SAFETY SUIT OF AERONAUTS.

The accompanying illustration shows a padded suit and casque used by Count de la Vaulx in his recent balloon trips and aeroplane experiments. It was owing to the protection afforded by his padded helmet that the Count came out of his recent aeroplane accident without serious injury.

A CHEMICAL PUZZLE.

BY GUSTAVE MICHAUD, COSTA RICA STATE COLLEGE.

The following experiment is easily performed, even by those who have had little or no previous chemical training. It gives an idea of the infinite diversity of chemical and physical changes which one and the same reagent may induce in other substances.

Fourteen glasses, arranged in seven pairs, are brought before the spectators, who are requested to examine them and their contents. The experimenter then pours one and the same liquid into the fourteen glasses. The following contradictory results become at once apparent:

Substance contained in glass *A* becomes so hot that the glass cannot be kept in the hand. Substance contained in glass *A'* becomes so cold that frost promptly collects outside of the glass.

Liquid contained in glass *B* was blue; it becomes colorless. Liquid contained in glass *B'* was colorless; it becomes blue.

Glass *C* contained a clear liquid which becomes muddy. Glass *C'* contained a muddy liquid which becomes clear.

If a lighted match be introduced into glass *D*, several inches above the liquid, noisy flames are seen to spring in every direction. If the same experiment is made in the same manner with glass *D'*, the match is quietly but immediately extinguished. Liquid in glass *E* had a burning, suffocating smell; it becomes odorless. Liquid in glass *E'* was odorless; it acquires such an offensive smell that it becomes necessary to carry it outside.

Liquid in glass *F* was red; it becomes blue. Liquid in glass *F'* was blue; it becomes red.

Glass *G* contained a solid substance which becomes liquid. Glass *G'* contained a clear liquid which becomes instantaneously solid.

Every transformation is the result of the action of common hydrochloric acid over some chemical. Here is the nature and proportions of these; capacity of glasses being supposed to be about one pint.

Glass *A* contains 50 grammes of sodium hydrate dissolved in 100 cubic centimeters of water. This solution fills about one-half of the glass. During the experiment the other half must be entirely filled with hydrochloric acid. This should be poured slowly while the liquid is agitated with a glass or wooden stick. The last additions of acid cause the liquid to boil. The glass will then be found to contain common table salt mixed with an excess either of acid or of sodium hydrate. Glass *A'* is filled with sodium sulphate in small crystals, such as is sold by pharmacists to be taken internally. Enough hydrochloric acid must be poured to cover the salt. Temperature goes at once much below 32 deg. F. Cold becomes still more intense if the mixture be agitated.

Three-quarters of glass *B* are filled with water; then one decigramme of copper sulphate is dissolved in it. Ammonia is added in small portions until an intense blue color appears. The addition of hydrochloric acid will cause it to vanish. A solution of two centigrammes of potassium ferricyanide in 100 cubic centimeters of water is made in glass *B'* and, in this, another solution of 3 centigrammes of ferrous sulphate in 100 cubic centimeters of water is poured. A little ammonia is then added until the beautiful blue color vanishes. Hydrochloric acid will cause it to reappear instantaneously.

Glass *C* contains the ordinary solution of lead acetate sold by druggists for local or external application. Hydrochloric acid forms in it a dense precipitate of lead chloride. Three-quarters of glass *C'* are filled with water to which about a quarter of a teaspoonful of slaked lime, free from coarse particles, is added. Calcium chloride, resulting from the action of hydrochloric acid on lime, is exceedingly soluble in water.

A few pieces of zinc are deposited in glass *D*. Bubbles of hydrogen will set noisily on fire when a match is introduced into the glass. The experiment is free from danger so long as no attempt is made to close the glass.

One-third of glass *D'* is filled with wood ashes with enough water to make a thin paste. Carbon dioxide is the gas which promptly extinguishes the match. A hundred cubic centimeters of water, fifty cubic centimeters of ammonia, and enough litmus solution to

From the Sketch.

PADDED SUIT AND CASQUE FOR AERONAUTS.

give the liquid a bluish tint are poured into glass *E*. During the experiment, hydrochloric acid is added, little by little, until the bluish color suddenly becomes reddish. The odor will then be found to have vanished.

One-third of glass *E'* is filled with water, and 8 grammes of powdered iron sulphide are thrown into it. Hydrochloric acid will generate hydrogen sulphide in the glass. This gas is the active agent found in some mineral waters, to which it gives a characteristic smell of putrefied eggs. It is poisonous, but the

A CHEMICAL PUZZLE.

amount evolved during the experiment is small, and the smell is so strong that it makes the air apparently irrespirable long before there is any danger. It should not, however, be smelled directly over the glass, nor should the glass remain in the room longer than is necessary to detect the odor.

Glass *F* contains the same liquid as used in glass *B*, with the addition of one centigramme of aniline red scarlet. Glass *F'* contains the ordinary solution of blue litmus.

The Instrument Arranged for Drawing an Ellipse.

Arrangement for Drawing a Hyperbola.

AN INSTRUMENT FOR DRAWING ELLIPSES AND HYPERBOLAS.

Calcined magnesia is the solid substance which fills about one-third of glass *G*, and the ordinary syrupy soluble glass or sodium silicate solution sold by druggists is the liquid substance which will become instantaneously solid, in glass *G'*, if mixed with about one-third its volume of hydrochloric acid.

AN INSTRUMENT FOR DRAWING ELLIPSES AND HYPERBOLAS.

BY HARRY A. HANNUM.

An ingenious instrument for drawing ellipses and hyperbolas has recently been invented which is so arranged that if a pen be used it will keep the latter at all times tangent to the curve. The instrument is based on the principle that the sum or the difference respectively of the distances from any point of an ellipse or a hyperbola to the foci of such curve is constant.

It is constructed with two posts provided with points to be placed at the foci of the ellipse or hyperbola. These two posts are connected by slotted beams clamped together by a thumb screw. On the top of each post is a stationary pinion, about which is swiveled a head. Passing freely through the two heads, and engaging each pinion are two racks, crossing each other and both engaging a traveling pinion. Passing through the traveling pinion is a vertical shaft, at the bottom of which is connected a pen or pencil. Around the pinion are two heads adapted to travel along the racks.

If the instrument is put in motion by placing the hand at the top of the shaft, the traveling pinion will revolve, taking up on one rack and letting out exactly the same distance on the other rack, thereby causing the pen to describe an ellipse which is mathematically correct. By reassembling the instrument so that the traveling pinion will pass between the two foci, the pen or pencil will describe a hyperbola. For drawing an ellipse with ink, it is necessary that the pen always travel tangent to the point of the curve which it is drawing.

The mechanism which achieves this purpose is based on the well-known property of the ellipse or hyperbola, that the tangent in each point of the curve bisects the angle between the two connecting lines of said point with the foci of said ellipse. Each of the traveling heads is provided with a flange, in which is cut a spiral-shaped groove running in opposite directions. Between the two flanges there is a steel plate swiveled around the pinion and having a slot running in a radial direction. The pin engaging both of these grooves, and also a slot in the plate between the two flanges, causes this plate to revolve around the vertical shaft whenever the instrument is put in motion. The steel plate has an extension at the point opposite the radial slot, in the end of which is riveted a short vertical pin engaging a hole at the end of a horizontal arm, which is threaded into the head carrying the pen. By this arrangement the revolving motion of the steel plate is conveyed to the pen, and thereby the pen is properly directed.

By using an attachment not shown in the cut to take the place of one of the posts at the foci, and having this slide along a T square, the pen or pencil will describe a parabola.

THE NEW HENRY DYNAMOMETER.

BY JACQUES BOYER.

Mr. Charles Henry, director of the laboratory for investigating the physiology of the sensations at the Sorbonne, has just designed a new registering dynamometer which allows the energy of the muscles of the hand to be measured, at the same time eliminating the effect of pain, that prevents the exertion of the full strength in the various types of spring dynamometer. This very exact apparatus, shown in its completed form in our photographs, will give very precise results concerning the influence of various diets on man. The role of foods is twofold: They should

furnish the material for the growth or repair of the tissues, and at the same time should make up the expenditures of energy of the organism, whether these expenditures are in the form of heat or in the form of mechanical work. Certain foods, like the albumens and the fats, contribute both to the repair of the tissues and to the production of energy. Others, such as the hydrocarbons, seem to serve entirely as energy furnishers. But within what limits