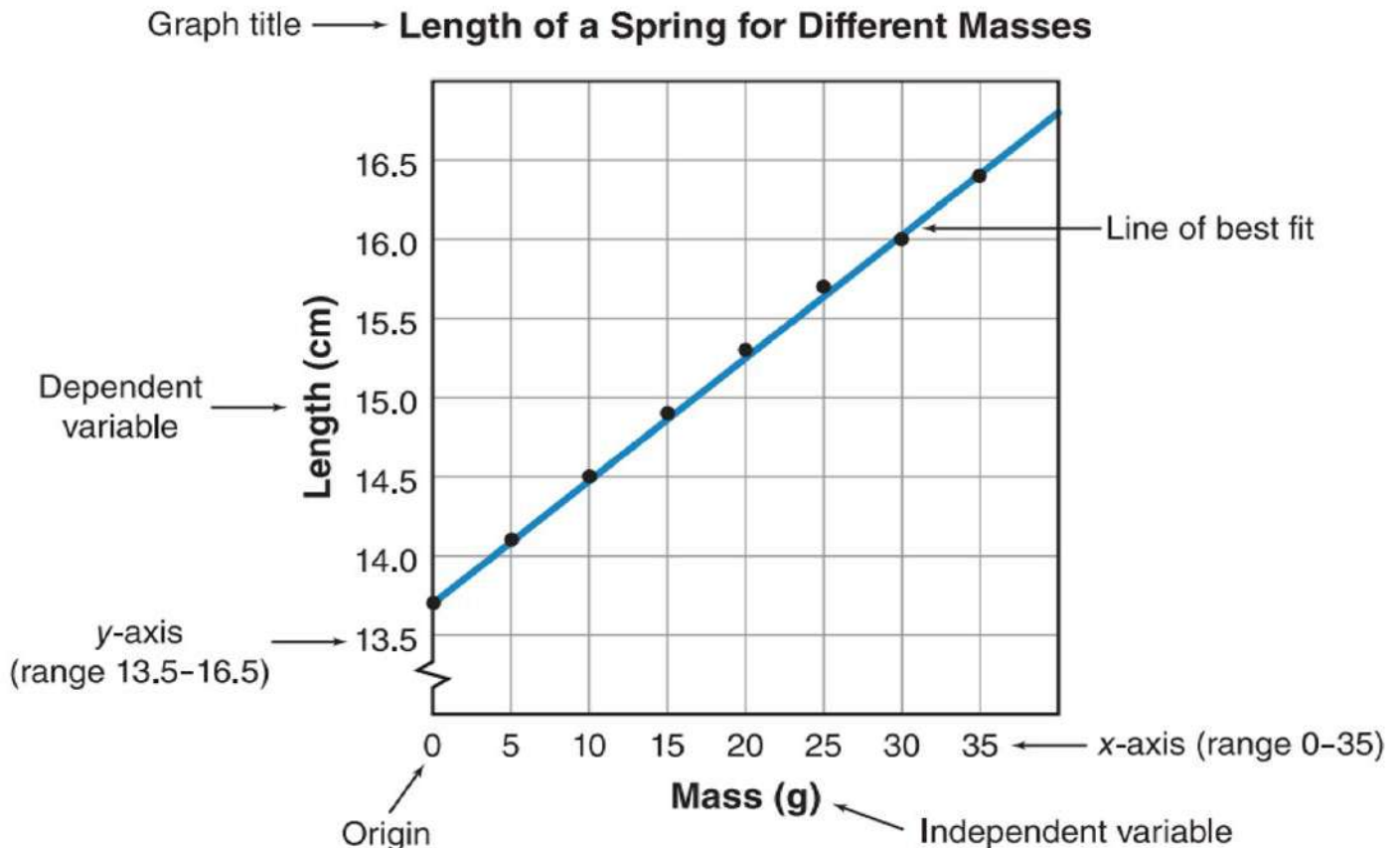
Identifying Variables.

- **Independent variables:** the factor that is changed or manipulated during the experiment.
- **Dependent variable** is the factor that depends on the independent variable.

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

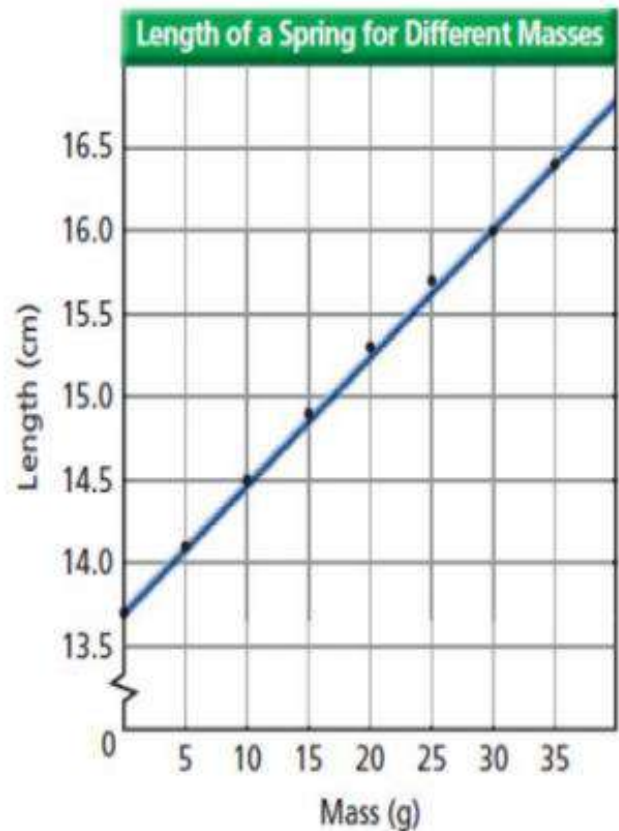
Three of the most common relationships include linear relationships, quadratic relationships and inverse relationships.

Plotting Graphs



A- Linear relationships:

Table 1-3	
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



Linear Relationship Between Two Variables

$$y = mx + b$$

y = dependent variable

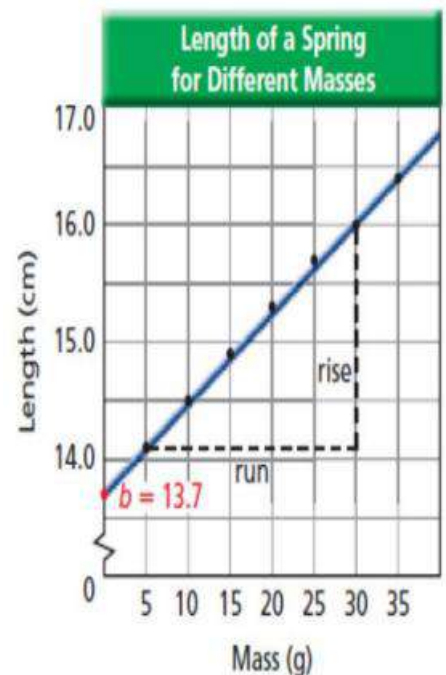
m = slope

x = independent variable

b = y intercept

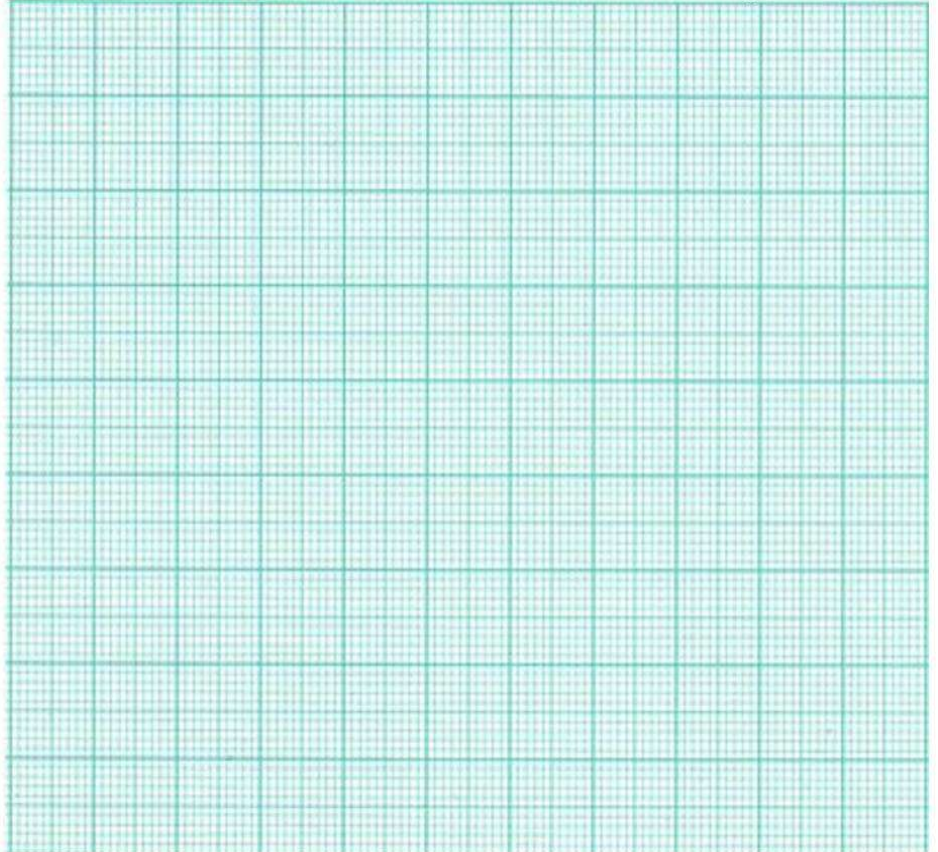
The slope $m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$

$$m = \frac{\text{Rise}}{\text{Run}}$$



Draw the graph and work out the slope

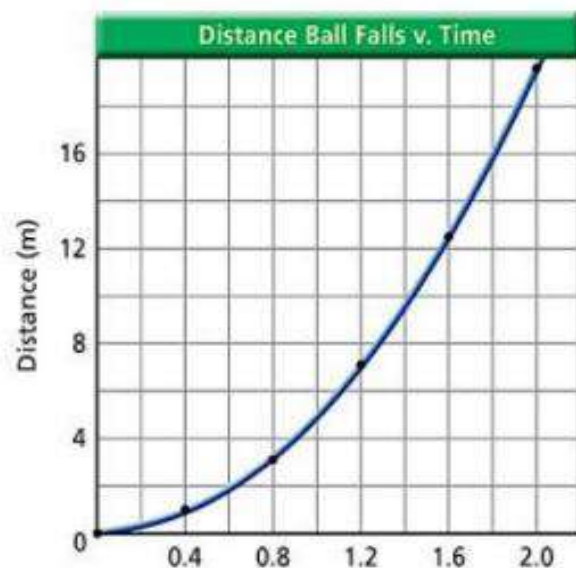
Time (seconds)	Temperature of reaction (°C)
0	19
5	22
10	25
15	27
20	29
40	29



B- Nonlinear Relationships

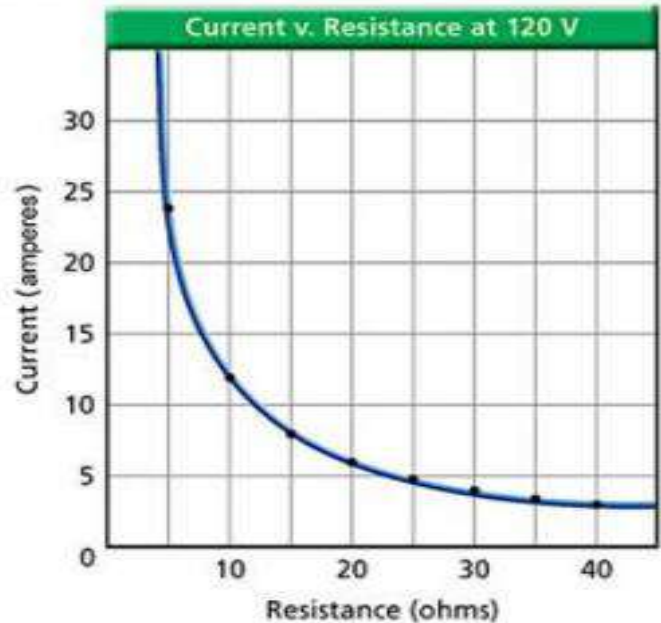
B1-quadratic relationship exists when one variable depends on the square of another

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



B2- inverse relationship, a hyperbola results when one variable depends on the inverse of the other

$$y = \frac{a}{x}$$



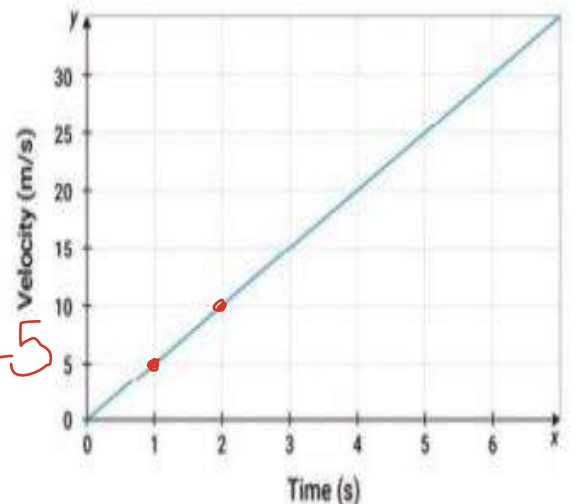
- Practice Questions

4) The straight line on a graph that is the ratio of the vertical difference between two points to the horizontal difference between the same two points ($\frac{\Delta y}{\Delta x}$) is called the

Slope

5) Calculate the slope of the following graph and give the correct unit.

$$\frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{10 - 5}{2 - 1} = \frac{5}{1} = 5$$



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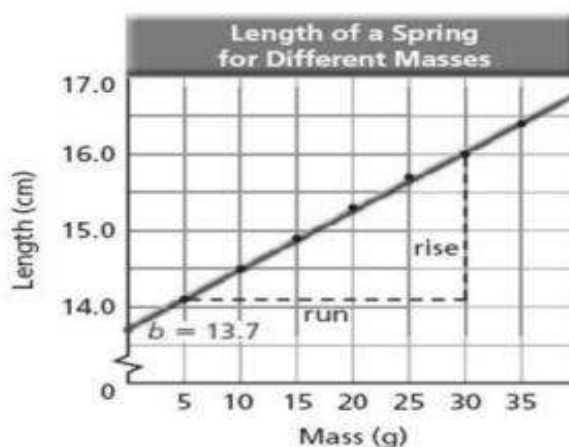
Multiple choice questions

1. Which describes an independent variable?

- ☒ A. The factor that is changed or manipulated during an experiment
- ☐ B. The factor that depends on what is changed or manipulated during an experiment
- ☐ C. The line of best fit
- ☐ D. The result of an experiment

2. Where is the dependent variable plotted on the graph?

- ☐ A. Horizontal axis
- ☒ B. Vertical axis
- ☐ C. At the origin
- ☐ D. The dotted line



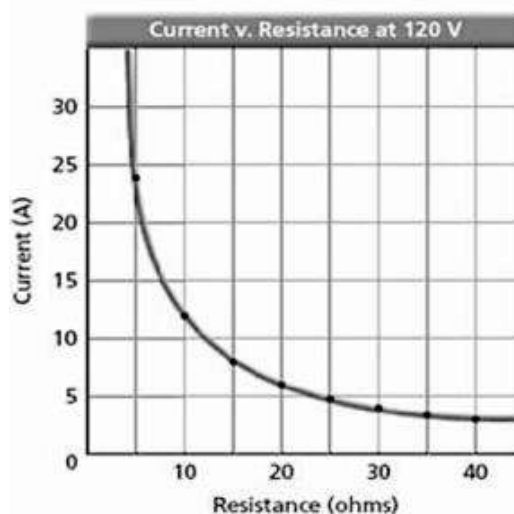
Questions 3 and 4

3. What type of relationship is represented in this graph?

- ☐ A. Linear
- ☐ B. Inverse
- ☒ C. Reverse
- ☐ D. Quadratic

4. What can you determine from looking at this graph?

- ☐ A. As resistance decreases, current decreases
- ☒ B. As resistance increases, current decreases
- ☐ C. As resistance increases, current stays the same
- ☐ D. As current increases, resistance increases

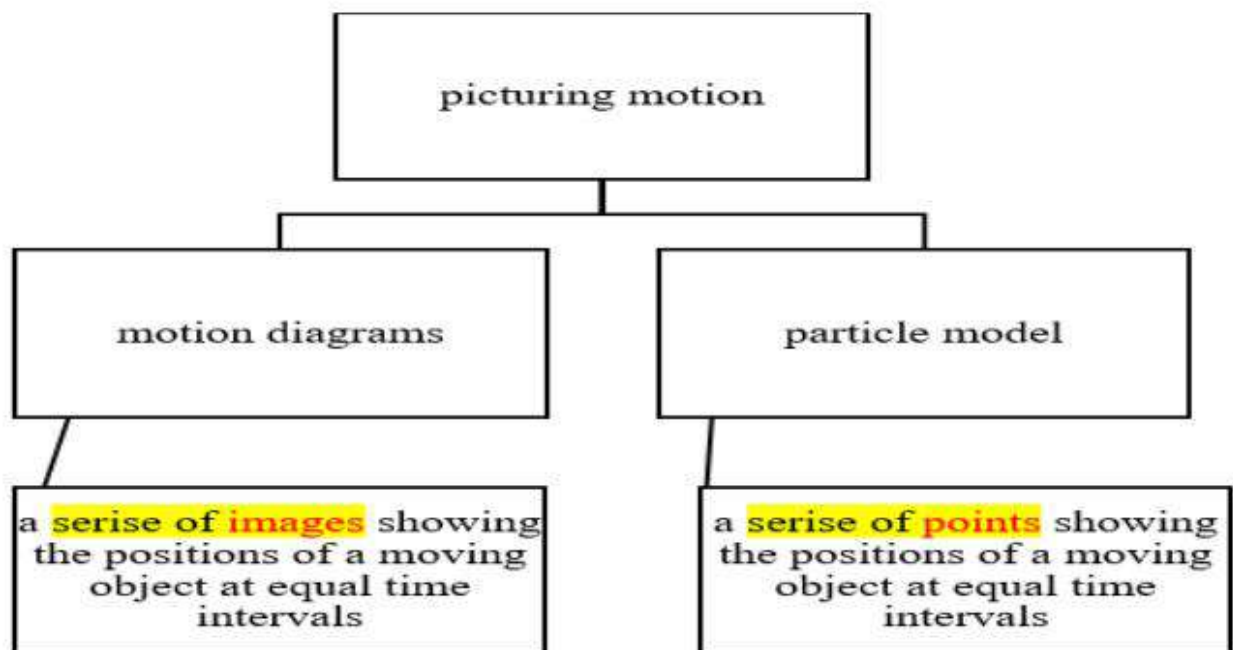


REPRESENTING MOTION

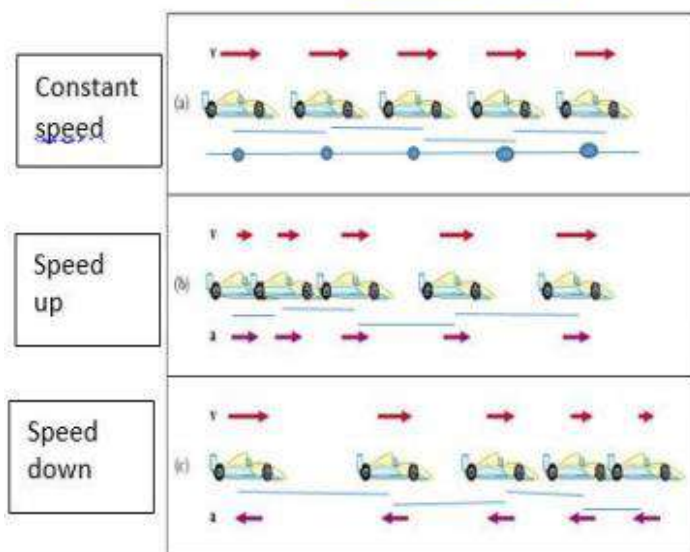
LESSON 1

PICTURING MOTION

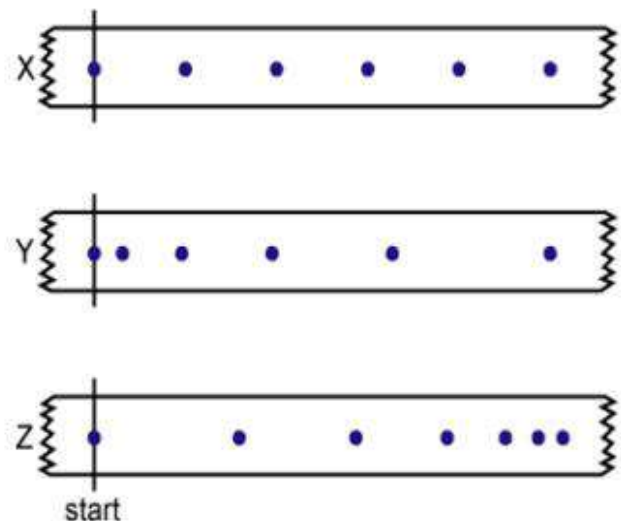
- **Movement along a straight line:** -linear motion/ is describe an objects motion as (forward, backward), (up and down) or (north and south).



*example of **motion diagrams**



* example of **particle model**



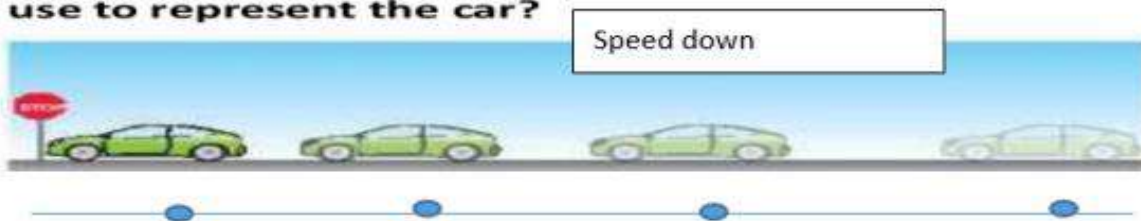
Question 2 page32 :- Draw a **particle model** motion diagram for a bike rider moving at **constant speed** along a straight path.



Question3 page 32:-

MOTION AND PARTICLE DIAGRAM ACTIVITY

- Draw a particle model motion diagram corresponding to the motion diagram in Figure 4 for a car coming to a stop at a stop sign. What point of the car did you use to represent the car?



Question 4 page 32:-

MOTION AND PARTICLE DIAGRAM ACTIVITY

- Draw a particle model motion diagram corresponding to the motion diagram in Figure 5 for a flying bird. What point on the birds did you choose to represent the bird?





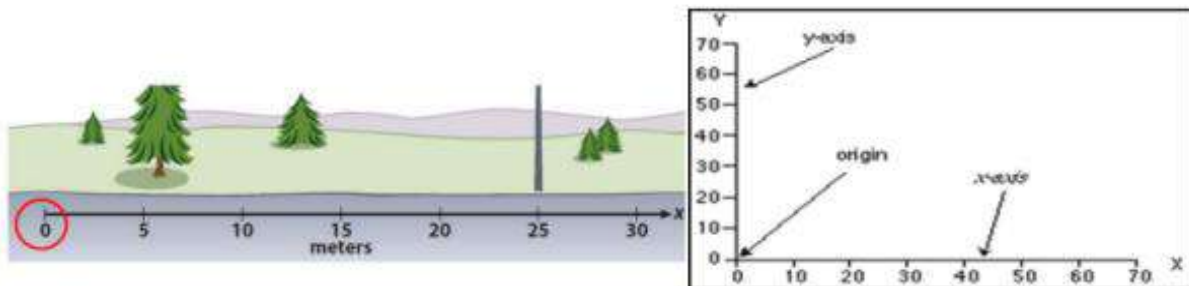
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LESSON 2 WHERE AND WHEN?

A. Coordinate Systems

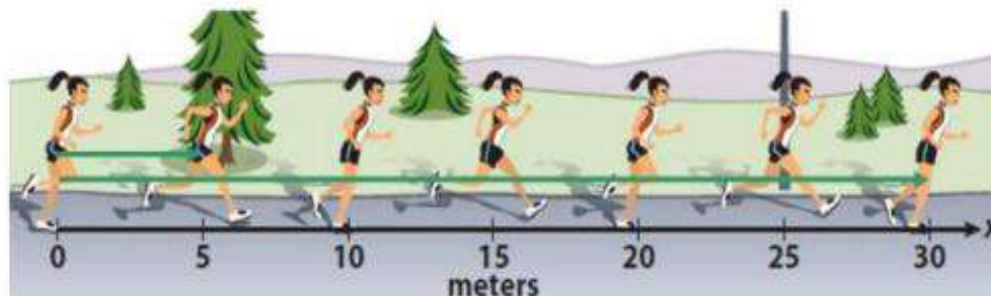
- **Origin(Zero Point):** The surrounding which we compare the motion of an object with it. A point that can be used to locate a place or thing.
- **Coordinate system** is a system of measurement of (distance and direction of motion), in which the value of the distance increases with respect to origin (zero point).



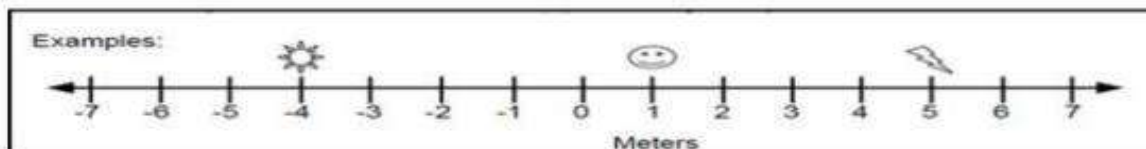
In a linear motion, the number line is (X or Y) axis of coordinate system that identifies the direction of motion of an object.

B. Position:

- Consider a runner on this coordinate system.
- You can indicate how far away an object is from the origin at a particular time by drawing an arrow from the origin to the object.
- The two arrows locate the runner's position at two different times.
- **Position is the distance (magnitude) and direction from origin to object. It is a vector quantity. It is expressed by a symbol (x).**



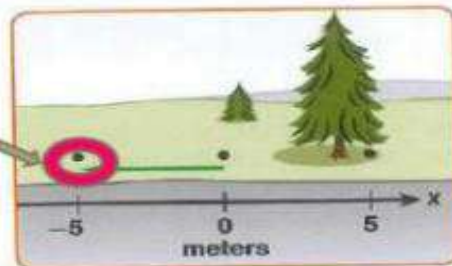
Sample:



- What is the position of the lightning bolt? 5 m to the right of origin.
- What is the position of the sun? 4 m to the left of origin.
- What is the position of the happy face? _____

Negative position

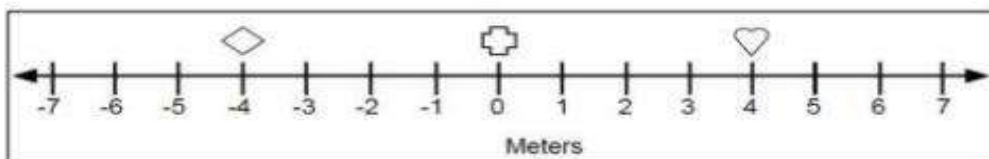
How can you describe this position



- 1) It is 5 m to the west of the origin.
- 2) It is 9 m to the left of the tree

❖ **ACTIVITY:** Answer the following question:

Q: Imagine a meter stick is placed next to the object. The meter stick acts like a number line. Consider zero point as your reference point.



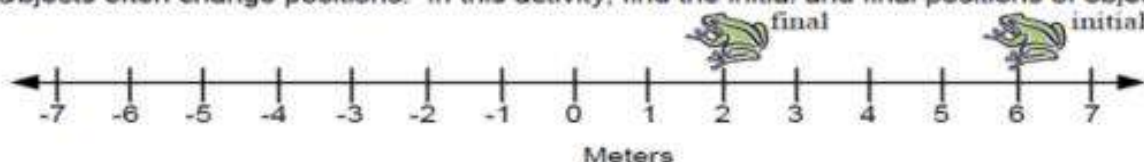
1. What is the position of the heart? _____
2. What is the position of the diamond? _____
3. What is the position of the cross? _____

C. Motion: A change in position

- Motion is a change in position of an object with respect to time and its reference point.
- The starting point A is called the initial position of an object and it is expressed by a symbol x_i .
- The ending point B is called the final position of an object and it is expressed by a symbol x_f .

Sample:

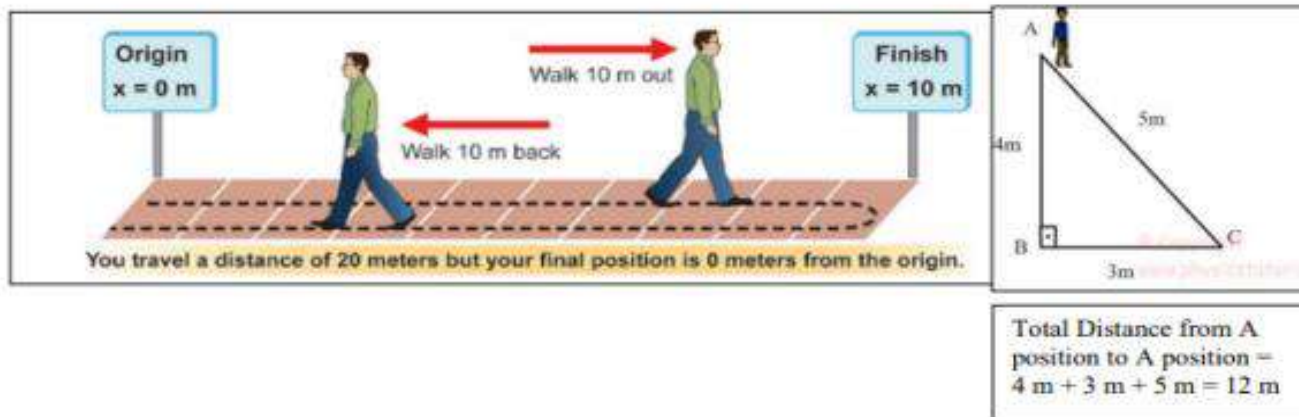
Objects often change positions. In this activity, find the initial and final positions of objects.



8. What is the initial position of the frog? _____
9. What is the final position of the frog? _____

D. Distance (d)

- Distance is the entire length of path covered by object no matter what direction the object moves. It is a scalar quantity.
- SI unit of distance is meter (m).



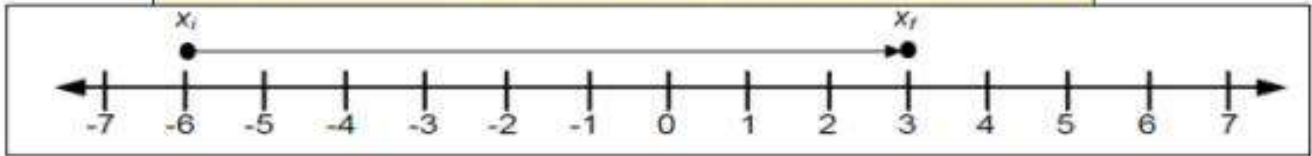
E. Displacement (Δx)

- Definition 1: Displacement is the difference between final position and initial position.
- It is a vector quantity, so it can be positive or negative.
- SI unit of displacement is meter.

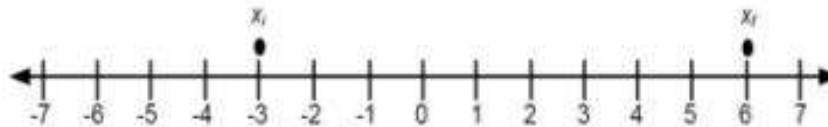
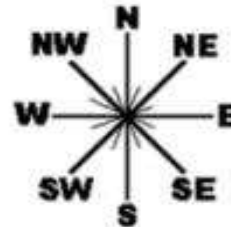
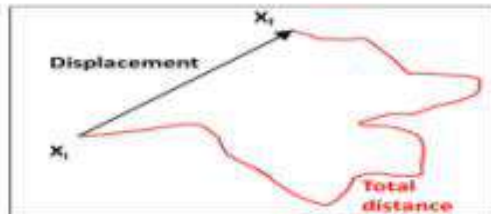
DISPLACEMENT

$$\Delta x = x_f - x_i$$

displacement = change in position = final position – initial position



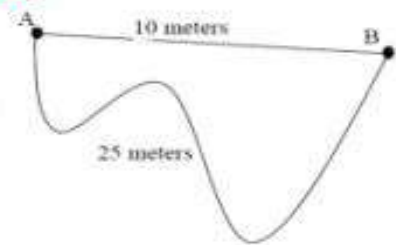
- Definition 2: Displacement Δx is the straight line from (Initial position) to (final position). It is expressed by symbol Δx . It may be positive or negative.
- Displacement is positive if object is moving towards right ($\rightarrow$), up ($\uparrow$), east (E) or north (N).
- Displacement is negative if object is moving towards left ($\leftarrow$), down ($\downarrow$), west (W) or south (S).



- Sample:
- What is the displacement [magnitude (with units) and direction (+ or -)]? _____

➤ Displacement is not always equal to the distance traveled:

- If an object travels in one direction in a straight line, distance traveled is EQUAL to the displacement.
- Often, objects do not travel in straight lines, so distance and displacement are NOT EQUAL.



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F. Time interval

- The difference between the initial and the final times is called the time interval.
- Time intervals are scalar.
- $\Delta t = t_f - t_i$
- Δt is the time interval, t_i is the initial time and t_f is the final time.

Time Interval

The difference between the initial and the final times

$$\Delta t = t_f - t_i$$

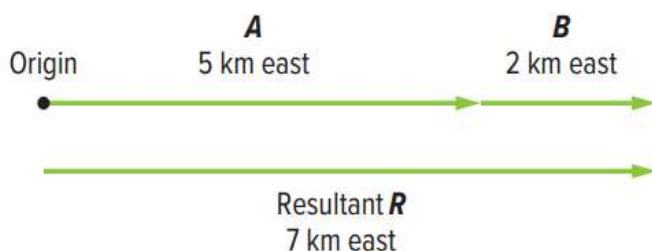


Vectors and Scalars

Quantity	Vectors	Scalars
Definition	Quantities that have magnitude and direction	Quantities that are just numbers without any direction
Examples	Displacement , velocity, and acceleration	distance, time, and temperature



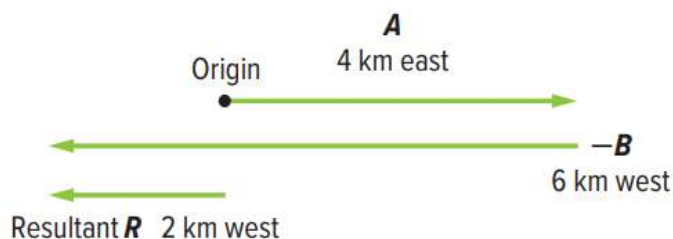
Example of Vector Addition



$$\begin{aligned} R &= A + B \\ &= 5 \text{ km} + 2 \text{ km} \\ &= 7 \text{ km} \end{aligned}$$

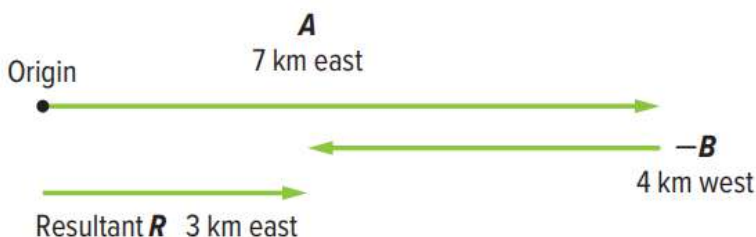
$$\begin{aligned} R &= A + B \\ &= 7 \text{ km east} \end{aligned}$$

Examples of Vector Subtraction



$$\begin{aligned} R &= A - B \\ &= 4 \text{ km} - 6 \text{ km} \\ &= -2 \text{ km} \end{aligned}$$

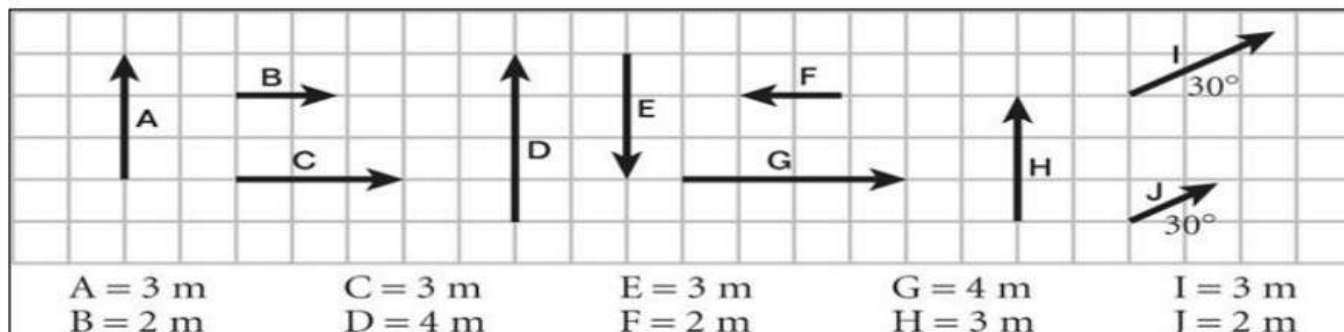
$$\begin{aligned} R &= A - B \\ &= A + (-B) \\ &= 2 \text{ km west} \end{aligned}$$



$$\begin{aligned} R &= A - B \\ &= 7 \text{ km} - 4 \text{ km} \\ &= 3 \text{ km} \end{aligned}$$

$$\begin{aligned} R &= A - B \\ &= A + (-B) \\ &= 3 \text{ km east} \end{aligned}$$

❖ **ACTIVITY:** Use the following vectors to answer questions:



- Which vectors have the same magnitude?
- Which vectors have the same direction?
- Which arrows, if any, represent the same vector?

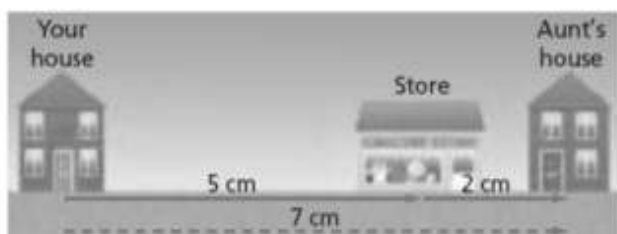
• Practice Questions

Multiple choice question

1. In a coordinate system the ____ is the point at which both variables have the value zero.

- A. distance
- B. magnitude
- C. origin
- D. vector

2. In this image, 7 cm represents the ____.



- A. origin
- B. resultant
- C. scalar
- D. interval

3. Final position minus the initial position is called ____.

- A. distance
- B. displacement
- C. magnitude
- D. time interval

4. Which of the following quantities is a vector?

- A. Distance
- B. Speed
- C. Work
- D. Displacement

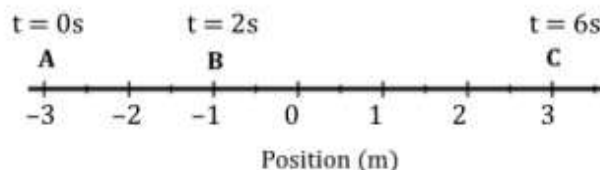
5. All of the following are scalar quantities except ____.

- A. mass
- B. distance
- C. acceleration
- D. temperature

6. Which of the following physical quantities is not a vector quantity?

- A. Time
- B. Force
- C. Velocity
- D. Acceleration

7. The diagram below shows the position of an object changing with time.

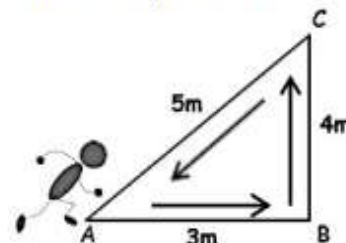


The displacement of the object if it moves from A to C and then back to B is ____.

- A. 1 m
- B. 2 m
- C. 4 m
- D. 6 m

8. A boy moved from point A to B to C and finally back to A as shown below. What is his displacement?

- A. 0 m
- B. 3 m
- C. 5 m
- D. 12 m

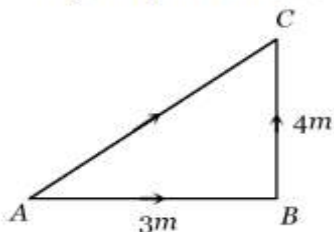


Questions 9 and 10

A particle starts from A and reaches C through point B as shown in the figure.

9. The distance travelled by the particle is ____.

- A. 1 m
- B. 3 m
- C. 5 m
- D. 7 m



10. The displacement of the particle is ____.

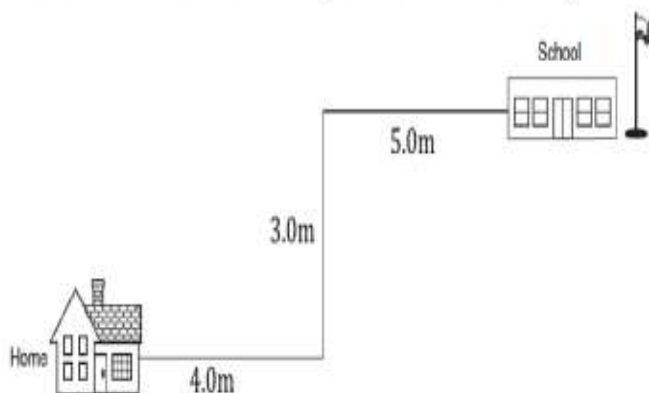
- A. 1 m
- B. 3 m
- C. 5 m
- D. 7 m

3. A student on her way to school walks 4.0m east, 3.0m north and another 5.0m east, as shown in the diagram.

a. Calculate the total distance she covers from her home to school.

b. Compared to the distance she walks, the magnitude of her displacement from home to school is _____ (Tick the correct answer).

- ☐ Less
- ☐ Greater
- ☐ The same



2. Classify the following quantities into scalar or vector quantities by putting a tick ($\checkmark$) in the table below.

Quantity	Scalar	Vector
Distance		
Displacement		
Speed		
Velocity		
Acceleration		
Force		
Work		
Energy		
Pressure		



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LESSON 3 POSITION-TIME GRAPHS

The motion of an object could be represented by a graph called position-time graph.

- In position-time graph:

- position is represented on the vertical axis

(y -axis) (dependent variable)

- and time is represented on the horizontal axis
(x-axis) (independent variable)

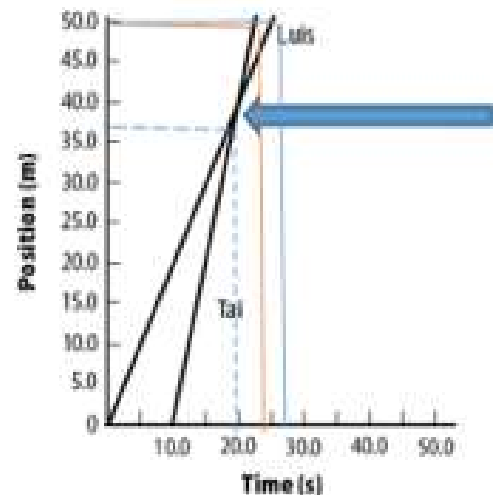
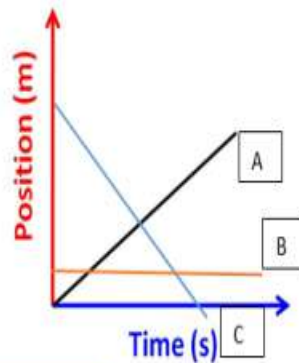
- A: The object is move in **constant speed** in **positive direction**

- C: The object is move in **constant speed** in **negative direction**.

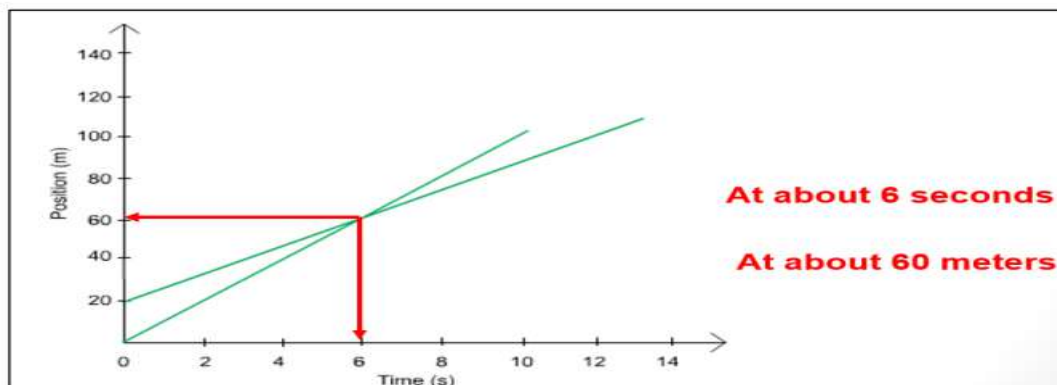
- B: object at rest جسم ساكن (speed=0, not moving)

- The instantaneous time point at which the object was at a specific position

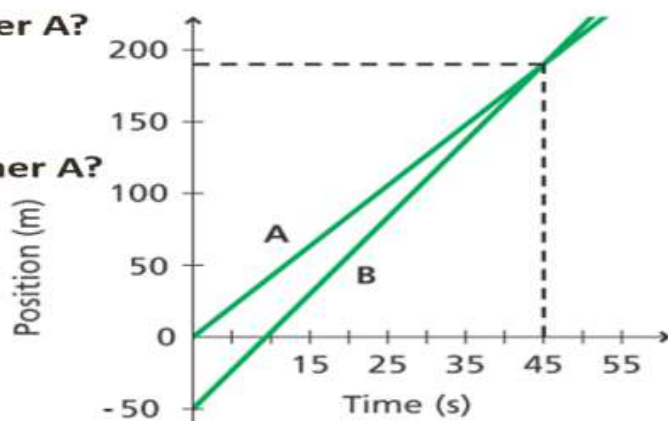
- When two lines intersect, the objects are in the same place at the same time.



From the following position-time graph of two brothers running a 100-m dash, at what time do both brothers have the same position? At what position?



- When does runner B pass runner A?
 - **45 seconds into the race**
- Where does runner B pass runner A?
 - **190 m**
 - When runner A was at 0m, where was runner B?
 - **-50m**



Multiple Objects On A Position-Time Graph

Two runners were moving along a straight path. The lines representing their motion are labeled A and B.

Q1. When and where does runner B pass runner A?

.....

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

.....

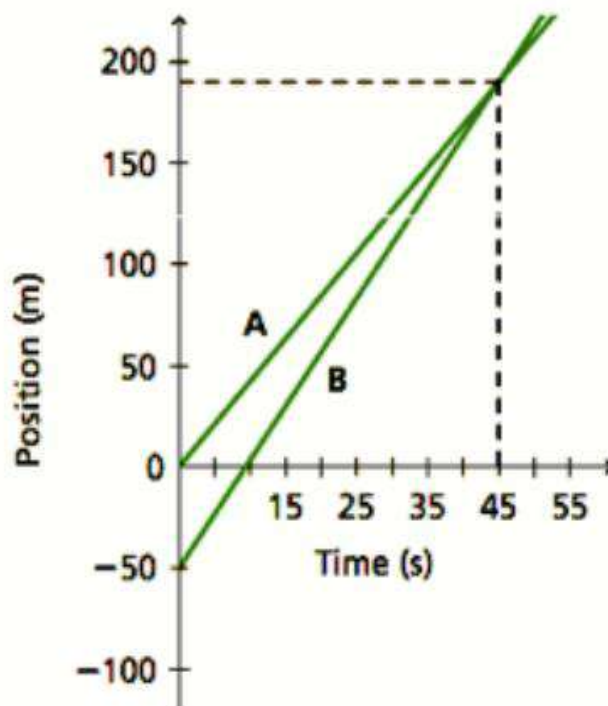
Q3. What is the position of A and B at the beginning of the time?

.....

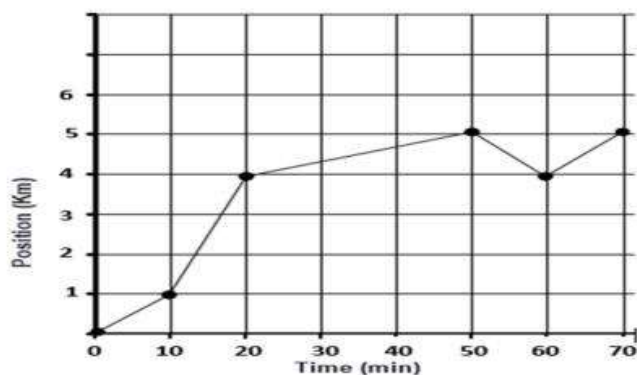
Q4. What is the position of A and B at $t=25s$, and how was ahead?

.....

Q5- Which runner was moving faster?

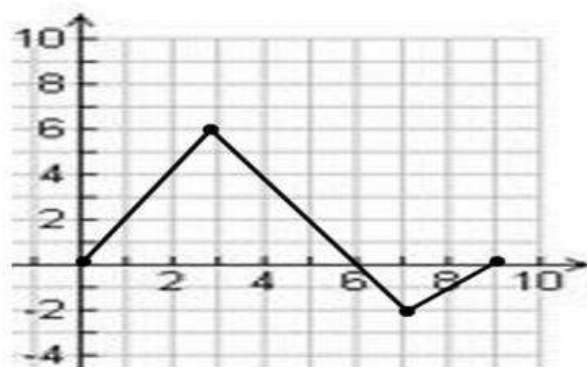


ACTIVITY 2:



Total distance: _____

Total displacement: _____



Total distance: _____

Total displacement: _____

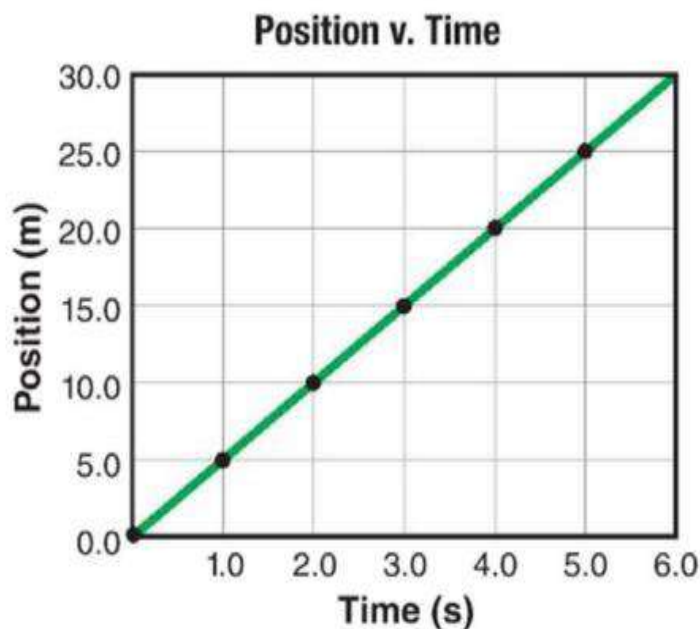
❖ **Sample 1:** Refer to the diagram below to answer questions.

1. What is the position of the object at 3 s?

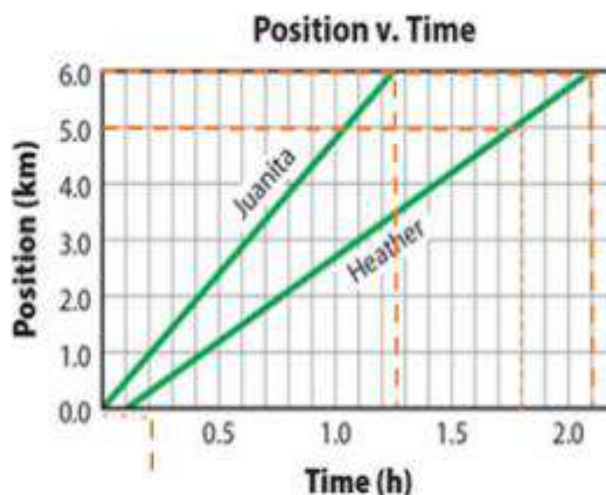
2. How much time has passed when the object is at 2 m?

3. If the object continues at this speed, when will the object reach 40 m?

4. If the object continues at this speed, where will the object reach at 10 s?



Exercise 4: - Juanita goes for a walk. Later her friend Heather starts to walk after her. Their motions are represented by the position-time graph.



- How long had Juanita been walking when Heather started her walk?
.....
- Will Heather catch up to Juanita?
.....
- How can you tell?
.....
.....
- What was Juanita's position at $t = 0.2\text{hr}$?
.....
- At what time was Heather 5.0 km from the start?
.....
- Who will win the race? Juanita because she reach finish line in less time than Heather

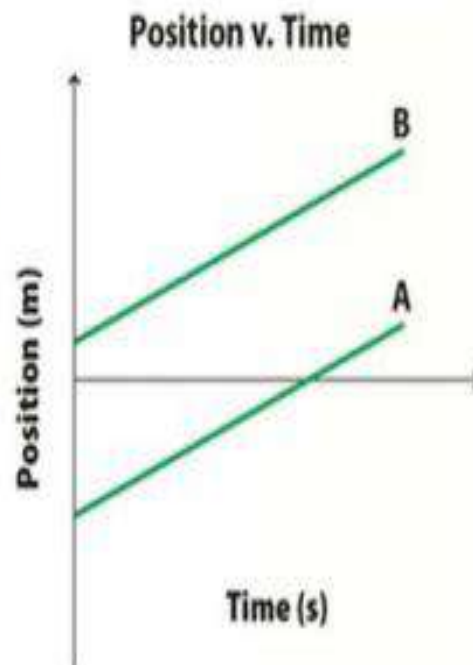
Exercise 3: - The graph represents the motion of two pedestrians who are walking along a straight sidewalk in a city.

Describe in words the motion of the pedestrians. Assume that the positive direction is east of the origin.

.....the two runner are same speed because lines are parallel

And both are walking to positive direction (east)

(B) start from east , and (A) start from west



LESSON 4

HOW FAST?

Velocity and Speed

Difference Between Speed and Velocity

Speed

1. The speed is the distance travelled by a body in a unit time.
2. It is a scalar quantity. The speed does not tell us the direction of the motion of a body.
3. The speed is always positive.
4. During the circular motion, the average speed does not become zero after completing one round.

Velocity

1. The velocity is the displacement of a body in a unit time.
2. It is a vector quantity. The velocity tells us the speed and direction of the motion of a body.
3. The velocity can be positive and negative depending on the direction of the motion.
4. During the circular motion, average velocity becomes zero after completing one round.

$$v = \frac{d}{\Delta t}$$

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

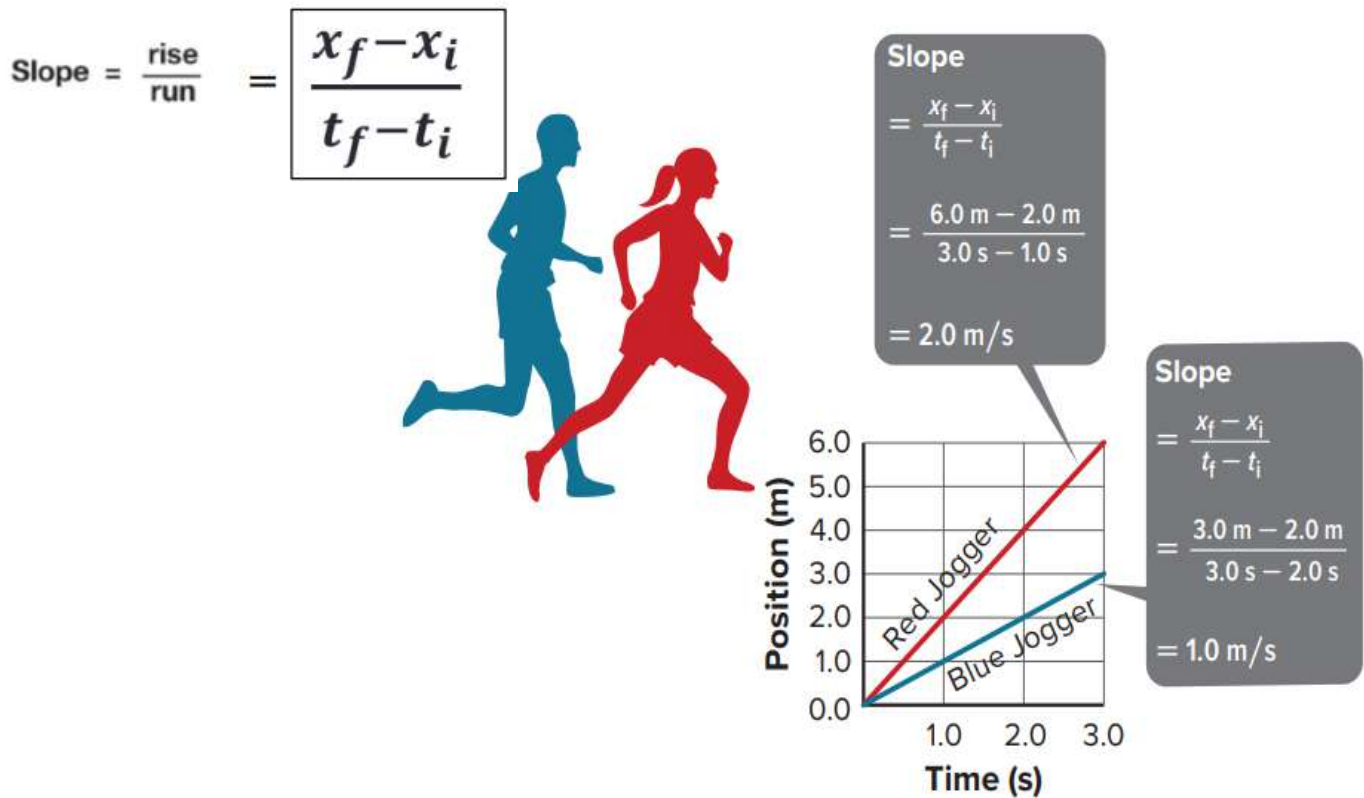
An object's velocity tells how fast it is moving and in what direction it is moving.

Speed is the magnitude of velocity.(absolute value of the average velocity)

Instantaneous velocity: the speed and the direction of an object at a particular instant (v).

A. Slope of Position Time Graph:

- The slope of a line is the ratio of the “rise” (vertical change) to the “run” (horizontal change) of the line.
- In a position time graph the slope of the line is **average velocity ($\bar{v}$)**. Slope is the rise/run of a line.
- The motion of more than one object can be graphed on a single position-time graph.



Average velocity

Average velocity is defined as the change in position divided by the time during which the change occurred.

$$\bar{v} \equiv \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

V = velocity

X_i = initial position

X_f = final position

Δx = displacement

t_i = initial time

t_f = final time

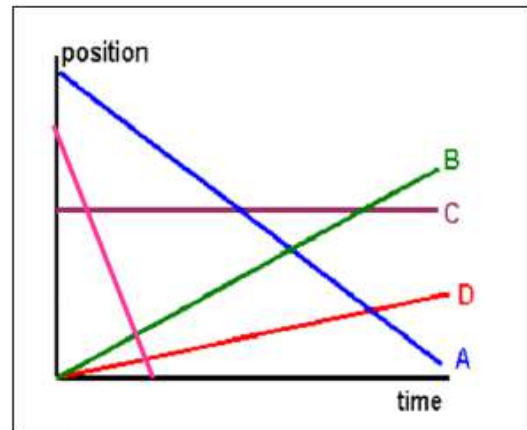
Δt = change in time



Interpreting Position-Time graph

1. Steepness of slope on Position-Time graph:

- The steepness of a line on a graph is called slope
- Steep slope = higher velocity
- Shallow slope = less velocity



2. Positive and negative (Slope) velocity

- The motion of an object can be expressed as moving with positive velocity, negative velocity or at rest. Consider the example of a moving car.



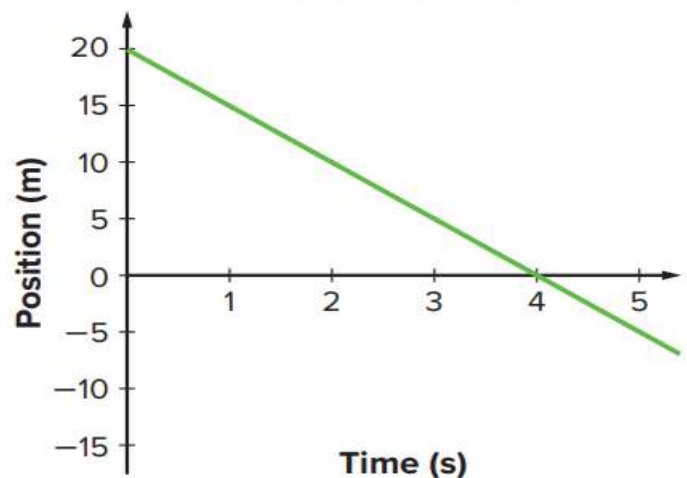
A. This car is moving towards right or east, it has positive velocity.

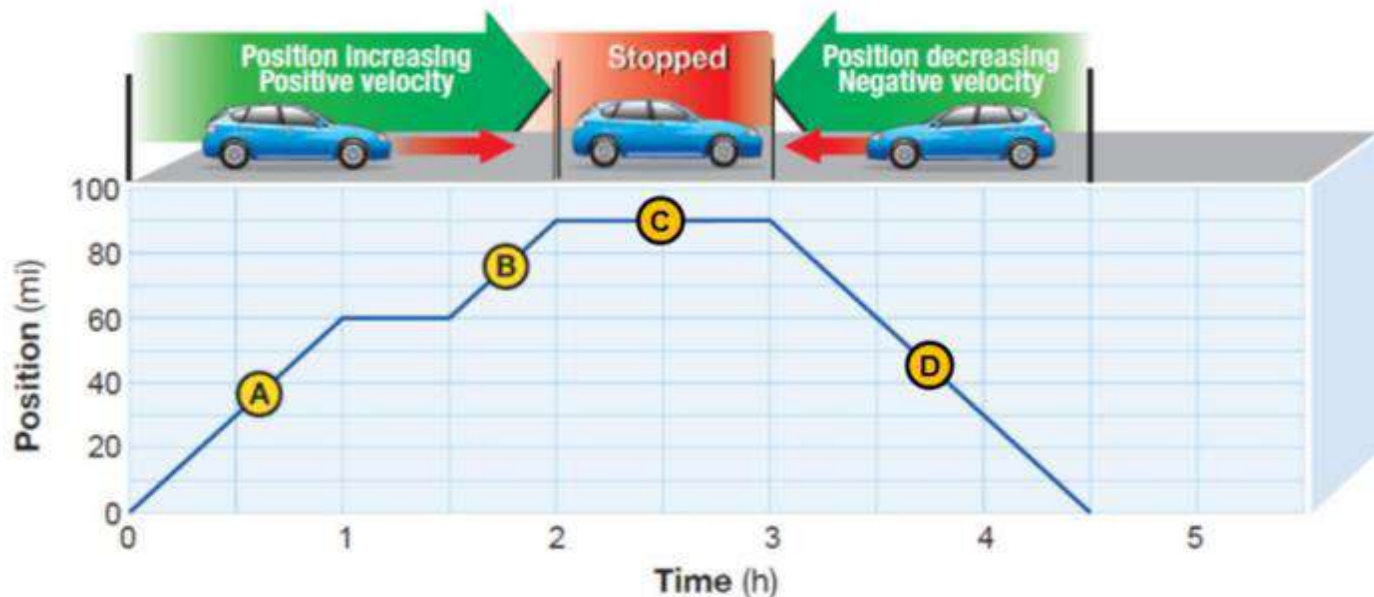


B. This car is moving towards left or west, it has _____.

The slope of this position-time graph is -5.0 m/s , that mean the motion is in the negative direction. The sign of the slope tells you in what direction the object is moving.

Position v. Time



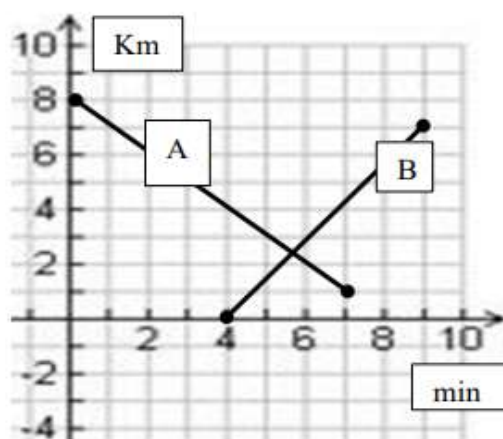


In the graph the lines **A** and **B** represent the positive velocity. The line **C** represents the car at rest $\bar{v} = 0$ and line **D** represents the car moving in opposite direction towards the origin or it has negative velocity.

3. Intersection on Position vs time: Intersection in Position vs time indicates that the two objects share the same position at that instant in time, Ex: Overtaking cars.

❖ **Sample 1:** Two drivers (driver A and driver B) are traveling in opposite directions on a long, straight road. Their motions are represented by the position-time graphs of each, shown below.

- I. How long had driver A already been driving when driver B started to drive? 4min
- II. How long had driver A been driving when she was 4 km away from her starting point? 4min
- III. Which driver is faster? B



- **ACTIVITY 1:** Three friends run a race. The graph below describes their motion

A. Who runs at the slowest velocity?

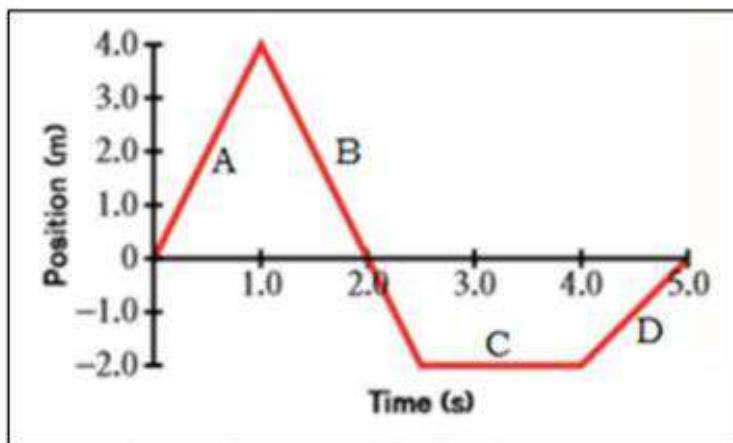
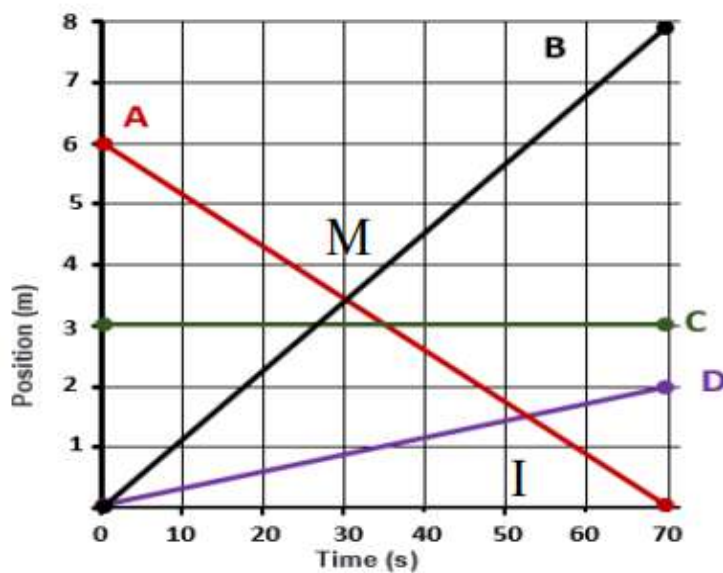
B. Who runs at the fastest velocity?

C. Who is at rest?

D. What happens at point I and M?

E. Who passes C path first and when?

F. Who travels the farthest after 40 s?



1. Solve the slope of A.

2. Solve the slope of B.

3. Solve the slope of C, Describe its motion.

4. Solve the slope of D.

5. Based on the slope, at which time it is moving the fastest?

6. Based on the slope, at which time it is at rest?

Equation of Motion

Any time you graph a straight line, you can find an equation to describe it ,any straight line can be represented by the formula: $y = mx + b$, where m is the slope of the line, and b is the y -intercept of the line. So in position- time line-graph it will be..

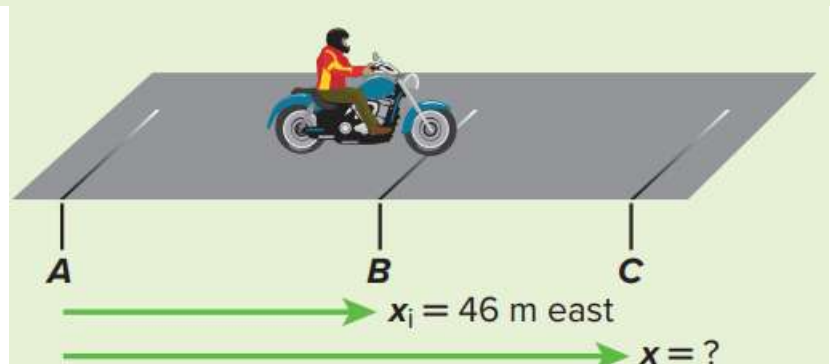
Equation of Motion for Average Velocity $x = v t + x_i$

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

x = position (m) v = average velocity(m/s) t = time(s) x_i = initial position.(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**?



For problems 32–35, refer to **Figure 24**.

- 32.** The diagram at the right shows the path of a ship that sails at a constant velocity of 42 km/h east. What is the ship's position when it reaches point **C**, relative to the starting point, **A**, if it sails from point **B** to point **C** in exactly 1.5 h?

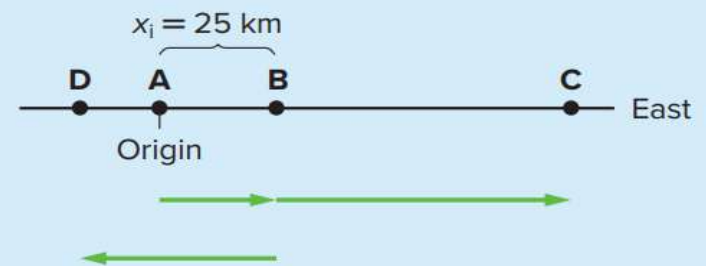


Figure 24

- 33.** Another ship starts at the same time from point **B**, but its average velocity is 58 km/h east. What is its position, relative to **A**, after 1.5 h?

- 34.** What would a ship's position be if that ship started at point **B** and traveled at an average velocity of 35 km/h west to point **D** in a time period of 1.2 h?



35. CHALLENGE Suppose two ships start from point **B** and travel west. One ship travels at an average velocity of 35 km/h for 2.2 h. Another ship travels at an average velocity of 26 km/h for 2.5 h. What is the final position of each ship?



• Practice Questions

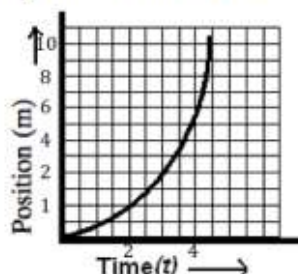
Multiple choice question

1. ____ is the change in position divided by the time during which the change occurred.

- A. Average velocity
- B. Average speed
- C. Instantaneous velocity
- D. Instantaneous speed

2. The figure below shows a position-time graph for an object in motion. Its velocity at 4s is called its ____ velocity.

- A. average
- B. variable
- C. constant
- D. instantaneous

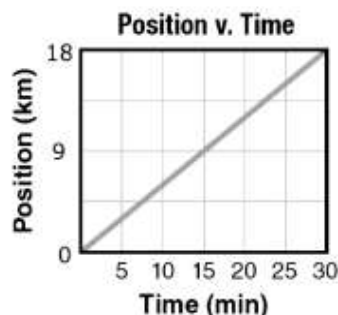


5. When is the average velocity of an object equal to the instantaneous velocity?

- A. when the velocity is constant
- B. only when the velocity is decreasing at a constant rate
- C. only when the velocity is increasing at a constant rate
- D. always

6. The graph below represents the motion of a bicycle. What is the average speed of the bicycle?

- A. 0.1 m/s
- B. 0.6 m/s
- C. 1.7 m/s
- D. 10 m/s



3. You drive a car for 3.0 h at 97 km/h, then for another 3 h at 72 km/h. What is your average velocity?

- A. 85 m/s^2
- B. 85 km/s^2
- C. 85 km/h
- D. 85 km/h^2

4. What is the average velocity of an object that moves from 6.5 cm to 3.5 cm relative to the origin in 3.0 s?

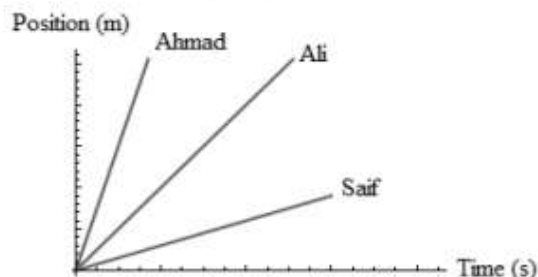
- A. 1.0 m/s
- B. 2.0 m/s
- C. 3.3 m/s
- D. 9.0 m/s

7. An object's equation of motion is given by $x_f = (12 \text{ m}) + (5 \text{ m/s}) t$,

where x_f is the final position and t is the time. Which statement is true for the object?

- A. Initial velocity could be 12 m/s
- B. Moves with a constant velocity of 5 m/s
- C. Moves with a constant velocity of 12 m/s
- D. Accelerates at 5 m/s²

8. Which of the following correctly compares the velocities represented by the graph below?



- A. $v_{\text{Saif}} > v_{\text{Ali}} > v_{\text{Ahmed}}$
- B. $v_{\text{Saif}} = v_{\text{Ali}} = v_{\text{Ahmed}}$
- C. $v_{\text{Ahmed}} > v_{\text{Ali}} > v_{\text{Saif}}$
- D. $v_{\text{Ali}} > v_{\text{Ahmed}} > v_{\text{Saif}}$

ACCELERATED MOTION

LESSON 1

ACCELERATION

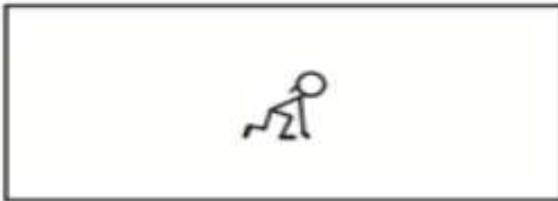
Section 1 : Acceleration.

main idea : an object accelerates when its velocity change- that is , when it speed up,slow down, or changes direction.

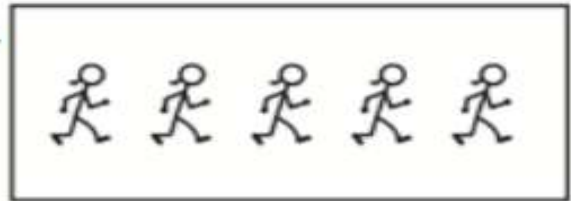
Objects do not always move at constant velocities. Understanding accelerated motion will help you better describe the motion of many objects.

how would you describe the motion of the person in figure?

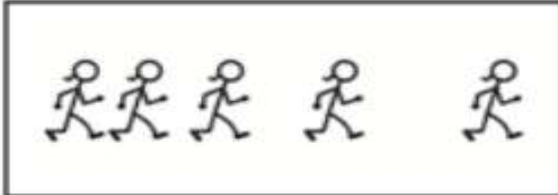
a



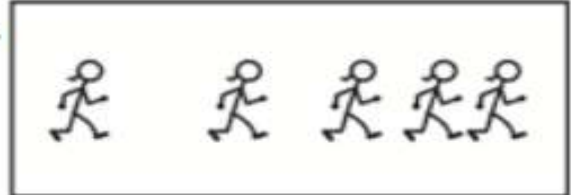
b



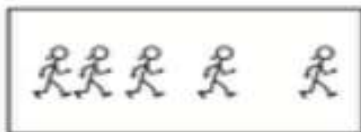
c



d



particle model diagram



The particle-model version of the motion diagram indicates the runner's changing velocity not only by the change in spacing of the position dots, but also by the change in length of the velocity vectors.

the arrow is velocity vector

Average Acceleration

Average acceleration is defined as the change in velocity divided by the time it takes to make that change.

$$\bar{a} \equiv \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

a = acceleration in meters per second squared (m/s^2)

Δv = change in velocity in meters per second (m/s)

Δt = time taken in seconds (s)

change in velocity = final velocity – initial velocity

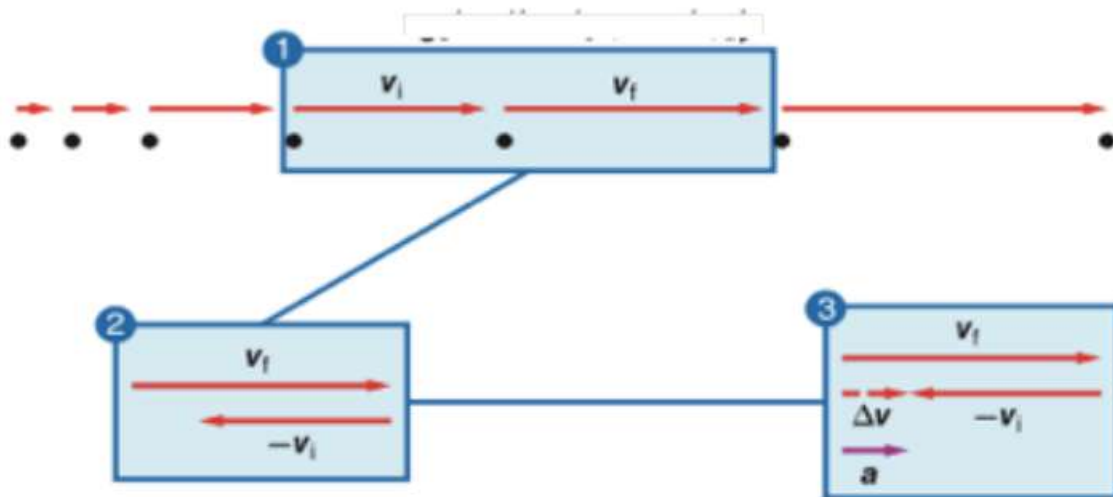
Displaying acceleration on a motion diagram.

Acceleration : it is the rate at which an object's velocity changes .

Acceleration is a vector quality (has magnitude and direction).

You can draw the acceleration vector from tail of the final velocity to the tip of the initial velocity vector.

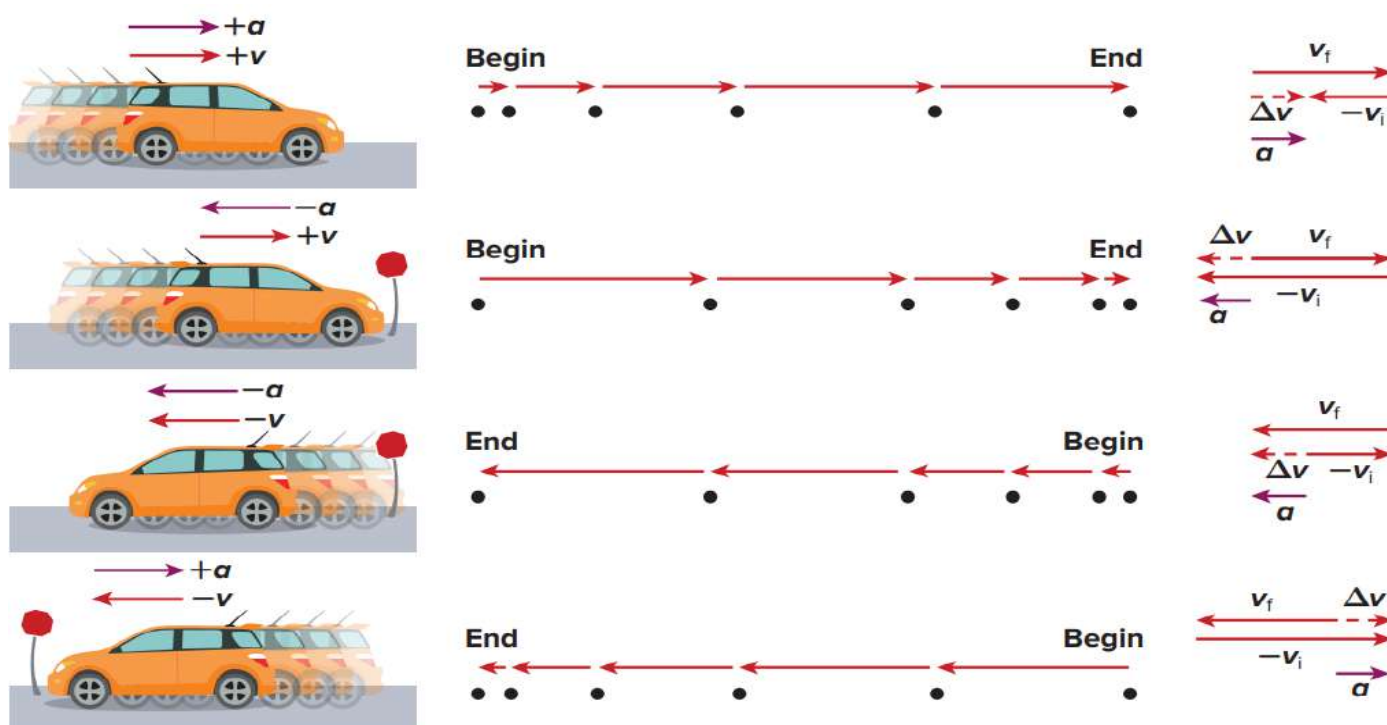
finding acceleration vector



First drew V_f , below that, drew V_i with its tail aligned with the tip of V_f

next, drew the vector ΔV from the tail of V_f to the tip of V_i . the acceleration vector a is the same as divided by the time interval.

- The acceleration of an object can be positive or negative, depending on whether the object is speeding up or slowing down.
- If an object is speeding up, its acceleration is positive
- If an object is slowing down, its acceleration is negative (sometimes called deceleration)
- An object that speeds up is accelerating
- An object that slows down is decelerating



• Practice Questions

Multiple choice questions

1. As a car is driven south in a straight line with constant speed, the acceleration of the car must be ____.

- zero
- directed northward
- directed southward
- constant, but not zero

2. A car, initially traveling at 15 m/s north, accelerates to 25 m/s north in 4.0 seconds. The magnitude of the average acceleration is ____.

- 2.5 m/s^2
- 6.3 m/s^2
- 10 m/s^2
- 20 m/s^2

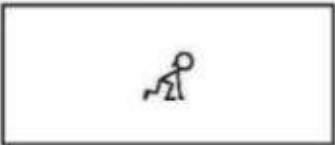
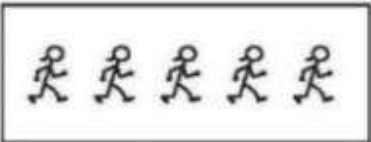
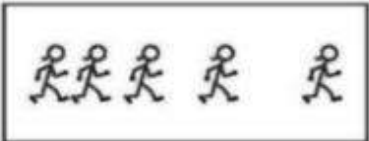
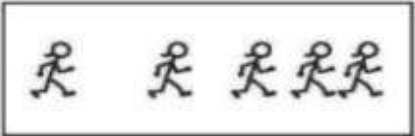
3. A car, initially traveling at 15 m/s north, accelerates at a rate of 2.5 m/s^2 . What is its final velocity after 4.0 s?

- A. 5.0 m/s
- B. 6.0 m/s
- C. 25 m/s
- D. 38 m/s

4. As a car is driven south in a straight line with decreasing speed, the acceleration of the car must be:

- A. zero
- B. directed northward
- C. directed southward
- D. constant, but not zero

5. Which of the motion diagrams below show an object moving with constant velocity?

- A. 
- B. 
- C. 
- D. 

7. Identify which of the following can all be true about the motion of an accelerating object.

Velocity	Acceleration	Motion
A. Positive	Positive	Speeding up
B. Positive	Negative	Speeding up
C. Negative	Negative	Slowing down
D. Negative	Positive	Speeding up

8. The uniform acceleration has a_____.

- A. varying magnitude and direction
- B. constant magnitude and direction
- C. varying magnitude and a constant direction
- D. constant magnitude and a varying direction

9. If an object's velocity and acceleration have the same direction, then the object is _____.

- A. at rest
- B. speeding up
- C. slowing down
- D. moving at a constant velocity



- 1) A dragster going at 15 m/s increases its velocity to 25 m/s in 4 seconds. What is its acceleration?
- 2) The driver of a car steps on the brakes, and the velocity drops from 20 m/s to 10 m/s in a time of 2 seconds. Find his acceleration.
- 3) A car starts from rest and reaches a velocity of 42m/s in 1 minute. Find the acceleration of the car?

4. A sprinter runs a 100 m race in a straight line. The table shows how his speed changes with time for the first 5.0 s of the race.

Speed (m/s)	0	1.7	4.1	5.7	6.5	6.8
Time (s)	0	1.0	2.0	3.0	4.0	5.0

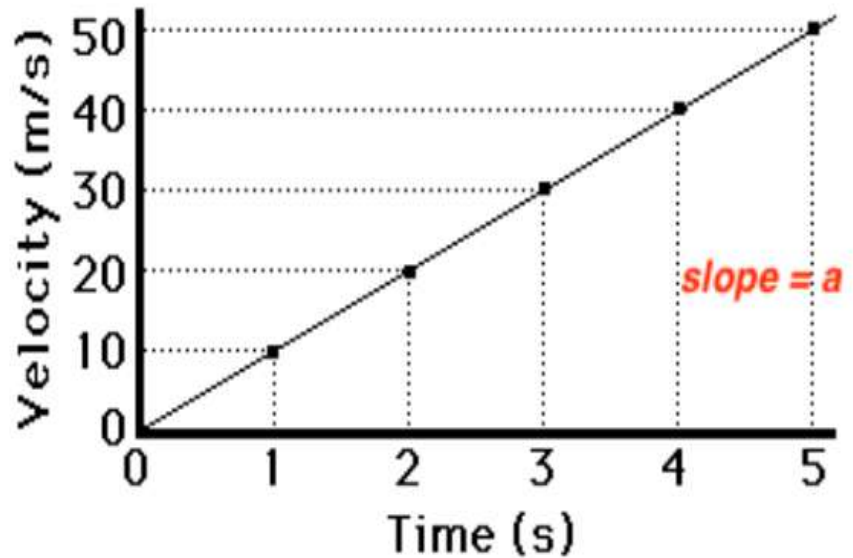
What is the average acceleration of the sprinter between time 2.0 s and time 3.0 s?

- A. 1.6 m/s^2
- B. 1.9 m/s^2
- C. 4.1 m/s^2
- D. 5.7 m/s^2

Velocity-Time Graphs

you can determine acceleration from
a velocity-time graph by
calculating the slope

slope = acceleration .



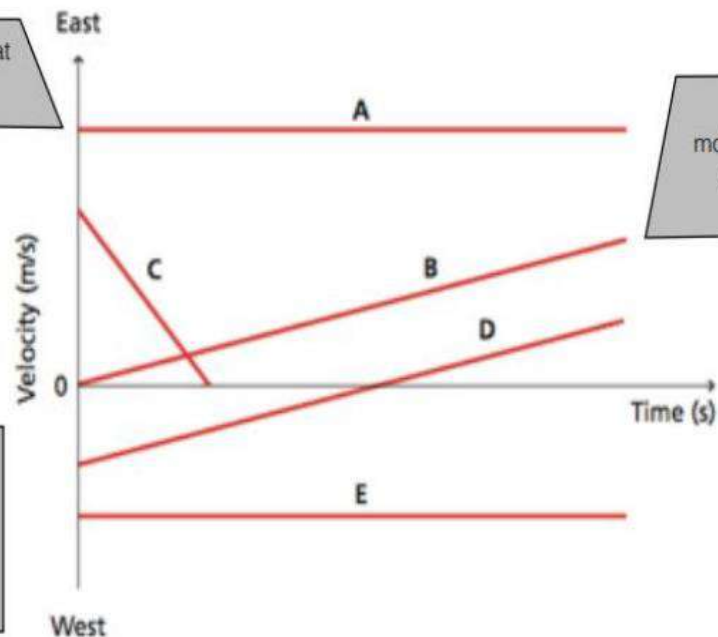
Reading velocity-time graph

the motion of five runners are shown in figure.

A & E: slope=0 → a=0 → A motion at constant velocity to the East

C: slope (—) a (—)
motion begins with positive velocity, slows down then stops

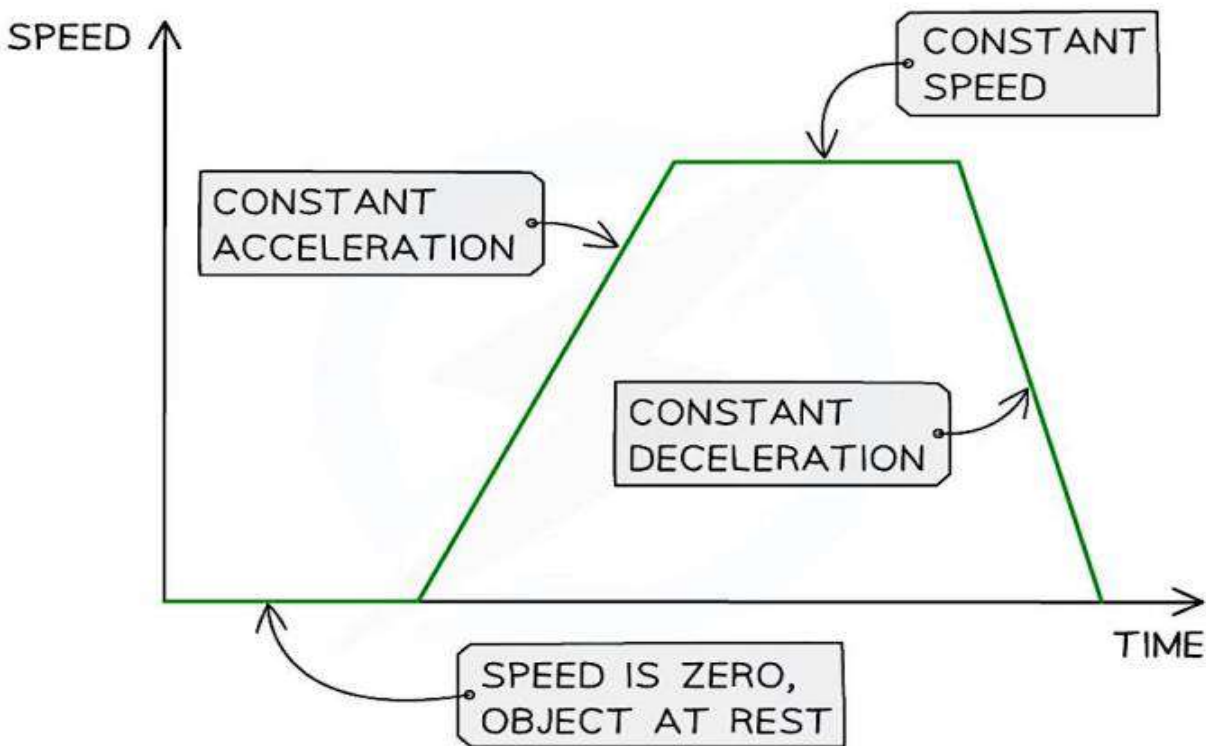
D: slope (+) a (+)
motion begins out toward the west, slow down, for an instance has zero velocity, then move east velocity after that the speed increases



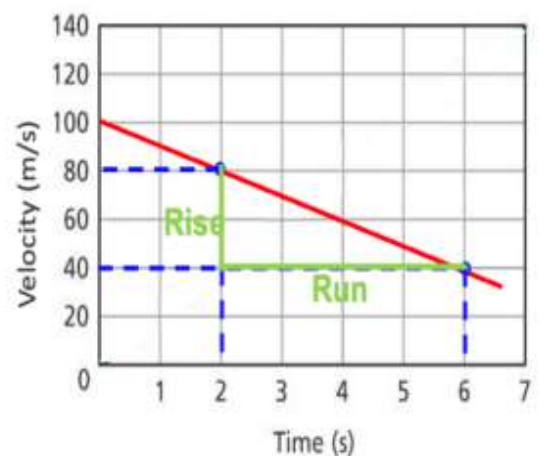
B : slope (+) a (+)
motion with positive velocity eastward the velocity increases,

➤ The **slope** of the line represents the **magnitude** of acceleration

- A **steep** slope means **large acceleration** (or deceleration) - i.e. the object's speed changes very **quickly**
- A **gentle** slope means **small acceleration** (or deceleration) - i.e. the object's speed changes very **gradually**
- A **flat line** means the acceleration is **zero** - i.e. the object is moving with a **constant speed**



The opposite graph represents the motion of a plane. Find the acceleration of the plane. Is the plane speeding up or slowing down? Justify your answer.



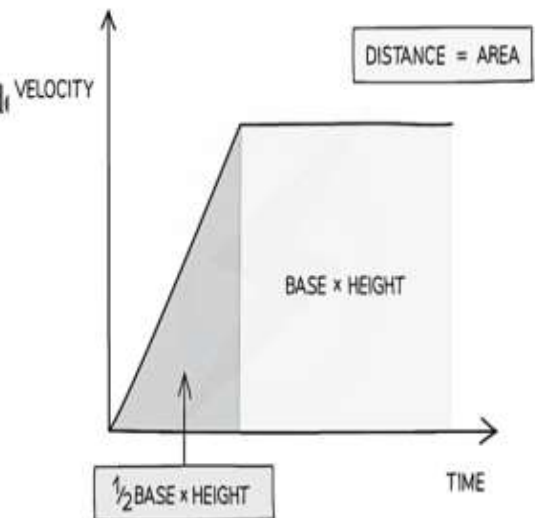
The total distance travelled by an object can be found by determining the area under the graph.

If the area under the graph forms a triangle (the object is accelerating or decelerating) then the area can be determined using the formula:

$$\text{area} = \frac{1}{2} \times \text{base} \times \text{height}$$

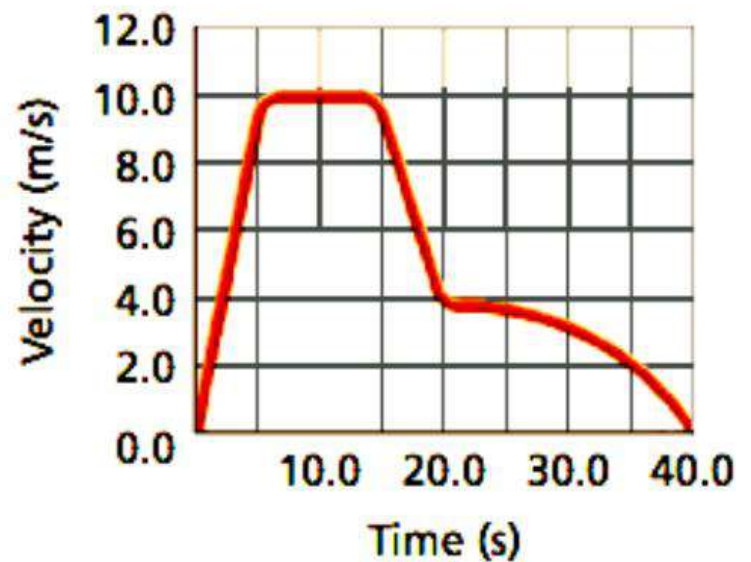
If the area beneath the graph forms a rectangle (constant velocity) then the area can be determined using the formula:

$$\text{area} = \text{base} \times \text{height}$$



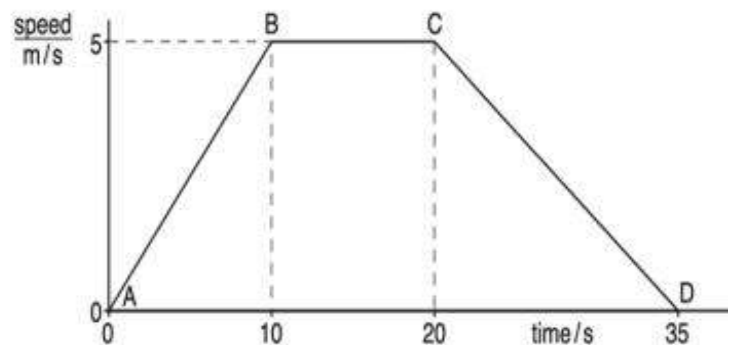
4. Refer to Figure to find the average acceleration of the train during the following time intervals.

- 0.0s to 5.0s
- 15.0s to 20.0s
- 0.0s to 40.0s



Calculate the distance in the last 25 s .

Distance = area under the graph



Average and instantaneous Acceleration

Average acceleration is equal to the change in velocity, divided by the time it takes to make that change.

it is measured in meter per second per second (m/s/s) or meter per second squared (m/s²)

$$\bar{a} \equiv \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

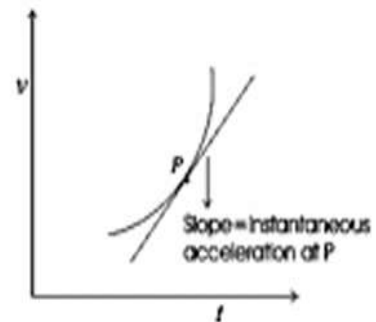
average acceleration depends of starting and ending velocity during time interval.

average acceleration **a = slope of (velocity- time) graph**

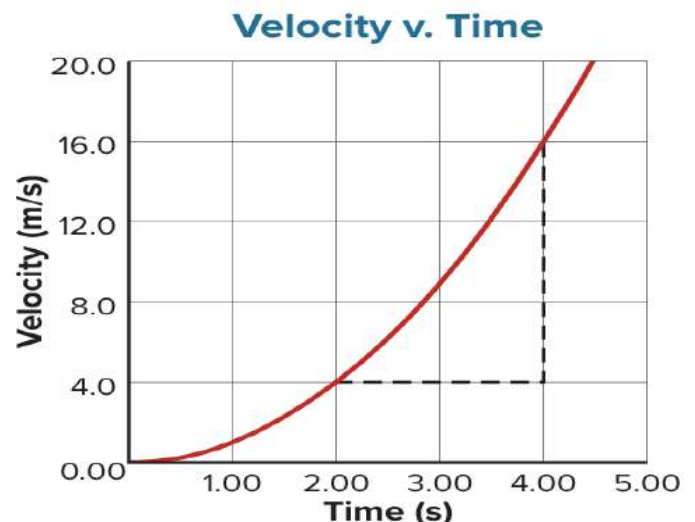
Instantaneous acceleration the change in an objet's velocity at an instant of time.

On velocity vs time graph, slope equals $\Delta v / \Delta t$.

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 want. then find the slope of this tangent line.



Calculate *How large is the average acceleration between 0.00 s and 2.00 s?*

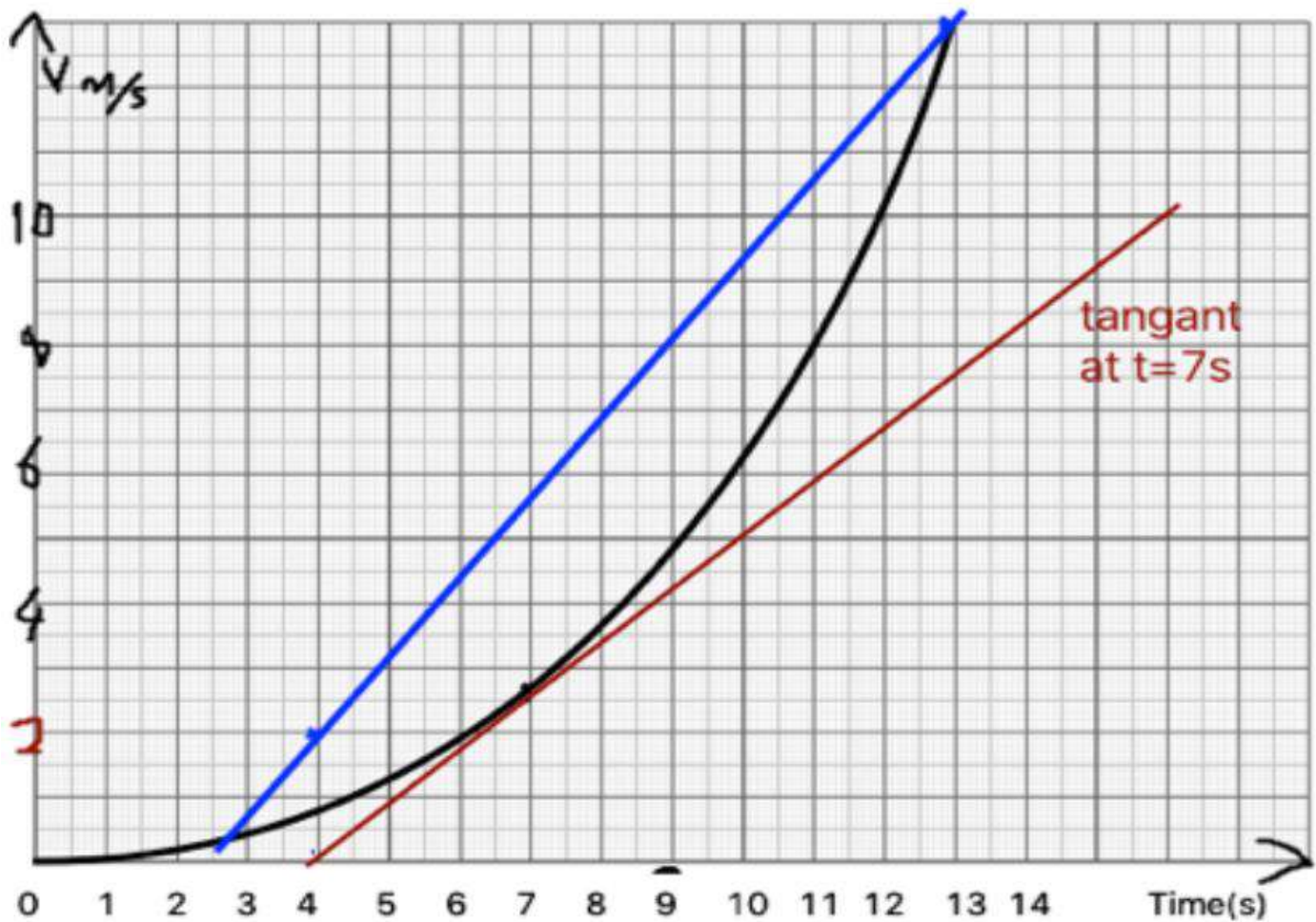


example

A curved line on a velocity-time graph shows that the acceleration is changing.

a. what is the average acceleration from $t_i=3\text{s}$ to $t_f=13\text{s}$?

b. What is the instantaneous acceleration at $t=7\text{s}$?

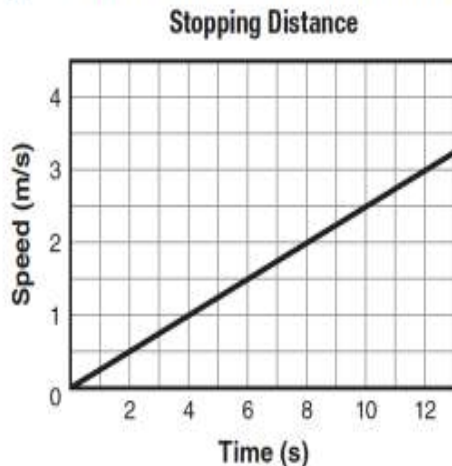


a. average acceleration = slope of the line passes in $(t=3\text{s}, t=13\text{s})$

b. instantaneous acceleration = slope of tangent at specific time. ($t=7\text{s}$)

• Practice Questions

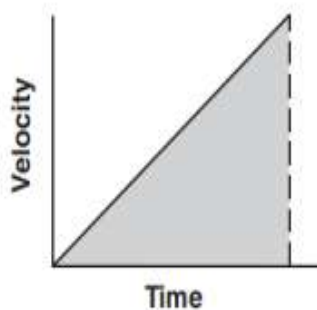
10. The graph below represents the motion of an object. What is the acceleration of the object?



- A. 0.25 m/s^2
- B. 0.40 m/s^2
- C. 2.5 m/s^2
- D. 4.0 m/s^2

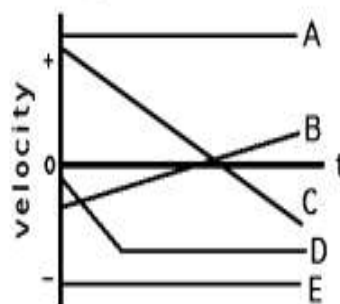
11. The graph below represents the relationship between velocity and time of travel for a toy car moving in a straight line. The shaded area under the line represents the car's _____.

- A. speed
- B. position
- C. acceleration
- D. displacement



Questions 15 and 16

The velocity-time graph below represents the motion of five different objects A, B, C, D and E.



15. Which of the objects is/are moving with a constant velocity?

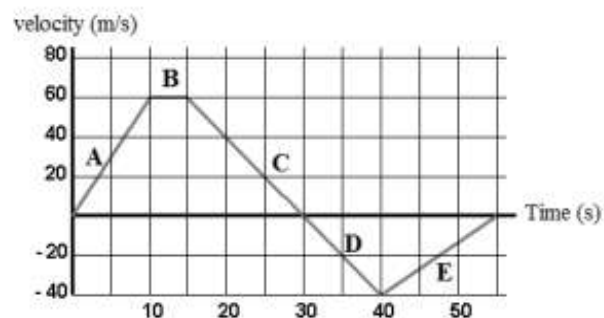
- A. A only
- B. A and E only
- C. B and C only
- D. A, B and C only

16. Which object has a constant negative acceleration throughout its motion?

- A. B
- B. C
- C. D
- D. E

Questions 26 & 27.

The following velocity-time graph represents the motion of an object.



26. When is the acceleration zero?

- A. A
- B. B
- C. C
- D. D

27. When is the acceleration negative?

- A. A
- B. B
- C. C
- D. E

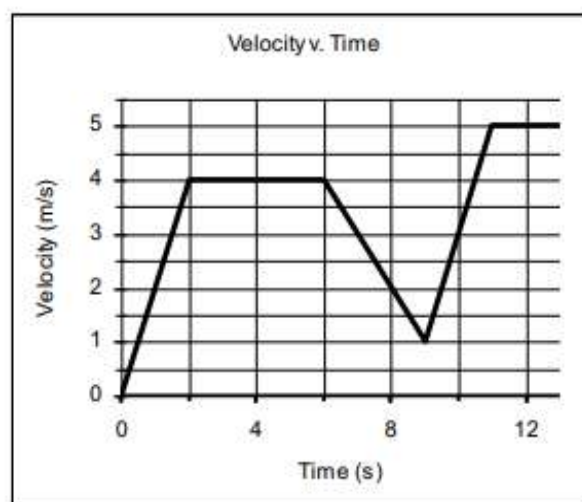
28. A car is taking a circular path with a constant speed of 20m/s.



- I. The object has a uniform velocity
 - II. The direction of motion is changing
 - III. The object has a non-zero acceleration
- A. I only
 - B. II and III only
 - C. I and III only
 - D. I, II and III

Questions 29 & 30

The following is a velocity-time graph for the motion of an object.



29. The slope of the graph represents ____.

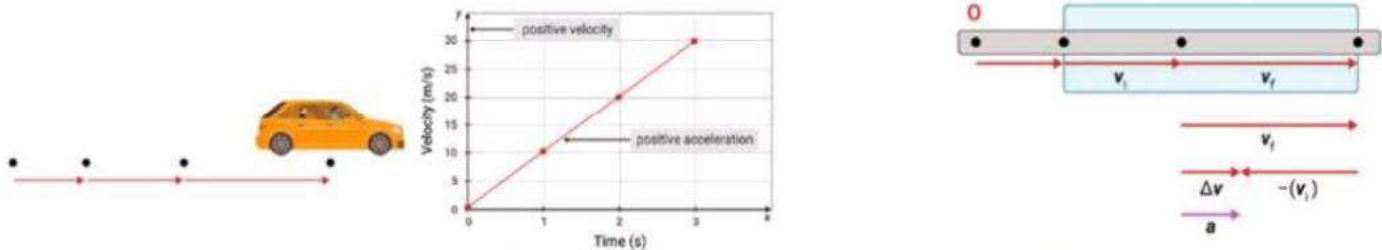
- A. speed
- B. acceleration
- C. displacement
- D. instantaneous velocity

30. What is the distance covered by the object during the interval $t = 2s$ to $6s$?

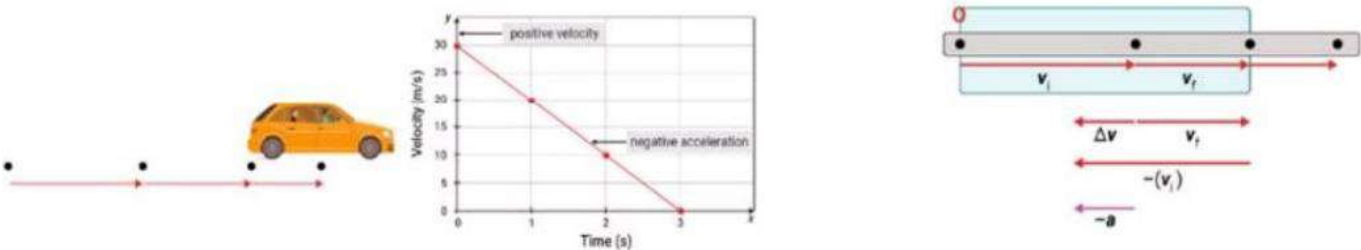
- A. 0 m
- B. 4.0 m
- C. 8.0 m
- D. 16 m

Remember

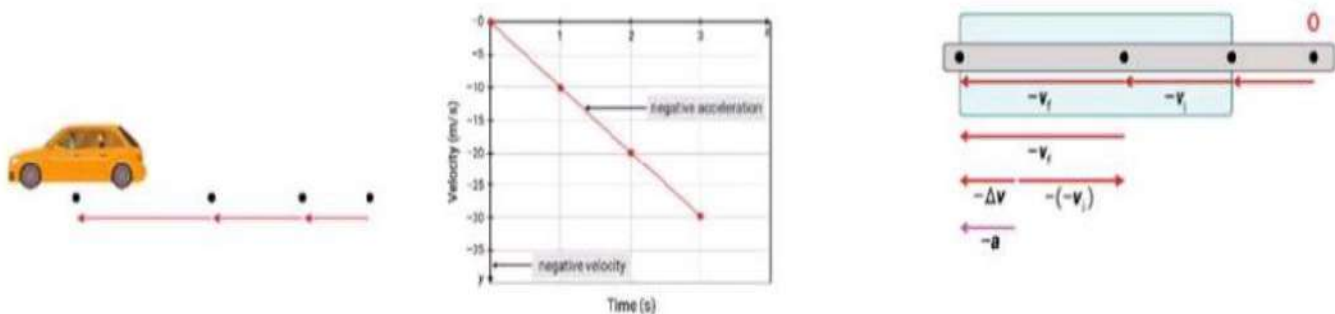
- Velocity increasing in positive direction, positive acceleration



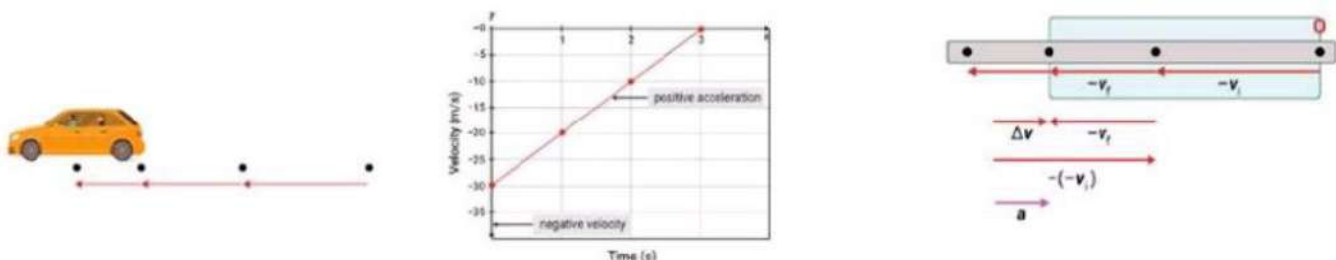
- Velocity decreasing in positive direction, negative acceleration



- Velocity increasing in a negative direction, negative acceleration



- Velocity decreasing in a negative direction, positive acceleration



Position with Constant Acceleration

if an object move in constant acceleration ,its velocity changes at constant rate its velocity-time graph is straight line ,but the position -time graph is a parabola.

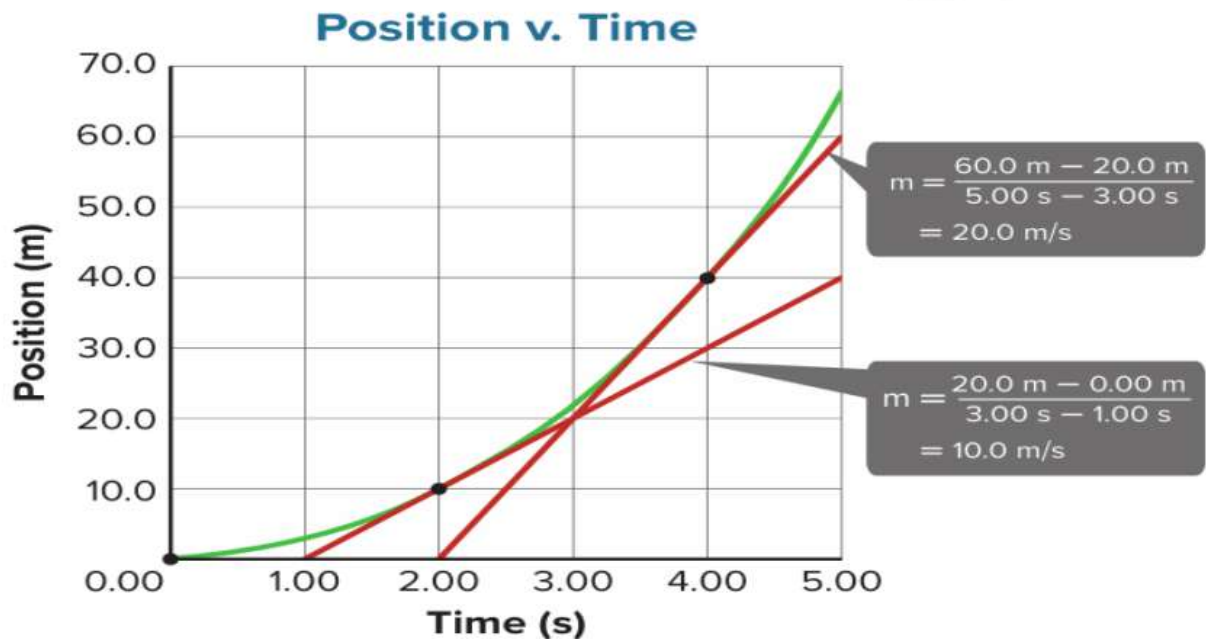
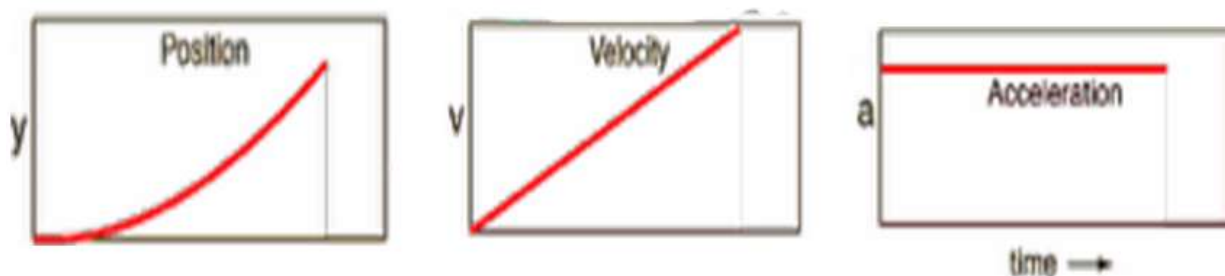


Figure 11 The slope of a position-time graph changes with time for an object with constant acceleration.

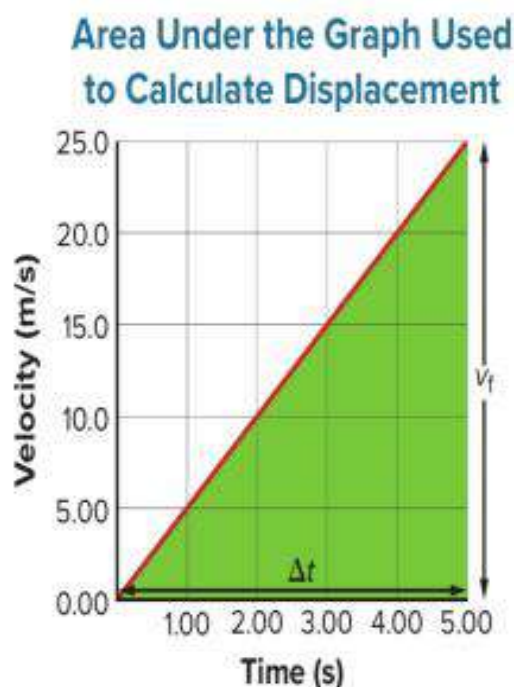
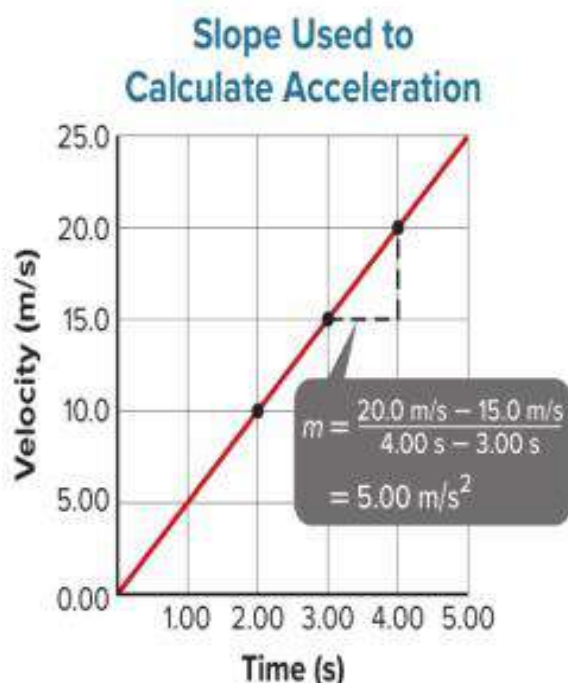


Figure 12 The slopes of the position-time graph in **Figure 11** are shown in these velocity-time graphs. The rise divided by the run gives the acceleration on the left. The area under the curve gives the displacement on the right.

Calculate What is the slope of the velocity-time graph on the left between $t = 2.00 \text{ s}$ and $t = 5.00 \text{ s}$?

Determine mathematical relationships among position, velocity, acceleration, and time.
Apply graphical and mathematical relationships to solve problems related to constant acceleration.

Motion equations	
Equation	Variables
$V_f = V_i + \bar{a} \Delta t$	$V_f \& V_i \& \bar{a} \& \Delta t$
$X_f = X_i + V_i t_f + \left(\frac{1}{2}\right) \bar{a} t_f^2$	$X_f \& X_i \& V_i \& t_f \& \bar{a}$
$V_f^2 = V_i^2 + 2 \bar{a} (\Delta X)$	$V_f^2 \& V_i^2 \& \bar{a} \& (\Delta X)$

$$\Delta x = \frac{1}{2} (v_i + v_f) t$$



Problem 1:- 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 slow at constant rate of (0.50m/s^2), what is its velocity after (2.0s)?
- b) what is the golf ball's velocity if the constant acceleration continues for (6.0s)



Problem 2:- A car is traveling at 20 m/s when the driver sees a ball roll into the street. From the time the driver applies the brakes, it takes 2 s for the car to come to a stop

- a. What is the average acceleration of the car during that period

- b. How far does the car travel while the brakes are being applied?

Problem 3 :- A bus that is traveling at 30.0 km/h speeds up at a constant rate of 3.5 m/s^2 . What velocity does it reach 6.8 s later?



Problem 4 :- . If a car accelerates from rest at a constant 5.5 m/s^2 , how long will it take for the car to reach a velocity of 28 m/s ?

Problem 5 :- . A car slows from 22 m/s to 3.0 m/s at a constant rate of 2.1 m/s^2 . How many seconds are required before the car is traveling at 3.0 m/s ?



معهد رواد التعليم

و

مركز النخبة المتميزة



LESSON 3

FREE FALL

main idea:

- The acceleration of an object in free fall is due to gravity alone.
- Free-fall acceleration on Earth is about 9.8 m/s^2 downward.
- The sign associated with free-fall acceleration in equations depends on the choice of the coordinate system.
- When an object is in free fall, gravity is the only force acting on it.
- Equations for motion with constant acceleration can be used to solve problems involving objects in free fall

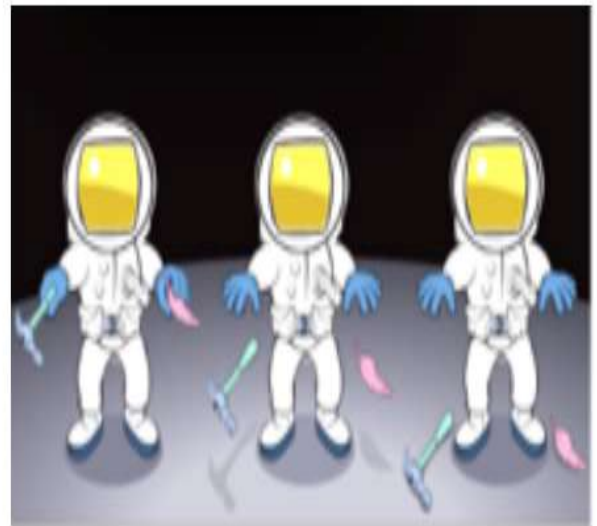


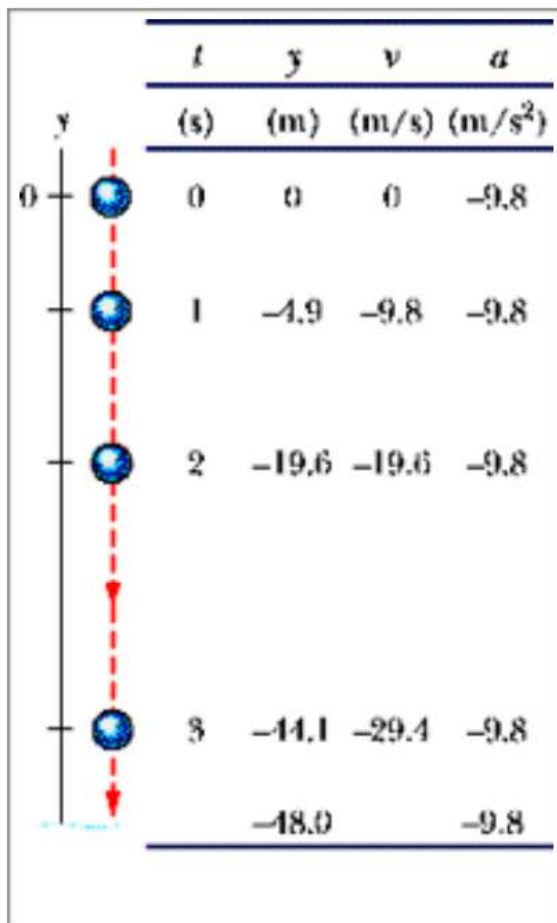
Which falls with more acceleration, a piece of paper or your physics book?

Free fall is the motion of an object when gravity is the only significant force acting on it. (air resistance is negligible , and without initial velocity)

About 400 years ago, Galileo Galilei discovered that, neglecting the effect of the air, all objects in free fall have the same acceleration (reach land in the same time).

The acceleration of an object due only to the effect of gravity is known as free-fall acceleration. Near Earth's surface, free-fall acceleration is about 9.8 m/s^2 downward. The sign associated with free-fall acceleration in equations depends on the choice of the coordinate system.





A combining image of free fall ball the coordinate system (origin 0 at the top , the positive direction is upwards)
(time intervals =1s) shows the distance increases each second and the speed increases (negative direction),while acceleration is $a = -9.8 \text{ m/s}^2$.

NOTE :we can use a constant accelerated 1 motion equation for solving Free Fall problems.

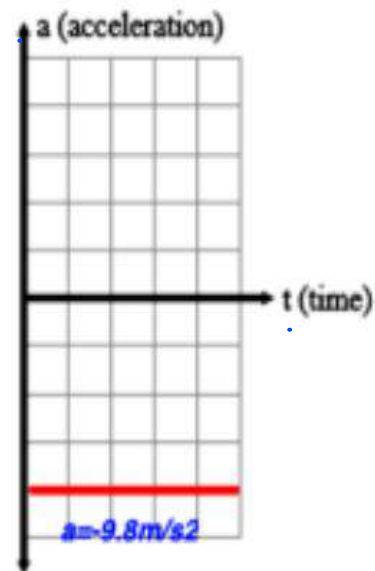
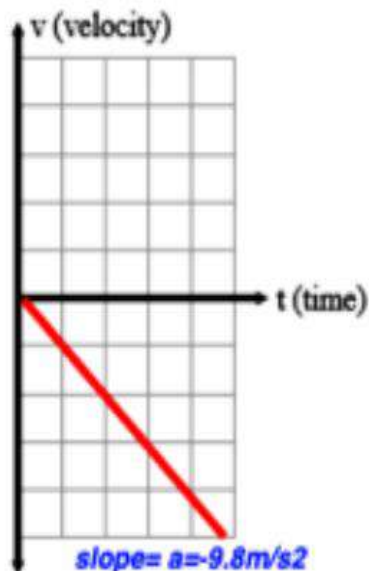
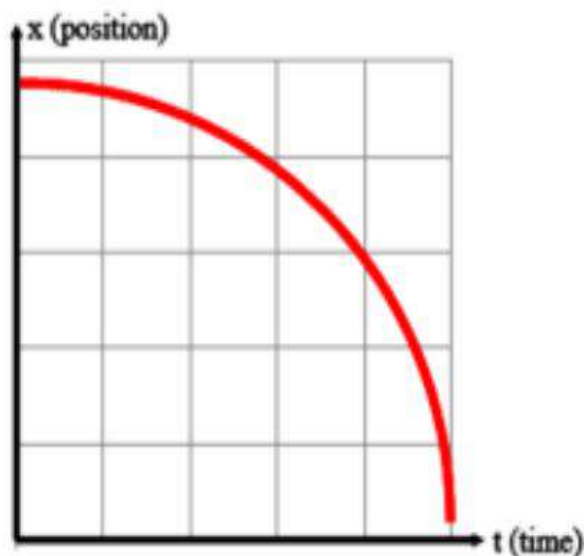
with ($v_i = 0$, $a = -9.8 \text{ m/s}^2$)

$$v_f = v_i + at$$

$$\Delta x = v_i t + \frac{1}{2} a t^2$$

$$v_f^2 = v_i^2 + 2 a \Delta x$$

Free fall Graphs



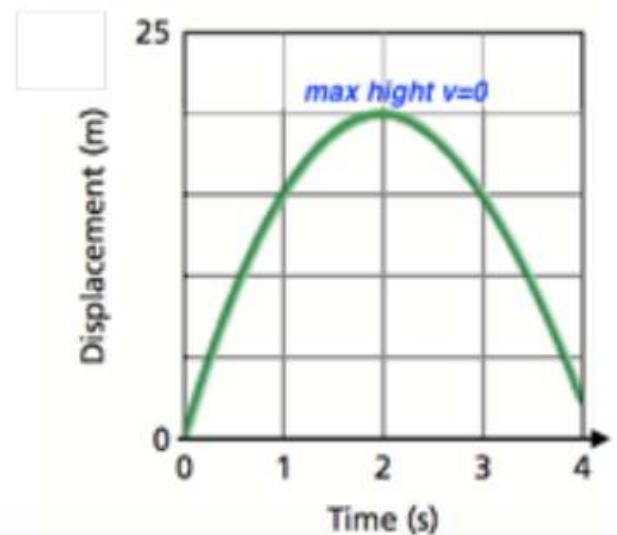
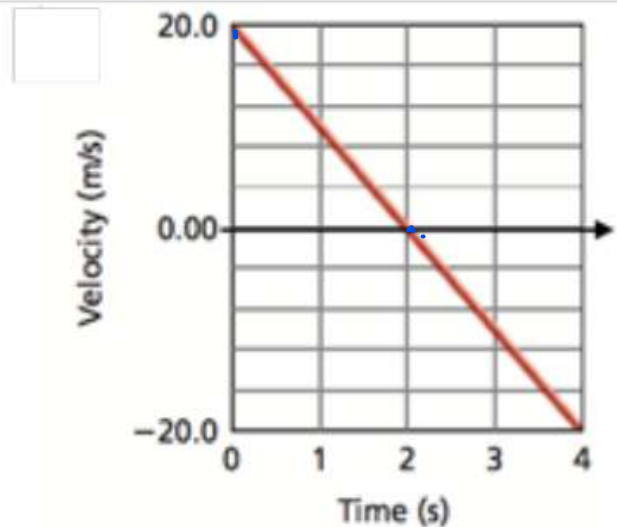
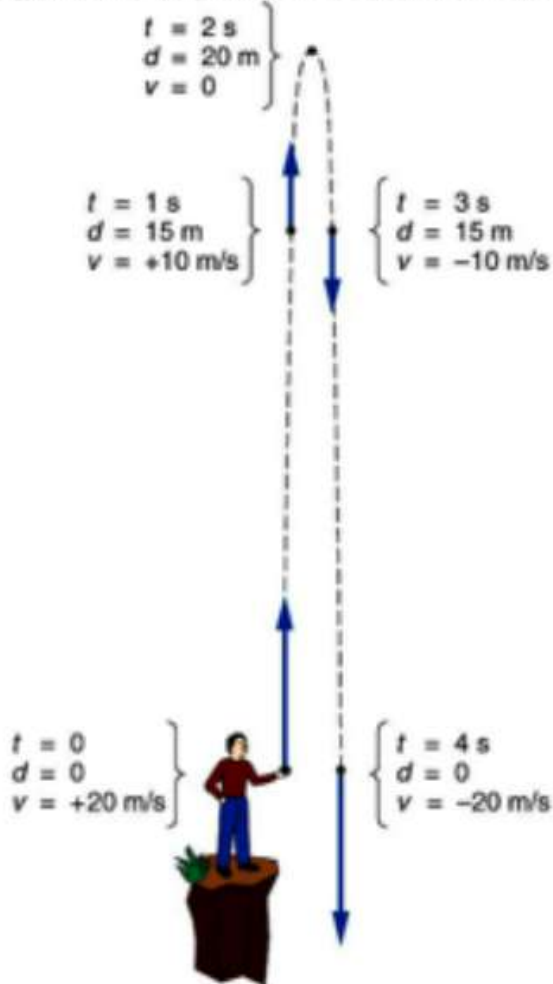
Ball thrown upward

You throw a ball upward with a speed of 20 m/s , upward is the positive direction .

The ball will goes up ,its speed decreases until it stops ($v=0\text{ m/s}$) and it reaches the maximum hight, its acceleration is ($a=-9.8\text{ m/s}^2$).

Then the ball will start to fall downward , its position decreases and its speed increases (negative direction) with the same acceleration ($a=-9.8\text{ m/s}^2$).

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- **Free fall** is the motion of an object when gravity is the only significant force acting on it.
- The acceleration of an object due only to the effect of gravity is known as **free-fall acceleration**.
- Free-fall acceleration is represented by the symbol g .
- Near Earth's surface, $g = 9.80 \text{ m/s}^2$ downward.

When an object is thrown up

1. During upward journey velocity is positive but it is reducing
2. At the highest point its velocity is zero
3. Through out the journey its acceleration is the same $g = 9.80 \text{ m/s}^2$ downward or -9.8 m/s^2

• When the object is dropped down

1. During downward journey velocity is negative but its magnitude is increasing
2. Initial velocity is zero
3. Through out the journey its acceleration is the same
 $g = 9.80 \text{ m/s}^2$ downward
or -9.8 m/s^2

$$v_y = v_{y0} - gt$$

$$y = y_0 + v_{y0}t - \frac{1}{2}gt^2$$

$$v_y^2 = v_{y0}^2 - 2g(y - y_0)$$



2.66 A ball is tossed vertically upward with an initial speed of 26.4 m/s. How long does it take before the ball is back on the ground?

$$V_f = V_i + g t$$

$$0 = 26.4 + (-9.8) \times t$$

$$9.8t = 26.4$$

$$t = \frac{26.4}{9.8} = 2.7 \text{ s}$$

$$t = 2 \times 2.7 = 5.4 \text{ s}$$

$$\begin{aligned} &= \dots \text{ m/s} \\ g &= -9.8 \text{ m/s}^2 \\ V_f &= 0 \\ t &= ? \end{aligned}$$

2.67 A stone is thrown upward, from ground level, with an initial velocity of 10.0 m/s.

- What is the velocity of the stone after 0.50 s?
- How high above ground level is the stone after 0.50 s?

$$V_f = V_i + g t$$

$$V_f = 10 + (-9.8) \times 0.5$$

$$V_f = 5.1 \text{ m/s}$$

$$\Delta y = V_i t + \frac{1}{2} g t^2$$

$$\Delta y = 10 \times 0.5 + \frac{1}{2} \times (-9.8) \times 0.5^2$$

$$\Delta y = 3.8 \text{ m}$$

$$\begin{aligned} V_i &= 10 \text{ m/s} \\ V_f &= ? \\ t &= 0.5 \text{ s} \\ g &= -9.8 \text{ m/s}^2 \\ \Delta y &= ? \end{aligned}$$

2.68 A stone is thrown downward with an initial velocity of 10.0 m/s. The acceleration of the stone is constant and has the value of the free-fall acceleration, 9.81 m/s². What is the velocity of the stone after 0.500 s?

$$V_f = V_i + g t$$

$$V_f = -10 + (-9.8) \times 0.5$$

$$V_f = -14.9 \text{ m/s}$$

$$V_i = -10 \text{ m/s}$$

$$g = -9.8 \text{ m/s}^2$$

$$t = 0.5 \text{ s}$$

$$V_f = ?$$

2.69 A ball is thrown directly downward, with an initial speed of 10.0 m/s, from a height of 50.0 m. After what time interval does the ball strike the ground?

$$V_f^2 = V_i^2 + 2g \Delta y$$

$$V_f = \sqrt{(-10)^2 + 2 \times -9.8 \times -50}$$

$$V_f = -32.9 \text{ m/s}$$

$$V_f = V_i + g t$$

$$-32.9 = -10 + (-9.8) t$$

$$-32.9 + 10 = -9.8 t$$

$$t = \frac{-22.9}{-9.8} =$$

$$V_i = -10 \text{ m/s}$$

$$\Delta y = -50 \text{ m}$$

$$t = ?$$

$$g = -9.8 \text{ m/s}^2$$

Q1: A plane starting from rest accelerates to 40 m/s in 10 s . How far did the plane travel during this time?

Q2: To avoid an accident, a car decelerates at 0.50 m/s^2 for 3.0 s and covers 15 m of road. What was the car's initial velocity?

Q3: A cheetah is walking at 1.0 m/s when it sees a zebra 25 m away. What acceleration would be required to reach 20.0 m/s in that distance?

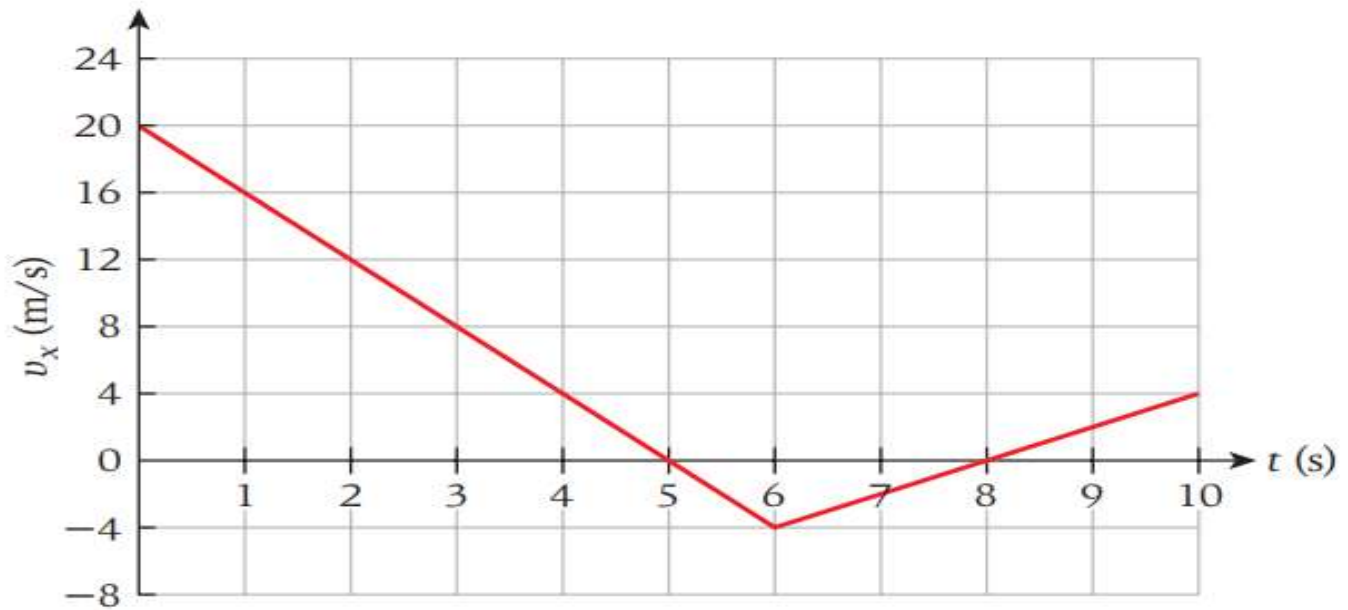
2.54 How much time does it take for a car to accelerate from a standing start to 22.2 m/s if the acceleration is constant and the car covers 243 m during the acceleration?

2.55 A car slows down from a speed of 31.0 m/s to a speed of 12.0 m/s over a distance of 380. m.

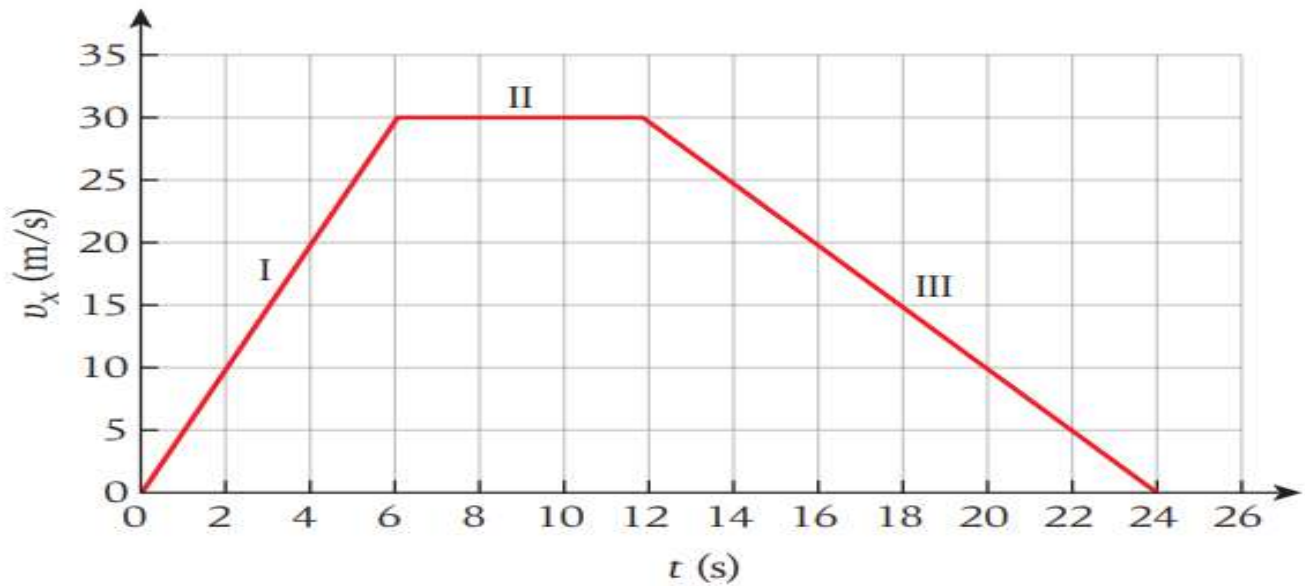
- a) How long does this take, assuming constant acceleration?
- b) What is the value of this acceleration?



•**2.51** A car is moving along the x -axis and its velocity, v_x , varies with time as shown in the figure. If $x_0 = 2.0$ m at $t_0 = 2.0$ s, what is the position of the car at $t = 10.0$ s?



2.42 A fellow student found in the performance data for his new car the velocity-versus-time graph shown in the figure.



- Find the average acceleration of the car during each of the segments I, II, and III.
- What is the total distance traveled by the car from $t = 0$ s to $t = 24$ s?



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