

pound weight, attached to a string one foot long, would generate a centrifugal force equal to its weight, if it be made to revolve once round in 1.11379965 seconds.

Now, if the square root of the semi-diameter of the earth, or the square root of 20,923,637 feet (which is equal to 4574.23622), is multiplied into 1.11379965 seconds, the product will be 5083.7146 seconds (which is equal to 84 minutes and 43.7146 seconds); this, therefore, is the precise time in which a body would revolve around the earth, near its surface at the equator, without falling.

The amount of centrifugal force generated can be calculated by making the length of the string equal to 20,923,637 feet, and the velocity of the revolving one-pound weight equal to the square root of the length of the string; that is, 4574.23622 times swifter than the ball with one foot radius. The numerical formula will be

$(4574.23622)^2 = 1$  pound; that is, the one

pound of centrifugal force upwards from the centre of the earth, just balances the one pound of gravitating force towards the centre.

The moon is 59.96435 times the equatorial radius of the earth distant. Why does it not fall to the earth? We answer, it would fall, if it did not revolve around the earth with a velocity sufficient to generate a centrifugal force upwards, equal to that of its gravitation downwards. Under the influence of these two opposing forces, it is constantly maintained at its orbit distance.

If the intensity of gravitation were the same at all distances, the moon would fall towards the earth, from the tangent to the curve of its orbit, 16 feet and 1 inch, in one second of time. To balance this downward tendency, its velocity around the earth would have to be increased 59.96435 times greater than its present mean velocity; that is, the moon would have to revolve around the earth in 10 hours, 56 minutes and 6.58275 seconds. This is calculated by taking the square root of the moon's distance, which we have already stated to be 59.96435 times the earth's radius. The square root of 59.96435 is equal to 7.743665; this multiplied into 5083.7146 seconds, gives a product of 39386.58275 seconds, which is equal to 10 hours, 56 minutes, and 6.58275 seconds.

One pound of centrifugal force generated at the distance of the moon, by the whirling of a one pound weight, would require a velocity, greater than when whirled near the surface of the earth. The exact velocity necessary, will be found by taking the square root of the moon's distance, or 7.743665 times the velocity of a revolving body at the earth's surface. Then we shall have the numerical formula, thus—

$(7.743665)^2 = 1$  pound.

But from observation we know that the moon's real velocity around the earth is not 7.743665 times swifter than a revolving body at the surface of the earth; indeed, it is known to have a mean velocity 7.743665 times slower than that of a body at the earth's surface, or 59.96435 times slower than the velocity necessary to generate 1 pound of centrifugal force.

But we have already shown that the tensions or strains upon cords, or rather the centrifugal forces, generated by the revolution of balls or globes, when the distances are the same, are as the squares of the velocities. But the real velocity of the moon is only, the 59.96435th part of that velocity necessary, if gravitation remained the same in intensity at all distances. Therefore, the square of 59.96435, which is equal

to 3596.12327, is the true measure of the centrifugal force, at the mean distance of the moon. But the gravitating force towards the earth, must be equal to the centrifugal force from the earth; and therefore, the gravitating force must vary inversely as the square of the distance; that is, it must be about 3,596 times less at the moon's distance, than at the surface of the earth. Hence, the moon falls towards the earth about 3,596 times slower than a stone would fall near the earth's surface.

We have proved that if gravitation was the same at all distances, the moon must necessarily go once around the earth in 10 hours, 56 minutes, 6.58275 seconds, in order to balance the central force. But as gravitation is greatly diminished by distance, the period must be greatly increased; that is, 14 hours, 56 minutes, and 6.58275 seconds, or rather 39,386.58275 seconds must be multiplied by 59.96435, which is the number of times the velocity is decreased; the product will be 2,369,591.546152 seconds in the moon's real period; this is equal to 27.321661418 mean solar days, which is the exact period as given in Herschel's Tables, in his "Outlines of Astronomy."

It is a wonderful achievement in science to be able to demonstrate the law of gravity, from the simple experiment of whirling a weight, attached to a cord of given length, around a pivot as a centre, and observing the centrifugal force generated in any given time. Who could have supposed that the whirling of a ball in a small circle of one foot radius, was a phenomenon of precisely the same nature, as the revolution of magnificent worlds, in their grand orbits; and that the laws which apply to the one class of motions, apply equally certain to the other? The problem may be generalized thus—

Given the time of the revolution of a weight, having a foot radius, in generating a centrifugal force equal to its weight, to discover the universal law of gravitation.

The method of solution has been fully developed in this lecture. And its truth may be verified in the most minute particulars, by its application to the grand machinery of the solar system. We will now give two examples.

EXAMPLE 1.—Let the distance of the moon be called unity, then the distance of the sun on the same scale will be = 382.8839; and the velocity of the moon around the sun will be 28.07 times its velocity around the earth, what will be the centrifugal force generated by the revolution of the moon around the sun? We have

$\frac{v^2}{d} = \frac{(28.07)^2}{382.8839} = 2.147$

Hence the centrifugal force which the moon generates, in revolving around the sun, in company with its primary, is 2.147 times greater than that generated by her revolution around the earth.

EXAMPLE 2.—If the earth and sun were placed at equal distances from the moon, what would be the intensity of the gravitation of the latter towards the sun?

Gravitation increases as the square of the distance decreases; therefore we have

$d^2 \times 2.147$ ; or  $(382.8839) \times 2.147 = 146,600.08 \times 2.147 = 314,760$

Thus we see, that if the moon were taken as near the sun as she is to the earth, the intensity of her gravitation to the solar orb would be increased 146,600 times more than at her present distance. But we have seen, by the first example, that even in her present position, she has over twice the intensity of gravitation towards the sun, that she has towards the earth; hence, the whole intensity is 314,760 times greater; or in other words, the sun must contain 314,760 times more matter than the earth.

14. The mechanical laws which I have explained constitute a perfect balance in which to accurately determine the comparative weights of worlds. The astronomer of the present day is as familiar with the process of weighing worlds, as the chemist is in weighing the ingredients which enter into his compounds. These wonderful problems are now exceedingly simple; and their solutions are within the reach of all who have acquired a common school education. An Arithmetic, including mechanical and astronomical problems of the nature of those just investigated, would not be too abstruse for common school purposes, and would inspire the youth of our country with a love for these grand exhibitions of mechanical skill, so wonderfully displayed in the mechanism of Creation.

Nothing is calculated to inspire the mind of man with a more profound reverence for the Great Author of nature, than the contemplation of his marvellous works. For the exact mathematical adjustments of the various forces of nature—the consummate wisdom and skill exhibited in every department of the universe, accessible to finite minds—the omnipotent power and grandeur displayed in the construction of the magnificent machinery of creation—proclaim the majesty and glory of Him who formed and governs the mighty fabric.

## By Telegraph.

### AMERICAN.

NEW YORK, 16.—The following entry was made in the clerk's office of the common pleas court to-day: "In the letter of assignment, dated 27th of July, 1875, by Wm. Butler Duncan, Wm. Watts Sherman, and Francis H. Grain to Wm. D. Sherman, Aug. 16, 1875, received a schedule of debts and inventory of assets; debts and liabilities \$4,910, 138; the assets nominally amount to \$2,119,468, but actually to \$2,830,853."

WASHINGTON, 16.—W. J. Murtagh, editor and proprietor of the *National Republican*, brought a suit against the District Commissioner to-day, to recover forty-seven thousand dollars, the amount claimed by him as remaining due for the advertising of the tax sales last June, fifty thousand dollars having already been paid by the Commissioners on account.

The *Evening Star* says of the marine frauds, that by some means Barum & Bros., who manufactured the clothing in New York, ascertained that the amounts of the bills which they made out in blank were not filled up by Captain Maddox, the inspecting officer in Philadelphia, and some time ago they resolved on a bold move. They made a bill out, which would cover twenty-three thousand dollars for clothing, which they had not manufactured. It was sent to Captain Maddox at Philadelphia, who approved it. It is said that his approval was secured through the collusion of one of his clerks; at all events he gave a certificate of inspection covering enough garments to meet the aggregate of the list, and also approved it and sent it on to Washington to General Zelin, who likewise approved it, and Major Slack paid the bill.

TORONTO, 16.—The steamer *Rothsay Castle*, well known as a successful blockade runner during the war for the Union, on entering Toronto harbor this p.m., with 300 excursionists on board, struck a sunken snag, and rapidly sank to the upper decks; the passengers were taken off by tugs and landed safely.

PROVIDENCE, R. I., 16.—The New England ten-hour demonstration to-day, was attended by 1,500 operatives from Fall River and other points in Mass. Addresses were made and resolutions adopted strongly favoring a ten hour law, and pledging the operatives to the agitation of the subject until legislation is procured favorable to their view.

DETROIT, 16.—The saw mill of Saylor & Co., near East Saginaw, was destroyed by fire to-day; loss \$35,000.

A collision occurred on the Flint and Pere Marquette R. R., near Flint this a.m., by which Thomas Hurd, conductor, and John Hendey were killed, and four train men were badly injured.

FAIRPOINT, N. Y., 16.—This has been the last day of the Chatauqua Sunday School Assembly, and people have been leaving in boats and trains all day. Addresses were made this a.m. by President Lewis Miller, Dr. Vincent, and others; and in the evening Prof. Eber

Tourgee, of Boston, delivered a fine address on music in the Sunday school and sanctuary. The general closing exercises were held in the evening, and addresses were made by Dr. Vincent, Dr. Presby, of Washington, the Rev. Dr. Deems, of N. Y., the artist, Mr. Frank Beard, and Miss Hatnick Morris. It has been decided to hold a Chatauqua Assembly each year on the same grounds, which have been secured permanently for that purpose. A large organ will be erected and an immense hotel will be built on the ground during the year.

MAUCH CHUNG, Pa., 16.—Wm. L. Lee, son of Sam'l C. Lee, of Baltimore, was killed here to-day by the breaking of the conducting rod of the engine of a passenger train.

NEW YORK, 17.—Edwin Booth was probably fatally injured yesterday. While driving in his phaeton near his residence, at Coscob, his horse became frightened and ran away; the phaeton was demolished and Mr. Booth was thrown to the ground with great violence, receiving internal injuries. Information of the sad accident was telegraphed by his wife to her father, Mr. McVicker, of Chicago. Mrs. Booth, mother of Edwin, and his brother Joseph were summoned from Long Branch. Coscob is the point at which Charles M. Barras, the author of the Black Crook, was killed several years ago.

A Washington special says that the celebrated and important case lately decided by the Court of Claims in favor of the Union Pacific Railroad Company has been appealed by the Attorney General to the Supreme Court of the U. S.

It is now said that the total assets of the firm of Duncan, Sherman & Co., including their personal property will be not less than \$900,000 or \$1,000,000, while their total indebtedness does not exceed \$625,000.

At the unveiling of the Hermann Statue, at Detwold, yesterday, the Emperor of Germany made a short address, in which he said that it was one of the most affecting festivals he had ever witnessed, and he rejoiced in this movement, inaugurating a new era of happily united Germany; and if all the world would do their duty toward the beloved fatherland it would remain so forever.

CHARLESTON, 17.—There was an exciting time last evening in Columbia, caused by proceedings under *habeas corpus* for the release of ex-Treasurer Parker. The application was heard at five p.m., before Judge Mackey, Parker's counsel claiming his discharge under the provision of the Constitution prohibiting imprisonment for debt. The sheriff's return failed to allege that the case was one of fraud, a charge which is especially excepted by the constitutional prohibition of imprisonment for debt, and after argument the Judge released the prisoner. The court room was filled with an excited crowd. Parker was immediately re-arrested on a criminal warrant for grand larceny, but his counsel waived an examination, urging that the amount involved in the alleged robbery had nothing to do with the amount of bail, and he succeeded in getting him released on two thousand dollars. The *News and Courier* denounced the release as a gross judicial outrage and a job put up by certain State officials.

CHICAGO, 17.—The Rockford, Rock Island and St. Louis railroad was sold under the hammer in this city yesterday, and brought one million, three hundred and twenty thousand dollars. The Union Trust Company of New York held a claim against the corporation for over a million; the German bondholders were the purchasers.

A Washington special says—"Preparations for the retirement of the fractional currency outstanding, and the substitution of silver therefor, are being pushed forward by the Treasury Department. To the accomplishment of this end over \$10,000,000 of five per cent. bonds have already been sold in the purchase of silver bullion, and it will require the disposition of \$10,000,000 more before a sufficient amount of silver will have been accumulated to commence resumption, thus adding \$20,000,000 to the interest-bearing debt. To carry out the provisions of the so-called specie-resumption bill, passed last January, which will, it is estimated at the Treasury

Department, necessitate a total increase of the bonded debt of about \$350,000,000. Should this estimate prove correct, there will be an additional burden of near \$18,000,000 imposed upon the taxpayers of the country, to meet the interest on these bonds. Secretary Bristow claims the right, under the provisions of the bill, to issue any amount of five per cent bonds necessary to carry it into effect. The funding act of 1870 fixed the amount of five per cent bonds to be issued at \$500,000,000; of this amount \$463,000,000 have been disposed of, and the syndicate has the option of the remainder until November next.

A special to the *Evening Journal* says that the body of Grimwood was found yesterday near Stony Creek, on the shore of Lake Michigan; nearly all the clothes were on it, and notes and letters were discovered which prove unmistakably his identity.

PORT CHESTER, N. Y., 17.—Edwin Booth's injuries consist of fractures of the left elbow bone and of one rib. He is quite comfortable, and will be as good as new in a few weeks.

INDEPENDENCE, Ks., 17.—Information from Coffeyville is to the effect that the commissioners appointed to investigate the charges against Indian agent Gibson will arrive at the Osage mission and commence their labors to-day. The chief of the Osage Indians makes a number of charges against Gibson, the most important of which are making false vouchers for salaries paid his employees, and false vouchers in regard to the amount of rations furnished the Little Osages.

Somebody is hiding in the woods near Nashua, N. H., and shooting at boys who venture near.

A person looking at some skeletons asked a young doctor present where he got them. He replied, "We raised them."

"Please, sir," said a boy, with two bottles, to a grocer, "mother want's a cent's worth of your best yeast." "Well, which bottle will you have it in?" "Please, sir, she wants it in both; and won't you put corks in 'em, and send 'em home, as I'm going t'other way; and mother says she hain't got no cent, but you must charge it."

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