UIL SCIENCE CONCEPTS

PHYSICS

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We are a small company that listens! If you have any questions or if there is an area that you would like fully explored, let us hear from you. We hope you enjoy this product and stay in contact with us throughout your academic journey.
~ President Hexco Inc., Linda Tarrant

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Coaching Strategies for UIL Science Success

There are a number of things that you can do as a student or a Science UIL coach to improve your success at any level of the competition. Here are a few of the things that done successfully in the past with students.

1. If you can, **establish a time in the beginning of the year to meet** individually and as a team for practice. This ensures that you get into a good habit early and get your students off to a quick start.

2. If you don't have a feel for the knowledge base of your students, give them a **practice test** from past years. I would recommend an Invitational or District test as you don't want to scare off your freshmen.

3. Nothing can substitute for a student taking physics, chemistry, biology or advanced forms of these. A student can study prep materials, but discussion between student and well-qualified instructor is invaluable.

4. Remember that the UIL science contest is not just for juniors and seniors. Many coaches make the mistake of not **cultivating the younger students**, (freshmen and sophomores), and are faced at the beginning of the year with trying to fill the void left by the graduating seniors. Encourage the underclassmen to try out. Take them to invitationals where they can compete with other 9^{th} and 10^{th} graders in the area. They will see that they can be successful.

5. In the UIL science contest, a student that is a whiz in only biology, chemistry, or physics is a great asset. Remember, you can advance as high individual in each of the three subsections on the test, not just as one of the high individuals or the high team.

6. Break down the materials into **workable sections,** and set a calendar for studying these sections. For example, have them study photosynthesis or solution chemistry one week then go back at the end of the allotted time and discuss this as a group.

7. Be involved. Don't just give students old tests, and let them go. These students have many activities other than your science team, and need guidance. If they see you are dedicated and excited, they will be as well.

8. I always remind my students of the **scoring**: +6 for correct, -2 for incorrect, 0 for blank. Guessing is not encouraged by this grading setup. If they guess and do well, take them to Las Vegas when they are 21 and you can retire, otherwise refrain from flipping a coin in the testing session.

9. Encourage them to go through an entire test. You never know if there will be that one physics question that they remember your discussing, and they can answer it without even turning on their calculator!

10. Many of my students tear off the first page of the test so that they have the **formula sheet** with constants and the periodic table easily accessible. Use units in a problem to help solve problems and remember formulas.

11. Remind them it is cool to be a science nerd and that many of those students that give them a hard time about it will someday call them BOSS!

12. Memorization has its place, but the successful students can **think through problems**. Many of the problems at the Regional and State level involve a combination of several equations in order to solve.

13. Graphing calculators are fine, but we have found a simple scientific calculator does just as well on the test. Make sure your students are comfortable and practice with the same calculator they will use during the competition. We also send our students in with a spare calculator in case of a technical malfunction.

Have fun and good luck in your science endeavors!

Ken Davis

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Metric Measure

In physics, almost every problem you will be faced with will involve the use of the metric system. You must be comfortable in not only the use, but also the converting of units within the system. The metric system is simple; just remember the base units and that to make the base unit larger or smaller add a prefix. To change from one to another unit, simply move the decimal one place for each metric prefix.

Base units:

Temperature:	degrees Celsius
Length:	meter
Mass:	gram
Volume:	liter
Time:	second

Kilo, hecto, deka, base, deci, centi, milli,

Move right, on chart, move decimal right number of places you move to convert.

Micro: $10^{-6,}$ nano: 10^{-9}, Pico: 10^{-12} ;Mega: 10^{6}; Giga: 10^{9}; Tera: 10^{12}

Periodically on the test there is a problem where you have to convert units from standard units to metric units. Here are just a few simple conversion factors. Even if there isn't a problem, these conversions will give you an idea of about how much a given answer is in terms many of you are more familiar with than the metric system.

Common Conversion Factors

1 cm^3 = 1 mL	1 dm^3 = 1 L
1 mile = 1.61 km	1 yard = 0.9144 m
1 hr = 3600 sec	1 quart = 0.9464 L

Significant Figures

Significant figures allow us to ensure that our calculations are as precise as the numbers used in the calculations. All of the answers on the UIL Science Test use significant figures; therefore, it is helpful when selecting answers on the Test to remember your significant figure rules.

- Nonzero numbers are always significant.
- For zeros, remember the poem:

	Example	**# sig. fig.**
Leading no.	~~0.000~~58	2
Captive yes.	9.1<u>00</u>8	5
Trailing yes, if decimal.	1<u>0.0</u>	3
	1<u>~~00~~</u>	1

**Note: Conversion factors are considered to have an infinite number of significant figures and don't have to be counted.

Mass vs. Weight

Mass is constant, weight varies and depends on gravity. In order to calculate your weight, we need to know your mass and the acceleration due to gravity where you are. Unless otherwise noted, the acceleration due to gravity for these calculations will be -9.81 m/s/s (m/s^2). It is not given on the UIL cheat sheet, but it may be given in the problem, otherwise, just use -9.81.

- $F_g = mg$
- F_g = force of gravity in Newtons
- m = mass in kilograms
- g = acceleration due to gravity (-9.81 m/s^2)

Galileo and Forces

- Galileo hypothesized as to the presence of friction from experiments. He also understood that objects stay in motion and objects stay at rest unless disturbed.
- kinematics: study of how objects move
- dynamics: study of why objects move the way they do

Newton's First Law of Motion

- Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted on by an unbalanced force.
- Balanced forces cause no motion. They are at equilibrium with one another.
- In these problems, remember to draw free body diagrams showing all forces involved.

In other words: *INERTIA!!*

Newton's Second Law of Motion

The acceleration of a body is directly proportional to the sum of all the forces acting on it and inversely proportional to its mass.

In other words: F = ma

According to Newton's Second Law, a net force acting on an object causes it to accelerate. In addition, the larger the mass of the object, the smaller the rate of acceleration. For this reason we say a massive body has more inertia than a less massive body, therefore, the greater the mass, the greater the inertia.

Newton's Third Law of Motion

According to this law, for every action, there is an equal and opposite reaction. This does not mean that the two forces cancel each other out. Simply put, forces exist in pairs.

When Newton was asked about how he made so many important discoveries, he replied, "*Nocte dieque incubando.*" ("By thinking about it night and day"). And your UIL Science coach is only asking you to think about physics/science 5-6 hours a week!

Fluids

Matter that can flow or doesn't have a definite shape is known as a fluid. For this discussion, we will consider two fluids, liquids and gases. Separation between the two is according to their molecular arrangement. Liquids have definite volume and no definite shape where gases have no definite volume or shape.

Fluids have physical properties such as density and viscosity. A fluid's volume and density can change according to changes in pressure and or temperature. Fluids exert forces on objects as well. In water, one such force is buoyant force, a measurable quality that involves a liquid's density and its mass. Objects can float in liquids depending on density of the fluid, the volume of the fluid displaced and the density and volume of the object that may or may not float.

With fluids, we can calculate pressure they exert (force/area). In physics, we measure pressure in atmospheres, kiloPascals, Pascals, torr, and mm of Hg. I teach my students to work with Pascals because that is the SI unit of pressure. Once the pressure is calculated in Pascals, they can convert to any unit of pressure desired. (1 atm = 760 torr = 760 mm Hg = 101.3 kPa = 101300 Pa).

In fluids, when dealing with pressure, remember that atmosphere is a fluid and it exerts atmospheric pressure on everything around it. Water exerts pressure and it is influenced by density, temperature and depth (Remember the old submarine movies as they dove deeper, the sub creaked and groaned under the effects of pressure).

Fluids Basics Concepts

- Fluids are defined as matter without definite shape (ex. Gas, liquid)
- Liquids exert a force on objects from all sides.
- Fluid pressure is influenced by depth, density, and temperature.
- Make sure to use Kelvin degrees in any gas calculation.

Density

Density is a physical characteristic of matter that allows us to group and classify it. In calculating density, remember that it is defined as mass per unit volume.
Density formula for a fluid $r = m/v$: r =mass density; m=mass kg; v = volume in m^3

Buoyant Force and Archimedes Principle

- Buoyant Force: Force exerted on an object in a fluid; usually an upward push opposite gravity
- Archimedes Principle: Any object completely or partially submerged in a fluid experiences an increase in buoyant force equal to the weight of the fluid displaced by the object.

Calculating Buoyant Force

$\mathbf{F_B = F_g = m_f g}$
Where:
F_B = buoyant force
m_f = mass of displaced fluid
g = acceleration due to gravity