Summary & Practice Sheets

Grade 9 - Physics

A Physics Toolkit
Representing Motion
Accelerated Motion
Forces in One Dimension

Chapter 1 1. Methods of Science in Physics

Summary

- Physics is the study of the physical world - matter and energy - and how they relate to each other.
- The **scientific method** is a common approach to conduct an investigation. The common steps include:

- State the problem
- Research and gather information
- Form and test a hypothesis
- Analyze the data
- Draw conclusions

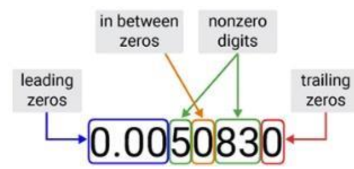
- Scientists use **models** to represent ideas about things that are too difficult to investigate. They may be too small, for example, like subatomic particles, or too far away, like distant galaxies, or dangerous, such as the interior of nuclear reactors.
- Scientists come up with **theories** to explain phenomena based on observations. These become scientific **laws** when they become a true general observation of nature.
- Scientists don't know everything and they make mistakes. This is why it is important for other scientists to **peer review** one another's work.

Chapter 1 2. Using Math to Express Concepts in Physics

Summary

- The International System of Units (**SI**) as a common system that scientists use worldwide. It has seven base units. All other units, like m/s, are derived.

- **Dimensional analysis** is used to simplify calculations and derive the correct unit in a calculation.
- **Significant figures** are used with scientific notation as the most effective way to express numbers that are too small or too large, such as the size of an atom or distance to a planet.

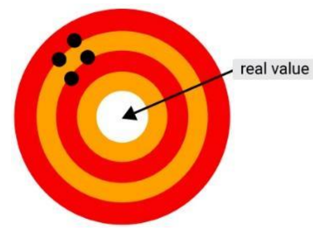


- You have to solve a lot of problems in Physics and it is important to develop a strategy to avoid making mistakes along the way
  1. **Analyze:** Identify the knowns and unknowns.
  2. **Solve:** Identify the right equation and rearrange it for the unknown. You then add the values into the equation to solve it.
  3. **Evaluate:** Check that the number, the sign (direction) and units make sense. The number of significant figures should correspond to input values.

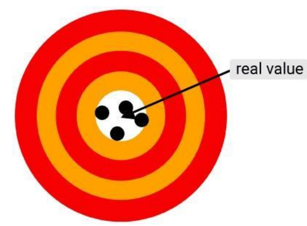
Chapter 1 **3. Defining Accurate Measurements in Physics**

Summary

- Every time that physicists take measurements, they have to record the degree of **uncertainty** in those measurements. Uncertainty gives a numerical value to the level of confidence in the result. This allows a comparison between different scientific studies.
- Uncertainty in a measurement is +/- half of the smallest readable value (like the millimeter gradation on a ruler).
- **Precision** is how exact and repeatable a measurement is. Precision is determined by the sensitivity of the instrument used and the technique used to make the measurement. The figure to the right shows high precision.



- **Accuracy** is how close a measurement is to the real value. The figure to the right shows high precision and high accuracy. Accuracy is affected by the calibration of an instrument. Two-point calibration is used to check the accuracy of the instrument.

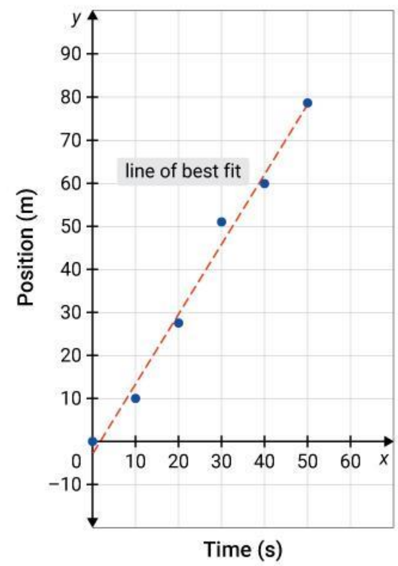


- The Global Positioning System (GPS) is a system of 24 satellites that orbit the Earth and send signals to a lot of receivers on Earth. It uses sensitive equipment and has many applications including satellite navigation in your car.

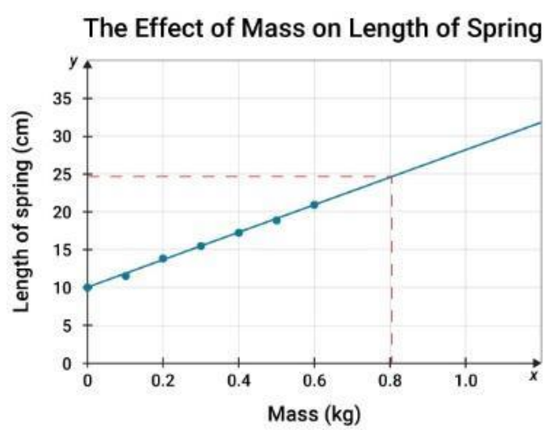
Chapter 1 **4. Using graphs in Physics**

Summary

- Graphs are a visual tool to display experimental data and show patterns in data.
- The **independent variable** (what is changed in an experiment) is plotted on the **x-axis** of a graph and the **dependent variable** (the change that is measured in an experiment in response to the independent variable) is plotted on the **y-axis**.



- A **line of best fit** is drawn through the data points to show the general relationship between the independent and dependent variables. The graph on the right shows a linear relationship, expressed by
  y = mx + b,
  where ***m*** is the slope of the line and ***b*** is the intercept with the y-axis.
- Nonlinear relationships include quadratic ($y = ax^2 + bx + c$) and inverse relationships ($y = \frac{a}{x}$).
- A line of best fit can be used to predict data. Extrapolation is the extension of a line of best fit beyond the range of measurements. Care should be taken not to extrapolate too far. In this example, if too much mass is added to a spring it will eventually stretch in a nonlinear way.



Grade 9 Physics - Chapter 1: Methods of Science in Physics

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

.

6) A bus is moving at a speed of 45 km/h. What is the speed of the bus in m/s?

a) 1.25×10^{1} m/s

b) 1.5×10^{3} m/s

c) 2.5 m/s

d) 1.5×10^{2} m/s

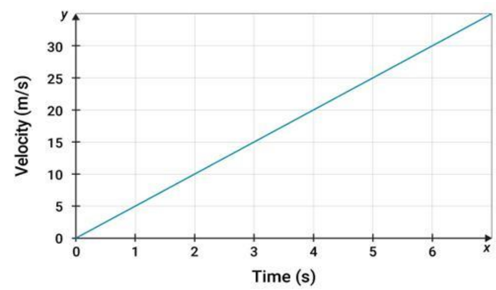
7) Which type of relationship is shown by this graph?

a) Parabolic

b) Quadratic

c) Linear

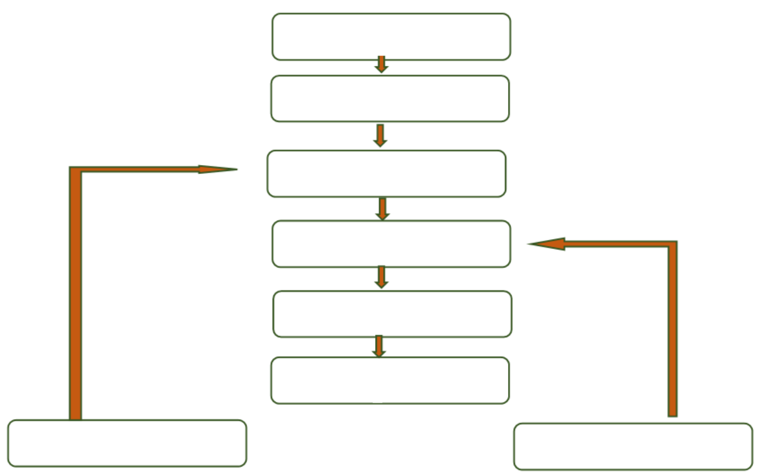
d) Inverse



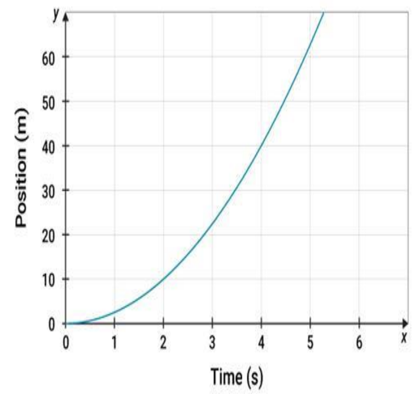
Think and Solve:

8) Re-order the following sentences to get a diagram about the scientific method.

Draw conclusions - Form a hypothesis - State the problem - Test the hypothesis - Gather information - Analyze data - Hypothesis is not supported - Hypothesis is supported.



9) Refer to the graph to answer the following questions.



1-What sort of relationship is shown in this graph?

....

2- Is the slope of this graph positive or negative?
....

3- What is the approximate position when the time is 4 s?
....

4- Write the general equation for this graph (in symbols).
....

10) Omar, Ahmad and Hamad measure the length of a box and each of them records the measurements:

Omar	21.46 cm	21.47 cm	21.48 cm
Ahmad	21.51 cm	21.51 cm	21.52 cm
Hamad	21.40 cm	21.53 cm	21.44 cm

If the length of the box equal (21.47 cm), answer the following:

1- Whose measurements are imprecise and inaccurate?

....

2- Whose measurements are precise and inaccurate?

....

3- Whose measurements are precise and accurate?

....

11) How many significant figures are there in each of the following?

1- 256.0005 (..........)

2- 00215000 (..........)

3- 3568.01050 (..........)

4- 1.000704 (..........)

5- 1001000 (..........)

12) Convert the following measurements to the units shown.

❖ 52 km/h to m/s: ....

❖ 741.3 g to kg: ....

❖ 3.2 h to min: ....

13) The device shown in the image used to measure a fundamental physical quantity.

1- What is the name of the physical quantity that the device measures?

....

2- Type the measurement in the unit (g) to the right number of significant figures.

....

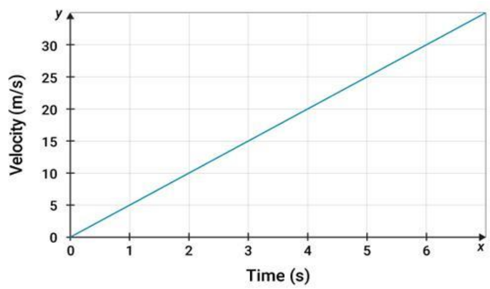
3- Type the error margin.

....

14) 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

....

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



....

Chapter 2 **5. Picturing Motion**

Summary

- Objects move in different ways (straight line, curved path, spiral).
- Motion along a straight line is a direct path between two points.

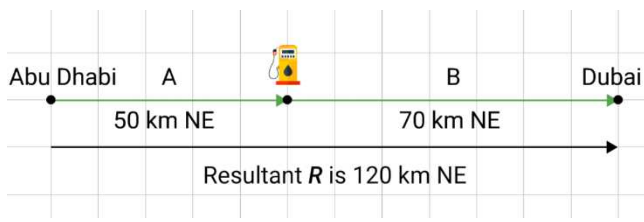
- **Motion diagrams**: the images represent position at equal time intervals, so change in position with time.
- A **particle model** (ticker tape) – each dot represents a point to record an object's position at equal time intervals.
- This is an object that is covering the same distance in the same amount of time.

- This is an object that is covering increasing distance in the same time interval.

Chapter 2 6. Describing an Object's Position

Summary

- A **coordinate system** gives the location of the zero point of the variable being studied and the direction in which the variable will increase.
- To the right of the **origin** (where all variables are zero), values are positive. To the left of the origin, values are negative.
- **Scalars** are variables that have magnitude, like mass (m), time (t), distance (x) and speed (v).
- **Vectors** are variables that have magnitude and direction, like position ($\boldsymbol{x}$) and displacement ($\Delta\boldsymbol{x}$), velocity ($\boldsymbol{v}$), force ($\boldsymbol{F}$) or acceleration ($\boldsymbol{a}$). They are represented by bold symbols to tell the difference from scalars.
- **Displacement** is overall change in **position:** $\Delta\boldsymbol{x} = \boldsymbol{x}_f - \boldsymbol{x}_i$
- **Distance** is the total length covered.
- **Time interval:** $\Delta t = t_f - t_i$
- Vectors are represented by arrows. The length of the arrow is the magnitude and it points in the direction of the vector.

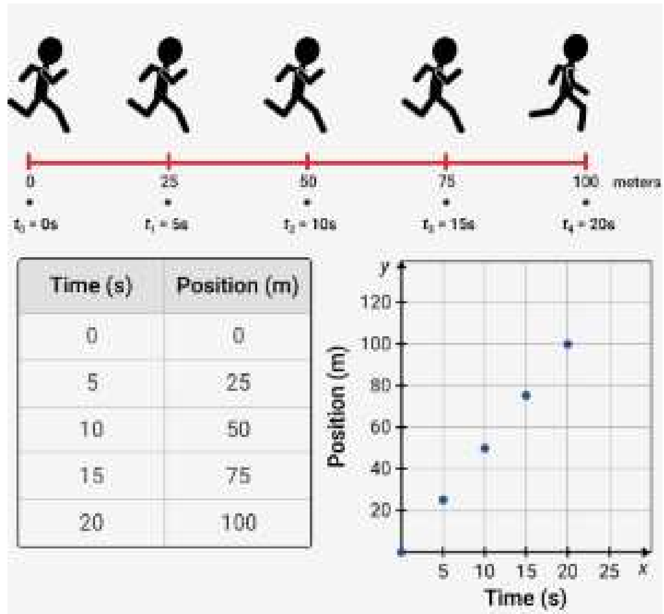


- The resultant is the sum of the vectors. The resultant displacement in the above figure is positive, but it can be negative if the larger displacement vector is in the negative direction, or zero if the final position is the same as the original position.

7. Understanding Position-Time Graphs

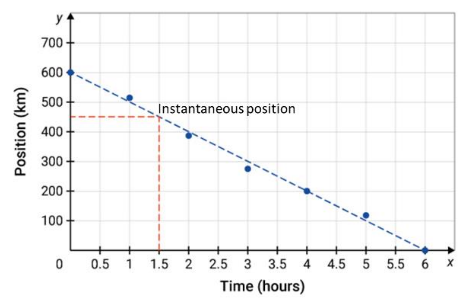
Summary

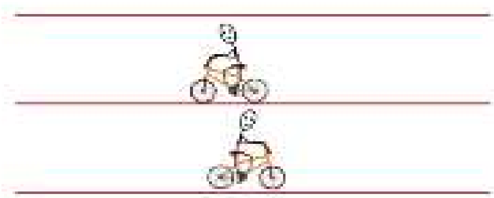
- Motion can be represented in motion diagrams, particle diagrams, tables and graphs.
- On a **position-time graph**, time is plotted on the x-axis (horizontal axis) and position is plotted on the y-axis (vertical axis)

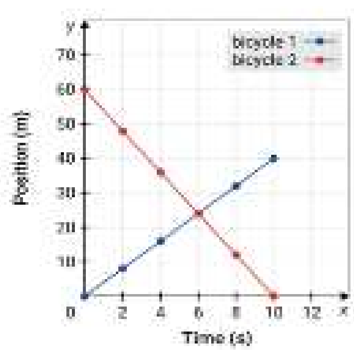


Time (s)	Position (m)
0	0
5	25
10	50
15	75
20	100

- **Instantaneous position** (***x***) is a position at a particular instant in time.





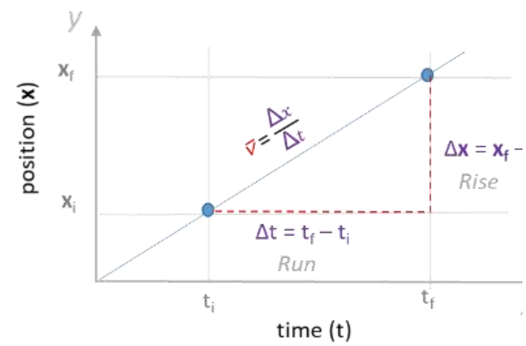


- Position-time graphs can be used to interpret position and time for multiple objects. For example, the graph to the right shows that the bikes are moving in opposite directions that they meet after 6 seconds of travel.

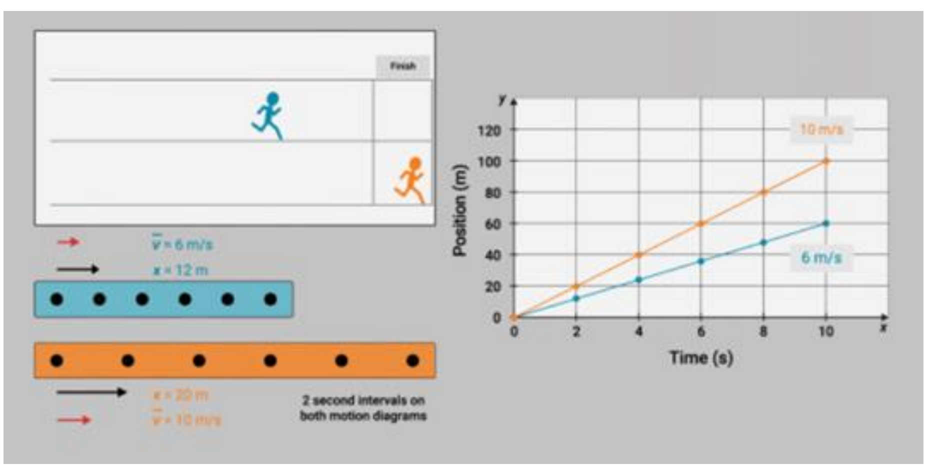
Chapter 2 8. Comparing Speed and Velocity

Summary

- Speed (v) = $\frac{Distance}{Time}$. It is a scalar so it has a magnitude but no direction.
- Velocity ($\boldsymbol{v}$) = $\frac{Displacement}{Time}$. It is a vector so it has magnitude and direction (and so its symbol is in boldface).
- The slope (steepness) of a position-time graph = velocity – the greater the slope, the greater the velocity. It is calculated by dividing the rise by the run.



- The **average velocity** $\bar{v} \equiv \frac{\Delta x}{\Delta t}$
- **Instantaneous velocity** is the velocity at a particular instant in time.
- Vector arrows can be drawn on particle models to represent displacement (black arrows) and velocity (red arrows). The runners are running at constant velocities, but the orange runner has a greater velocity.



- **Position** can be calculated from a straight line position-time relationship using this equation: $\mathbf{x} = \bar{v}\,t + \boldsymbol{x}_i$

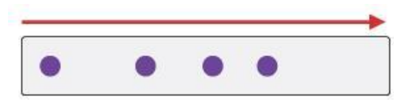
Grade 9 Physics - Chapter 2: Representing Motion

QUESTIONS

Choose the correct answer:

1) Which statement best describes the motion diagram of an object in motion?
   a) a graph of the time data on a horizontal axis and the position on a vertical axis.
   b) a series of images showing the positions of a moving object at equal time intervals.
   c) a diagram in which the object in motion is replaced by a series of single points.
   d) a diagram that tells us the location of the origin of the object in motion.

2) What does the following particle model show?



   a) the object is speeding up.
   b) the object is slowing down.
   c) the object is moving at a constant velocity.
   d) the object is stationary.

3) In the particle model, the object in the motion diagram is replaced by....................
   a) a series of dots.
   b) a large rectangle.
   c) a stick figure.
   d) an arrow showing direction.

.

4) An object's velocity is how fast it is moving and ....
   a) in what direction it is moving.
   b) how far it has been.
   c) its initial position.
   d) its instantaneous position.

5) Position-time graphs can be used to find out the .... of an object, as well as where and when two objects meet.
   a) time interval.
   b) momentum.
   c) magnitude.
   d) velocity.

.

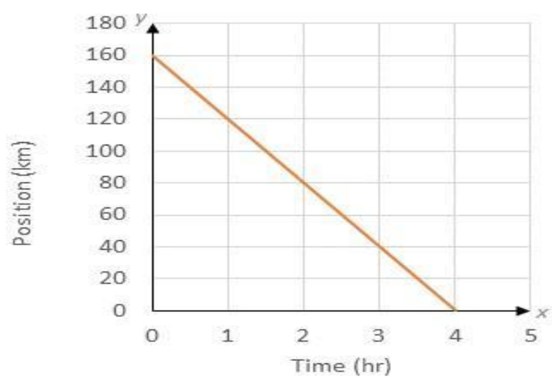
6) The length of the displacement vector represents how far an object ....

a) is visible.
b) traveled.
c) can be thrown.
d) can be stretched.

7) The slope of an object's position-time graph is the .... of the object.

a) average velocity.
b) instantaneous velocity.
c) displacement.
d) distance.

8) This position-time graph represents the positions of a cyclist at 1-hour intervals.



Based on this graph, which statement is true?

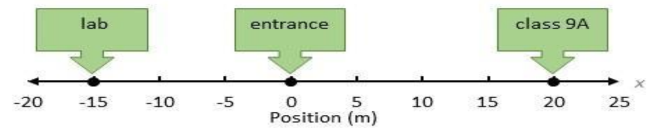
a) the cyclist moved away from the origin.
b) the cyclist was stationary.
c) the cyclist changed direction.
d) the cyclist moved back toward the origin.

Think and Solve:

9) Classify these quantities as vectors or scalar.
Mass – Velocity – Distance – Displacement – Time – Speed – Acceleration

Scalar quantity	Vector quantity

10) A student entered the school and walked to his class 9A, then he walked with his teacher to the lab.



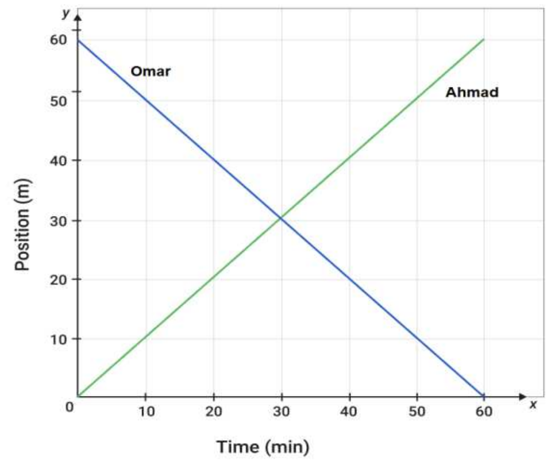
Calculate the distance covered by the student.

....

Calculate the displacement of the student.

....

11) This position-time diagram represents the positions at 10-min intervals of **Ahmad** and **Omar** walking on a road.



Based on this graph, answer the following questions.

What is the distance between Ahmad and Omar at the beginning of the walk?

....

....

How would you compare the motion of the two boys?

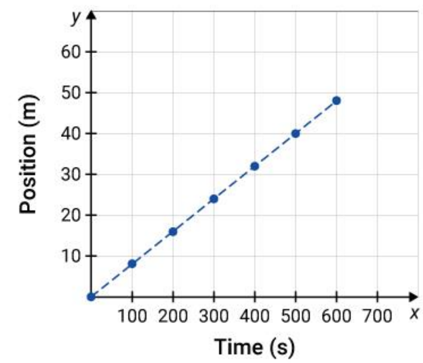
....

At what time do Ahmad and Omar pass each other?

....

....

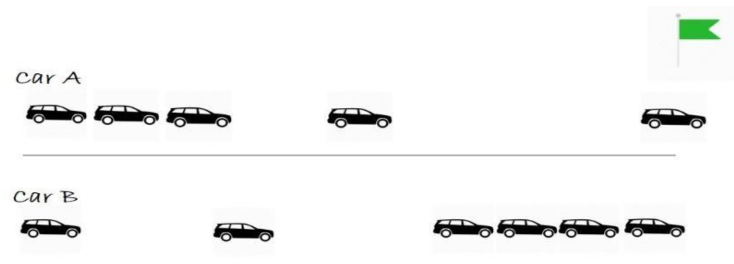
12) Calculate the average velocity in this position-time graph.



....

....

13) Look at the motion diagrams of the two cars A and B and answer the following questions.

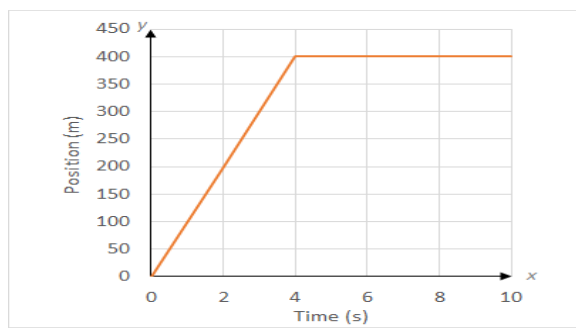


Draw the particle models under the motion diagrams.

Which car is speeding up?

....

14) This position-time graph represents the positions of a cyclist at 2-minute intervals. Calculate the velocity of the cyclist at the following time intervals:



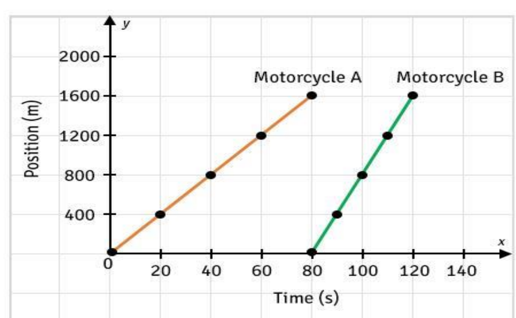
0 to 4 minutes

…………………………………………

4 to 10 minutes

………………………………………..

15) This position-time graph represents the positions at 20-second intervals of two motorcyclists riding on a highway.



Which motorcycle is moving faster? Explain.

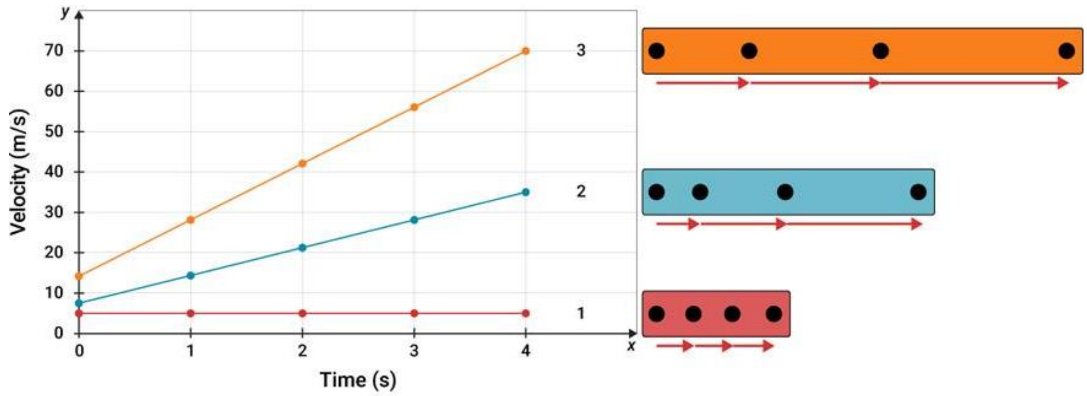
....

....

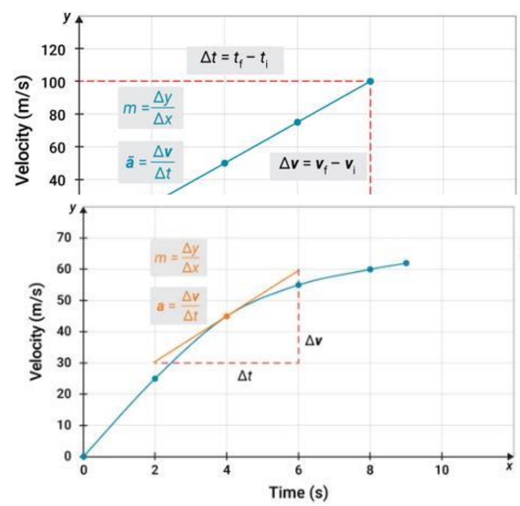
Chapter 3 9. Describing Acceleration Using Graphs

Summary

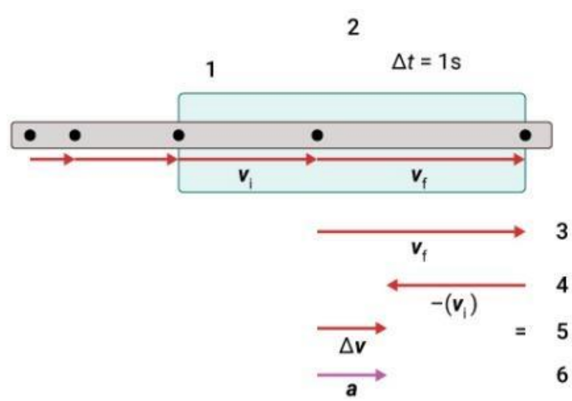
- **Acceleration** is a vector. It is the rate of change of velocity. $\boldsymbol{a} \equiv \frac{\Delta v}{\Delta t}$



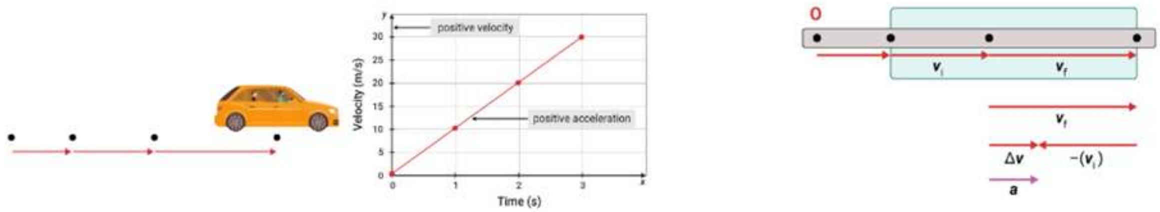
- The above velocity-time graph shows 1. **uniform motion** = constant velocity = zero acceleration. 2. and 3. **non-uniform motion** = changing velocity = acceleration.



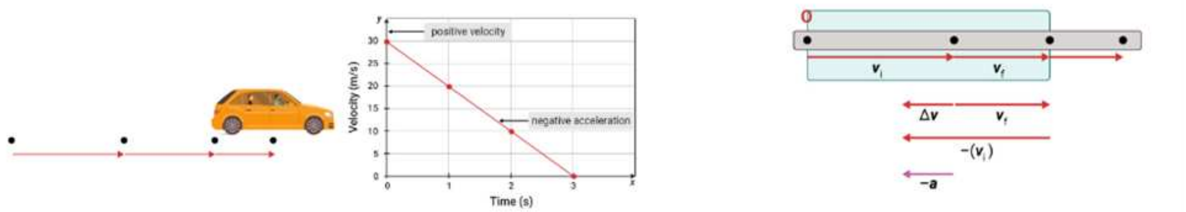
- The slope (steepness) of a velocity-time graph = acceleration – the greater the slope, the greater the acceleration.
- The **average acceleration** $\bar{\boldsymbol{a}} \equiv \frac{\boldsymbol{\Delta v}}{\boldsymbol{\Delta t}}$
- Instantaneous acceleration is calculated by drawing a tangent to a point on a position-time graph and calculating its slope.
- Motion diagrams can be used to determine direction of acceleration. In the diagram to the right, the final velocity vector is subtracted from the initial velocity vector. If the time interval is 1 s, the change in velocity Δv is equal to acceleration $\boldsymbol{a}$.



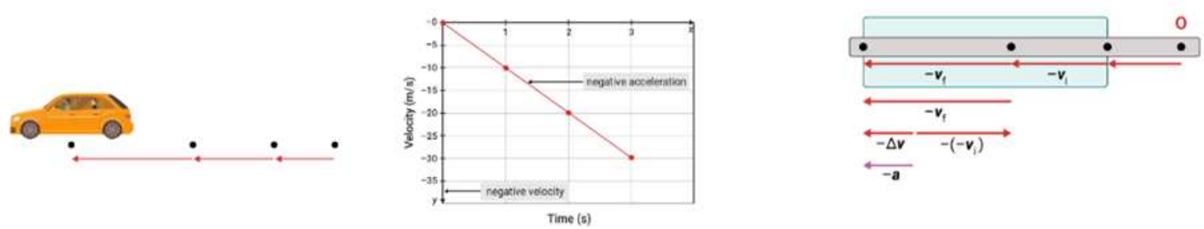
- Velocity increasing in positive direction, positive acceleration

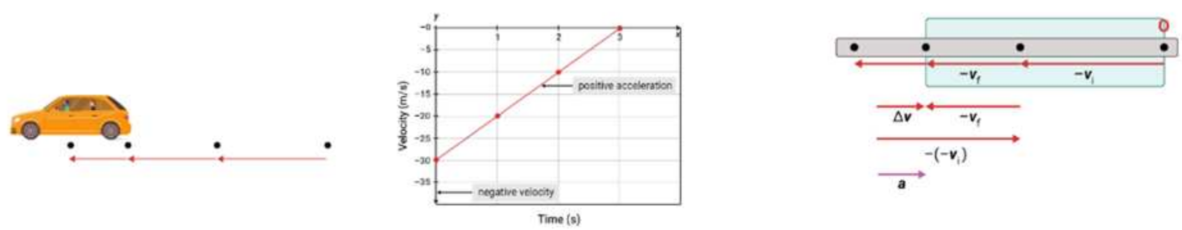


- Velocity decreasing in positive direction, negative acceleration



- Velocity increasing in a negative direction, negative acceleration
- Velocity decreasing in a negative direction, positive acceleration.



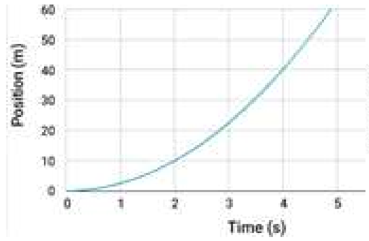


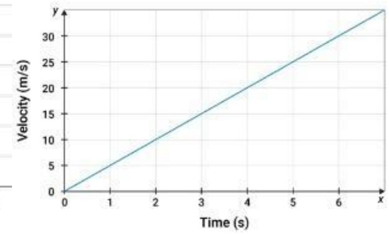
- It is possible to accelerate at a constant speed. Remember, speed is a scalar and so if there is a change in direction at the same speed, there is a change in velocity and therefore an acceleration.

Chapter 3 10. Calculating Motion

Summary

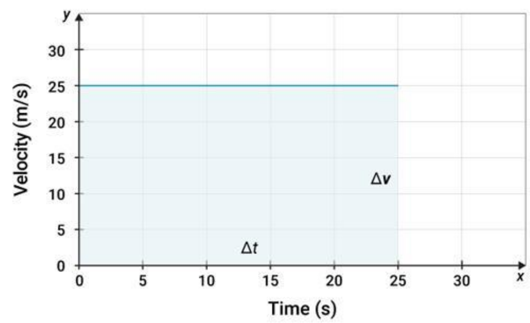
- **Constant acceleration** shows up as a curve (parabola) on a position-time graph



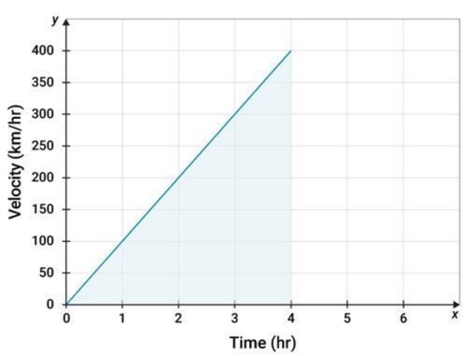


and as a straight line on a velocity-time graph.

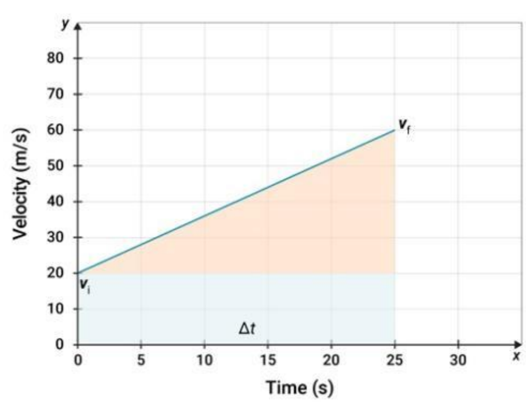
- Displacement can be calculated from the area under the v-t graph.
- In the example to the right, there is a constant, non-zero velocity (zero acceleration). Displacement is calculated by calculating the area of the rectangle = (base x height)



- For a zero initial velocity and constant acceleration, as below, displacement is calculated from the area of the triangle = (1/2 base x height)



- For a non-zero initial velocity and constant acceleration, the displacement is calculated from the area of the triangle + the area of the rectangle.



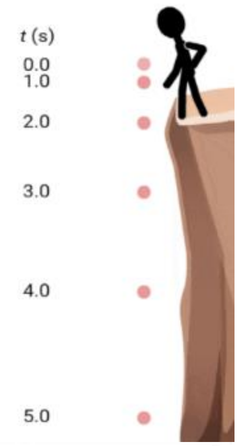
Equation	Solves for any of these variables i f the others in the same row are given							
	Δt	t_i	t_f	x_i	x_f	v_i	v_f	a
$v_f = v_i + a\,\Delta t$	✓	Usually zero				✓	✓	✓
$x_f = x_i + v_i t_f + \frac{1}{2} a t_f^2$			✓	✓	✓	✓		✓
$v_f^2 = v_i^2 + 2a(x_f - x_i)$				✓	✓	✓	✓	✓

Motion is described by the following variables: time (initial and final), position (initial and final), velocity (initial and final) and acceleration. The above **motion equations** can solve for any of these variables if the others are known. You need to know how to use them to solve motion problems.

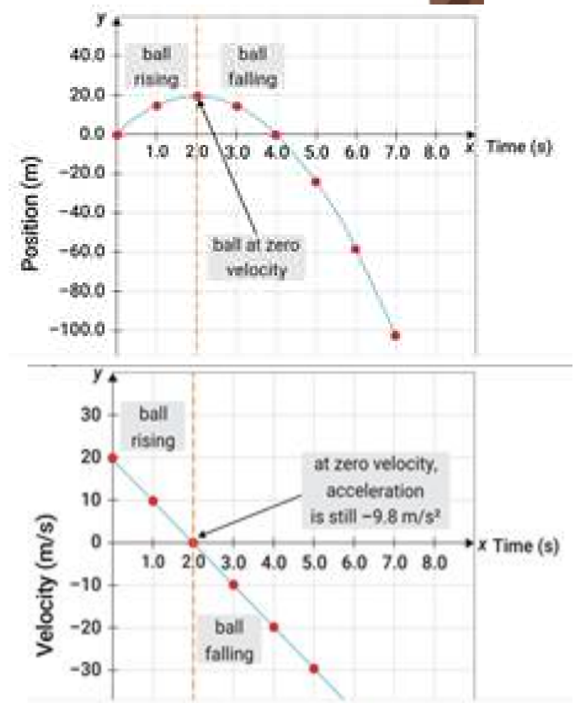
Chapter 3 **11. Introducing Free-Fall Acceleration**

Summary

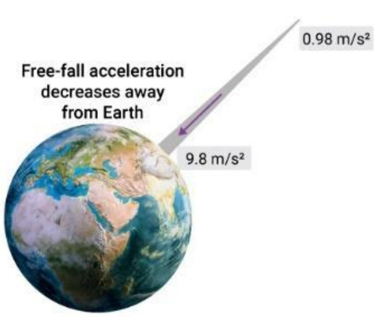
- **Free-fall** is the motion of objects in the air.
- All objects fall to Earth due to gravity in **free-fall acceleration**.
- Galileo Galilei discovered that all objects in free fall have the same acceleration (in the absence of air friction). The value is 9.8 m/s^2 downward. (downward is treated as negative here).



- The position-time graph shows the ball rising and falling. The slope of the graph is velocity, which reaches zero at maximum height.
- The velocity-time graph is a straight-line graph. The slope of this graph is -9.8 m/s^2, the value of free-fall acceleration. It is the same regardless of whether the ball is rising or falling – even when the ball reaches zero velocity at the maximum height!



- Free-fall acceleration on the Moon is about a sixth of that on Earth, at around 1.6 m/s^2. This is because the Moon has less mass than Earth.
- The further an object is away from the Earth's surface, the weaker the gravitational pull. About 1 Earth diameter away from Earth, free-fall acceleration is a tenth of that on the surface.



Grade 9 Physics - Chapter 3: Accelerated Motion

QUESTIONS

<u>Choose the correct answer:</u>

1) The slope of a tangent to a point on a nonlinear velocity-time graph is the .....

a) instantaneous acceleration

b) velocity

c) average acceleration

d) displacement

2) If a runner accelerates from 1.5 m/s to 2.3 m/s in 4 s, her average acceleration is......

a) 2.0 m/s^2

b) 0.2 m/s^2

c) 0.95 m/s^2

d) 1.5 m/s^2

3) The area under a velocity-time graph is equal to the object's.......

a) displacement

b) stop time

c) average speed

d) acceleration

4) When acceleration and velocity vectors are pointing in opposite directions, the object is........

a) not moving

b) speeding up

c) slowing down

d) moving at a constant speed

5) The change in velocity divided by the time interval is.......

a) speed

b) instantaneous acceleration

c) displacement

d) average acceleration

6) The displacement of an object is the change in its......

a) position

b) speed

c) distance

d) velocity

7) Which of the following results represent the largest acceleration?

a) a small change in velocity over a long time interval

b) a large change in velocity over a long time interval

c) a small change in velocity over a short time interval

d) a large change in velocity over a short time interval

8) As the displacement of an object increases in a given time interval, its velocity ......

a) accelerates

b) remains constant

c) decreases

d) increases

9) Average acceleration is the same as instantaneous acceleration when......

a) acceleration is decreasing

b) acceleration is increasing

c) velocity is constant

d) acceleration is constant

<u>Think and solve:</u>

10) A ball falls freely from rest. Calculate the ball's velocity after 12.5 s.

....

....

11) If a car accelerates uniformly from 8 m/s to 13 m/s in 4 seconds, calculate the car's acceleration?

....

....

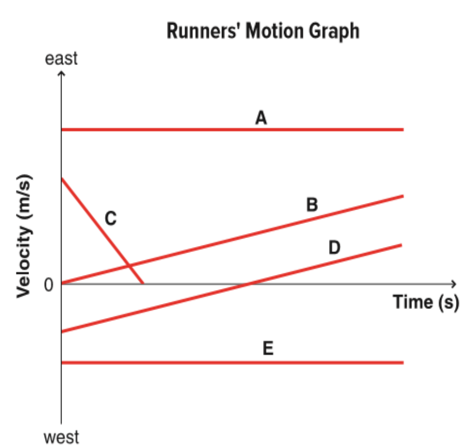
12) The graph to the right represents the motion of five runners A, B, C, D and E. Answer the following questions by referring to the graph.

1. Which of these runners have a greater acceleration, runner A or runner B?

....

2. Which of these runners started his motion from rest?

....



3. Write down the order of acceleration for the runners, from the lowest to highest.

....

13) A car starts from rest and speeds up at 2.2 m/s^2 after the traffic light turns green. How far will it have gone when it is traveling at 18 m/s?

....

....

14) A construction worker accidentally drops a brick from a high scaffold.

1. What is the velocity of the brick after 4.0 s?

....

2. How far does the brick fall during this time?

....

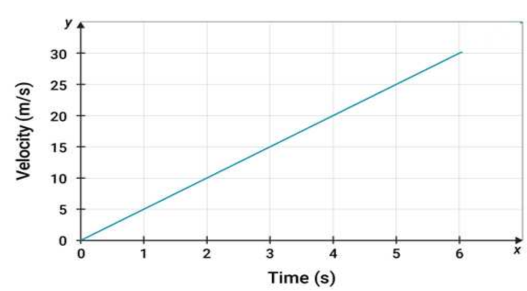
15) This is a velocity-time graph for a runner. What is her displacement in the first 4 seconds?

....

....

....

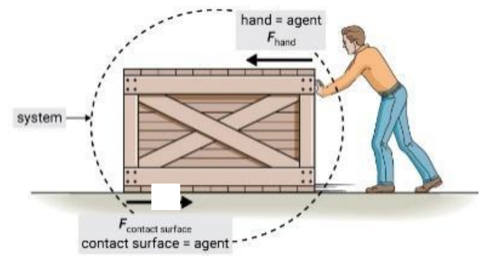
....



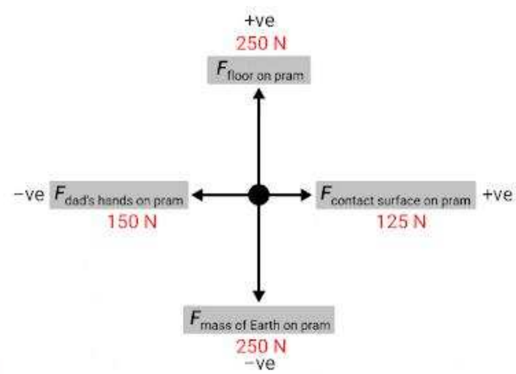
Chapter 4 12. Describing Forces and Force Diagrams

Summary

- A **force** is a push or a pull on an object. It is a vector with a symbol ***F*** and is measured in newtons (N). 1 N = 1 kg m/s^2.
- There are two types of force: **contact** and **field** forces. Contact forces touch the object, like friction or tension while field forces do not, like gravity and magnetism.
- An object or a group of objects on which forces act is called a **system**. **Agents** act on the system and exert forces on it.



- A **free-body diagram** is an illustration of the forces acting on a system, represented by a dot. The forces are given as symbols with the agents acting on the system in subscript.

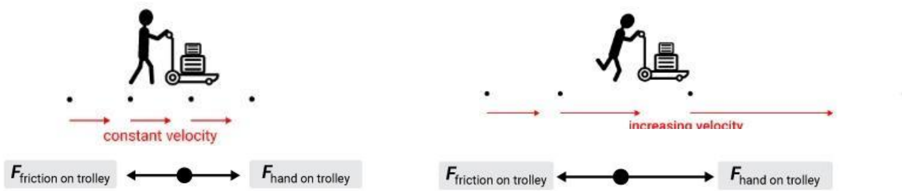


- The **net force** is calculated by adding the vector arrows. It is important to put the sign though. The vertical forces are balanced so there is zero net force acting on the pram in a vertical direction. The net horizontal force F_{net} in the above free-body diagram = -150 N + 125 N = -25 N.

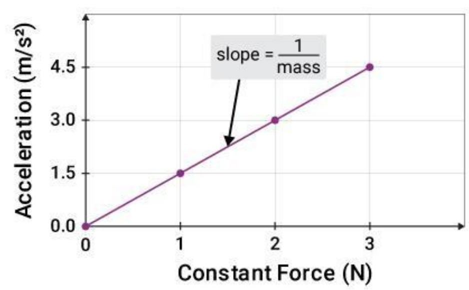
Chapter 4 13. Acceleration and Force

Summary

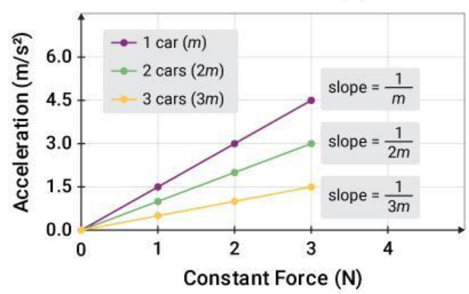
- There is a relationship between net force and acceleration.



- When the net force is zero, the object is in **uniform motion**, which means a constant or zero velocity and acceleration is zero. This is also called a state of **equilibrium**.
- When there is a net force acting on an object, it is in **non-uniform motion** and it accelerates (**nonequilibrium**).
- **Friction** is a contact force between two surfaces that resists motion. It acts in the direction opposite to motion.
- The relationship between the constant net force and acceleration is shown in the graph opposite. The greater the force, the greater the acceleration.



- The slope of the line = $\frac{1}{mass}$
- The greater the mass, the smaller the acceleration



- This is **Newton's second law**: $\boldsymbol{a} = \frac{Fnet}{m}$
- **Newton's first law** states that an object in motion remains in motion and an object at rest remains at rest unless acted on by an external force.
- Newton's first law is also called the **law of inertia**. Inertia is not a force. It is related to the mass of an object: the greater the mass, the harder it is to change the object's state of motion.

Chapter 4 14. Weight and Drag Forces

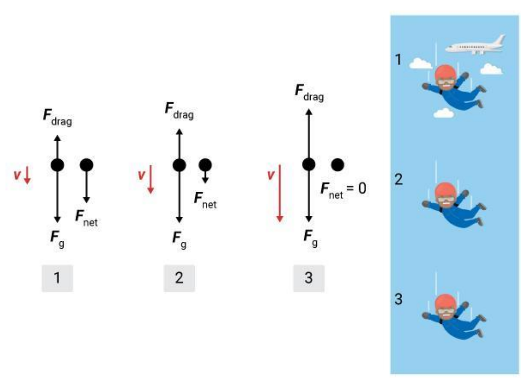
Summary

- Your **mass** is related to the number and size of atoms in your body. It is measured in kilograms (kg).
- Your **weight** (***F***$_g$) is the gravitational force acting on your body. It is a downward force (***g***) of 9.8 N on every kilogram of mass, or 9.8 N/kg:
- $F_g = mg$ (Remember, 1 N = 1 kg m/s^2)
- When you stand on the scales, there is a contact force from the scales up on you that is equal to your weight. There are springs in the scales which stretch according to the applied force and are calibrated against known masses to give a precise reading of mass or weight.

- **Apparent weight** is when the reading on the scales does not give the real weight. This can happen when an object is accelerating up or down.

- Upward acceleration: the upward contact force = $F_{g\ \text{apparent}} = mg + ma$
- Downward acceleration: the upward contact force = $F_{g\ \text{apparent}} = mg - ma$

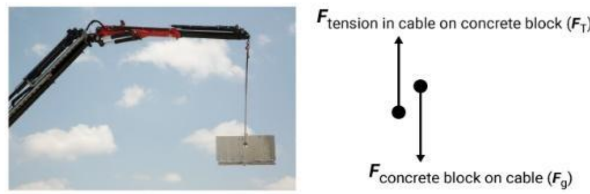
- **Weightlessness** is when the upward contact force = $F_{g\ \text{apparent}} = 0$. This happens in free fall.
- Remember, when an object is in free fall, it experiences the force of gravity. It also experiences **drag forces**. Drag forces are forces in a fluid (gas or liquid) that oppose motion. They depend on the object's weight, size, and shape.
- As the object falls, the drag forces increase until they become equal to the weight of the object. At this point, the object cannot accelerate downward anymore. It has reached **terminal velocity**.



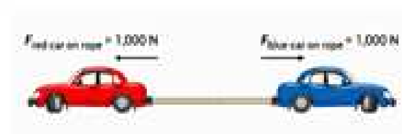
Summary

- **Newton's third law** states that, when two objects interact, they exert equal and opposite forces on each other.

- These forces are **interaction pairs**. Their symbols appear as follows: $\boldsymbol{F}_{\text{A on B}}$ and $\boldsymbol{F}_{\text{B on A}}$.
- When you are studying the motion of an object, you have to consider the forces acting on that single object (the system).
- Interaction pairs act on different objects.



- **Tension** ($\boldsymbol{F}_T$) is the force exerted by an extended rope or string. It is equal in magnitude and opposite in direction to the force stretching that cable. Tension is the same everywhere in the rope.



- If each of these cars pulls with a force of 1,000 N, the tension in the rope is actually 1,000 N. To understand this, imagine one of the cars pulling on a wall with a force of 1,000 N. The wall pulls back with the same force and $\boldsymbol{F}_T$ = 1,000 N.

- Upward acceleration: $\boldsymbol{F}_T = \boldsymbol{F}_{g\ \text{apparent}} = m\boldsymbol{g} + m\boldsymbol{a}$
- Downward acceleration: $\boldsymbol{F}_T = \boldsymbol{F}_{g\ \text{apparent}} = m\boldsymbol{g} + m\boldsymbol{a}$

- The **normal force** ($\boldsymbol{F}_N$) is the upward force exerted on an object, like a vase, by the object it is resting on, like a table. It is perpendicular (at 90°) to the surfaces of contact.

- The normal force can be greater or less than the weight of an object at rest, depending on whether there is an additional push or pull force on it.

Grade 9 Physics - Chapter 4: Forces in One Dimension

QUESTIONS

Choose the correct answer:

1) According to Newton's .... law, an object with no net force acting on it remains at rest or in motion with a constant velocity.

a) first

b) second

c) third

d) universal gravitation

2) If you push against a wall, the wall pushes back against you with ....force.

a) a greater

b) a smaller

c) an equal

d) a noncontact

3) Moving faster as you pedal your bicycle harder on a level road demonstrates Newton's .... law.

a) first

b) second

c) third

d) universal gravitation

4) Mass and weight are related by the equation

a) $\boldsymbol{F} = m\boldsymbol{a}$

b) $\boldsymbol{F} = m\boldsymbol{g}^2$

c) $\boldsymbol{F}_g = m\boldsymbol{a}$

d) $\boldsymbol{F}_g = m\boldsymbol{g}$

5) The normal force is …… the surface of contact between two objects.

a) perpendicular to

b) parallel to

c) greater than

d) less than

6) An object is in equilibrium if ....

a) it has no weight

b) only one force is acting on it

c) it is accelerating

d) the net force on it is zero

7) The gravitational force exerted by a large body, such as Earth, on an object with mass is ....

a) apparent weight

b) acceleration

c) weight

d) weightlessness

8) The force exerted by a fluid on an object moving through the fluid is ....

a) tension

b) the drag force

c) thrust

d) the force of gravity

9) The force exerted by any part of a string or rope on the next part of the string or rope is ....

a) friction

b) gravity

c) tension

d) the drag force

Think and Solve:

10) Categorize the following examples of force forces to **Contact Forces** or **Field Forces.**

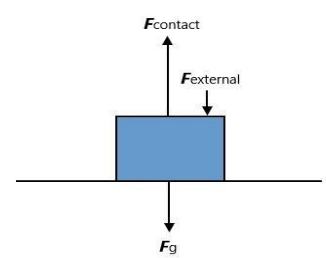
force between two electric charges - Earth attracts the moon - pull on a table - push on a chair - magnet attracts a nail - apple falls freely from a tree

Contact Force	Field Force

11) The weight (F_g) of the box is equal to 49 N, and someone pushes the box down with a force ($F_{external}$) equal of 11 N without causing it to accelerate. Calculate the value of the contact force ($F_{contact}$).

…………………………………………………………....

………………………………………………………….



12) Two men are applying different forces on a concrete mixer: one is pushing with a force of 124 N to the left, and the other is pulling with a force of 207 N to the left.

Calculate the net force applied to the concrete mixer.

…………………………………………………………………….....

……………………………………………………………………..

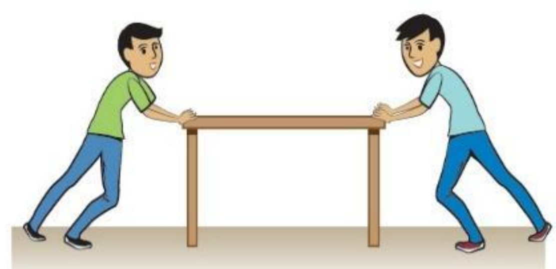
13) A rope is lifting a 24.0 kg bucket. The rope will not break if the tension is 235 N or less. The bucket started at rest and then moved at 1.3 m/s while being raised 5.2 m.

If the acceleration is constant, is the rope in danger of breaking?

…………………………………………………………………….....

……………………………………………………………………..

14) The table pushed in opposite directions with the same amount of force.



Why does the table not accelerate?

…………………………………..

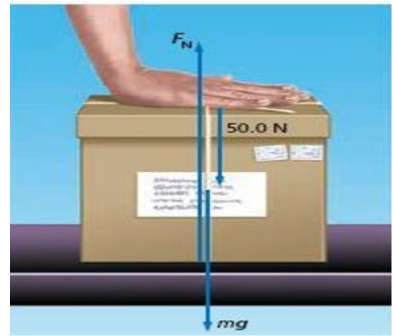
What will be the net force if the boy to the right applied a force of 12 N while the boy to the left applied a force of 8 N?

………………………………………………………………………………

What is the acceleration of the table with the above net force if it is has a mass of 14.5 kg?

…………………………………………………………………………

15) The mass of the box shown to the right is 12.0 kg. It is pushed down with a force of 50 N. Find the value of the normal force of the table on the box. The box does not accelerate.



…………………………………………………………......

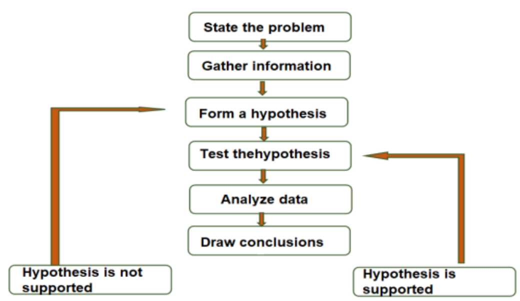
…………………………………………………………..

ANSWER KEYS

Grade 9 Physics - Chapter 1: Methods of Science in Physics

Answer Key

1) Scientific theory
2) Physics
3) Scientific law
4) Scientific method
5) Hypothesis
6) 1.25×10^1 m/s
7) Linear
8)



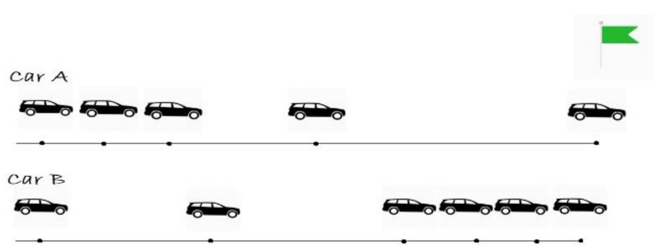
9) **1.** Quadratic relationship **2.** Positive **3.** 40 m **4.** $y = ax^2 + bx + c$
10) **1.** Hamad **2.** Ahmad **3.** Omar
11) **1.** (7) **2.** (3) **3.** (10) **4.** (7) **5.** (4)
12) **1.** 14.44 m/s **2.** 0.7413 **3.** 192 min
13) **1.** Mass **2.** 1.32 g **3.** ± 0.005
14) Slope
15) 5 m/s^2

Grade 9 Physics - Chapter 2: Representing Motion

Answer Key

1) a series of images showing the positions of a moving object at equal time intervals.
2) the object is slowing down.
3) a series of dots.
4) in what direction it is moving.
5) velocity.
6) traveled.
7) average velocity.
8) the cyclist moved away from the origin.
9) Scalar Quantity: **mass – distance – time – speed**.

   Vector Quantity: **velocity – displacement – acceleration.**
10) Distance: 50 m - Displacement: -15 m (or 15 m left or west)
11) 60 m; they are moving in opposite directions (or any equivalent answer like Omar to the right and Ahmad to the left); 30 minutes.
12) $\bar{v} = \frac{x_f - x_i}{t_f - t_i} = \frac{48 - 0}{600 - 0} = 0.08\ m/s$ (accept 50 - 0)
13)



Car A is speeding up.

14) 0 min to 4 min: $\bar{v} = \frac{x_f - x_i}{t_f - t_i} = \frac{400-0}{4-0} = 100\ m/s$

    4 min to 10 min: $\bar{v} = \frac{x_f - x_i}{t_f - t_i} = \frac{400-400}{10-4} = 0\ m/s$
15) Motorcycle B is faster because the same distance covered by motorcycle A and B but the time interval of motorcycle B is less than the time interval of motorcycle A. Also accept answers which refer to the slope of B being steeper or greater than the slope of B.

Grade 9 Physics - Chapter 3: Accelerated Motion

Answer Key

1) instantaneous acceleration
2) 0.2 m/s^2
3) displacement
4) slowing down
5) average acceleration
6) position
7) a large change in velocity over a short time interval
8) increase
9) acceleration is constant
10) $v_f = v_i + at = 0 + (9.8) \times (12.5) = 122.5\ m/s$
11) $a = \frac{v_f - v_i}{t} = \frac{13-8}{4} = 1.25\ m/s^2$
12) **1.** Runner B **2.** Runner B **3.** A and E (***a*** = zero, constant velocity), B and D (same acceleration), C in order of increasing acceleration.
13) $x_f = x_i + \frac{v_f^2 - v_i^2}{2a} = 73.64\ m$
14) **1.** $v_f = v_i + at = 0 + (9.8)(4) = 39.2\ m/s$ **2.** $x_f = x_i + v_i t + \frac{1}{2}at^2 = 78.4\ m$
15) **1.** $area = \frac{1}{2}\ base \times height = \frac{1}{2}(4) \times (20) = 40\ m$

Grade 9 Physics - Chapter 4: Forces in One Dimension

Answer Key

1) First
2) Same
3) Second
4) $\boldsymbol{F}_g = m\boldsymbol{g}$
5) perpendicular to
6) the net force on it is zero
7) weight
8) the drag force
9) tension

10)

Contact Force	Field Force
pull on a table - push on a chair	force between two charges - Earth attracts the moon - Magnet attracts a nail - apple falls freely from a tree

11) $\boldsymbol{F}_{contact} = \boldsymbol{F}_g + \boldsymbol{F}_{external}$ = 49 N + 11 N = 60 N
12) $\boldsymbol{F}_{net}$ = 124 N + 207 N = 331 N to the left
13) $\boldsymbol{F}_{net} = \boldsymbol{F}_T - \boldsymbol{F}_g$; $\boldsymbol{F}_T = \boldsymbol{F}_{net} + \boldsymbol{F}_g = m(\boldsymbol{a} + \boldsymbol{g})$

$a = \frac{v_f^2 - v_i^2}{2\Delta x} = 0.1625\ m/s^2$; $\boldsymbol{F}_T$ = 24 (0.1625 + 9.8) = 239.1 N

The rope is in danger of breaking because because the tension exceeds 235 N.

14) $\boldsymbol{F}_{net}$ equal to zero;
$\boldsymbol{F}_{net}$ = 12 N – 8 N = 4 N to the left;

$\boldsymbol{F}_{net} = m\boldsymbol{a}$ so $\boldsymbol{a} = 0.276\ m/s^2$

15) $\boldsymbol{F}_N = \boldsymbol{F}_g + \boldsymbol{F}_{external} = m\boldsymbol{g} + 50$ N = (12)(9.8) + 50 = 167.6 N