Introduction:

Runners have improved performances with the advent of plastics in sport, as running shoes can now be 50% lighter and 100% more durable than they were 30 years ago. Polyether-block-amide is used in the soles of sports shoes, as it is resistant to flexure and abrasion as well as being lightweight. Polyvinyl acetate foam is used to make inner soles for its shock absorbency and elasticity.

Lightweight water resistant plastics are also taking over from the traditional leather as leather was heavier and got even more so when it was water logged.

Running trainers, in comparison with others, are both lighter and more flexible. Also, differences range in grip. For example, trainers for skateboarding tend to have far more grip than trainers for Astroturf. Also, many trainers are suitable for many sports such as basketball trainers and running trainers, however some are not suitable for other sports such as football boots. This is because football boots have studs underneath them for increased grip, and these studs mean that you cannot use the boots on many surfaces.

The choice of sports footwear:

For my experiment I have chosen to use a well known running shoe (Nike Cortez). It is usually used by athletes competing in marathons and other long term races. In this experiment, I will put this shoe under various experiments to see if the features of the shoe match the standard requirements of a running shoe. Features such as, sufficient grip, flexibility and impact absorption.

The vocational aspects of your footwear:

Identify materials used in footwear:

Last

The last is a three dimensional foot shaped mould which governs the inside shape of the shoe. It is based on 'average' foot sizes so varies between manufacturers for example in width, length and degree of curve from heel to toe. This is one of the reasons why shoes from different manufacturers have a different 'feel'.

There are four types of last (and therefore shape of shoe):

- curved, turning inwards from heel to toe
- semi-curved, not quite so curved
- slightly curved, closer to straight but with a slight curve
- straight, with little or no curve from heel to toe.

Generally the straighter the last, the more suitable the shoe will be for runners requiring a shoe that controls their foot strike.

Last Method (or Construction Technique)

The last method is the manner in which the upper is attached to the sole.

There are three methods:

- slip last, which involves sewing the upper directly to the sole
- board last, which uses a board to attach upper and lower elements
- combination last, which uses a board last in the heel area, while the forefoot is slip lasted.

The method used can be worked out by removing the in-sole and examining the interior - a full length piece of card indicates board lasting, stitching indicates slip-lasting and both, a combination last.

Slip lasts tend to provide less control and more absorption than board lasts. Board lasted shoes are usually more stable, while combos provide rear foot control with forefoot absorbency.

Sole (or Out-sole)

There are numerous types of sole. For instance, some combine various types of materials to maximise traction on and off the road, while a number of new soles are made from moulded, composite materials. Other than for use in extreme conditions such as fell running, many designs don't really have a great deal of bearing on function.

Mid-sole

The mid-sole is the thick layer of rubber that sits between the outsole and foot bed. The mid-sole absorbs impact, flexes in the ball of the foot at toe off and determines the level of foot control. It is usually constructed of foam type compound, frequently EVA (ethylene vinyl acetate).

Manufacturers have developed 'technology' such as air bags, gel and structures of other material which are designed to provide various functions. The best new materials improve shock absorbency without increasing weight, which is beneficial.

Three factors determine how good a mid-sole is:

1 Shock absorbency

This can be tested by pressing the material. If it's extremely spongy then it may not provide the shock absorbency required by heavier runners, and conversely, if it's too taut it may be inappropriate for lighter runners. When longitudinal creases develop - those parallel to the ground - the mid-sole will be losing its shock absorbency.

2 Heel height

Most people require a small heel to help reduce forces within the foot and stress on the Achilles' tendon. Heel height can be determined by taking the thickness of the sole at the ball of the foot from the thickness at the heel. An increased heel height is preferable for calf problems or rigid feet.

3 Pronation control

Some trainers incorporate a wedge within the mid-sole - making the sole thicker on the inside than it is on the outside - to increase foot control. Other shoes use plastic inserts to achieve this. A more popular method is to use two densities of material within the sole. Typically, the material on the inside of the heel is harder than it is on the outside, so when a load is applied there is more compression on the outside of the foot forming an effective wedge.

Arch Fill

This is the area of mid-sole and sole under the arch. It should be designed to let the shoe flex with movement of the foot, whilst still providing it enough support. A large number of shoes have less material here. In most cases this does not provide enough support, and any trainer which is weak at this point should be avoided. A simple test is to bend the shoe and see if the arch correspondingly flexes - if it does it is too weak. Shoes that are strengthened in this area will not bend as easily.

Upper

This fits around the foot holding the shoe in place when the laces are tied. It can be made of nylon or nylon mesh, or a combination. It sometimes incorporates design features such as light weight, reflective or waterproof (and breathable) material.

Sometimes parts of the upper which are prone to wear, such as the outer toe box and area around the lower heel, are reinforced with a leather type material or rubber.

For comfort, increased cushioning may be used around the ankle collar at the top of the shoe where it meets the ankle, in the heel tab and in the tongue, under the laces to prevent them rubbing. Some shoes use an inner sleeve to improve fit, but there is little evidence that this has a significant effect.

Toe box

This is the part of the shoe that holds your toes, the height of which it should comfortably accommodate. A small toe box will constrict your toes and increase the risk of bruising on the toenails.

Lacing

This secures the upper and therefore the rest of the shoe to the foot. An eyelet is the hole the lace passes through - this should be strong enough not to snap when the lace is done up at normal tension. There are a few types eyelet used:

- traditional eyelets, which are punched out of a (usually reinforced) part of the upper
- 'D' ring eyelets, which are designed to lace up quicker. Some manufacturers call a lacing system comprised of D ring eyelets a 'ghilly' lacing system
- multi hole eyelets which are often staggered to accommodated a wider variety of foot widths.

Heel

Heel counter

This is the portion of the heel that is stiffened. Research indicates that a stiffer heel does not necessarily improve control, but it is preferable to the side to side displacement of more flexible designs. You can squeeze the heel to see whether it will be firm and supportive. For runners who require specialist in-soles or orthoses, a stiffer heel will prevent the insert from slipping. Any insert within a shoe is known as an orthoses.

Heel tab

This is the top part of the heel counter. It is important it is not so high that it protrudes into the Achilles tendon, which could cause inflammation. Some heel tabs have small straps attached to help pull your trainer on.

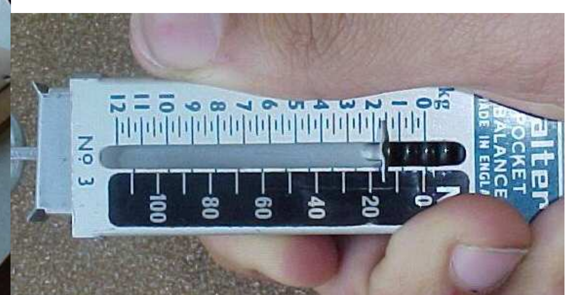
In-sole

This sits on the foot bed, inside the bottom of the shoe. The in-sole is cushioned material, frequently made of low density foam, which manufactures insert into the shoe to provide additional shock absorbency and shape. Most removable in-soles do not provide enough arch support, resulting in a loss of control. However, if additional inserts are placed on to an existing in-sole - particularly one that already has an arch support - then there may be a problematic increase in control.

<u>Carry out safe and fair experiments to test the suitability for materials used in your footwear:</u>

Grip:

- Grip can be tested by using a weighted trainer and a Newton meter on a running track. Shoes/boots of different sports could be tested to compare the best grip on other surfaces. For my experiment, I used a 1kg weight.



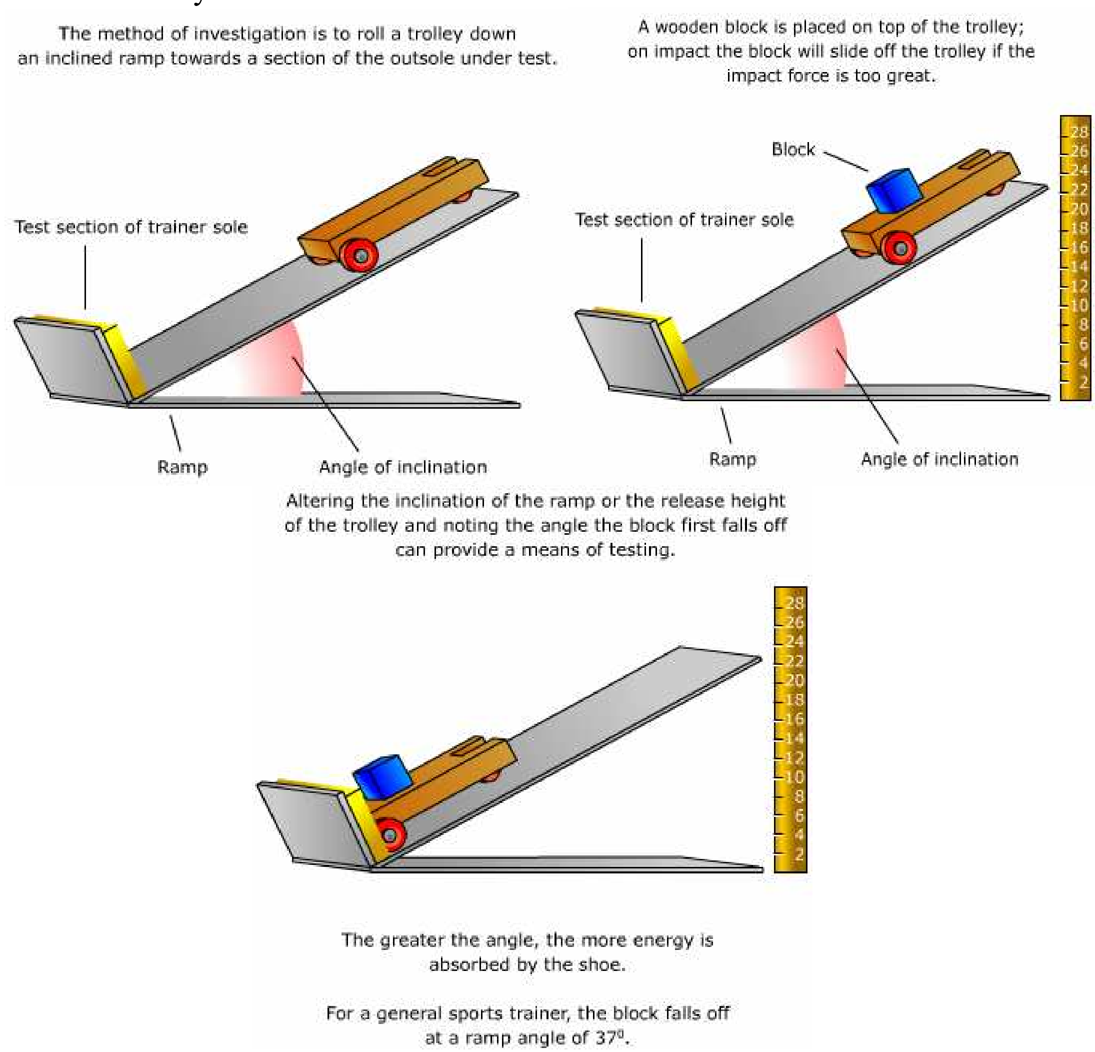
Here are my results:

Surface	Newton's needed to move the weighted trainer.
Cardboard	16.8N
Grass	32.1N
Tarmac	31N

I have concluded that the trainer has the best grip on grassy surfaces, and also has a fair amount of grip on tarmac. I would definitely recommend this trainer to cross country runners, as they do most of their running in fields and grassy surfaces.

Impact absorption:

- Impact absorption could be tested by a trolley on an inclined slope with a test block on it. By altering the ramp's inclination, the angle at which the block falls off provides the means of testing. The greater the angle the more energy is absorbed by the shoe.



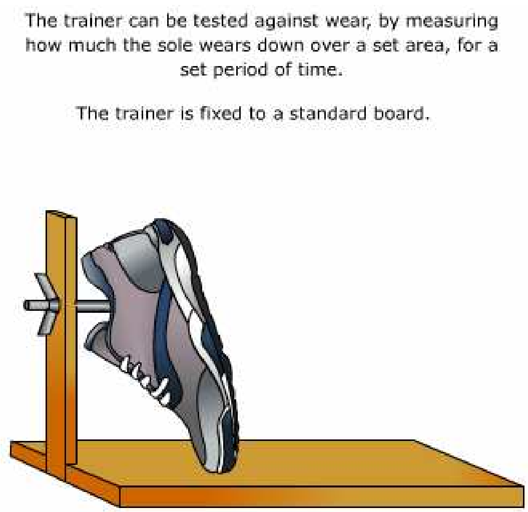
Here are my results:

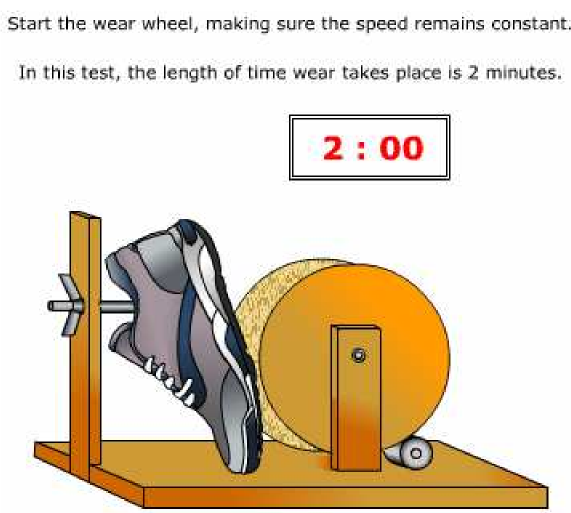
Angle of inclination	Did the block fall off?
15°	No
20°	No
25°	No
30°	No
35°	No
40°	No
45°	Yes

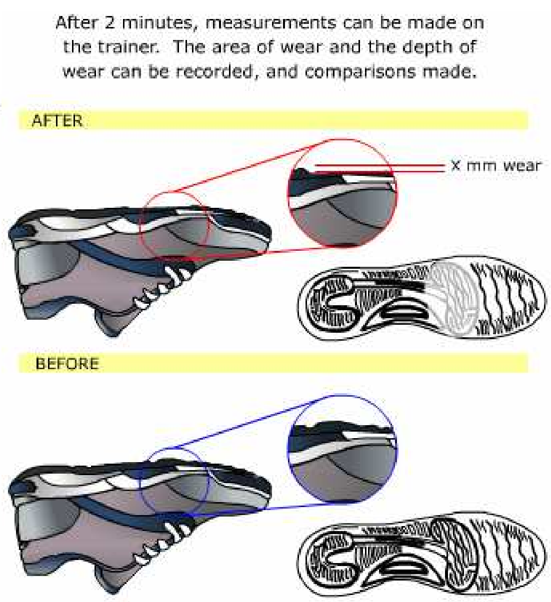
To conclude, I would say that these trainers have a very high impact absorption level. This can mean many things. Firstly, it can mean that the trainers could be comfortable to wear. Secondly, it means that the outsole can absorb large amounts of impact and can prevent knee and ankle injuries because of its 'suspension'.

Resistance to wear:

- A wear-wheel can be used to test the trainer's resistance to wear.







- Density can be tested with a Eureka can and a digital measuring scale. By recording the amount of water pouring out of the Eureka can and finding out the mass of the material with the scales, you can work out the density of the material.
- Resistance to chemical corrosion can be tested by placing the piece of material into a weak acid, into water and under intense lighting. I will then note any physical changes.

Conclusion:

Evaluation:

Comparison to manufacturing aspects:

Compare footwear designs: