THE KNOX SCHOOL

Physics

2020 Summer Assignment

Directions: This assignment is in preparation for Physics next year.

Due Date: First day of your Physics class.

WEEK 1

(I) Vocabulary - Define each term below:

(1) Scientific Method

(2) Hypothesis

(3) Theory

(II) Data Inference - For the data below, determine the minimum, maximum, and average value of each pair of values in each row.

Table 4.2 Coefficients of Friction[a]

	μ_s	μ_k
Steel on steel	0.74	0.57
Aluminum on steel	0.61	0.47
Copper on steel	0.53	0.36
Rubber on concrete	1.0	0.8
Wood on wood	0.25–0.5	0.2
Glass on glass	0.94	0.4
Waxed wood on wet snow	0.14	0.1
Waxed wood on dry snow	—	0.04
Metal on metal (lubricated)	0.15	0.06
Ice on ice	0.1	0.03
Teflon on Teflon	0.04	0.04
Synovial joints in humans	0.01	0.003

[a]All values are approximate.

(Disregard “Wood on wood” and “Waxed wood on wet snow.”)

(III) Reading - Read the following and give 5 examples of the two types of motion:

"*Two types of circular motion are rotation and revolution. When an object turns about an internal axis—that is, an axis located within the body of the object—the motion is called rotation, or spin. Both the Ferris wheel and the skater rotate. When an object turns about an external axis, the motion is called revolution. Although the Ferris wheel rotates, the riders revolve about its axis. Earth undergoes both types of rotational motion. It revolves around the sun once every 3651 4 days,10.1.1 and it rotates around an axis passing through its geographical poles once every 24 hours.*"

WEEK 2

(I) Vocabulary - Compare each pair of terms below:

(1) Distance / Displacement

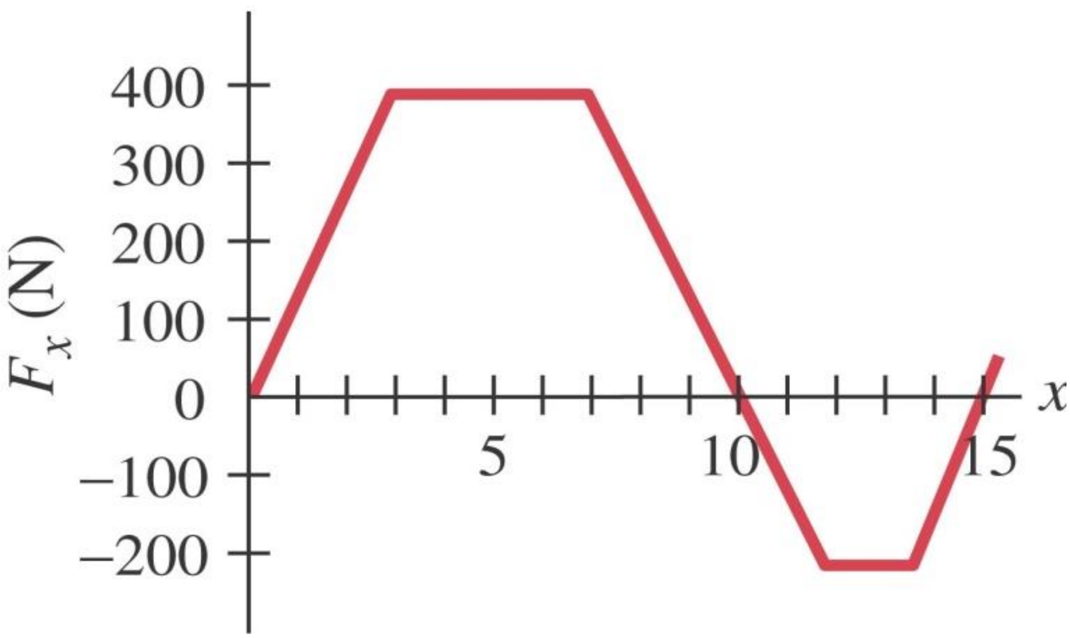
(2) Speed / Velocity

(II) Data Inference :

(1) Find the slope of the plot from t=0 to t=3 sec.

(2) Find the slope of the plot from t =3 to t = 7 sec.

(3) Find the Area under the plot from t= 0 to t = 10 sec.



(III) Reading - Read the following and define 2 physical quantities that are central topics in the article:

https://www.sciencedaily.com/releases/2020/04/200424150738.htm

WEEK 3

(I) Vocabulary - Define each term below:

(1) Force

(2) Vector

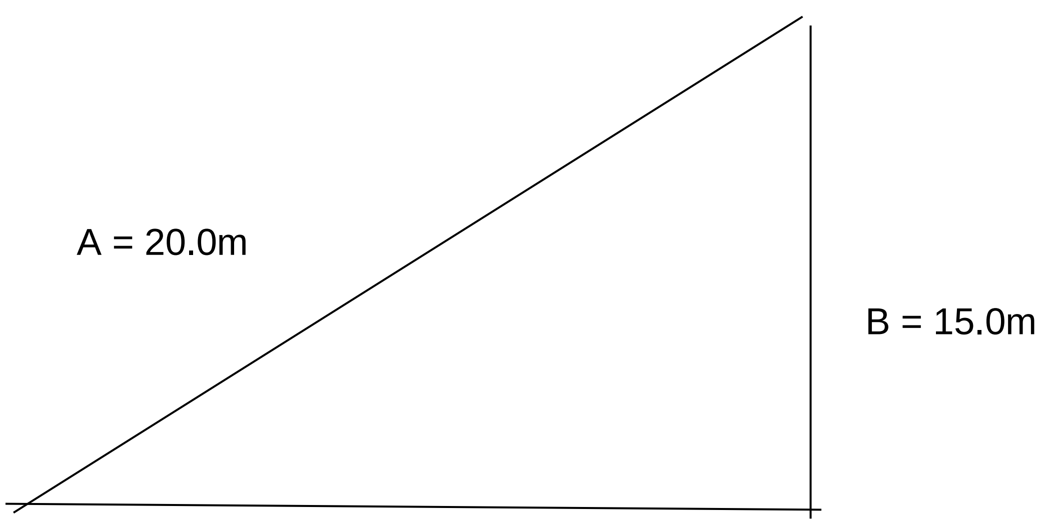
(3) Scalar

(4) Which of the following are scalars and which are vectors?:

Speed, velocity, distance, displacement, temperature, force, and time.

(II) Data Inference :

(1) Find all sides and angles in the Right Triangle below -



(2) Calculate the perimeter and the area of the above right triangle.

(III) Reading - Read the following:

https://openstax.org/books/college-physics/pages/1-2-physical-quantities-and-units#4132

Answer the following:

(1) How many centimeters are in 5.0 kilometers?

(2) How many seconds are in 1 day?

(3) If Density is equal to Mass / Volume, what is the density of a metal block having mass of 10. cg and sides equaling 10., 15., and 20. centimeters?

WEEK 4

(I) Vocabulary - Define each term below:

(1) Energy

(2) Work

(3) Power

(II and III) Data Inference and Reading:

Physical Properties

Physical properties are the characteristics of a substance that are called "observable." They are measurable, collectible information about substances that scientists can gather, record, and compare to previous recordings.

There are two kinds of physical properties: intensive properties and extensive properties. Intensive properties aren't dependent on the size or reach of the system. They also don't depend on the amount of the substance being measured. Extensive properties, on the other hand, show an additive relationship that builds with more matter.

Both intensive and extensive properties are usually only true when the amount of the sample and its divided amounts don't affect a physical or chemical process.

Examples of Physical Properties:

1. States of Matter
The boiling point, melting point, and freezing point of a substance would be considered to be a physical property. In addition, the substance's temperature would be a physical property. Also, as these properties don't change depending on the amount of the substance being tested, these would be considered intensive properties.
2. Units of Measurement
Some physical properties that can be measured for every substance include the mass, volume, density, area, elasticity, thermal conductivity, radioactive qualities, length, weight, solubility, and concentration. These properties would be considered extensive because the values would change depending on the amount present, with the exception of volume which will remain the same as the mass and volume values are changed.

Questions:

(1) If a block of material at 150 degrees Centigrade is cut in half, does each half have the same Temperature? Same Mass? Same Volume? Same Density?

(2) Temperature of the block increases at a constant rate from 0 to 150 degrees in 15 seconds. Plot Temperature (deg Centigrade) vs Time (sec) for this heating. Find the slope of this linear plot. Use correct units.

WEEK 5

(I) Vocabulary - Define each term below:

(1) Momentum

(2) Impulse

(3) Impulse-Momentum Theorem

(II) Data Inference / Computational Exercise: Solve the following 6 problems:

may use your calculator for any problems you choose, 4. The word *average* indicates arithmetic mean.

DO YOUR FIGURING HERE.

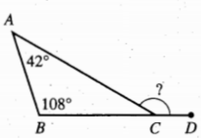
1. A calculator has a regular price of \$59.95 before taxes. It goes on sale at 20% below the regular price. Before taxes are added, what is the sale price of the calculator?

A. \$11.99
B. \$29.98
C. \$39.95
D. \$47.96
E. \$54.95

2. Given $r = 6$, $b = 4$, and $g = -9$, $(r + b - g)(b + g) = ?$

F. −95
G. −5
H. 5
J. 13
K. 14

3. In the figure below, C is on $\overline{BD}$, $\angle BAC$ measures 42°, and $\angle ABC$ measures 108°. What is the measure of $\angle ACD$?



A. 108°
B. 120°
C. 132°
D. 138°
E. 150°

4. If $\frac{3}{5}x + 10 = 17$, then $x = ?$

F. $-\frac{35}{3}$
G. $\frac{5}{3}$
H. $\frac{35}{3}$
J. $\frac{21}{5}$
K. 45

ACT-B02 14 **GO ON TO THE NEXT PAGE.**

#5) 6x^2 + 8x + 2 = 0 , Find the value of x.

#6) Find each angle to the nearest whole degree:

Sin A = 0.2678

Cos B = 0.1046

WEEK 6 and 7

(I) Solve the following:

1) Convert the following numbers to scientific notation: (a) 568017; (b) 0.000309.

2) At a horizontal distance of 45 m from the bottom of a tree, the angle of elevation to the top of the tree is 26 degrees. How tall is the tree?

3) Two points in a rectangular coordinate system have the coordinates (5.0, 3.0) and (-3.0, 4.0), where the units are centimeters. Determine the distance between the two points, in centimeters.

4) In a certain right triangle, the two sides that are perpendicular to each other are 5.00m and 7.00m long. What is the length of the third side of the triangle?

5) In problem #4 above, what is the tangent of the angle for which 5.00 m is the opposite side?

(II) Reading -

Read the following article entitled "Your Favorite Units". https://physicsworld.com/a/your-favourite-units/

Answer the following questions. Your answers should consist of a short paragraph. Answer the questions, concisely but completely.

1. Why do most scientists prefer using the S.I. system of units?

2. Give an example that illustrates the coherence of the S.I. system.

3. Despite the advantages of the S.I. system, why are non-S.I. units still used? Give an example.

4. Create your own unit. Use it to measure something and give the measurement in your unit.

WEEK 8 and 9:

Read the following article entitled "Up in the Air, and Down, With a Twist".

Answer the following questions. Your answers should consist of a short paragraph or diagram as indicated. Answer the questions, concisely but completely.

1. Describe the motion of Mr. Onge once he leaves the ski jump.

2. Draw a free-body diagram of the skier when he or she is skiing down the ramp. (ie, draw what you think are forces on the skier (weight, friction, etc..)

3. Draw a free-body diagram of the skier when he is in the air.

4. Why does the jumper's center of mass trace out a perfect parabola?

5. In your own, words, what is angular momentum?

UP IN THE AIR, AND DOWN, WITH A TWIST

February 2, 2010 By HENRY FOUNTAIN PARK CITY, Utah —

The first time you watch skiers hurtle off a curved ramp at 30 miles per hour, soaring six stories in the air while doing three back flips and up to five body twists, you can't help but think: These people are crazy.

Keep watching and you will quickly have second — and third — thoughts. You begin to notice how the skiers adjust their starting point on the inrun to reach the proper takeoff speed, how they practice odd arm movements, like giant Barbie dolls whose limbs are being manipulated by unseen hands.

Freestyle aerialists, as these athletes are known, are not actually throwing caution, along with themselves, to the winds. It is not fate that plops them down at the end of their jumps, more or less upright and safe, in a cloud of powdery snow. ***It is physics, and plenty of preparation.***

Aerials, in which skiers are judged on how stylishly they perform their flips and twists and whether they stick their landings, has been an Olympic medal event since 1994 and will be featured in prime time this month at the 2010 Games in Vancouver, British Columbia. It has roots in freestyle skiing, the devil-may-care approach to the sport that started catching on in the 1960s and '70s. But aerials has developed into a serious discipline that borrows much from gymnastics.

It is two parts hot-doggery to one part Nadia Comaneci, with Isaac Newton keeping everybody honest. “The forces are pretty simple,” said Adam Johnston, a physics professor at Weber State University in Ogden, Utah, who broke away from his teaching duties one recent afternoon to watch aerialists with the United States Freestyle Ski Team train at Utah Olympic Park, which was built for the 2002 Games in Salt Lake City.

“There’s the force of the ramp on his skis, and the force of gravity on him,” Dr. Johnston said, after Ryan St. Onge, the reigning world champion in men’s aerials and a member of the Olympic team, zipped down a steep inrun, leaned back as he entered the curved ramp until he was nearly horizontal and flew off at a 70-degree angle. “That’s all there is.” But it is enough to create torque that sends Mr. St. Onge somersaulting backward as he takes to the air, arcing toward a landing on a steep downslope that the skiers and coaches have chopped and fluffed for safety. “Once he’s in the air, the only force on him is gravity,” Dr. Johnston said. “You could trace his center of mass as a perfect parabola through the whole thing. From the physics point of view, that’s one of the beautiful things.”

To ensure he will have sufficient rotational, or angular, momentum to see him through three flips, Mr. St. Onge raised his arms entering the ramp, distributing his mass away from his center of rotation, which is near his hips. In physics, he increased his rotational inertia, resulting in more rotational momentum. The same principle rules sports like figure skating, in which a skater speeds or slows a spin by moving the arms in or out. It is called the conservation of rotational momentum, and Mr. St. Onge, who is 26 and first joined the ski team 12 years ago, may not be able to recite the related formula — for the record, it is rotational momentum equals rotational inertia times rotational velocity — but he knows what is going on.

He will bring his knees up, for instance, on his last flip if he needs to rotate a little more for the landing. “We get longer if we’re too fast with a flip, or shorter if we’re too slow,” Mr. St. Onge said. During a jump, he does this more or less intuitively because, like other team members, he has spent hours practicing without skis on trampolines and — in the warm months — skiing off ramps lined with a plastic snowlike surface into water. But while not in the air, Mr. St. Onge devotes a lot of time to analyzing what he does. “I probably spend 80 percent of my time thinking about it, and 20 percent doing it,” he said.

His preparations extend to the ramp itself, called a kicker and made by compacting snow into a huge block and then shaping it to the curve decreed by the sport’s governing body, the International Ski Federation. Over the season at the Olympic Park, the snow has been compacting further and the inrun has been building up, so that when the team showed up for several days of training the kicker was about six inches short of the required 13.5 feet. A small block of snow was added to bring it to the proper height. But this had skewed the ramp’s curvature, as Mr. St. Onge, ever the perfectionist, had learned by measuring it with a digital level. “That’s always the first thing I do,” he said. “I do that more than most people, absolutely.” Not finding the angles to his liking — parts of the curve were off by a degree or two — he spent more time carefully shaving down certain areas with a metal scraper welded to the business end of a pitchfork. “I try very hard to jump off the same ramp week to week to week,” he said.

A proper ramp provides a good start to a jump. If a skier just holds his body still, the rotational momentum will result in a triple flip in layout, or nontwisting, position. While it looks death-defying, that kind of jump is kid stuff to a judge. So aerialists add body twists, rotating about a second axis, one that runs head to toe. In this training jump, Mr. St. Onge adds a full twist in both the second and third flips— a lay-full-full in the language of the sport. Aerialists have several ways to produce twisting motions, said Fred Yeadon, a professor at Loughborough University in England who studies biomechanics in sport and who made some of the first studies of aerialists at the 1988 Winter Olympics in Calgary, where freestyle skiing was a demonstration sport.

The simplest is called contact twisting — jumping and turning on takeoff. Another is through counterrotation, called hula twisting because the skier circles the hips as if using a hula hoop. “It’s what cats do to land upright when they fall,” Dr. Yeadon said. “Humans can do this as well. They get half a twist with every wiggle they do.” But to really twist, skiers have to use the tilt method, which transfers some of the somersaulting rotational momentum to the head-to-toe spin axis. They move their arms up or down and forward or back, which tilts the body to one side. The more tilt, the faster the spin, as more momentum is transferred. A skier will usually use all three twisting methods, in combination or separately at various times in the jump. Mr. St. Onge, for example, will sometimes do half a hula near the end of his jump to slow his twist down for landing. And when doing a double-full-full-full, which requires four full twists, including two in the first flip, he will use all three methods at takeoff. “You start your motions and make them as small and efficient and strong as possible,” he said, “so you can do the maximum amount of work with the least amount of movement.”

So much twisting can make it harder to keep an eye on the landing area, which skiers try to do to judge their rotation and land without falling back or, worse, pitching forward. “It’s all about picking that one spot,” Mr. St. Onge said, “and making sure that’s exactly where you’re going to land.” Perfect landings are rare, but so are severe crashes. “We can crash every jump of the day and not feel sore,” he said. By contrast, Mr. St. Onge said, in “conventional” ski jumping, the Nordic kind, a skier can crash once and feel it for the rest of the year. The reason is speed. He has never been interested in trying that kind of jumping, in which skiers may reach 60 miles per hour. “It terrifies me,” he said. “Flying through the air at 100 kilometers per hour just seems silly.”

Week #10

(I) Play the following Video on Law of Gravitation by Professor Richard Feynmann

https://www.youtube.com/watch?v=QRE0GxT6Zbw

Answer the following questions. Your answers should consist of a short paragraph or diagram as indicated. Answer the questions, concisely but completely.

1. Describe Law of Gravitation;

2. What type of motion does the planets revolve around the Sun - describe history of the theory.

3. How are tides caused according to Prof Feynmann's lecture - who first got it right?

4. What was the experiment that determined the mass of the Earth?

5. Is the pull exactly proportional to the mass? To what accuracy?

6. What other law has a 1/r^2 dependency?

7. How did Einstein modify Law of Gravitation to his Principle of Relativity ?