**Practical Physics PLA**

I am applying for credit in practical physics based on my prior learning of the subject through the application of the basic principles of physics as it relates to harness racing. A far stretch you say? Well read on and then think about the connections. My knowledge of this subject was gained over 20+ years as a standardbred horse trainer. Some previous unfinished course work allowed me to see the relevance of the laws of physics as they applied to racing. Over the years I used these ideas and theories with great success as a trainer.

**The theory of shoeing and balancing a standard bred racehorse.**

One of the best ways to improve performance on the track is to eliminate any interference or unnecessary motion in a horse’s stride. To accomplish this one must study not only the anatomy of the specific animal but apply many principles of physics to the way the horse is shod. First consideration is anatomy. You look at the alignment of the skeletal structure of each horse and then visualize the motion of each joint. When you have confidence that you understand the way the various joints are connected and how they move naturally you can then begin to apply various external physical forces to adjust the motion. You must keep in mind that pushing the envelope with any outside force can and will cause damage to the joints if you are not very careful. Let’s look at three areas where the laws of physics affect the stride of a race horse.

1. ***Leveling the hoof: vectors, inertia, momentum, leverage.***

By changing the angle of the horses hoof in relation to the ground in any direction you can change the motion of the entire leg. Letting the heel grow higher will increase the angle and usually heighten the stride. This happens because there is less resistance at the break over point and the speed of the break over increases allowing momentum to raise the hoof higher. The reverse is true when you let the toe

grow out and lower the angle. By tipping the hoof (trimming the outside or inside of the hoof) you can move the breakover point to the inside or outside of the center of the hoof. This will utilize momentum to get the legs to move wider or narrower. Leverage comes into play when you change these angles by changing the stress applied to the joints and bones of the legs. Adding length to the toe increases the force applied to the ankles and pastern. This can be the cause of injury to the lower joints.

1. ***Adjustment to weight: laws of inertia, momentum, centrifugal force, vectors, gravity***

By adding or subtracting weight from the shoe one can change the height length and impact of a horses’ stride. Adding weight will increase the radius of the stride and also increase the force of hitting the ground. By gradually increasing the weight and then working the horse you can listen for the sound of the impact to get the most effective stride. You try to achieve as natural of a stride as possible with the least amount of force hitting the ground. Once you establish the optimum height and reach you move to alignment. By moving the center of the weight on a horse’s hoof to the front back or side you add vector forces to the stride. These forces can widen the distance between any area of interference in a horse’s stride for example if your horse interferes with its knees you can either add weight to make the stride higher and carry the hoof over the point of the knee or lessen the weight and try to go under the point.

You can also move the center of the weight to the inside or outside of the hoof to narrow or widen the stride and get a more flat landing of the hoof.

1. ***Adjusting the composition of the shoe: friction is added to the weight adjustment***

By changing the material used to make a shoe one can allow the horses hoof to slide a little longer when in contact with the ground. Tempered steel shoes because of their hardness will allow the most slide. Aluminum or plastic will shorten the slide because the softer materials allow for increased friction when in contact with the surface.

In addition to the principles learned from balancing the horse by shoeing methods you learn the properties of various metals (and how they change) when heated, cooled, or bent and you also learn a little about tinsel strength of some metals.

**Fitting and maintaining a race bike (sulky)**

Another overlooked area in racing where the laws of physics can change the outcome of a race is the design, fitting and maintenance of a racing bike or sulky as it is called. These bikes are designed to be lightweight, balanced, aligned and extremely durable. Under racing conditions they take a lot of stress and if not properly fitted and balanced can add or subtract time for a horse’s performance.

1. ***Balancing a bike to lift or not to lift: fulcrum and leverage***

Racing bikes are generally built in various heights and lengths just for clearance of a horse’s stride but utilizing physics you can actually affect performance. Adding lift to a sulky means you are putting the driver’s weight behind the wheels and using the seat and shafts as levers to increase the upward force

at the point of connection to the harness. Raising or lowering the angle of the shafts will increase or decrease the lift applied to the horse. This adjustment has to be made for each horse based on how they react to the lift. Some horses loose a little of their balance if too much life is applied and by adding lift you change which areas of the horse’s body endure the highest stress levels. Again adding or removing lift can injure a horse by increasing stress levels on certain muscles and joints and decreasing it on others.

1. ***Wheel maintenance and alignment: Friction, torque and inertia.***

The wheels on a sulky are very important. Since they are used almost exclusively on dirt and sand surfaces they must be maintained regularly. A little sand in the bearings adds friction and adds drag to the sulky. If the wheels are not aligned correctly you create a “snow plow” effect and that also adds drag. The really interesting concept however is how torque impacts performance. Torque applies perpendicular forces to the direction of the spinning wheels. Banked tracks allow this force to aid the horse in making a turn at high speed. As the sulky wheels tilt with the right side becoming elevated torque causes a perpendicular force to be applied to the spinning wheel this force actually pushes the shafts of the sulky to the left assisting the horse to fight off the forces of inertia and make a better turn.