Name: Key.

PHYSICS PRACTICE BOOKLET

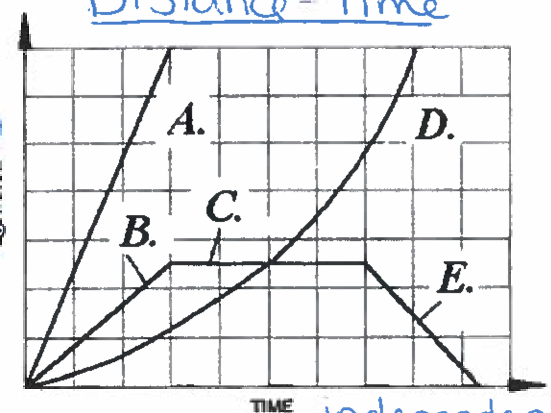
2.1 Pre-Requisite Skills

1. Use the following graphs to do the following:

- Give an appropriate title.
- Identify manipulated, responding, independent, and dependent variables.
- Describe the situation in the graph using words like increasing and decreasing.

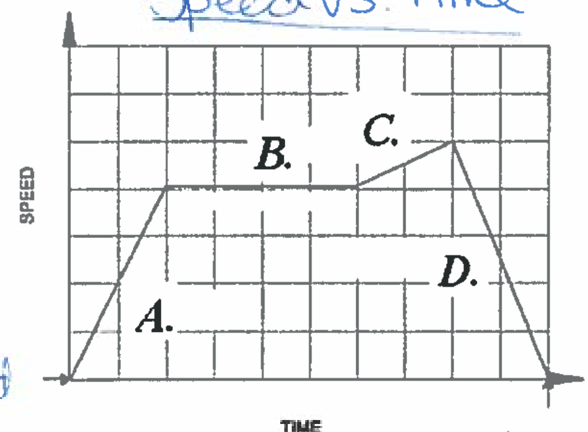
Distance-Time

dependent/ responding



independent/manipulated

Speed vs. Time



A. increasing distance over time
B. " "
C. constant/no distance/standing still
D. increasing (acceleration)
E. decreasing

A. increasing speed /accelerating
B. constant speed
C. increasing speed
D. decreasing speed.

2. Convert the following:

a. 100 km = 10000000 cm	d. 80 g = 80 000 mg
b. 5 m = 50 dm	e. 19 mg = 0.019 g
c. 3 mm = 0.003 m	f. 0.05 kg = 50 g

3. Fill in the following Dimensional Analysis Calculation:

$$12\ days \times \frac{24\ hours}{1\ day} \times \frac{60\ min}{1\ hour} \times \frac{60\ sec}{1\ min} = 1036800\ seconds$$

4. Use dimensional analysis to convert the following:

a. 1 year → minutes

$$1\ year \times \frac{365\ days}{1\ year} \times \frac{24\ hours}{1\ day} \times \frac{60\ min}{1\ hour} = 525600\ min$$

b. 2.05 x 10⁵ sec → years

$$2.05 \times 10^5\ s \times \frac{1\ min}{60\ s} \times \frac{1\ hour}{60\ min} \times \frac{1\ day}{24\ hours} \times \frac{1\ year}{365\ days} = 0.0065\ year$$

c. 110 km/h → m/s

$$\frac{110\ km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{60\ min} \times \frac{1\ min}{60\ s} = 30.5\bar{5}\ m/s$$

5. Use your calculator to perform the following operations:

a. $(6.02 \times 10^{23})(8.65 \times 10^{4})$ $= 5.2073 \times 10^{28}$

b. $(7.0 \times 10^{28})(-3.2 \times 10^{-20})(-6.4 \times 10^{35})$ $= 1.4336 \times 10^{45}$

c. $\frac{7.85 \times 10^{26}}{6.02 \times 10^{23}}$ $= 1303.986...$

$= 1.30 \times 10^{3}$

6. Solve the following mathematical problems such that the answers have the correct number of significant figures:

a. 334.540 grams + 198.9916 grams = 533.532g

b. 34 grams / 10.1 mL = 3.4 g/mL

c. 2.61×10^6 joules / 0.0034 seconds = 7.7×10^8 J/s

d. 0.0610 m – 0.18 m = −0.12 m

e. 349.0 cm + 1.10 cm + 100 cm = 450cm

f. 252 meters / 910 seconds = 0.277 m/s

g. 248.01010 kilograms + 84.097 kilograms = 332.107 kg

7. State the number of significant digits in each measurement.

a. 2804 m 4sd

b. 2.84 km 3sd

c. 5.029 m 4sd

d. 0.003068 m 4sd

e. 4.6×10^5 m 2sd

f. 4.06×10^{-5} m 3sd

g. 750 m 3sd

h. 75 m 2sd

i. 75 000 km 5sd

j. 75.00 cm 4sd

k. 75 000.0 m 6sd.

8. Solve the following problems and report answers with appropriate number of significant digits.

a. 6.201 cm + 7.4 cm + 0.68 cm +12.0 cm = 26.3cm

b. 1.6 km + 1.62 m +1200 cm = 1604 m = 1.6×10^3 m

1600m + 1.62m + 12m

c. 10.4168 m - 6.0 m = 4.4m

d. 12.00 m+15.001 kg= can't add different units

e. 1.31 cm x 2.3 cm = $3.0 cm^2$

f. 5.7621 m x 6.201 m = $35.73 m^2$

g. 20.2 cm / 7.41 s = 2.73 cm/s

h. 40.002 g / 13.000005 g = 3.0771

units cancel with division

2.2 Calculating with Scalars and Vectors

1. Most of the quantities used to describe motion can be categorized as either *vectors or scalars.* A *vector* is a quantity that is fully described by both magnitude and direction. A *scalar* is a quantity that is fully described by magnitude alone. Categorize the following quantities by placing them under one of the two column headings.

displacement, distance, speed, velocity, acceleration

Vectors	Scalars
displacement velocity acceleration	distance speed

2. A quantity that is ignorant of direction is referred to as a Scalar.

3. A quantity that is conscious of direction is referred to as a vector.

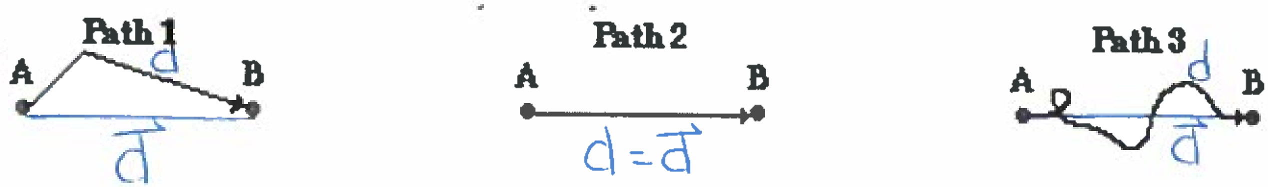
4. True or False: An object can be moving for 10 seconds and still have zero displacement.

if the object returns to its starting position

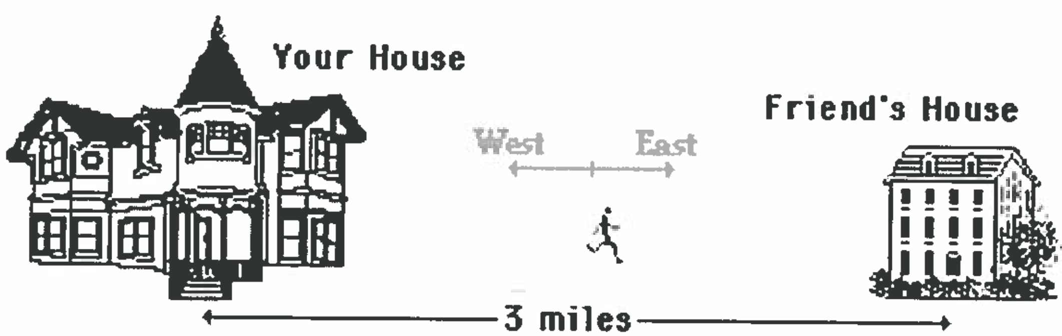
5. If the above statement is true, then describe an example of such a motion. If the above statement is false, then explain why it is false.

Ex.) Connor McDavid is trying to beat the record for fastest skater by doing one lap of the rink.

6. Suppose that you run along three different paths from location A to location B. Along which path(s) would your distance traveled be different than your displacement? Path 1 and 3.



7. You run from your house to a friend's house that is 3 miles away. You then walk home.

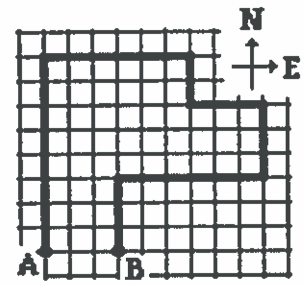


a. What distance did you travel? 6 miles

b. What was the displacement for the entire trip? 0 miles

back where you started.

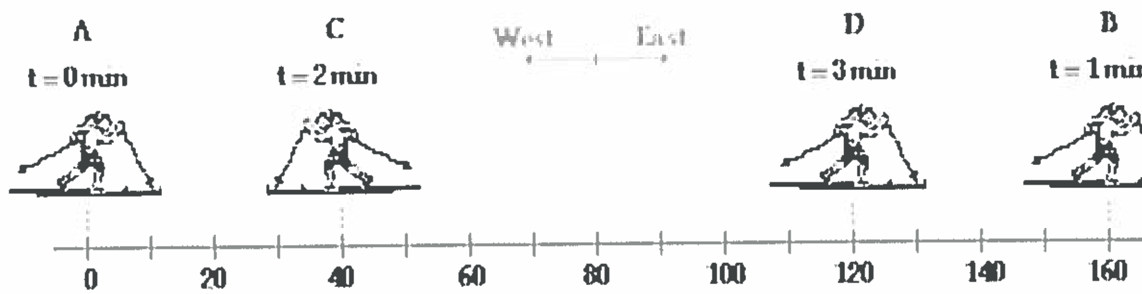
8. Observe the diagram below. A person starts at A, walks along the bold path and finishes at B. Each square is 1 km along its edge. Use the diagram in answering the next two questions.



a. This person walks a distance of 31 km.

b. This person has a displacement of 3km [East].

9. A cross-country skier moves from location A to location B to location C to location D. Each leg of the back and-forth motion takes 1 minute to complete; the total time is 3 minutes. (The unit is meters.)



a. What is the distance traveled by the skier during the three minutes of recreation?

160m + 120m + 80m

= 360m

b. What is the net displacement of the skier during the three minutes of recreation?

120m [East]

c. What is the displacement during the second minute (from 1 min. to 2 min.)?

120m [West]

d. What is the displacement during the third minute (from 2 min. to 3 min.)?

80m [East]

.3 Velocity: Non-Uniform Motion

1. A ticker tape records the motion of an object at intervals of 0.10 s.

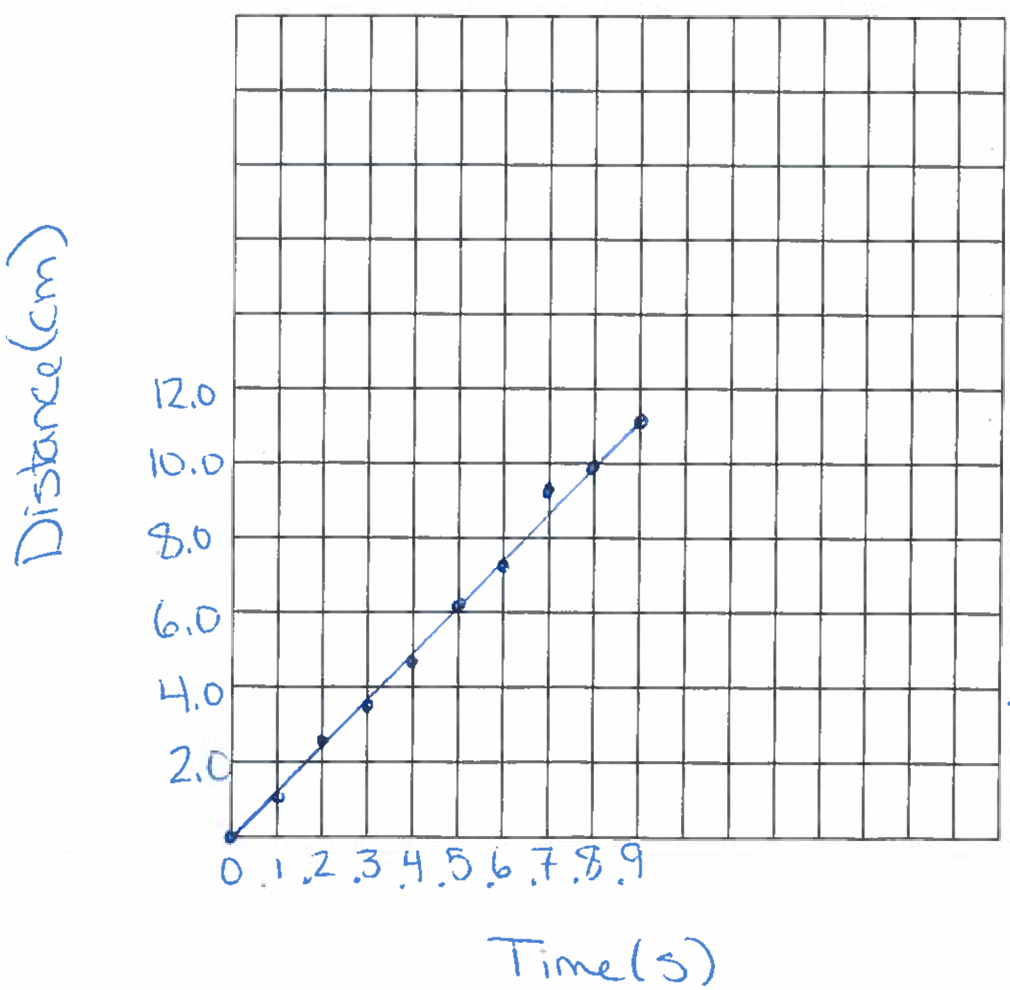
. . . .

a. Complete the following table of values, and draw a distance-time graph of the motion.

Time t(s)	Distance d(cm)
0	0
.1	1.3
.2	2.4
.3	3.6
.4	4.9
.5	6.1
.6	7.5
.7	8.7
.8	9.9
.9	11.2

b. On the graph determine the slope and what it represents.

Distance - Time



$m = \frac{rise}{run} = \frac{11.2cm}{.9s}$

$= 1.24 cm/s$

Slope = speed.

3sd 3sd

2. A skateboarder travels 50.0m in 12.0 s. What is the average speed of the skateboarder?

d=50.0m
t=12.0s
V=?

$V = \frac{d}{t} = \frac{50.0m}{12.0s} = \boxed{4.17 m/s}$

3. A baseball player throws a ball a distance of 45.0m at a speed of 30.0 m/s. How long is the ball in flight?

d=45.0m
V=30.0m/s
t=?

$V = \frac{d}{t}$

$t = \frac{d}{V} = \frac{45.0m}{30.0m/s} = \boxed{1.50 s}$

4. An airplane flies at a speed of 990 km/h for 4.10 hours. How far does the airplane travel?

V=990km/h
t=4.10h
d=?

$d = vt = (990 km/h)(4.10h) = \boxed{4.06 \times 10^3 km}$

5. A bird is flying 6.00 km/h in a straight line at a constant rate. How long will the bird take to travel 30.0 km?

V=6.00km/h
d=30.0km
t=?

$t = \frac{d}{V} = \frac{30.0km}{6.00km/h} = \boxed{5.00 h}$

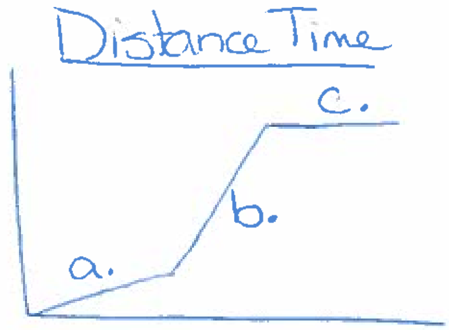
6. A person walks 15.0 m in 5.00s and then walks 12.0 m in 10.00s. What is the average speed of the person?

$V_{total} = \frac{15.0m + 12.0m}{5.00s + 10.00s}$

$V_{total} = \boxed{1.80 m/s}$

7. Sketch a graph with 3 lines on it.

   a. Slow-moving object
   b. Fast-moving object
   c. An object that is not moving

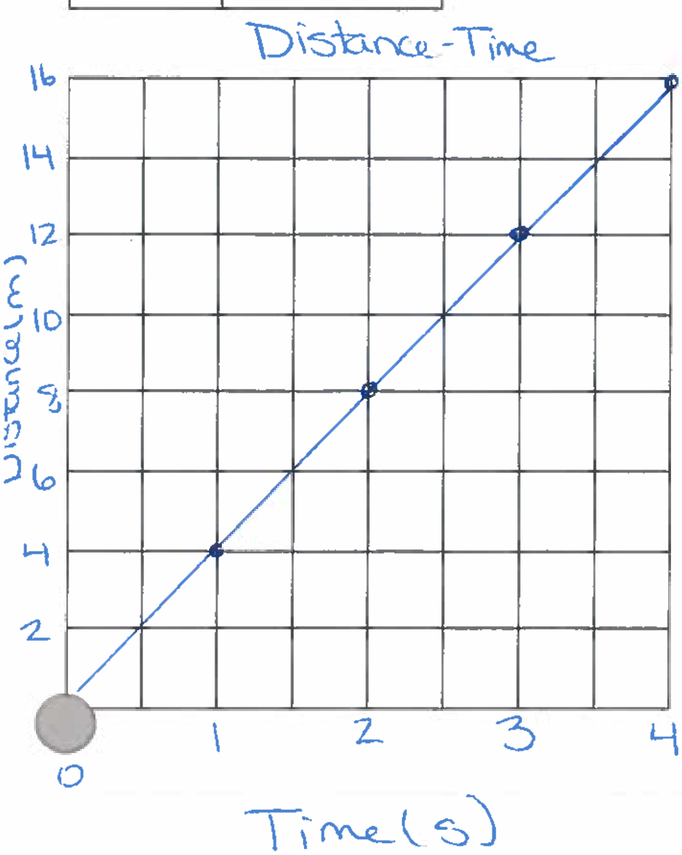


9. For each constant motion below:

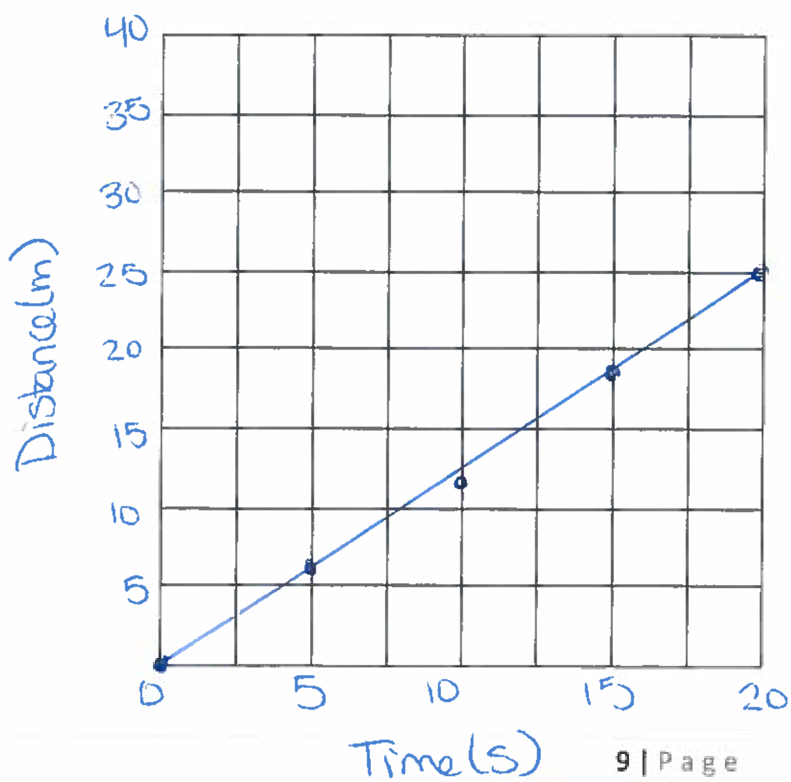
   a. Plot the values for distance-time on a graph.
      i. Put time on the horizontal (manipulated) axis and put distance on the vertical (responding) axis.
      ii. Find the slope of each line

Time (s)	Distance (m)
0	0
1.0	4.0
2.0	8.0
3.0	12.0
4.0	16.0

Time (s)	Distance (m)
0	0
5.00	6.25
10.0	12.50
15.0	18.75
20.0	25.0



$m = \frac{16.0m}{4.0s} = 4.0m/s$

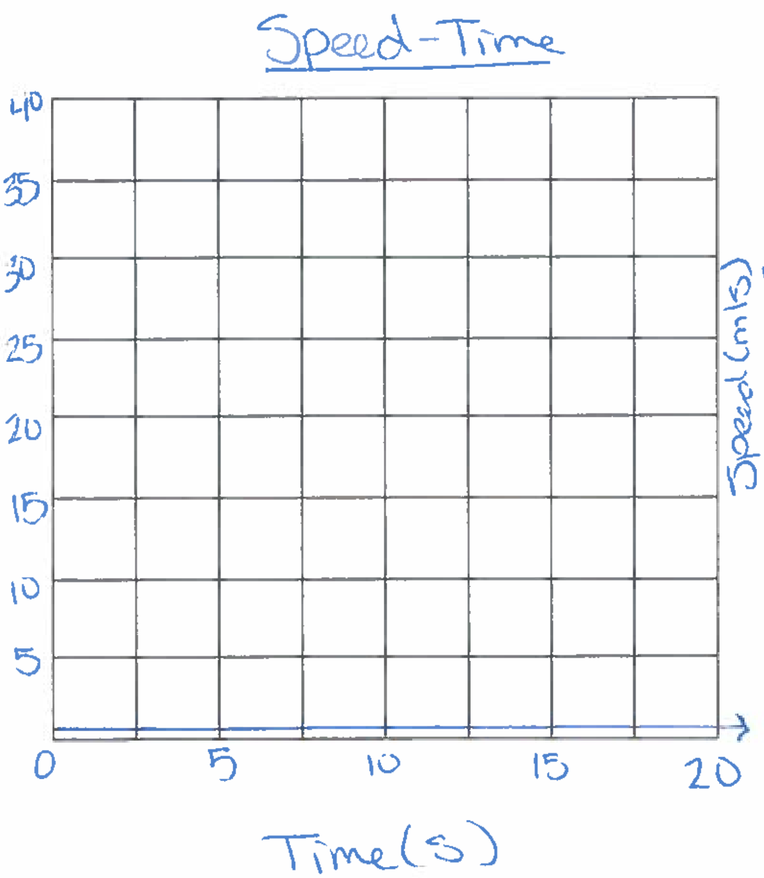


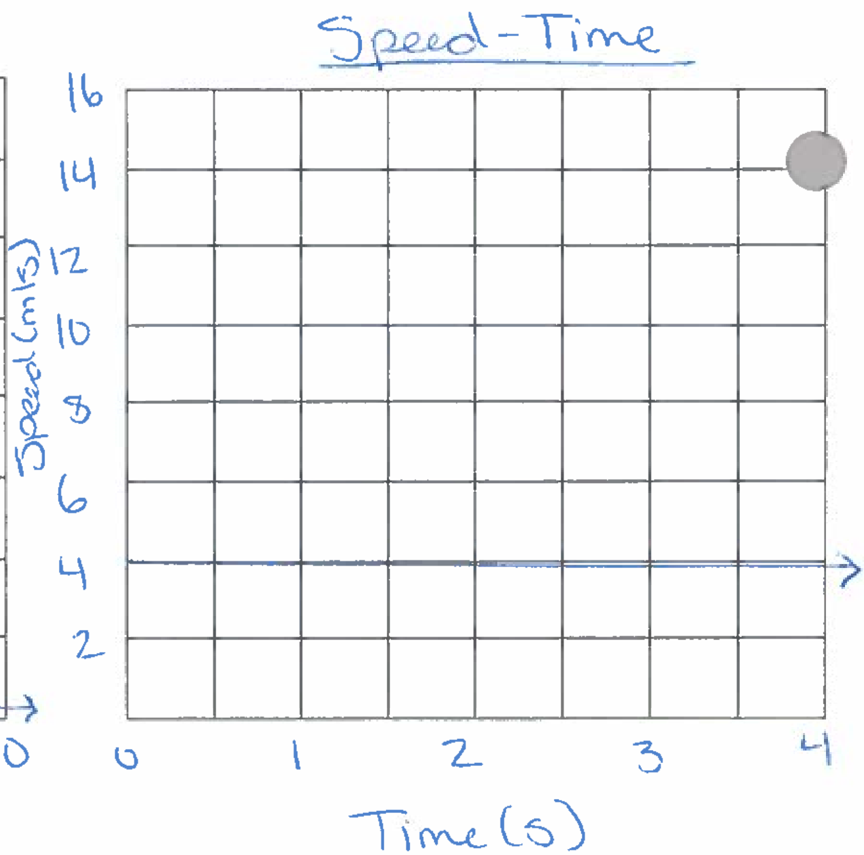
$m = \frac{25.0m}{20.0s} = 1.25m/s$

b. Plot the values for speed – time on a graph. Determine the speed for each time period
   a. Put time on the horizontal (manipulated) axis and put speed on the vertical (responding) axis.
   b. Calculate the slope for each

Time (s)	Distance (m)	Speed (m/s)
0	0	0
5.0	6.25	1.25
10.0	12.50	1.25
15.0	18.75	1.25
20.0	25.0	1.25

Time (s)	Distance (m)	Speed (m/s)
0	0	0
1.0	4.0	4
2.0	8.0	4
3.0	12.0	4
4.0	16.0	4





$m = 0\ m/s^2$

$m = 0\ m/s^2$

this means no acceleration or constant speed.

2.4 V_f Formulas

1. A ball traveling [W] at 10 m/s increases in speed to 25 m/s in 8.0 s. Find the acceleration of the ball in $\frac{m}{s^2}$.

$\vec{V_i} = {}^{-}10 m/s$

$\vec{V_f} = -25 m/s$

$t = 8.0 s$

$a = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t}$

$= \frac{-25 m/s - {}^{-}10 m/s}{8.0 s}$

$\vec{a} = -1.9 m/s^2$

$\vec{a} = 1.9 m/s^2 [W]$

2. A bowling ball traveling [N] at 8.0 m/s is accelerated by 0.50 m/s² for 5.0 s. Find the final velocity of the bowling ball in $\frac{m}{s}$

$\vec{V_i} = +8.0 m/s$

$\vec{a} = +0.50 m/s^2$

$t = 5.0 s$

$\vec{V_f} = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t}$

$5.0 \cdot 0.50 = \frac{\vec{V_f} - 8.0}{5.0} \cdot 5.0$

$2.5 = V_f - 8.0$

$+8.0 \quad +8.0$

$\vec{V_f} = 11 m/s [N]$

3. A car traveling [E] at 50 km/h comes to a stop in 12 s. Find the acceleration of the car in m/s².

$\vec{V_i} = 50 km/h$

$\vec{V_f} = 0$

$t = 12 s$

$\vec{a} = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t} = \frac{0 - 50}{12} = -4.2 m/s^2$

4. A marble initially travels [S] at 12.0 m/s. It is accelerated at -2.25 m/s² for 3.50 s. Find the velocity of the marble in m/s at that moment.

$\vec{V_i} = +12.0 m/s [S]$

$\vec{a} = -2.25 m/s^2$

$t = 3.50 s$

$\vec{V_f} = ?$

$\vec{V_f} = \vec{V_i} + \vec{a}t$

$= +12.0 + (-2.25)(3.50)$

$\vec{V_f} = 4.13 m/s [S]$

5. A ball is thrown upwards at 20 m/s. How much time (in seconds) will have passed before the ball stops rising? Remember that acceleration due to gravity is a -9.81 m/s².

$\vec{V_i} = 20 m/s$

$\vec{V_f} = 0 m/s$

$\vec{a} = -9.81 m/s^2$

$t = ?$

$t = \frac{\vec{V_f} - \vec{V_i}}{a} = \frac{0 - 20}{-9.81}$

$t = 2.0 s$

6. An inch worm travels [W] at 0.15 m/s. He encounters a patch of mud that accelerates him at a rate of -0.052 m/s². How much time (in seconds) will have passed before the mud brings him to a stop?

$\vec{V_i} = 0.15 m/s$

$\vec{V_f} = 0 m/s$

$\vec{a} = -0.052 m/s^2$

$t = ?$

$t = \frac{\vec{V_f} - \vec{V_i}}{\vec{a}} = \frac{0 - 0.15}{-0.052}$

$t = 2.9 s$

7. Clayton is racing for a puck. He starts from a dead stop at the boards and heads [E]. He allows his skating rate to increase by 6.0 m/s² for 2.5 s. What is his final velocity in $\frac{m}{s}$?

$\vec{V_i} = 0 m/s$

$\vec{a} = 6.0 m/s^2$

$t = 2.5 s$

$\vec{V_f} = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t}$

$2.5 \cdot 6.0 = \frac{V_f - 0}{2.5} \cdot 2.5$

$\vec{V_f} = 15 m/s [E]$

8. Cassie drives her golf cart [E] at 15 km/h. There is a massive speed bump coming, so Cassie brings the cart to 5.0 km/h. If this takes her 3.5 s, find the deceleration of the cart in m/s.

$\vec{V_i} = 15 km/h$

$\vec{V_f} = 5.0 km/h$

$t = 3.5 s$

$\vec{a} = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t} = \frac{5.0 - 15}{3.5}$

$\vec{a} = -2.9 m/s^2 [E]$

9. Andy kicks a soccer ball [N] towards the net. It leaves his foot at 18 m/s and strikes the goal post 2.5 s later. If the speed of the ball was 10 m/s when it struck the goal post, find the acceleration of the ball in m/s²

$\vec{V_i} = 18 m/s$

$t = 2.5 s$

$\vec{V_f} = 10 m/s$

$\vec{a} = ?$

$\vec{a} = \frac{\vec{V_f} - \vec{V_i}}{t} = \frac{10 - 18}{2.5} = -3.2 m/s^2 [N]$

2.5 Energy Types

1. Using the six types of energy (chemical, electrical, magnetism, nuclear/solar, motion(kinetic and potential), and heat) determine which one best fits with the following:

a. An antacid pill in a glass of water and its starts to bubble chemical

b. A fluorescent dial glows at night chemical/electrical

c. A downhill skier increases speed as they go down a hill kinetic

d. The shock you feel after putting a fork in a socket electrical

e. The inside of a car getting warm in the sun solar

f. An eagle lifting a mouse off the ground potential

g. A compass needle pointing North. magnetic

2. Name an appliance or machine that uses the following types of energy:

a. Chemical fluorescent lights, glowsticks, etc.

b. Heat toaster

c. Electrical all appliances that plug in

d. Magnetic compass, generator

e. Solar solar panels

3. Determine the input energy and output energy for the following:

a. Flashlight; Chemical to electric

b. Car; Chemical to kinetic

c. Food; Chemical to kinetic

d. Light Switch; potential to electric

e. Dryer; electric to heat

f. Cellphone; chemical to electric

g. Hair Dryer; electric to heat

h. Toaster; electric to heat

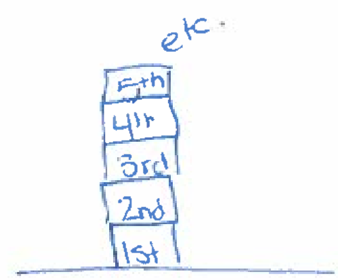
Answers may vary.

4. What is the gravitational potential energy of a 61.2 kg person standing on the roof of a 10-story building relative to (a) the tenth floor, (b) the sixth floor, (c) the first floor? (Each story is 2.50 m high.)

a) $E_p = mgh$
$= (61.2)(9.81)(2.50)$
$= 1.50 \times 10^3$ J

b) $(61.2)(9.81)(12.5)$
$= 7.50 \times 10^3$ J

c) $(61.2)(9.81)(25.0)$
$= 1.50 \times 10^4$ J



5. A 1.00 x 10⁴ kg airplane lands, descending a vertical distance of 10.0 km while travelling 100.0 km measured along the ground. What is the plane's loss of potential energy?

10000 m

doesn't matter

$E_p = mgh$
$= (1.00 \times 10^4)(9.81)(10\,000)$
$= 9.81 \times 10^8$ J

6. A coconut falls out of a tree 12.0 m above the ground and hits a bystander 3.00 m tall on the top of the head. It bounces back up 1.50 m before falling to the ground. If the mass of the coconut is 2.00 kg, calculate the potential energy of the coconut relative to the ground at each of the following sites:

(a) while it is still in the tree,

(b) when it hits the bystander on the head,

(c) when it bounces up to its maximum height,

(d) when it lands on the ground,

(e) when it rolls into a groundhog hole, and falls 2.50 m to the bottom of the hole.

a) $E_p = mgh$
$= (2)(9.81)(12.0)$
$= \boxed{235 J}$

b) $E_p = mgh$
$= (2)(9.81)(3)$
$= \boxed{58.9 J}$

c) $E_p = mgh$
$= (2)(9.81)(1.5)$
$= \boxed{29.4 J}$

d) 0J

e) 0J

7. Calculate the potential energy of a 5.00 kg object sitting on a 3.00 meter high ledge.

$E_p = mgh = (5.00)(9.81)(3.00)$
$= \boxed{147 J}$

8. A 10.0 kg rock is at the top of a 20.0 m. tall hill. How much potential energy does it have?

$E_p = mgh = (10.0)(9.81)(20.0)$
$= \boxed{1.96 \times 10^3 J}$

2.6 Kinetic Energy

1. Calculate the kinetic energy of a 0.45 kilogram golf ball travelling at: (a) 20.0 m/s, (b) 40.0 m/s, (c) 60.0 m/s.

$m = 0.45 kg$

$E_K = \frac{1}{2}mv^2$

a) $E_K = (\frac{1}{2})(0.45)(20.0)^2 = 90 J$

b) $E_K = (\frac{1}{2})(0.45)(40.0)^2 = 3.6 \times 10^2 J$

c) $E_K = (\frac{1}{2})(0.45)(60.0)^2 = 8.1 \times 10^2 J$

2. A 50.0 kg bicyclist on a 10.0 kg bicycle speeds up from 5.00 m/s to 10.0 m/s.

(a) What was the total kinetic energy before accelerating?

$m = 50.0 + 10.0 = 60.0 kg$

$v = 5.00 m/s$

$E_K = \frac{1}{2}mv^2 = (\frac{1}{2})(60.0)(5.00)^2 = 750 J$

(b) What was the total kinetic energy after accelerating?

$E_K = \frac{1}{2}(60.0)(10.0)^2 = 3.00 \times 10^3 J$

(c) How much work was done to increase the kinetic energy of the bicyclist?

$W = \Delta E = 3000 - 750 = 2250 = 2.25 \times 10^3 J$

(d) Is it more work to speed up from 0 to 5.00 m/s than from 5.00 to 10.0 m/s?

$W = 750 J - 0 J = 750 J$

$W = 2250 J$ ← more work

3. A 4.00 kg rock is rolling 10.0 m/s. Find its kinetic energy.

$E_K = \frac{1}{2}mv^2$

$= (\frac{1}{2})(4.00)(10.0)^2 = \boxed{200 J}$

4. An 8.0 kg cat is running 4.0 m/s. How much kinetic energy does it have?

$E_K = (\frac{1}{2})(8.0)(4.0)^2 = \boxed{64 J}$

5. At the moment when a shot-putter releases a 5.00 kg shot, the shot is 3.00 m above the ground and travelling at 15.0 m/s. It reaches a maximum height of 14.5 m above the ground and then falls to the ground. If air resistance is negligible,

(a) What was the potential energy of the shot as it left the hand relative to the ground?

$E_p = mgh = (5.00)(9.81)(3.00) = \boxed{147 J}$

(b) What was the kinetic energy of the shot as it left the hand?

$E_K = \frac{1}{2}mv^2 = (\frac{1}{2})(5.00)(15.0)^2 = \boxed{563 J}$

(c) What was the total energy of the shot as it left the hand?

$E_{Total} = E_p + E_K = 147 + 563 = \boxed{710 J}$

(d) What was the total energy of the shot as it reached its maximum height?

$E_{p\,max} = (5)(9.81)(14.5) = 711 J$

$E_{K\,max} = 0 J$

$E_T = \boxed{711 J}$

(e) What was the potential energy of the shot at its maximum height?

$\boxed{711 J}$

(f) What was the kinetic energy of the shot at its maximum height?

0 J

stops at max. height for a split second.

(g) What was the kinetic energy of the shot just as it struck the ground?

$\boxed{711 J}$

energy always conserved.

6. A 10.0 kg ball is thrown into the air. It is going 3.0 m/s when thrown. How much potential energy will it have at the top?

* $E_{K\,bottom} = E_{P\,top}$ *

$E_{K\,bottom} = \frac{1}{2}(10.0)(3.0)^2$

$= 45\text{ J}$

7. A 4.00 kg ball is on a 5.00 m ledge. If it is pushed off the ledge, how much kinetic energy will it have just before hitting the ground?

* $E_{K\,bottom} = E_{P\,top}$ *

$E_{P\,top} = (4.00)(9.81)(5.00)$

$= 196\text{ J}$

8. A physics teacher exerts a force upon a 3.29-kg pile of snow to both lift it and set it into motion. The snow leaves the shovel with a speed of 2.94 m/s at a height of 0.562 m. Determine the work done upon the pile of snow.

$W = \Delta E = E_K + E_P = \frac{1}{2}mv^2 + mgh$

$= (\frac{1}{2})(3.29)(2.94)^2 + (3.29)(9.81)(0.562)$

$= 32.4\text{ J}$

9. A 2.00 kg ball is dropped from the top of a 10.0 m high building. Calculate the potential AND kinetic energies at: (a) 10.0 m (b) 8.00 m (c) 5.00 m (d) 0.00 m.

* energy always conserved.

$E_T = E_{P\,top} = (2)(9.81)(10.0) = 196\text{ J}$

a) 196 J

b) $E_P = (2)(9.81)(8.00) = 157\text{ J}$

$E_K = E_T - E_P = 196 - 157 = 39\text{ J}$

c) $E_P = (2)(9.81)(5.00) = 98.1\text{ J}$

$E_K = 196 - 98.1 = 97.9\text{ J}$

d) $E_P = 0\text{ J}$

$E_K = 196\text{ J}$

2.7 Force and Work

1. Calculate the work done by a 47 N force pushing a pencil 0.26 m.

$W = Fd = (47)(0.26) = \boxed{12\ J}$

2. How much work is it to lift a 20. kg sack of potatoes vertically 6.5 m?

$W = mad = (20)(9.81)(6.5) = \boxed{1.3 \times 10^3\ J}$

3. A crane that loads ships must exert a force of 24 550 N on a crate and lift it 22.00 m. How much work is done on the crate?

$W = Fd = (24550)(22.00) = \boxed{5.401 \times 10^5\ J}$

4. A weight lifter does 420 J of work to lift a barbell a height of 0.35 m. What force did the weight lifter exert on the barbell?

$\frac{W}{d} = \frac{Fd}{d}$ $F = \frac{W}{d} = \frac{420}{0.35} = \boxed{1.2 \times 10^3\ N}$

5. A farmer exerts a force of 12.00 N on a wheelbarrow. When the farmer has used 7198 J of energy how far has he pushed the wheelbarrow?

$\frac{W}{F} = \frac{Fd}{F}$ $d = \frac{W}{F} = \frac{7198}{12.00} = \boxed{599.8\ m}$

6. Sally has a car that accelerates at 5 m/s^2. If the car has a mass of 1000 kg, how much force does the car produce?

$F = ma = 1000(5) = \boxed{5000\ N}$

7. What is the mass of a truck if it produces a force of 14,000 N while accelerating at a rate of 5 m/s^2?

$\frac{F}{a} = \frac{ma}{a}$ $m = \frac{F}{a} = \frac{14\,000}{5} = \boxed{2800\ kg}$

8. What is the acceleration of softball if it has a mass of 0.5 kg and hits the catcher's glove with a force of 25 N?

$\frac{F}{m} = \frac{ma}{m}$ $a = \frac{F}{m} = \frac{25}{0.5} = \boxed{50\ m/s^2}$

2.8 Law of Conservation of Energy/Mechanical Energy

1. A 20 kg object is dropped from the top of a 40 m tall building. Ignoring friction and any energy conversions which reduce the object's mechanical energy, complete the table:

h (m)	v (m/s)	GPE (J)	KE (J)
40 m	0 m/s	7848	0 J
35	10 m/s	6848	1000
20	20	4000 J	3848
9	24	1848	6000 J
5 m	26	981	6867

2. A volleyball of mass of 0.450 kg at 1.8 m above ground is served so that it has an initial velocity of 15 m/s. Find the kinetic, potential, and mechanical energies at the beginning of the trajectory.

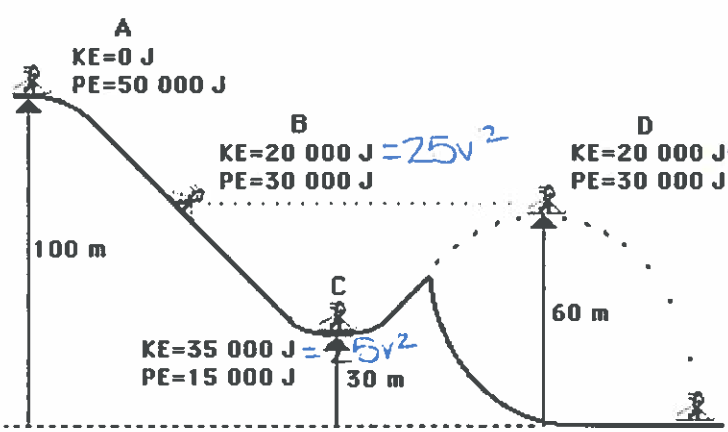
$E_p = mgh = (0.450)(9.81)(1.8) = \boxed{7.9\ J}$

$E_K = \frac{1}{2}mv^2 = (\frac{1}{2})(0.450)(15)^2 = \boxed{51\ J}$

$E_m = E_p + E_K = 7.9 + 51 = \boxed{59\ J}$

3. Determine Sally's (mass of 50 kg) speed at locations B, C, D and E.

$E_K = \frac{1}{2}mv^2 = \frac{1}{2} \cdot 50v^2 = 25v^2$



B: 28 m/s
C: 37 m/s
D: 28 m/s
E: 45 m/s

2.9 Efficiency

1. A steam engine has a heat input of 1000J and does 350.00J or useful work. What is the steam engine's efficiency?

$\% \text{ efficiency} = \frac{W_{output}}{W_{input}} \times 100 = \frac{350}{1000} \times 100 =$ ~~[illegible]~~ **35%**

2.10 Laws of Thermodynamics

1. How is work different than heat?

Work is change in <u>any</u> energy.
Heat is change in <u>thermal</u> energy.

2. What is the law of the conservation of energy?

Energy is never <u>created</u> or <u>destroyed</u>, just changes forms.

3. First Law of Thermodynamics states :

Total energy in a system, including heat, remains constant, just changes forms.

4. What is meant by the statement?

Heat added to the system = mechanical energy + heat ← friction

(mechanical energy: total energy ($E_p + E_k$))

5. In theory a system could gain the same amount of mechanical energy as heat input energy, but in reality this does not happen. Why?

heat always moves from hot → cold so it's hard to conserve heat.

6. What is a perfect machine?

no energy loss due to friction / heat

7. Second law of Thermodynamics states :

- heat naturally flows from hot to cold.
- no system is 100% efficient.