0-1

The standard (SI) unit for mass is the Kilograms, represented by kg.

0-2

The SI unit for length or distance is the meter, represented by m.

0-3

The SI unit for time is the second, represented by s.

0-4

Variable	Symbol	Unit
Mass	m	kg
Distance	d	m
Time	t	s
Velocity	v	m/s
Acceleration	a	m/s^2
Force	F	N

0-5

The higher the degree of accuracy in a measurement, the greater the number of significant Figures we can use for that measurement.

0-6

How many significant figures are in the following numbers?

0.45 2 9004.7 5
0.01 1 607 3
130 2 →130. 3 (decimal)

0-7

Calculate the following, taking significant figures into account:

$(203.7\text{m})(76\text{m}) = 15481 = 15000\text{m}^2$
$(8.967\text{kg})/(2.3\text{kg}) = 3.897 = 3.9$

0-8

How many significant figures are in:

2.3×10^{14} m 2

5.684×10^{3} s 4

0-9

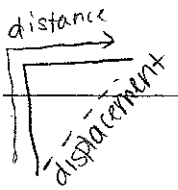
$(3.45 \times 10^{12}\text{ m})(1.6 \times 10^{8}\text{m}) = 5.52 \times 10^{20}\text{m}^2$
$= 5.5 \times 10^{20}\text{m}^2$
$(7.8 \times 10^{2}\text{kg})(6 \times 10^{2}\text{m}) = 468000$
$= 5 \times 10^{5}\text{kgm}$

0-10

Solve:

$$\frac{(4.5 \times 10^{15}\text{ kg})(3.34 \times 10^{4}\text{m})}{(6.7\text{s})^2}$$

$= 3.348 \times 10^{19}\ \text{kgm}^2/\text{s}^2 = 3.3 \times 10^{19}\ \text{kgm}^2/\text{s}^2$

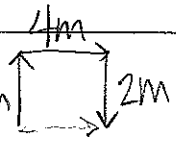


1-1

What is the difference between distance and displacement?

Which is a vector? displacement
Which is a scalar? distance

1-2

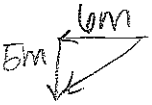


If an object moves 2m north, then 4m east, then 2m south, what is its distance traveled?
What is its displacement?
(Be able to solve mathematically or graphically)

distance = 8m
displacement = 4m E

1-3

If an object travels 6m west, then 5m south,
What is its distance traveled?
What is its displacement?
(Be able to solve mathematically or graphically)



$a^2+b^2=c^2$ $5m^2+6m^2=c^2$ $c=7.8m$ SW

1-4

speed is a rate = $\frac{\text{distance}}{\text{time}}$

What is the difference between speed and velocity?
Which is a scalar? speed
Which is a vector? velocity

velocity is the rate $\frac{\text{displacement}}{\text{time}}$
velocity has Mag & direction

1-5

What is the average speed of an object which travels 63m in 3.4s?

$S=\frac{d}{t}$ $S=\frac{63m}{3.4s}=18.53\frac{m}{s}$

1-6

What is the average velocity of an object that moves 57m, N in 3.1s?

$\bar{V}=\frac{d}{t}$ $\bar{V}=\frac{57m\ N}{3.1s}=18.4$ m/s N

1-7

$V_i=0m/s$
$V_f=60m/s$
$t=15s$

If an object goes from rest to 60.m/s in 15s uniformly,
what is its average speed?

$\bar{V}=\frac{V_f+V_i}{2}=\frac{0m/s+60m/s}{2}=30\frac{m}{s}$

1-8

In 1-7, how far will the object travel in those 15s?

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

$\frac{30m}{s}=\frac{d}{15s}$ $d=450m$

1-9

In 1-7, what will be the object's acceleration rate?

$a=\frac{\Delta V}{t}$

$a=\frac{V_f-V_i}{t}=\frac{60m/s-0m/s}{15s}$

$=4\ m/s^2$

1-10

What is the average speed of an object that accelerates uniformly from 3.6 m/s to 5.7 m/s?

$\bar{V}=\frac{V_f+V_i}{2}=\frac{3.6m/s+5.7m/s}{2}$

$=4.65m/s$

1-11

How far will an object going 6.3m/s travel in 16.7 s?

$\bar{v} = \frac{d}{t}$ $\quad \frac{6.3m}{s} = \frac{d}{16.7s}$ $\quad d = 105.21m$

1-12

What is the acceleration of an object which uniformly changes its velocity from 6.6 m/s to 18.4 m/s in 8.2 s?

$V_f = V_i + at$

$18.4m/s = 6.6m/s + (a)(8.2s)$ $\quad a = 1.43m/s^2$

$V_i = 0m/s$ $\quad d = 72m$
$t = 6.8s$

1-13

If an object uniformly accelerates from rest and it takes 6.8s to cover a distance of 72m, how fast will It be going at the end of those 6.8s?

$\bar{v} = \frac{d}{t}$ $\quad \bar{v} = \frac{72m}{6.8s}$ $\quad \bar{v} = 10.6m/s$

$\bar{v} = \frac{V_f + V_i}{2}$ $\quad 10.6\frac{m}{s} = \frac{V_f + 0m/s}{2}$ $\quad V_f = 21.2m/s$

1-14

In 1-13, what is the rate of acceleration?

$a = \frac{\Delta V}{t}$

$a = \frac{V_f - V_i}{t} = \frac{21.2m/s - 0}{6.8s} = 3.1\ m/s^2$

$a = 2.9m/s^2$
$t = 9.7s$

1-15

How far will an object go in 9.7 s if it undergoes a uniform acceleration of 2.9 m/s^2?

$d = V_i t + \frac{1}{2}at^2$

$d = 0m/s(9.7s) + \frac{1}{2}(2.9m/s^2)(9.7s)^2$

$d = 136.43m$

1-16

When an object is slowing down, the value of its acceleration will be _____ (+ or -).

—

1-17

What is the final velocity of an object after 6.0s if it starts from rest and accelerates at 4.3 m/s^2?

$V_f = ?$
$V_i = 0m/s$
$t = 6s$
$a = 4.3m/s^2$

$a = \frac{\Delta V}{t}$ $\quad 4.3m/s^2 = \frac{V_f - 0m/s}{6s}$ $\quad V_f = 25.8m/s$

1-18

What is the final velocity of an object after a distance of 216m if it has an acceleration of 3.6 m/s^2?

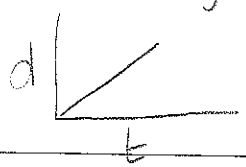
$V_f^2 = V_i^2 + 2ad$

$V_f^2 = 0\frac{m^2}{s} + 2(3.6m/s^2)(216m)$

$V_f = 39.44m/s$

1-19

In a displacement-time graph, the slope equals the object's velocity.



1-20

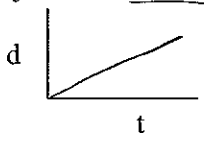
In a velocity-time graph, the slope equals the object's acceleration.

1-21

In a velocity-time graph, the area beneath the curve equals the object's displacement

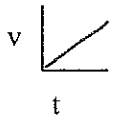
1-22

Sketch the displacement-time graph that shows an object with a non-zero constant velocity:



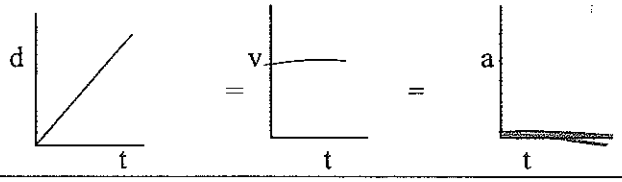
1-23

Sketch the velocity-time graph for an object undergoing uniform positive acceleration:



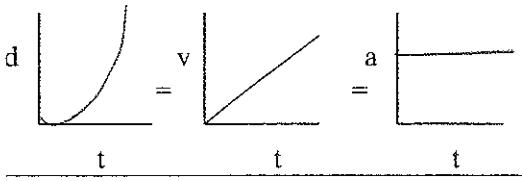
1-24

Sketch the velocity-time and acceleration-time graphs for the given displacement-time graph:



1-25

Sketch the d-t and a-t graphs for the given v-t graph:



1-26

What's the final velocity of an object that starts at 5.9 m/s, and accelerates at 4.0 m/s^2 for 2.8s?

$V_f = V_i + at$

$V_f = 5.9 m/s + 4 m/s^2 (2.8 s)$

$V_f = 17.1 m/s$

1-27

How far will an object travel if it starts from rest and accelerates at 7.82 m/s^2 for 9.0 s?

$d = V_i t + \frac{1}{2} a t^2$

$d = 0 m/s (9s) + \frac{1}{2}(7.82 m/s^2)(9s)^2$

$d = 316.71 m$

1-28

What will be the final velocity of an object that starts at 1.5 m/s, and accelerates at 6.3 m/s^2 for a distance of 72m?

$V_f^2 = V_i^2 + 2ad$

$V_f^2 = (1.5 m/s)^2 + 2(6.3 m/s^2)(72 m)$

$V_f = 30.16 m$

1-29

What is the rate of acceleration due to gravity? (neglecting air resistance) $9.81 m/s^2$

What is it represented by?

"g"

1-30

When an object is dropped from a height of 28m. how long will it take to hit the ground?

$d = V_i t + \frac{1}{2} a t^2$

$28m = 0 m/s (t) + \frac{1}{2}(9.81 m/s^2)(t^2)$

$t = 2.39 s$

1-31

In the above question, how fast will the object be going when it hits the ground?

$V_f = V_i + at$
$V_f = 0 m/s + 9.81 m/s^2 (2.39 s)$
$V_f = 23.4 m/s$

1-32

How fast will an object be going after 6.4 s when it is dropped from rest?

$V_f = V_i + at$
$V_f = 0 m/s + 9.81 m/s^2 (6.4 s)$
$V_f = 62.78 m$

1-33

How fast will an object be going after 6.7 s when it is dropped with an initial downward velocity of 1.9 m/s ?

$V_f = V_i + at$
$V_f = 1.9 m/s + 9.81 m/s^2 (6.7 s)$
$V_f = 67.68 m/s$

1-34

Is gravity a vector or a scalar?

a vector, that is because it is an acceleration and it always has a direction

1-35

If it takes a thrown object 1.7s to go as high as it will go, how long will it take to come back down?

1.7 s

1-36

How far will an object fall in 5.8s?

$d = v_i t + \frac{1}{2} a t^2$
$d = 0 m/s (5.8 s) + \frac{1}{2} (9.81 m/s^2)(5.8 s)^2$
$d = 165 m$

2-1

The study of forces at rest is Statics

all balanced non moving forces = Static equilibrium

2-2

The unit for force is the Newton

One of these results in a mass of 1 kg having an acceleration of 1 m/s^2.

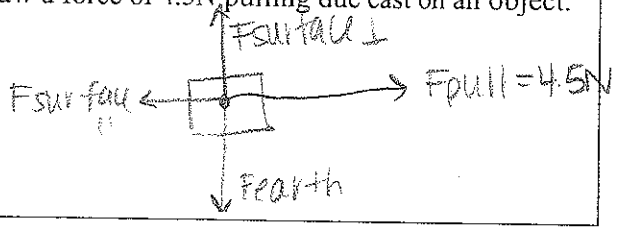
2-3

Are forces vectors or scalars?

Vector has Mag. & direction

2-4

Draw a force of 4.5N pulling due east on an object.



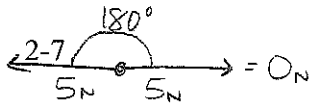
2-5

Two or more forces acting on an object at the same time are called Concurrent forces.

2-6

A single force equal to two or more concurrent forces combined is called the resolved vector

2-7



At what angle should two concurrent forces be to obtain the smallest resultant?

180°

At what angle should they be to obtain the largest resultant? 0°

5N 5N = 10N E

2-8

What is the greatest resultant obtainable with two concurrent forces of 4.8 N and 2.3N?

4.8N 2.3N = 7.1N

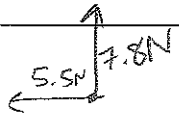
What's the smallest?

4.8N 2.3N = 2.5N

2-9

Forces are added tip to tail. The resultant can be found graphically, or if the two concurrent forces are at right angles, the resultant can be found using the Pythagorean theorm ($a^2+b^2=c^2$).

2-10



If a force of 5.5N acts due west on an object while another of 7.8N acts due north, what is the magnitude of the resultant?

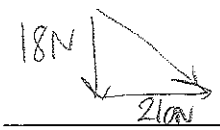
$a^2+b^2=c^2$ $(5.5N)^2+(7.8N)^2=c^2$ $c=9.5N$

What is the direction of the resultant?

NW

2-11

Using the parallelogram method, find the resultant (magnitude and direction) of a due south 18N force and a due east 26N force.



$a^2+b^2=c^2$

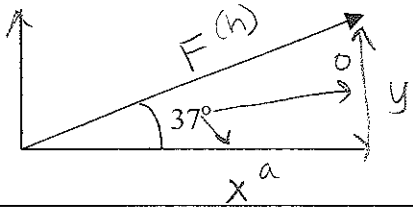
$18N^2+26N^2=c^2$ $c=31.6N$ SE

2-12

Just as concurrent forces can be combined into a resultant, a single force can be broken up into two or more concurrent forces. Commonly, these are the X and Y components.

2-13

What are the X and Y components of this force?



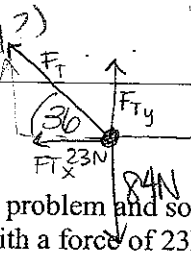
2-14

The force equal in magnitude but opposite in direction to the resultant is called the Fictional force or the equilibrant force (the force that makes equilibrium)

y: F sin (37)

x: F cos(37)

(This is a poorly worded 2-15 --)



$F_{net x} = F_{rod} + F_{Tx} = 0N$

$F_{rod} = F_{Tx}$

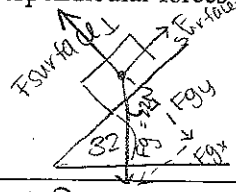
Draw a free-body diagram for this problem and solve mathematically: A rod pushes with a force of 23N on a cable that holds an 84N sign. If the cable is at 36° to the building, what is the tension on the cable?

$F_{Tx} = 23N$ $\quad \cos(36) = \frac{23N}{X}$

$X = F_T = 28.4N$

2-16

If a 22N box sits on a 32° ramp, find the parallel and perpendicular forces mathematically.



$F_{gy} = \cos(32)(22N) = 18.7N$

$F_{gx} = \sin(32)(22N) = 11.67N$

2-17

An object is being held up by two ropes, 120° apart from each other and 120° from the object. What is special about the tension on the ropes in this situation?

The tension on each is equal to the weight

$A_y = A\sin\theta$

$A_x = A\cos\theta$

2-18

If a girl is pulling on a sled rope with a force of 24N at an angle of 47° to the ground, find the horizontal and vertical components of her force.

$F_y = 24\sin(47) = 17.55N$

$F_x = 24\cos(47) = 16.37N$

3-1

Dynamics is the study of forces affecting objects that are in Motion.

In one word, describe Newton's First Law of Motion Inertia.

3-2

An object that has no net force acting on it may be at equilibrium, or may be moving at constant velocity.

If there is an unbalanced force, the object will accelerate.

3-3

What will be the acceleration resulting from a 6.7N force acting on a 8 kg mass?

$F_{net} = ma$

$6.7N = 8kg(a)$

$a = .838 m/s^2$

3-4

What force is needed to accelerate a 345 kg object at 2.3 m/s^2 ?

$F_{net} = ma$

$F_{net} = 345kg(2.3 m/s^2)$

$F_{net} = 793.5N$

3-5

By definition, one Newton =

$1\ kgM/s^2$

3-6

If you weigh 100N and sit on a chair, with what force is the chair pushing on you?

100N

3-7

What's the difference between mass and weight?

Mass is the amount of matter
Weight is the one that matter is accelerating

As an object travels from Earth to the Moon, what happens to the objects mass and weight?

Mass = remains the same
Weight decreases bc "g" is less on the moon

3-8

What is the weight of an 18.4 kg object?

$F_g = mg$ $F_g = 18.4\,kg(9.81\,m/s^2)$
$F_g = 180.5N$

What is the mass of a 34N object?

$F_g = mg$ $34N = m(9.81\,m/s^2)$
$m = 3.5\,kg$

3-9

If two objects of 36 kg and 24 kg are accelerated with equal forces, which will have the greater acceleration?

$F_{net} = ma$
the 24 kg object

3-10

If two objects of different mass are dropped from a window, how does the force of gravity on each compare?

How do their accelerations compare?

their accelerations are the same but their forces are proportional to whatever their masses are

3-11

Is force a vector or scalar quantity?

VECTOR

Is mass a vector or a scalar?

Scalar

Is weight a vector or a scalar?

Vector

3-12

If a 67 kg person weighs 300 N on a different planet, what is the gravitational acceleration on that planet?

$F_g = mg$
$300N = 67kg(g)$
$g = 4.48\,m/s^2$

4-1

What are the two types of friction and how do their magnitudes compare?

Static = start moving (Bigger)
Kinetic: already moving

4-2

What is the normal force?

$F_{surface}$

4-3

How does the magnitude and direction of the normal force compare to the magnitude and direction of an object's weight?

Normally equal in Magnitude opp. in direction

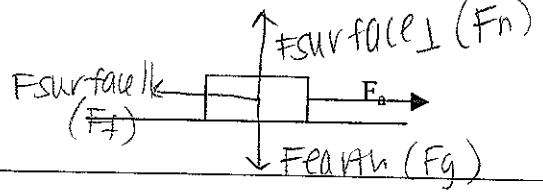
4-4

How does the direction of the frictional force compare to the direction of the applied force?

Opposite direction

4-5

If F_a is the applied force, draw and label the other three forces:



4-6

The frictional force can be less than or equal to the applied force, but never greater than it.

4-7

What is the coefficient of friction?

mu

What is its symbol?

μ

4-8

If an applied force of 6.2 N keeps an object moving at a constant velocity, what is the frictional force?

Fnet = 0N

6.2N

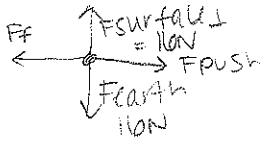
4-9

What's the formula used to find the frictional force when the weight and the coefficient of friction are known?

$F_f = \mu(F_n)$

4-10

If a 16 N object has a coefficient of friction of .23 with a tabletop, what is the frictional force?



$F_f = \mu F_n$

$F_f = .23(16N)$

$F_f = 3.68N$

4-11

In 4-10, if a force of 5.0 N is applied, what will be the net force?

$F_{net\,x} = F_{push} + F_f = ma$

$F_{net\,y} = 5N + -3.68N$

$F_{net\,x} = 1.32N$

$F_g = mg$

$16N = m(9.81 m/s^2)$

$m = 1.63kg$

4-12

In 4-11, what will be the resulting acceleration of the object?

$F_{net} = ma$

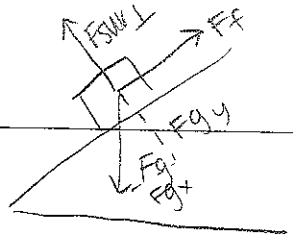
$1.32N = 1.63kg(a)$

$a = .809$

4-13

If a box is sitting on a ramp and not sliding down, the frictional force must be equal to the parallel force.

(perpendicular or parallel?)



4-14

An applied force of 4.7 N is needed to keep a wooden object moving at constant velocity across a wooden floor. What is the weight of the object?

wood/wood

$\mu = .3$

$F_f = \mu F_n$

$4.7n = .3(F_n)$

$F_n = 15.7N$

$F_n = F_g$ bc $F_{net\,y} = 0N$ (constant V)

$F_g = 15.7N$

5-1

What is the symbol for momentum?

P

What are the units?

kgm/s

What is momentum?

Mass · Velocity

5-2

What is the momentum of a 13.8 kg object moving at 6.0 m/s?

$p = mv$

$p = 13.8\,kg(6\,m/s)$

$p = 82.8\,kgm/s$

5-3

One 4 kg object moving at 3 m/s strikes an 8 kg object and stps (transfers all of its energy to the 8 kg object). How fast will the 8 kg object travel?

$P_b = P_a$

$P = mv$

$14kg(3m/s)$	$4kg(0m/s)$
$28kg/0m/s)$	$8kg(x)$

t $\frac{12kgm}{s} = 8x$ $x = 1.5m/s$

5-4

What is the symbol for impulse?

J

What are the units for impulse?

NS

What is impulse?

Force applied over time to change the momentum

5-5

If a force of 15 N is applied for 3 s, what is the impulse produced?

$J = Ft$

$J = 15N(3s)$

$J = 45NS$

5-6

A force of 9 N applied for 5 s to a 7 kg object will cause what change in the object's velocity?

$J = Ft = \Delta P = m(\Delta V)$

$Ft = m(\Delta V)$

$9N(5s) = 7kg(\Delta V)$ $\Delta V = 6.4\,m/s$

5-7

When a rifle is fired, how does the momentum of the bullet compare to the momentum of the rifle?

equal but opposite

5-8

If a 50 kg skater moving at 3.5 m/s strikes a 100kg skater at rest, and they cling together, what will be the velocity of the pair?

$P_b = P_a$

$P = mv$

1	$50kg(3.5m/s)$	$150kg(v)$
2	$100kg(0m/s)$	$100kg(v)$
t	$175kgm/s$	$150(v)$

$v = 1.167\,m/s$

5-9

*Need a mass to complete!

If someone standing on a frictionless surface throws a 6.2 kg ball at 7.8 m/s, with what speed will that person go backwards?

$P_{before} = P_{after}$

ball	$6.2kg(0)$	$6.2kg(7.8m/s)$
Man	$m(0)$	$m(-x)$

t $\frac{0kgm}{s} = 48.36 - mx$

$x = -\frac{48.36kgm/s}{Mass}$

5-10

If a 340. kg object traveling at 56 m/s collides head-on with a 170. kg going 112 m/s, what will be the result?

$p = mv$

$p = 340kg(50m/s)$

$P_1 = 19040\,\frac{kgm}{s}$

$P = mv$

$P = 170kg(-112m/s)$

$P_2 = -19040\,\frac{kgm}{s}$

$P_f = 0m/s(kg)$

6-1

What is the gravitational constant? $6.67 \times 10^{-11}\ Nm^2/kg^2$

What is its symbol? G

What are its units? Nm^2/kg^2

6-2

How do changes in two objects' masses affect the gravitational force between them?

$F_g = \frac{Gm_1m_2}{r^2}$, greater mass greater Force (proportional ↑ to mass ↑)

6-3

How do changes in the distance between two objects Affect the gravitational force between them?

$F_g = \frac{Gm_1m_2}{r^2}$ decrease the force by a squared value (ex doubler, quarter Fg)

6-4

6-4 If object A has a gravitational force of X on object B, and object B's mass is twice that of A, what will be the gravitational force that object B has on object A?

X (Equal but Opp. Forces)

6-5

If one object has a mass of 47.5 kg, and a second object has a mass of 67.9 kg, and they are 24m apart, what is the gravitational force of attraction between them?

$F_g = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11}\ \frac{Nm^2}{kg^2}(47.5kg)(67.9kg)}{(24m)^2} = 3.73 \times 10^{-10} N$

6-6

If one mass doubles the gravitational force becomes 2X what it was.

If the distance is doubled the gravitational force becomes $\frac{1}{4}$X what it was.

7-1

What is the symbol for work? W

What is the unit for work? N·M or J

What is work? a force applied over a distance or a change in total Energy of a system

7-2

What is the symbol for power? P

What is the unit for power? Watt or J/s

What is power? rate at which work is done

7-3

By definition, 1 Joule equals 1 NEWTON moving 1 meter, and 1 Watt equals 1 Joule of work being done in 1 second

7-4

The less time it takes to do a certain amount of work, the more power it takes.

$P = \frac{W}{t}$

7-5

If a 26N force moves an object 16m, how much work has been done?

$W = Fd$
$W = 26N(16m)$
$W = 416J$

7-6

$F_g = mg$
$F_g = 9.4kg(9.8m/s^2) = 92.2N$

How much work is done in lifting a 9.4 kg object 3.5 m upwards?

$W = Fd$
$W = 92.2N(3.5m) = 322.7J$

7-7

In 7-6, if this work was done in 4.7 s, what power was required?

$P = \frac{W}{t}$
$P = \frac{322.7J}{4.7s} = 68.7 \text{ Watts}$

7-8

If a bulldozer pushes against a building with 4.5 x 10^{15}N of force for 52 s, but the building didn't move, how much work was done?

0 J

8-1

KE = moving energy

What's the difference between potential and kinetic energy?

Potential - ability to produce energy

What are some types of potential energy? (normally has a displacement)

gravitational, elastic

What are the units for energy?

Joule

8-2

What's the potential energy of a 22.6 kg object located 16.89m above the ground?

$PE = mgh$
$PE = 22.6kg(9.8m/s^2)(16.89m)$
$PE = 3744 \text{ J}$

8-3

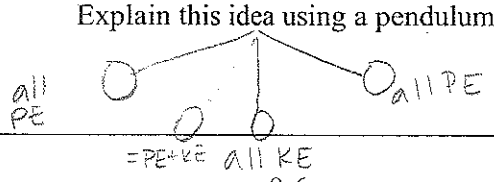
What's the kinetic energy of a 7.2 kg object that is moving at 8.4 m/s?

$KE = \frac{1}{2}mv^2$
$KE = \frac{1}{2}(7.2kg)(8.4m/s)^2$
$KE = 254 \text{ J}$

8-4

In any system, the loss or gain of potential energy equals the loss or gain of kinetic energy.

Explain this idea using a pendulum.



8-5

The potential energy plus the kinetic energy equals the total mechanical energy of the system. This energy, plus any heat energy (symbolized by Q) equals the total energy of the system.

8-6

What is the difference between a conservative force and a nonconservative force?

conservative: Not path dependent
nonconservative: path matters

8-7

If a 15 kg object falls 6.3 m, what will be its loss of potential energy?

$PE = mgh$ $PE = 15kg(9.81 m/s^2)(6.3m)$ $PE = 927J$

What will be its gain in kinetic energy? 927J

PE is converted to KE at bottom of 8-9 Fall

8-8

In 8-7, how fast will the object be traveling at the end of those 6.3 m? (solve this two different ways)

$KE = \frac{1}{2}mv^2$ $927J = \frac{1}{2}(15kg)(v^2)$ $v = 11.12 m/s$

$v_i = 0 m/s$ $a = 9.81 m/s^2$ $d = 6.3m$ $v_f = ?$

$v_f^2 = v_i^2 + 2ad$ $v_f^2 = (0 m/s)^2 + 2(9.81 \frac{m}{s^2})(6.3m)$ $v_f = 11.12 m/s$

8-9 Fall

What is potential elastic energy?

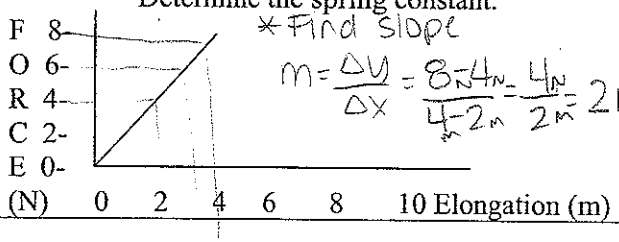
energy stored in a spring

What is the spring constant?

K

8-10

Determine the spring constant:



*Find slope

$m = \frac{\Delta y}{\Delta x} = \frac{8N - 4N}{4m - 2m} = \frac{4N}{2m} = 2 N/m$

8-11

If a spring is stretched .03 m by a force of .14 N, what is the spring constant?

$F = kx$ $.14N = .03m(k)$ $k = 4.67 N/m$

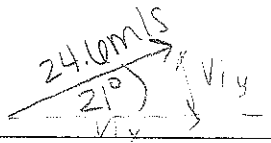
8-12

What is the potential energy stored in a spring that is stretched .43 m (k=1.38 N/m)?

$PE_s = \frac{1}{2}kx^2$ $PE_s = \frac{1}{2}(1.38 N/m)(.43m)^2$ $PE_s = .128J$

9-1

What is the horizontal velocity component of a golf ball launched at 21° and at an initial velocity of 24.6 m/s?



$V_{ix} = \cos 21 (24.6 m/s)$ $V_{ix} = 22.9 m/s$

9-2

In 9-1, what is the initial vertical component of the ball's velocity?

$V_{iy} = 24.6 \frac{m}{s} \sin(21)$ $V_{iy} = 8.82 m/s$

9-3

In 9-2, how long will it take the ball to reach the top of its trajectory?

V_{ix}	V_{fx}	$\bar{V}_x$	a_x	d_x	t	V_{iy}	V_{fy}	$\bar{V}_y$	a_y	d_y
22.9 m/s →			0 m/s	20.38 m	.9s	8.82 m/s	0 m/s		$-9.81 m/s^2$	
↓			0 m/s		.9s	0 m/s	8.82 m/s		$+9.81 m/s^2$	

$V_{fy} = V_{iy} + a_y t$ $0 m/s = 8.82 m/s + -9.81 m/s^2 (t)$ $t = .9s$

9-4

$t_u = t_d$

In 9-3, how long will the ball stay in the air?

$t_t = .9s + .9s = 1.8s$

How far will it go?

$\bar{V}_x = \frac{d_x}{t}$ $22.9 m/s = \frac{d_x}{.9s}$ $d_{xu} = 20.61$

So total $d_x = 41.22m$

$\bar{V}_y = \frac{V_f + V_i}{2} = \frac{8.82 + 0 m/s}{2} = 4.41 m/s$

9-5

In 9-3, how high will the ball go?

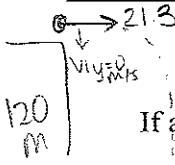
$\bar{V}_y = \frac{d_y}{t}$

$4.41 m/s = \frac{d_y}{.95}$ $d_y = 3.97 m$

9-6

When an object is thrown horizontally off a cliff at the same time another object is dropped from the cliff, which object will hit the ground first?

they will hit at the same time



9-7

$d = V_i t + \frac{1}{2} a t^2$ $120m = 0 m/s(t) + \frac{1}{2}(9.81 m/s^2)(t^2)$

If an object is thrown horizontally from a 120m high cliff with an initial velocity of 21.3 m/s, how long will it take to reach the bottom?

$t = 4.94 s$

$V_{ix} = 21.3 m/s$

9-8

In 9-7, how far from the base of the cliff will it land?

$\bar{V}_x = \frac{d_x}{t}$

$21.3 m/s = \frac{d_x}{4.94 s}$ $d_x = 105.22 m$

V_{ix}	V_{fx}	$\bar{V}_x$	a_x	d_x	t	V_{iy}	V_{fy}	$\bar{V}_y$	a_y	d_y
21.3 m/s			0 m/s²			0 m/s			9.81 m/s²	120 m

9-9

If an object takes 2.78 s to reach the bottom when thrown horizontally at 5.6 m/s off a cliff, how high is the cliff?

$t = 2.78 s$

$V_{ix} = 5.6 m/s$

$d_y = ?$

$V_{iy} = 0 m/s$

$a_y = 9.81 m/s^2$

$d_y = V_i t + \frac{1}{2} a_y t^2$

$d_y = 0 m/s(2.78 s) + \frac{1}{2}(9.81 \frac{m}{s^2})(2.78 s)^2$

$d_y = 37.9 m$

9-10

Describe centripetal force:

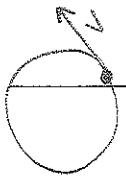
The force that keeps an object moving around a circular track directed inward

9-11

What is the symbol for centripetal force?

F_c

If the centripetal force is removed from an object in circular motion, the object will move in what direction?



tangent to the circle's velocity

9-12

Both centripetal force and centripetal acceleration act in which direction?

towards the middle of the circle

Besides centripetal force, what other force keeps an object in circular motion?

Inertia

when something is in orbit $F_c = F_g$

9-13

What is the centripetal acceleration on a bicyclist going around a curve (radius=20.m) at 6.7 m/s?

$F_c = ma_c$ $a_c = \frac{v^2}{r}$

$a_c = \frac{(6.7 m/s)^2}{20 m}$

$a = 2.24 m/s^2$

9-14

What's the centripetal force on a 95 kg object moving at 5.4 m/s around another object 7.7 m away?

$F_c = \frac{mv^2}{r} = \frac{95 kg (5.4 m/s)^2}{7.7 m}$

$= 359.8 N$

10-1

When an atom is neutral (not an ion), the number of electrons is equal the number of protons.

10-2

An atom or material that loses electrons becomes + charged, while an atom or material that gains electrons becomes − charged.
An electron or proton carries one elementary charge.

$e^- = -1.6\times10^{-19}$ C $1p^+ = +1.6\times10^{-19}$ C

10-3

An elementary charge is equal to 1.6×10^{-19} C

A coulomb is equal to 6.25×10^{18} elementary charges

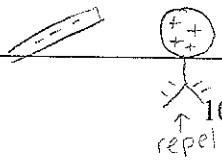
10-4

Objects can become charged (gain or lose electrons) due to Friction.
Two like-charged objects will repell, while oppositely charged objects will attract.
A charged object and a neutral object will also usually attract.

10-5

When a negatively charged rod is brought near a neutral electroscope, what happens and why?

the leaves split because it becomes polarized



10-6

In 10-5, this is called charging by Induction

10-7

An object which is capable of donating or accepting a large number of electrons is called an electrical ground. What's the major example? earth
If a negatively charged object is grounded,, what will happen? it will become neutral all excess charge will be removed and go into larger object

10-8

What is the law of conservation of charge?
charge cannot be created or destroyed
If two spheres, one having +5C and the other –9C, touch, when moved apart, each sphere will have a charge of $\frac{+5c + -9c}{2} = -2C$

10-9

An object that has 1.34×10^{16} extra electrons will have a charge of 2.14×10^{-3} C

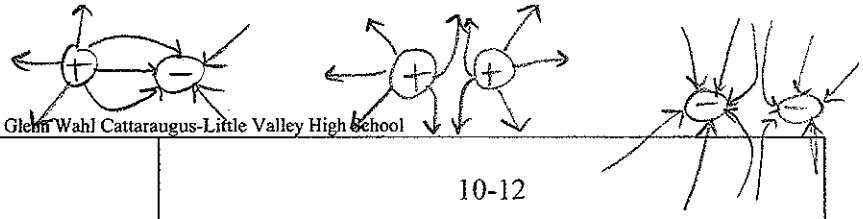
$1.34\times10^{16}\ e \cdot \frac{1.6\times10^{-19}\ C}{1\ e}$

10-10

As the distance between two charged objects triples, the electrostatic force between them decrease by 1/9

$F_e = \frac{k q_1 q_2}{r^2}$

$F_e = \frac{k q q}{(3r)^2} = \frac{1}{9}$



10-11

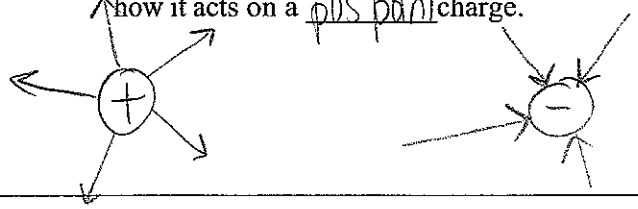
What is the force between two objects, each having a charge of 0.40C, if they are 14m apart?

$F_e = \frac{Kq_1q_2}{r^2} = \frac{8.99\times10^9 \frac{Nm^2}{C^2}(.4C)(.4C)}{(14m)^2}$

$= 7.34\times10^{6}$ N

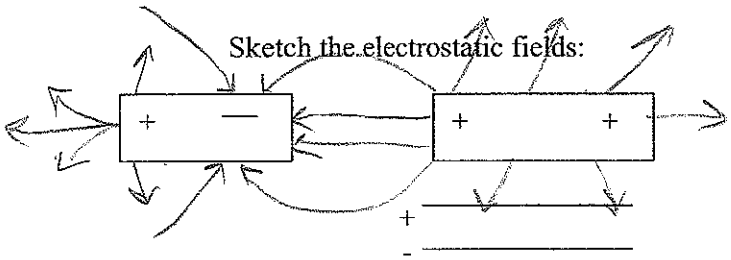
10-12

An electric field's direction is described according to how it acts on a pos part charge.



10-13

Sketch the electrostatic fields:



10-14

What is the field intensity if an object with a charge of 0.60 C is acted on by an electric force of 3.0×10^{-3} N?

$E = \frac{F_e}{q}$ $E = \frac{3\times10^{-3}N}{.6C} = 5\times10^{-3}$ N/C

10-15

The work needed to move a charged particle from one place to another within an electric field is known as the potential difference.

10-16

The unit of potential difference is the volt, represented by V.
Since this is often too large when dealing with charges, the electron volt represented by eV, and equal to 1.6×10^{-19} J is used.

11-1

The unit which describes electric current in terms of how much charge passes a given point in a conductor is called the ampere, which is represented by A. The meter used to measure this is called an Ameter, and is always connected in series.

11-2

If 140C of charge passes a spot in a wire in 7.0 s, how many amperes of current is the wire carrying?

$I = \frac{\Delta q}{t} = \frac{140C}{7S} = 20A$

11-3

In order for current to flow in a wire there must be a complete circuit, and a source of potential difference, or voltage.
The meter used to measure this is a voltmeter which is always connected in parallel.

11-4

What is the schematic symbol for:

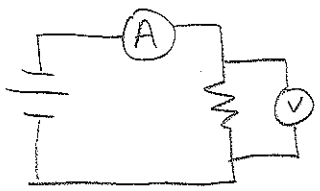
A battery (cell)? ⊣⊢

(V) A voltmeter?

An ammeter (A)

A resistor? ⏦

A switch? ⏜



11-5

Metals and other materials with many free electrons are called CONDUCTORS, because they allow current to pass easily. Things that don't allow current to pass easily, like glass, rubber, and plastic, are called INSULATORS.

11-6

The measurement of how easily current flows through a conductor is called resistance, measured in Ohms, and represented by Ω.

11-7

How much current is carried by a conductor that has a resistance of 20. Ω when there is a potential difference of 200.V ?

$R = \frac{V}{I}$ $20\Omega = \frac{200V}{I}$ $I = 10A$

$R = \frac{\rho L}{A}$

11-8

Generally, resistance decreases when a conductor's length decreases, diameter increases, and temperature decreases.

The term used to describe the material's inherent conductivity is Resistivity.

11-9

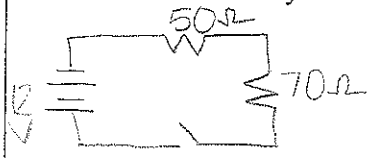
What is the resistance of a 3.50 m length of aluminum wire that has a diameter of 4.0×10^{-3}m and is at 20°C?

$R = \frac{\rho L}{A} = \frac{2.82 \times 10^{-8}\Omega m\,(3.5m)}{1.3 \times 10^{-5} m^2}$

$7.0 \times 10^{-3}\Omega$

11-10

Sketch a series circuit that has two resistors of 50.Ω and 70.Ω and a battery of 12V, along with a switch.



11-11

In 11-10, what is the total resistance?

$R_{eq} = R_1 + R_2$

$R_{eq} = 50\Omega + 70\Omega = 120\Omega$

11-12

In 11-10, what is the total current?

$V = IR$

$12V = I(120\Omega)$

$I = .1A$

11-13

In 11-10, what is the voltage across the 50.Ω resistor?

$V = IR$

$V = .1A(50\Omega)$

$V = 5V$

11-14

Sketch a parallel circuit with the same components as in 11-10.

11-15

In 11-14, what is the total resistance?

$\frac{1}{Req} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{Req} = \frac{1}{50\Omega} + \frac{1}{70\Omega}$.

$\frac{1}{Req} = .0343\frac{1}{\Omega}$ $Req = 29.2\Omega$

11-16

In 11-14, what is the total amperage?

$V = IR$

$12V = I(29.2\Omega)$

$I = .411A$

11-17

In 11-14, what is the current through the 50Ω resistor?

$V = IR$

$12V = I(50\Omega)$

$I = .24A$

11-18

In parallel circuits, the total resistance is always LESS than the smallest resistor.

11-19

The unit of electrical power is the Watt, symbolized by W. To find the power, multiply the voltage times the current.

11-20

If a hair dryer is rated at 120V and 10a, what is its power usage?

$P = VI$

$P = 120V(10A) = 1200W$

11-21

The power used through time is found by multiplying the power times the time. The unit is the Joules. This is the electrical energy.

11-22

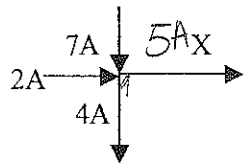
If a 600.W amplifier is used for 20.s, what's the electrical energy used?

$P = Wt$

$P = 600W(20s) = 12000J$

11-23

What is the current through conductor X?



11-24

If three lightbulbs are hooked in series to a battery, the brightness of each is dim compared to the brightness of one lightbulb hooked up to the same battery.

12-1

If a material has electrons that are aligned with each other, that material is Magnetic.
It will have two poles called North and South.
A magnetic field surrounds any charged object in motion.

12-2

Two like poles of magnets will repel, while two unlike poles will attract.
Since the North end of a magnet points towards Earth's North Pole, Earth's North Pole must really be a South magnetic pole.

12-3

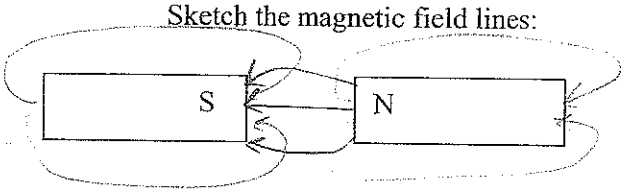
The field intensity of a magnetic field is measured by the force it exerts on a current in the field. The lines of magnetic fields are known as magnetic flux lines.

12-4

Magnetic field lines by convention go from the North pole to the South pole.

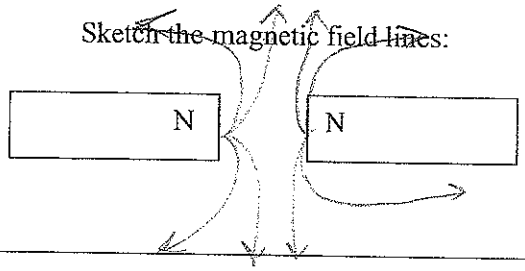
12-5

Sketch the magnetic field lines:



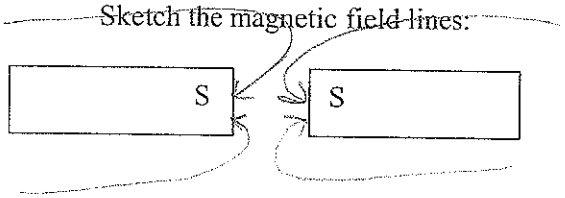
12-6

Sketch the magnetic field lines:



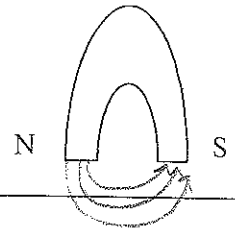
12-7

Sketch the magnetic field lines:



12-8

Sketch the magnetic field lines:



12-9

When a conductor cuts magnetic field lines, a potential difference is generated in the conductor. If the conductor is part of a complete circuit, a current will be induced.

12-10

The greater the number of field lines a conductor cuts, the greater will be the voltage produced.

13-1

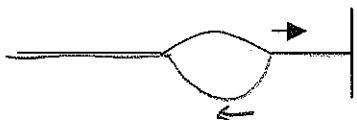
A vibratory disturbance that moves through a material (medium) or empty space is called a wave. Give four examples:

- light (visible)
- radio wave
- IR
- Gamma Ray

13-2

A single vibration is a pulse.

Sketch its reflection when it hits a barrier:



13-3

What is a longitudinal wave and what are two examples?

A wave that vibrates parallel to its velocity - this is a sound wave it requires a medium to travel through

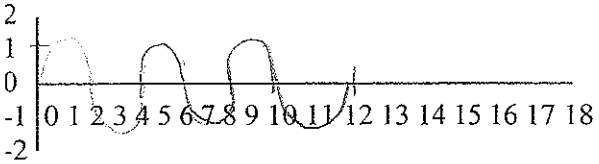
13-4

What is a transverse wave and what are two examples?

A wave that vibrates perpendicular to the velocity, all Electromagnetic waves can travel through a vacuum

13-5

Sketch three cycles of a wave that has a wavelength of 4m and an amplitude of 1m



13-6

If the wave in 13-5 is moving at 8 m/s, what is its frequency?

$V = f\lambda$

$8\,m/s = f(4m)$

$f = 2\,Hz$

13-7

The units for frequency are Hertz and 1/s. The time it takes for one wave cycle to go by is called the period, which has as its unit, the second.

13-8

What is the period of a wave that has a frequency of 100. cps?

cps = crests per second = 1/s

$T = 1/f$

$T = 1/100\,Hz$ $T = .01s$

13-9

The "top" of the wave is called the crest, and the "bottom" is called the trough.

13-10

If the frequency of a wave is 43 Hz and its wavelength is 5.4 m, what is its speed?

$V = f\lambda$

$V = 43\,Hz(5.4m)$

$V = 232.2\,m/s$

13-11

Frequency is symbolized by f.
Wavelength is symbolized by λ.
If the speed stays the same, as the wavelength increases, the frequency must decrease.

$V = f \downarrow \lambda \uparrow$

13-12

All points on a wave that are in phase make up a wave FRONT.
Waves transfer energy, not matter.

13-13

If a wave-making object is moving away from an observer, the perceived frequency is lower than it really is. This is called the doppler effect.

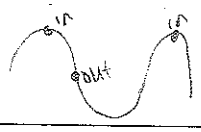
13-14

Because the light from stars is shifted toward the red end of the spectrum, we know that the stars are moving away from us.

Red = low f

13-15

When two waves are in phase, their combined amplitude will be greater than each one singly. This is called constructive Interference.



13-16

When two waves are out of phase, their combined amplitude will be smaller than each singly. This is called destructive interference.

13-17

Nodes form at points of maximum destructive interference, where the waves are an odd number of half-wavelengths apart, and antinodes form at points of maximum constructive interference, where the waves are an even number of half-wavelengths apart.

13-18

When two waves of the same amplitude and frequency travel in opposite directions (often from a wave reflecting back on itself), a standing wave is formed. This is also known as resonance.

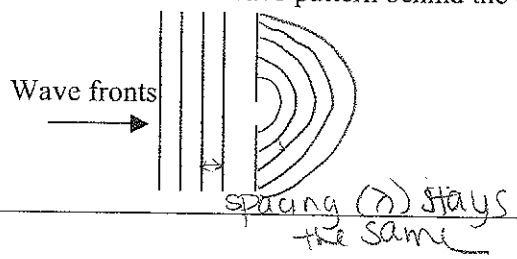
Give three examples:
guitar strings, string, tuning fork

13-19

When waves bend around corners or propagate behind a slit, this is called diffraction.

13-20

Sketch the wave pattern behind the slit:



14-1

The speed of light in a vacuum is 3×10^8 m/s, and is represented by C.

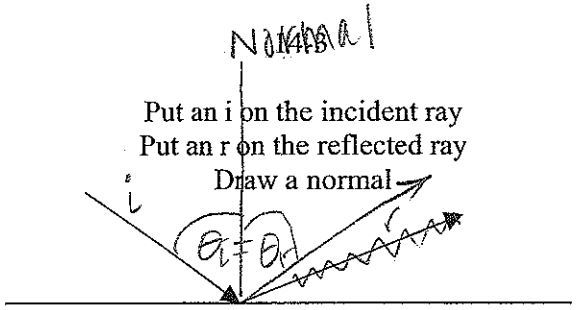
14-2

What's the frequency of a light beam that has a wavelength of 4.5×10^{-7} m?

$v = f\lambda$

$3 \times 10^8 \text{ m/s} = f(4.5 \times 10^{-7} \text{ m})$

$f = 6.6 \times 10^{14} \text{ Hz}$



Put an i on the incident ray
Put an r on the reflected ray
Draw a normal

14-4

On 14-3, label the angle of incidence and the angle of reflection.
How do these two angles compare?

$\theta_i = \theta_r$

14-5

Mirrors show regular reflection while this paper shows diffused reflection.

Images seen in a mirror are called virtual images.

14-6

When light enters a new medium at an angle, the wave fronts will be bent. This is called refraction.

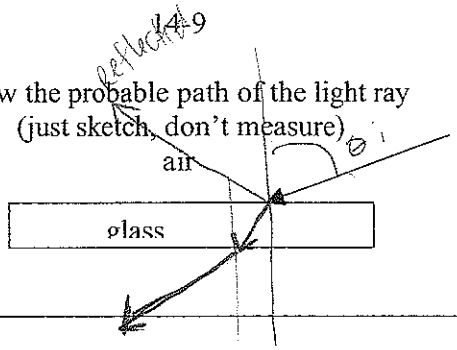
14-7

The ratio of the speed of light in a vacuum to the speed of light in a medium is called that medium's absolute index of refraction.
It's represented by n

14-8

When light enters a medium that has a higher index of refraction, it will bend towards the normal. When it enters a medium with a lower index of refraction, it will bend away the normal.

14-9



Show the probable path of the light ray (just sketch, don't measure)

14-10

If the speed of light in a certain medium is 2.3×10^8 m/s, what is that medium's index of refraction?

$n = \frac{c}{v}$

$n = \frac{3 \times 10^8 \text{ m/s}}{2.3 \times 10^8 \text{ m/s}} = 1.3$

14-11

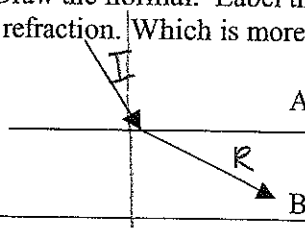
If a medium has an index of refraction of 2.4, what will be the angle of refraction from air if the angle of incidence is 25° ?

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1\sin(24) = 2.4\sin\theta \quad \theta = 9.76°$

14-12

Draw the normal. Label the angles of incidence and refraction. Which is more optically dense, A or B?



A more dense
B less dense
this is bc R bends away so its moving faster

14-13

Visible light makes up one part of the

Electromagnetic Spectrum

14-14

What is the approximate frequency of yellow light?

5.03×10^{14} Hz to 5.2×10^{14} Hz

15-1

List three examples which demonstrate ER (electromagnetic radiation) acting like a wave:

-Diffraction
-Interference -polarization
-Refraction

15-2

Name one example which shows ER behaving like a particle:

-photoelectric effect
-black body radiation

15-3

Briefly describe the photoelectric effect:

When light hits photoemissive material (metal) electrons will be given off if at a high enough frequency

15-4

Quantum theory describes ER in discrete amounts called photons. The energy of each photon of light increases with increasing frequency. The equation used to find this uses Planck's constant, represented by h and equal to 6.63×10^{-34} J·S.

15-5

At the atomic level, ER and matter both exhibit characteristics of waves and particles.

15-6

When atoms are excited, electrons can jump to higher Energy levels from their ground state. When they jump back down, light (photons) is emitted.

15-7

What is the color of the light emitted from a hydrogen atom when its electron drops from the n=5 to the n=2 level?

$E_{photon} = E_i - E_f$

$= -.54\ eV + 3.4\ eV = 2.86\ eV$

$2.86\ eV \cdot \frac{1.60 \times 10^{-19}\ J}{1\ eV} = 4.58 \times 10^{-19}\ J$

$E = hf$

$4.58 \times 10^{-19}\ J = 6.63 \times 10^{-34}\ J\cdot s\ (f)$

$f = 6.9 \times 10^{14}\ Hz$ purple

15-8

Each element will have certain emissions based on the possible energy level changes of its electrons. This causes each element to have a characteristic emission spectra or bright line spectra.

15-9

The structure of the atom is now known to include protons and neutrons (collectively known as nucleons), which are located in the nucleus. What keeps the protons from pushing each other apart?

strong force

15-10

The equivalency of mass and energy was described by Einstein in his equation:

$E=mc^2$

What is the energy produced when 2.3 kg of mass is converted to energy?

$E = mc^2 \quad E = 2.3\ kg\ (3 \times 10^8\ m/s)^2$

$E = 2.07 \times 10^{17}\ J$

15-11

What are the four fundamental forces, in order of strength?

- strong
- Electromagnetic
- weak
- gravity

15-12

The smallest particle known is the quark. These are found in six varieties, called up, down, charm, strange, top, & bottom.

Quarks have charges of either +/- 1/2 or +/- 2/3, and so can be combined to make various other particles.

15-13

Since all particles have antiparticles, there are also antiquarks.

15-14

A baryon is a type of hadron. It is made of three quarks.

Give one example of a Lepton: electron.

PRT-1

k represents the spring constant, but also is used to represent the electrostatic constant

Which is $8.99 \times 10^9\ \frac{N m^2}{C^2}$.

PRT-2

How fast does sound travel in air? $3.31 \times 10^2\ m/s$. Expressed in millimeters per second, it's _____, and expressed in picometers per second, it's _____

$3.31 \times 10^2\ \frac{m}{s} \cdot \frac{1\ mm}{1 \times 10^{-3}\ m} = 3.3 \times 10^5\ mm/s$

$3.31 \times 10^2\ m/s \cdot \frac{1\ pm}{1 \times 10^{-12}\ m} = 3.31 \times 10^{14}\ pm/s$

PRT-3

What is the mass of one proton?
1amu or 1.67×10^{-27} kg

What would this be in micrograms?
$1.6 \times 10^{-27}\ kg \cdot \frac{1 \times 10^{3}\ g}{1\ kg} \cdot \frac{1\ \mu g}{1 \times 10^{-6}\ g} = 1.67 \times 10^{-18}\ \mu g$

PRT-4

To change gigaseconds into nanoseconds, ÷ by ×.

$1\ Gs \cdot \frac{1 \times 10^{9}\ s}{1\ Gs} \cdot \frac{1\ ns}{1 \times 10^{-9}\ s} = 1 \times 10^{18}\ ns$

PRT-5

The acceleration due to gravity on Earth is:
$9.8\ m/s^2$.

PRT-6

The kinetic friction coefficient between rubber on wet asphalt is .53. This is the same coefficient as the starting friction coefficient between copper and steel (static)

PRT-7

TV waves have wavelengths of about
$1 \times 10^{1}\ m$

PRT-8

Which has the higher frequency?
ultraviolet or infrared?

UV

PRT-9

Corn oil has an index of refraction that is the same as glycerol = 1.47
Which listed material will bend light the most?
a diamond

PRT-10

In a series circuit, the current stays constant throughout the circuit, whereas in a parallel circuit, the voltage stays constant.

PRT-11

The electrostatic force on a particle divided by the charge of the particle gives the Electric Field Strength

$E = \frac{F}{q}$

PRT-12

Which listed conductor has the lowest resistivity?

Silver $1.59 \times 10^{-8}\ \Omega m$

PRT-13

What is the schematic symbol for a volume control (variable resistor)?

PRT-14

The frequency is inversely proportional to the period of a wave.

PRT-15

The energy of an emitted photon will equal the difference between the initial level the electron is on and the final level.

PRT-16

To find the ~~frequency~~ energy of an emitted photon of light, multiply the velocity (c) times plancks constant and divide by wavelength.

$E = \frac{hc}{\lambda}$

PRT-17

To find the cross-sectional area of a conductor, take the diameter and divide by 2 then square the radius and multiply by π

$r = \frac{1}{2}d$ $A = \pi r^2$

PRT-18

If you know the initial angle and speed of a kicked soccer ball, you can find the initial vertical component of the speed by $A_y = A \sin\theta$

PRT-19

What equation would you use if you know the distance an object accelerated and you want to find the final velocity?

$V_f^2 = V_i^2 + 2ad$ or

$\bar{V} = d/t$ $\bar{V} = \frac{V_f + V_i}{2}$

PRT-20

The momentum of a system before an event equals the momentum of a system after the event.

PRT-21

The change in momentum of an object is called the impulse, and can be found by multiplying the applied force times the time.

PRT-22

The total energy of an object equals the sum of its potential energy, kinetic energy, and heat or internal energy (U).

(now go back through these 250 cards until you've mastered them!- Best wishes on the Regents!)