THE MATHEMATICAL ASSOCIATION OF VICTORIA

VSSEC

MATHEMATICS IN CAREERS

Investigation - Bone Mineral Density (BMD) in Astronauts

Key career focus for this investigation: Health and biomedical sciences
Related career areas: Space sciences

Image by Gerd Altmann, Pixabay

THINKING ABOUT CAREERS

- Brainstorm health professions you can think of where maths is frequently used.
  Use https://joboutlook.gov.au/ to explore health related career pathways that include use of mathematics.
  How is maths used in these scenarios? What maths is used in these scenarios?
- This task focuses on how maths is used in Health Sciences, through investigating Bone Mineral Density (BMD). A decrease in BMD can lead to health issues and diseases such as osteoporosis. The tasks specifically looks at BMD in astronauts.
- Explore careers such as Radiologists and physiotherapists to discover how maths is used in these. For a more extensive list of careers related to this task, with a maths / science focus, refer to the table at the end of the task and explore the maths used in these jobs.

MATHEMATICS IN EVERYDAY LIFE AND CAREERS

Mathematical focus for this investigation

- use appropriate methods to sort, organise, and manipulate data
- create graphs to show patterns in data
- explore the connection between algebraic and graphical representations of relations

Scientists including health professionals model relationships comparing different scenarios. The relationship may be linear or other. They graph data and compare the graphs, changing one variable to see the effect on the other to test hypothesis.

- Linear equations use one or more variables where one variable is dependent on the other.
- Many people use linear equations every day, even if they do the calculations in their head without drawing a line graph.
- Brainstorm and share scenarios where this mathematics may be used in health and biomedical science and space sciences to solve problems.

MATHEMATICAL INVESTIGATION - BONE MINERAL DENSITY (BMD) IN ASTRONAUTS

INVESTIGATION BACKGROUND

The decrease in bone density during space travel and its effects on long term space deployment are of great concern to mission specialists. A normal human on earth experiences a 1% decrease in bone mineral density (BMD) per year from after the age of 30. An astronaut in space may experience a BMD decrease of 1% per month!

YOUR INVESTIGATION

Your task is to model the relationship between BMD readings on earth and their corresponding readings from space. To assist you in your calculations and modelling the tables below (see Tables 1 and 2 provided by VSSEC) provide Astronaut BMD data for three astronauts.

Five years observation prior to Mission (Time in years)	Astronaut 1 BMD	Astronaut 2 BMD	Astronaut 3 BMD
0 (initial measurement, taken 28 Sept 2015)	1050	1500	1250
1			
2			
3			
4			
5			

Table 1: Initial BMD data and BMD calculations for a 5-year period on Earth.

Time on ISS (Time in days)	Astronaut 1 BMD	Astronaut 2 BMD	Astronaut 3 BMD
0 (initial measurement, taken before launch into space)	1050	1500	1250
30			
45			
60			
75			
90			
105			
120			
135			
150			
165			
180			

Table 2: Initial BMD data and expected BMD calculations during time on International Space Station (ISS). (Note: data represents a 6-month period).

MATHEMATICAL INVESTIGATION - BONE MINERAL DENSITY (BMD) IN ASTRONAUTS

PART 1

Complete Table 1 finding the expected BMD measurements for astronauts 1, 2, and 3, for a 5 year period, assuming they are **not** going to space in this time. Use the data from your table to find a relationship or mathematical equation that models the BMD decrease in the 3 astronauts over the 5 years.

Demonstrate your relationship with a graph.

PART 2

Complete Table 2 finding the expected BMD measurements for astronauts 1, 2, and 3, for the 6 month period, when they are on the space station. Use the data from your table to find a relationship or mathematical equation that models the BMD decrease in the 3 astronauts over the 6 month period.

Demonstrate your relationship with a graph.

PART 3

How long would the astronauts returned to earth need to recover their BMD to original readings?

PART 4

Provide a summary of your findings, showing how the relationship you have modelled explains your reasoning and understanding.

REFERENCE MATERIAL

https://www.nasa.gov/mission_pages/station/research/benefits/bone_loss.html

https://en.wikipedia.org/wiki/Osteoporosis#/media/File:615_Age_and_Bone_Mass.jpg

MATHEMATICAL INVESTIGATION - BONE MINERAL DENSITY (BMD) IN ASTRONAUTS

CAREERS RELATED TO THIS INVESTIGATION

HEALTH SCIENCE

Career description	Key skills required	More information
Health science is a wide area of practice, this activity focuses more on careers that work with body systems and treatment of disorders and diseases related to skeletal system including: • Physiotherapist • Osteopath • Chiropractor • Radiologist • Orthopaedic surgeon	• Human biology knowledge • Knowledge of health-related medical issues and injuries and their treatment • Reasoning and problem solving • Teamwork and communication • Patient focused care • Scientific method and quantitative skills • Flexibility and adaptability	www.aeseducation.com/blog/health-science-career-pathways https://careerswithstem.com.au/the-a-z-of-health-jobs/ https://careerswithstem.com.au/5-awesome-jobs-you-could-get-with-a-health-science-degree/

BIOMEDICAL SCIENCE

Career description	Key skills required	More information
Biomedical science is the study of physiology, pathology and pharmacology. It is a wide area of study with careers that vary from a sales representative for a pharmaceutical company to a toxicologist helping investigate a crime. Some examples are: • Analytical chemist • Bio technologist • Biomedical lab technician • Biomedical researcher • Clinical scientist A **Research scientist** plans and conducts experiments in order to gain new data. They then analyse and interpret this data and present it to research staff. A Research Scientist with a biomedical degree will specialise in topics such as stem cells or pharmacology.	• Analysis and representation of data • Reasoning and problem solving • Scientific method • Team work and communication • Biological and chemical knowledge	www.glassdoor.com/blog/guide/biomed-careers/

MATHEMATICAL INVESTIGATION - BONE MINERAL DENSITY (BMD) IN ASTRONAUTS

CAREERS RELATED TO THIS INVESTIGATION

SPACE SCIENCE

Career description	Key skills required	More information
• **Flight surgeons** support the health, safety and wellbeing of astronauts. • **Space scientist** apply the laws of physics, chemistry and geology to understand the universe and its contents. • **Data scientists and analysts** collect organise interpret and report on data to gain insights and information for organisations. • **Earth observation scientists** use satellite and other data to monitor life cycles of the Earth from above.	• Strong academic skills in science, especially physics • Experience with computers and technology • Understanding and applying the principles of engineering • Public speaking • Writing for presentations and papers • Applying scientific method • Team work and communication	**Flight surgeon** www.industry.gov.au/data-and-publications/australian-space-discovery-centre/pathways-for-a-career-in-space/flight-surgeons **Space scientist** www.industry.gov.au/data-and-publications/australian-space-discovery-centre/pathways-for-a-career-in-space/space-scientist

OTHER RELATED CAREERS TO EXPLORE

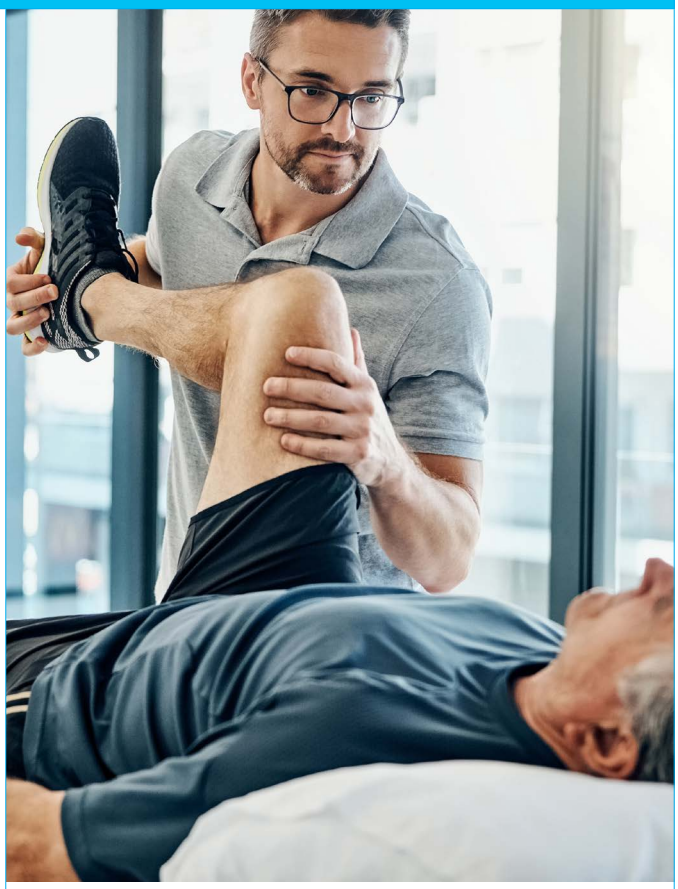
Physicist: Develops analytical methodologies and techniques to investigate the structure and properties of matter, the relationships between matter and energy, and other physical phenomena.
https://joboutlook.gov.au/occupations/physicists-including-astronomers?occupationCode=234914

Meteorologist: Studies composition, structure and dynamics of the atmosphere, investigating the direction and speed of air movements, air pressure and temperature, humidity and other phenomena.
https://joboutlook.gov.au/occupations/meteorologists?occupationCode=234913

Exercise physiologist: Assists and improves the function of muscles through physical activity and exercise programs.
https://joboutlook.gov.au/occupations/exercise-physiologists?occupationCode=234915

Other space careers: www.industry.gov.au/australian-space-discovery-centre/pathways-for-a-career-in-space

For an overview of space technology being a priority industry and sector: https://djpr.vic.gov.au/priority-industries-sectors/space-technologies.



MATHEMATICAL INVESTIGATION - BONE MINERAL DENSITY (BMD) IN ASTRONAUTS

CAREERS ACTIVITIES

THE 10 BEST RATED JOBS OF 2021			
Rank	Career	Median salary	Projected growth
1	Data Scientist	$98 230	33%
2	Genetic Counsellor	$85 700	21%
3	Statistician	$92 270	35%
4	Medical Services Manager	$104 280	32%
5	Mathematician	$110 860	33%
6	University Professor	$80 790	9%
7	Operations Research Analyst	$86 200	25%
8	Information Security Analyst	$99 730	31%
9	Actuary	$111 030	18%
10	Software Engineer	$110 140	22%

Data from Careercast.com.

Select one of the careers, from either of the tables above, that interests you and find out:

- What are the tasks involved in this career? What may a typical day look like?
- What level of education or qualifications do you need to do this career?
- What are some other similar or related careers?
- What mathematics skills would be used in this career?
- Where does the career you have selected, to investigate, rank according to careercast.com?
- How many people in Australia are currently employed in this career (or field)?

INDUSTRY PARTNER

This project was produced collaboratively between The Mathematical Association of Victoria (MAV) and the Victorian Space Science Centre (VSSEC).

The Victorian Space Science Education Centre (VSSEC) is a specialist STEM learning facility, one of six established by the Victorian State Government. Since its official opening in 2006, VSSEC has used the context of space to enhance the learning experiences in Mathematics, Science, Technology and Engineering for both teachers and students.
VSSEC is located in the grounds of Strathmore Secondary College. The spiral galaxy shaped building provides a stimulating environment which encourages students to be fully engaged in problem-solving and scenario-based learning.
www.vssec.vic.edu.au

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FURTHER CAREER REFERENCES

Australian Jobs Report 2021

www.nationalskillscommission.gov.au/australian-jobs-report
An overview of trends in the Australian labour market to support job seekers and employment service providers, career advisers, those considering future training and people interested in labour market issues.

Business Victoria Future Industries

https://business.vic.gov.au/grants-and-programs/future-industries
Future Industries is about supporting investment in high-growth industries through industry excellence and development projects, including establishing collaborative networks and building supply chain readiness capabilities.

Career Education

www.education.vic.gov.au/school/teachers/teachingresources/careers/Pages/default.aspx
Career Education teaching resources to help teach students to make informed career decisions and equip themselves for the world of work.

CEAV Online Learning Resources

https://ceav.vic.edu.au/media/250615/careers-in-the-construction-technology-industries-student-resource.pdf
Designed to enable students to attend a virtual Industry Immersion Experience, these online resources will help students discover more about Victoria's priority growth industries and give them the opportunity to reflect on their skills, interests and undertake career planning and exploration.

Jobs Victoria

www.jobs.vic.gov.au

JobOutlook

www.joboutlook.gov.au
Relevant and current labour market trends and career information.

MyFuture

www.myfuture.edu.au
A database of over 600 careers.

National Careers Institute

www.dese.gov.au/nci
The National Careers Institute (NCI) ensures Australians have access to reliable and accurate careers information, resources, and support.