

SPACE

Problems of Weightlessness

Man when weightless will become less tired, but he will have to exercise to keep in shape. Effects of weightlessness are tested in orbital flight, Tove Neville reports.

See Front Cover

► THE STRANGE WORLD of weightlessness that astronauts enter when they are in orbit or in outer space has one advantage.

The astronaut is not likely to get so tired when weightless in space, despite the prescribed "setting-up" exercises he must perform as a routine and the work he must do while in space. This is because human muscles do not have to hold up the weightless body.

This advantage does not compensate for the inconveniences of weightlessness: crumbs from solid food will float in the "air"; water will rise over the brim of a glass and scatter as droplets; magnetic footwear is necessary for walking, and special propulsion units must be carried on the back for moving through space itself. The reason is lack of gravity.

Gravity is a universal force that governs the motions of all matter. It ties the millions of stars in the Milky Way galaxy together and causes the planets to rotate around the sun, the moon around the earth. The same force causes an apple to fall from a tree toward the earth's center, which is also its center of gravity.

However, as one travels farther and farther away from earth, the gravitational field becomes weaker until it is almost nonexistent in outer space. The result is weightlessness because there is practically no "pull" on the body toward earth or in any other direction.

The state of weightlessness, also called free fall or zero gravity, means literally what it says. When weightless, a person has no weight and floats free in space if not strapped down. This state has been described as a light pleasant sensation.

Weightlessness can be experienced momentarily if an elevator descends fast enough or in a plane as it describes a curve, first climbing and then descending. Some of the effects of weightlessness can be experienced when a person is immersed in water.

In 1960 a U.S. Air Force physician, Capt. Duane E. Graveline, devised an experiment for himself and lived suspended in a tank of water for a week with some startling results. While in the tank, he felt no tiredness and slept on the average of one hour in each 24-hour period. He "worked" easily in the tank, moving levers, controlling lights and various devices, simulating what man would do in a spacecraft. No decrease in mental ability was found.

However, as he stepped out of the tank after a week of "weightlessness," his blood pressure dropped, his heart beat faster, and he had difficulty talking. Further tests

showed that his ability to solve problems was decreased, and urinalysis showed that his body was eliminating essential nitrogen, calcium, phosphorus and sulfur from his muscles and bones.

All these effects of prolonged "weightlessness" can be compared to those of a person under forced bedrest, Dr. Robert B. Voas of the National Aeronautics and Space Administration's Space Task Group, Langley, Va., told SCIENCE SERVICE. Because the body is in a resting state during space flights, all the problems of inactivity encountered by the Air Force physician in the tank or by a patient lying flat on his back would apply to astronauts on long weightless flights.

This is why exercises will be necessary to keep the astronauts on a trip to the moon or the planets physically fit. However, since it is not now known how exercises affect man when weightless, astronaut John H. Glenn Jr. will exercise periodically during his space flight as he orbits the earth. Scientists on the ground will check by telemetry



WALKING ON THE CEILING—
Nancy Wendler demonstrates shoes for weightless conditions (above). The shoes' developer, John F. Heard, engineer in space technology at Martin Marietta Corporation, Denver, Colo., looks on. Tiny nylon hooks of special Velcro material (right) fastened to the ceiling fit into eyes under the shoes and allow walking on the ceiling.

the astronaut's blood pressure and heart rate as he exercises with a Bungi cord during the flight.

The Bungi cord is a type of elastic cord with a handle that is anchored between astronaut Glenn's legs in the Mercury capsule. The exercise consists of pulling on the cord with both hands.

During the entire flight the astronaut will be strapped down in his form-fitting couch by a seat belt, similar to those used in airplanes. He will, however, be able to move his head and shoulders. Every half hour he will stretch his arms and press against the couch to get further exercise.

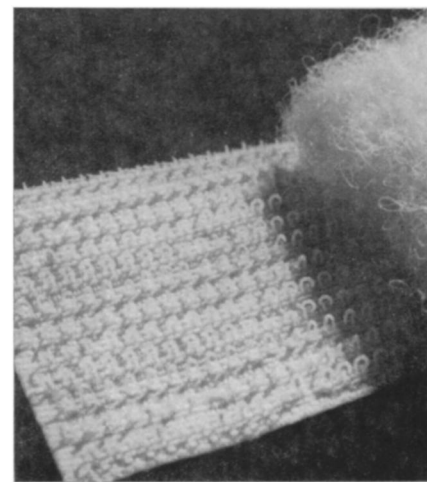
Mental as well as physical deterioration can be avoided on long space trips if the astronaut is kept busy and gets sufficient exercise. When U.S. astronauts go on longer trips, they will not be expected to sleep eight hours out of every 24. To fly in space means to work around the clock, Dr. Voas said. It is not like working an office routine from nine to five and then going home to rest. Chores may have to be done periodically during any 24-hour period.

Since there will be no night-day pattern to follow in space, astronauts, like men in Antarctica where there are long periods of daylight and darkness, will probably lose their regular routine and sleep when they need it. Since there is, in addition, less strain on the body in space, the result will probably be less sleep consisting of cat naps in between chores and recreation.

Only four men, two U.S. and two Russian astronauts, have so far experienced space weightlessness, although many men, monkeys and mice have experienced zero gravity during experiments in weightlessness.

Recently a talented group of young scientists had a chance to try weightless flight in a U.S. Air Force plane.

This was part of a three-day visit to Wright-Patterson Air Force Base, Dayton, Ohio, taken by seven of the nine winners of the Air Force awards given at the National Science Fair-International of 1961,



two of whom are shown, along with an airman in the background, on this week's cover.

The seven award winners, their home towns and their awards are as follows: William R. Eason, Longview, Texas, Aerospace Power Award; Robert E. Fischer, Forest Hills, N. Y., Photography and Optics Award; Mike F. Gorski, Indianapolis, Ind., Atmospheric Physics Award; James S. McAleer, Mobile, Ala., Aerospace Propulsion Award; Jay Sarajian, Huntington Valley, Pa., Electronics Award; Robert E. Strom, New York, Electronic Computer Award, and Baylor B. Triplett, Albuquerque, N. Mex., Materials Research Award. The two winners on the cover are James S. McAleer (right) and Jay Sarajian (left).

Two other winners, Robert Himes, Dayton, Aerospace Dynamics Award, and Christopher G. Cherniak, Eau Gallie, Fla., Biosciences Award, were unable to join the group.

When weightless, there is no such thing as right side up. Airmen at Wright-Patterson Air Force Base found this out when they walked the ceiling of a C-131 under free-fall conditions.

In these experiments, the crews wore magnetic sandals made by bolting permanent magnets to aluminum soles. Most surprising to the researchers was the fact that wherever the feet are is automatically

"down." One of the men walking on the ceiling later reported he was startled to see the pilot sitting "upside down." He also saw the men on the floor as upside down.

Men react differently to weightlessness. Some have the feeling of floating, others experience a falling sensation.

Still, this does not mean man is entirely powerless to move while weightless. While suspended experimentally in "space," men were able to move along by "swimming" as if they were in water. A person can also roll over and over by pulling his knees up under his chin and rotating his extended arms.

Another problem of weightlessness is that of providing food in suitable forms for men in free fall. The best answers found so far have been bite-size tablets made from such foods as chocolate malted milk, and cubes of beef or chicken puree paste than can be inserted singly into the mouth. Astronaut Glenn will have a supply of similar foods with him on his orbital trip for his space "lunch."

Liquids are a greater problem in weightless space. They can now be carried in plastic squeeze containers resembling toothpaste tubes. An astronaut merely inserts the open end into his mouth and squeezes to get a drink of water or his soup course for dinner.

• Science News Letter, 81:90 February 10, 1962

ASTRONOMY

Rare Grouping of Planets

► A RARE GROUPING of planets that was seen by only a few persons, yet had many talking about it, occurred Feb. 5.

The grouping was actually not a conjunction of the sun, moon and five brightest planets, although many called it that. However, on that day Mercury, Venus, the earth, Mars, Jupiter and Saturn, as well as the sun and the moon, were all located within 16 degrees of each other in the sky. This covers a region a little more than five times the distance between the two "pointer" stars of the Big Dipper.

Since the planets were all quite close to the sun, they were not visible except to those few who were in the path of the total eclipse which took place Feb. 4 in the Eastern Hemisphere and Feb. 5 in the Western Hemisphere. The path of totality, only 60 to 100 miles wide, swept across the Pacific Ocean, mostly across open ocean, from Borneo, ending several hundred miles west of Lower California.

Dr. Edgar W. Woolard, director of the U.S. Naval Observatory's Nautical Almanac Office, Washington, D. C., said the compact grouping had "virtually zero" effect on tides. The planets, he said, "do not produce" tides on earth, so it makes no difference what position they are in relative to earth, whether closely grouped or scattered across the heavens. Only the sun and moon produce tidal effects on earth.

Although astrologers attached great importance to this grouping, astronomers regard astrology as no more than a superstition. At the time of the grouping, the planets were in the direction of the constel-

lation of Capricornus, the horned goat, although they were in the astrological sign of Aquarius.

Thousands of years ago, the signs of the zodiac coincided with the constellations. However, because of the precession of the equinoxes, they have moved apart. The astrologers ignore this shift, which is one of many reasons why astronomers reject their teachings.

A Belgian astronomer, Dr. Jean Meeus of Kesselberg Observatory, found that there are historical records of two similar groupings some centuries ago, in September, 1186, and February, 1524, but that others have occurred. He computed all instances during the years from 1000 A.D. to 2400 A.D.

Taking 30 degrees of longitude as the largest extent of a compact grouping, and including the sun and the moon, he found 14 occurrences during this period. Three of these will follow the Feb. 5 grouping, the next being on May 5 in 2000 A.D.

Of all 14 events, only the Feb. 5 one occurred or will occur at the time of a total solar eclipse. Then, for observers within the moon's shadow, the sky around the sun was dark enough for the planets to be seen, weather permitting.

A number of planetary configurations combined to make this possible, Dr. Meeus reported in *Sky and Telescope*, 22:320, 1961.

Although Mars' passage by the sun occurred on Dec. 14, the planet was only 13 degrees to the west on Feb. 5. Slow-moving Jupiter was passed by the sun on Feb. 8, while Saturn passed the sun on Jan. 22.

• Science News Letter, 81:91 February 10, 1962

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