

The Bee's Home Magazine Page

Mysteries of Nature and Science

Earth's Gravitation Draws as Rapidly as It Does One that is Merely Dropped—How to Calculate the Height of Projectile.

By GARRETT P. SERVISS.

"I find myself totally unable to prove the following proposition to a layman: A cannon, at an elevation, H, from the ground, fires a projectile, A, in a horizontal direction. At the instant of discharge a shell, B, is dropped from the same elevation. I claim that the two shells reach the ground at the same time. Several of my friends disagree with me, and claim that B reaches the ground before A.—Leon A. Kaufman, New York City."



You are right, supposing perfect horizontality of the ground, and neglecting any difference of effect from atmospheric resistance, the two shells would strike the earth at the same instant. Assume the height to be about sixteen feet (more accurately 16.09 feet); then both shells would reach the ground in one second after starting. If you stood beside the mouth of the cannon, and dropped one of the shells at the instant that the other was fired, they would both touch the ground simultaneously at the end of one second, although they might, at that instant, be half a mile apart, in a horizontal direction.

If the speed of the shell fired from the cannon were made so great that its course always remained tangent to the curvature of the earth, then it would never touch the ground, but, neglecting atmospheric resistance, would become a satellite of the earth, traveling round it in a circle. The speed necessary for this purpose would be about five miles per second.

The shell flying at that speed would still fall toward the earth's center exactly as if it had been dropped from rest, but it could not reach the ground because the surface of the earth rounds off sixteen feet in about five miles, so that the shell would be just as high above it at the end of the first second of its flight as at the beginning. In two seconds the shell would drop sixty-four feet, but the earth would round off by the same amount, and so on.

The reason why both shells drop at the same speed toward the earth when one is simply allowed to fall while the other is fired horizontally out of a cannon is because the attraction of gravitation, by which bodies are forced toward the center of the earth, acts both con-

tinuously and instantaneously. The moment the shell leaves the cannon, and is thus deprived of support from beneath, it begins to fall, exactly as it would do if it were not being driven forward horizontally by the explosive force of the powder. Its forward motion has not the slightest effect on the downward motion produced by the earth's gravity.

Nothing can shake off, destroy or eliminate the latter. If you should shoot the shell vertically upward gravitation would cut off, during the first second sixteen feet from the height that it would otherwise attain, 14 feet during the first three seconds, and so on.

This enables us to calculate how high a shell, fired straight upward with any given velocity at starting, will ascend. So constant is the restraining force of gravitation that a projectile that the mathematical formula to be applied in making such a calculation is precisely the same that would be used to determine the distance that a body must fall in order to generate the same velocity as that with which the shell starts upward. This means that the shell will continue to rise only for the length of time required by gravity to destroy its motion.

The formula may be put in this form: The velocity equals eight times the square root of the height. This is derived from the ordinary formula: $V^2 = 2GS$.

Assume that the velocity of the shell on leaving the cannon's mouth is 2,400 feet per second, directly upward. By the formula, 2,400 divided by 8, or 300, equals the square root of the height. The height itself, then, must equal the square of 300, which is 90,000, expressed in feet, equivalent to a little more than 17 miles. At that height the shell will cease to ascend and begin to fall back, acquiring, at the end of the fall, the same velocity, 2,400 feet per second, with which it started under the impulsion of the exploding powder. What gravitation has done is, first, to destroy the upward motion of the flying projectile, and second, to impart to the arrested projectile the same speed of descent that it had of ascent.

It is important to note that all of these calculations purposely neglect the effects of the resistance of the air. Air resistance would bring the projectile to rest sooner, and diminish the height of its ascent. The amount of this resistance depends upon a large number of variable circumstances, and has to be determined by experiment, but it has been so successfully studied that the science of gunnery, as the present war demonstrates, has attained a very high degree of accuracy.

Two Coming Women Tennis Players



PHOTO BY INTERNATIONAL NEWS SERVICE

MISS BJURSTEDT (LEFT) IN FINALS FOR TWO TENNIS TITLES, OPPOSING MRS. WALLACH (RIGHT) FOR "MET." CHAMPIONSHIP.

Six-Cylinder Living

By BEATRICE FAIRFAX.

The thirst for excitement is as dangerous an appetite as the craving for stronger liquor. The longing for gaiety, for amusement, for the stimulation of bright lights and giddy throngs is the direct cause for the downfall or a dishearteningly large number of boys and girls.

Each week brings me numerous letters from boys and girls who are on the verge of leaving home because their parents deny them the freedom and social opportunity they think their youthful due.

Once youth tastes the strong wine of artificial gaiety it longs to sip again. At first curiosity impels—then a taste is cultivated, and then the strength of habit and custom steps in. Youth does not know enough to discriminate. Youth, elated at its success and popularity, does not see the wisdom of early departure and healthful long hours of sleep. Parents know how hideously the longing for innocent amusement deteriorates into the wild craving for amusement of any kind.

The drug habit is not formed overnight. It claims its victims by slow stages. And its victims are not foredoomed outright from homes of poverty and hereditary degradation. They are all too often men and women who were once as sane, as decent, as law abiding as you and I.

So with any appetite that masters you. Drink, drink, the craving for pleasure all so hard to hand—all produce the same dreadful effects.

A trusted employe just sent to prison for robbing the employer who was also his friend, confessed that his own fall was due to longing for gaiety at any price. He sums up his fall in these words: "The night life of New York completed my downfall. I began to drink. Then came fast company. But my love for my wife and babies never died. It was merely that, the lure of liquor and the six-cylinder life of Broadway was stronger."

The ability to find pleasure in kindred and friendship and the big, wholesome out doors and work well done and duty well performed and the love of beauty is a God-given gift. Hunt for a spark of it in your own nature and cultivate it as a tallman against the fever phantoms of unrest that pursue and destroy youth and conscience today.

Advice to Lovelorn

By BEATRICE FAIRFAX.

The Wedding.

Dear Miss Fairfax: I am a young man about to be married and several questions have arisen upon which I would be pleased to have you enlighten me.

What expense of a marriage is borne by the bride and what expense by the bridegroom?

The question has been put to me that the bridegroom should pay for the ball and the bride for the supper only.

If a reception is given to the friends it is proper for the bride and bridegroom to leave the reception before it is over? In many instances brides and bridegrooms do.

C. J. Brooklyn.

The bride, or parents of the bride, bear all the expense of the wedding festivities. The bridegroom merely sends the bride her flowers and gives his ushers and best man remembrances.

The bride and bridegroom invariably leave before the reception is over, and the guests consider seeing the happy couple start off as part of their pleasure in the evening.

Read It Here—See It at the Movies.

The Goddess

INTRODUCING
EARLE WILLIAMS
as Tommy Barclay
ANITA STEWART
as The Goddess

Written by
Gouverneur Morris
(One of the Most Notable Figures in American Literature)

Dramatized into a Photo-Play by
CHARLES W. GODDARD.

Author of
"The Perils of Pauline"
"The Exploits of Elaine"

(Copyright, 1915, by Star Company.)

FIRST EPISODE.

Finally Sturtevant looked his friend and master in the face and said: "Well, what's the answer?"

"I think," said Barclay, "that I have devised a remedy which shall serve us all, Mr. Stilliter."

As Prof. Stilliter advanced, Mr. Barclay said to the others: "The world's greatest psychologist."

"You do not have to tell us that," said Semmes, and they bowed to the professor.

"Well," said Barclay, "let's have a look at her."

Prof. Stilliter drew from his pocket a folded picture frame of red leather. When the gentlemen had examined the photograph, with an evidence of pleasure not to be mistaken, for the good looks of the Amesburys and their daughter, were as certain and sudden in their effect upon the eye as is the beauty of the Yosemite valley.

"But," said Sturtevant, "what is the remedy?"

For answer Barclay simply touched the photograph of the little Amesbury girl with the tip of his finger.

"She is the answer," he said, "but, by the way, Stilliter, what do you hear of the mother?"

Prof. Stilliter shrugged his shoulders very slightly.

"Dead?"

"Dying."

Barclay was not unmoved. "She thinks," he said, "that she is only dying in grief. As a matter of fact, she is taking a great place in the march of events."

"What are the child's habits?"

"She has a nap," said Prof. Stilliter, "from 10 to 10:30 and from 3 to 3:30. At other times she is mostly out of doors with her nurse. There is a wood back of the house, in which she has a play-house, a see-saw, etc. If you wished to see her it would be a simple matter, but I am ready to stake my reputation on her. She is absolutely out to our plan."

"Which," said Semmes, "is so far a complete mystery to Sturtevant and myself."

In spite of Prof. Stilliter's guarantee, the triumvirate, as they were popularly and unpopularity called, determined

to have a look at the little Amesbury girl for themselves. In a car driven so swiftly that the traffic cops had to look the other way so as not to get dust in their eyes, it did not take them long to reach the Amesbury house. They did not, however, draw up before the house itself, but in the wood back of it. Here decked out in Indian dress so that she resembled the ornamental side of a sent,

they found the object of their search. It was no difficult task for three such men to lull any suspicion that the child's nurse may have had. They complimented her upon the health and good manners of her little charge, inquired after her mistress and learned with every semblance of regret that the latter was sinking hourly. They joked Prof.

Stilliter a little on the fear with which he seemed to inspire the child. But to Stilliter, looking far ahead, perhaps this aversion seemed a serious thing.

"Well," he said brusquely, "am I right? Is she the finest child you ever saw, or isn't she? Just see the breadth of her skull above the ears?"

He would have touched her, but she

shrank from him. When Barclay, however, spoke to her she showed neither fear nor aversion, only a pleasant shyness.

"I have never seen you before," he said, "but I am very fond of little girls, and since I have none of my own I do not propose to lose sight of you in a hurry."

Leaving the others, he took the child and the nurse for a little drive in the car, and when they had come back he slipped something that jingled into the nurse's hand, so that the flighty woman felt prepared to go through fire with him.

(To Be Continued Tomorrow.)



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