



# Leonardo

DA VINCI'S WORKSHOP

EDUCATOR'S GUIDE | GRADES K-12

## DURING

THEIR VISIT TO LEONARDO DA VINCI'S WORKSHOP, STUDENTS WILL:

- Explore the science and art of machines;
- Interact with hands-on devices that present Leonardo's drawings and notebooks; and
- Learn about Leonardo's life story.

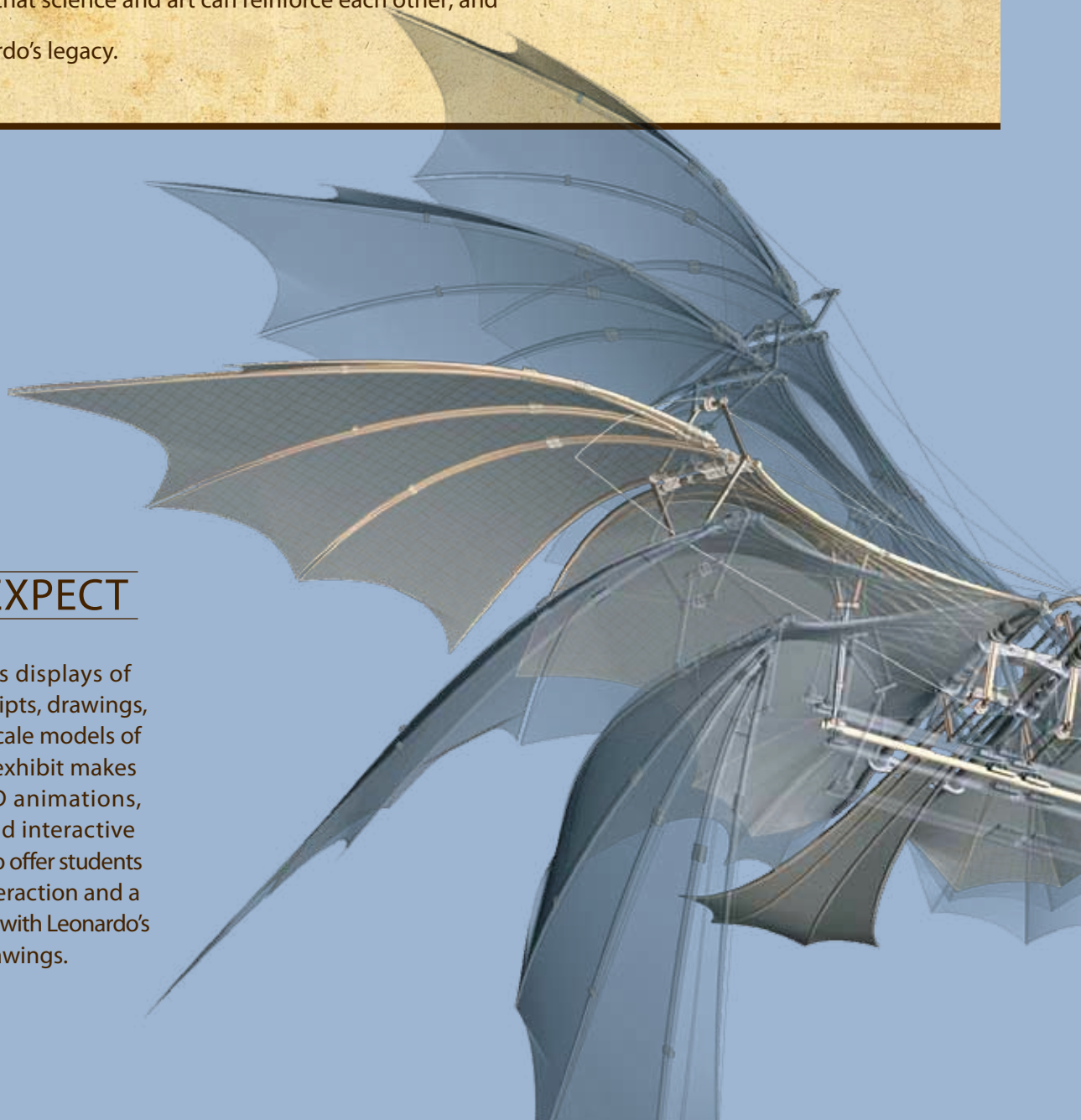
## AFTER

THEIR VISIT TO LEONARDO DA VINCI'S WORKSHOP, STUDENTS WILL:

- Be inspired to imagine their own innovative inventions;
- Understand that science and art can reinforce each other; and
- Know Leonardo's legacy.

## WHAT TO EXPECT

The exhibit features displays of Leonardo's manuscripts, drawings, paintings, and full-scale models of his inventions. The exhibit makes extensive use of 3D animations, physical models, and interactive touch-screen kiosks to offer students a unique level of interaction and a hands-on experience with Leonardo's manuscripts and drawings.



## QUICK TIPS

- The entrance to the exhibit is located in the Special Exhibition Hall on Level 6. To get to the Special Exhibition Hall from the front entrance on Level 2, take 3 escalators down and walk straight to the entrance of Leonardo da Vinci's Workshop - The Exhibition.
- The learning experience is greatest when students engage with the numerous interactive stations scattered throughout the exhibit. You might recommend that students work in small groups in order to enable everyone to use all of the devices.
- On average, most groups will spend about 45 minutes in the exhibit, if making full use of the interactive devices and carefully examining all of the models.



# WHO WAS LEONARDO DA VINCI?

## A BIOGRAPHICAL OVERVIEW



Born: April 15, 1452

Died: May 2, 1519

Leonardo was born on April 15, 1452, in Vinci, Italy, just outside Florence, to unmarried parents. His father was a notary and his mother a peasant. His father took custody of Leonardo shortly after his birth, while his mother married someone else and moved to a neighboring town. They kept on producing children, although not with each other, and they eventually supplied Leonardo with a total of 17 half sisters and brothers.

Growing up in his father's Vinci home, Leonardo had access to scholarly texts owned by family and friends. He was also exposed to Vinci's longstanding painting tradition, and when he was about 15, his father apprenticed him to the renowned workshop of the painter Andrea del Verrochio in Florence. Even as an apprentice, Leonardo demonstrated great talent. Leonardo stayed in the Verrocchio workshop for ten years until he left to start his own workshop where he painted his first commissioned work, "The Adoration of the Magi".

Five years later, in search of new challenges and in need of money, Leonardo moved on and entered the service of the Duke of Milan. He spent 17 years there, leaving only after the Duke's fall from power in 1499. It was during these years in Milan that Leonardo hit his stride, reaching new heights of scientific and artistic achievement.

The Duke kept Leonardo busy painting, sculpting, and designing elaborate court festivals, but he also put Leonardo to work designing weapons, buildings, and machinery. From 1485 to 1490, Leonardo studied many subjects, including nature, flying machines, geometry, mechanics, municipal construction, canals, and architecture—designing everything from churches to fortresses. His studies from this period include designs for advanced weapons, including a tank and other war vehicles, various combat devices, and submarines. Also during this period, Leonardo produced his first anatomical studies. His Milan workshop was a veritable hive of activity, buzzing with apprentices and students.

Alas, Leonardo's interests were so broad, and he was so often compelled by new subjects, that he usually failed to finish what he started. This lack of focus resulted in his completing only about six works in these 17 years, including "The Last Supper" and "The Virgin on the Rocks", leaving dozens of paintings and projects unfinished or unrealized. He spent most of his time studying science, either by going out into nature and observing things or by locking himself away in his workshop cutting up bodies or pondering universal truths.

# WHO WAS LEONARDO DA VINCI?

## A BIOGRAPHICAL OVERVIEW

(continued)

Between 1490 and 1495 he developed his habit of recording his studies in meticulously illustrated notebooks. His work covered four main themes: painting, architecture, mechanics, and human anatomy. These studies and sketches were collected into various codices and manuscripts, which are now collected by museums and individuals.

After the Duke of Milan fell from power in 1499, Leonardo was left to search for a new patron. Over the next 16 years, Leonardo worked and traveled throughout Italy for a number of employers, including Cesare Borgia. He traveled for a year with Borgia's army as a military engineer and even met Niccolo Machiavelli, author of "The Prince". Leonardo also designed a bridge to span the "golden horn" in Constantinople during this period and received a commission, with the help of Machiavelli, to paint the "Battle of Anghiari".

In about 1503, Leonardo reportedly began to paint the "Mona Lisa", what some might call his ultimate masterpiece. From 1513 to 1516, he worked in Rome, maintaining a workshop and undertaking a variety of projects for the Pope. He continued his studies of human anatomy and physiology, but the Pope forbade him from dissecting cadavers, which truly cramped his style.

In March of 1516, Leonardo was offered the title of Premier Painter and Engineer and Architect of the King by Francis I in France. His last and perhaps most generous patron, King Francis I provided Leonardo with a comfortable position, including a stipend and manor house near the royal chateau at Amboise.

Although suffering from a paralysis of the right hand later in life, Leonardo was still able to draw and teach. He produced studies for the Virgin Mary from "The Virgin and Child with St. Anne", studies of cats, horses, dragons, St. George, anatomical studies, studies on the nature of water, drawings of the Deluge, and of various machines.

Leonardo died on May 2, 1519 in France at the age of sixty-seven.





## WHAT'S IN THE EXHIBIT?

Leonardo kept meticulous notebooks that captured his inventive ideas. These notebooks are now known as the manuscripts and codices. Several of them are featured in the exhibit—either physically or through virtual reproduction.

### MANUSCRIPT B

Manuscript B is the earliest of Leonardo's bound manuscripts. It contains drawings and notes relating to a range of subjects, the most famous of which concern mechanical inventions for flight, a submarine, and architectural studies with designs for churches based on centralized plans.

### CODEX ON FLIGHT

As suggested by its name, this manuscript deals primarily with the flight of birds, which Leonardo analyzed closely in his efforts to build a mechanical flying machine. Here the mechanics of flight, air resistance, and the effects of wind on the wings and flight of birds are all considered in great detail.

### CODEX ATLANTICUS

The Codex Atlanticus is the largest and most amazing collection of Leonardo's manuscripts. Using the technique of high resolution digitalization, the 100 most fascinating manuscript pages have been reproduced and collected into an interactive book, allowing the pages to be turned and examined directly – something never before available to the public.

Some of Leonardo's ideas, as captured in his notebooks, have been produced as models and placed on display in the exhibit.

### MECHANICAL LION

In 1515, Leonardo built a mechanical lion that was brought to Lyon to impress Francis I, the king of France. Written testimonies recount that Leonardo had designed this mechanical automaton in the shape of a lion that walked on its own, came to a stop, and released lilies from its chest.



## WHAT'S IN THE EXHIBIT?

### HARPSICHORD-VIOLA

The Codex Atlanticus includes a study of a very complex musical instrument that has never seen the light of day until now. While there's no record of whether or not Leonardo ever made a physical version of it, the detailed nature of these drawings implies that he may very well have built a prototype.

### ROBOT-KNIGHT

The Codex Atlanticus also contains some confusing subjects. The Leonardo 3 research centre has brought several separated mechanisms on the page together: pulleys, a drum, a clock work system, some gears, various mechanisms, a helmet, and a coupling for battle armor. The result is the torso of an artificial soldier that can beat its hands against its chest when the central wheel is set in motion.

### SELF-PROPELLING CART

Featured in the Codex Atlanticus, Leonardo's famous self-propelling cart is a complex model for an automaton, a machine to provide theatrical effects. The vehicle can be programmed to move by itself and is wound up by the main springs.

### GREAT KITE

The Codex on Flight represents the most advanced of Leonardo's studies on flight. He drew inspiration for his work from his direct observation of the flight of the kite bird. He has left us with several drawings and designs for flying machines, especially in the Codex Atlanticus and Manuscript B.

### AERIAL SCREW

Manuscript B includes one of Leonardo's most famous drawings, believed to represent the first helicopter in history. In actuality, however, it's nothing of the sort. Instead, it represents an experimental design for an "aerial screw" used to verify air's fluid nature. Theoretically, this consistency of air would allow the "screw" to push against it and spin upwards off the ground.



## WHAT'S IN THE EXHIBIT?

### MECHANICAL BAT

One of the most advanced of Leonardo's designs for a flying machine is found in the Codex Atlanticus. It's an enormous mechanical bat almost 65 feet wide. The shape of the wings and the number of sections are exactly like those of a bat. The pilot's place is in the centre of the machine. The wings are covered in a square-mesh net that is used to secure the canvas and to allow air to pass through when the wings are folded upwards. Leonardo suggests using linen canvas, properly water-proofed, then sewn and fixed to the net as well as to the wooden struts which are soaked in water to make them pliable. The tail is used to give stability to a machine that could in fact be used as a glider.

### MULTI-CANNON GUNSHIP

The Codex Atlanticus begins with his drawing for a multi-cannon gunship with 16 barrels and a complex central mechanism, probably for moving and turning the "armored gunship" on the water. The sketches suggest other details of the gunship such as a series of oars.

Finally, Leonardo's masterful paintings must be considered. The exhibit features reproductions from the original plates produced by the Italian Royal da Vinci Commission.

### THE LAST SUPPER

The Last Supper (also known as The Cenacle) is painted in tempera and oils on two preparatory chalk layers over plaster. The painting measures 460 cm x 880 cm and was created between 1494 and 1497. The Cenacle is considered the greatest of Leonardo's paintings and the only one of his frescoes to have survived. It depicts the scene of the Eucharist at the moment when Christ says, "One of you shall betray me". Judas feels he is being accused. St. James the Great is stunned and throws his arms wide. Beside him, St. Philip clutches his hands to his breast. St. Peter leans forward impulsively, while in front of him, Judas steps back, looking guilty. At the far right of the table, from left to right, St. Matthew, St. Thaddeus, and St. Simon's agitated gestures express their bewilder-



## WHAT'S IN THE EXHIBIT?

ment and incredulity. In the centre, Christ is portrayed with his arms open on the table. The scene takes place in a virtual area that extends the walls of the supper room. The added virtual light coming from the left corresponds to the real light in the room, which in fact has windows in the left-hand wall.

### THE MONA LISA

The Mona Lisa shows a woman with a thoughtful expression and a slight smile. The painting, in oils on poplar wood, measures 77 cm x 53 cm. It was created between 1503 and 1506. The original hangs in the Louvre in Paris. The woman is probably Mona Lisa Gherardini, a courtesan from a country family of minor nobility, who lived around the end of the 15th century.

# CURRICULUM CONNECTIONS

## SCIENCE AND TECHNOLOGY

### UNDERSTANDING STRUCTURES AND MECHANISMS

#### Grade 4 Pulleys and Gears

- 3.1 describe the purposes of pulley systems and gear systems
- 3.2 describe how rotary motion in one system or its components is transferred to another system or component in the same structure
- 3.3 describe how one type of motion can be transformed into another type of motion using pulleys or gears
- 3.4 describe, using their observations, how gears operate in one plane and in two planes
- 3.5 distinguish between pulley systems and gear systems that increase force and those that increase speed
- 3.6 identify pulley systems and gear systems that are used in daily life, and explain the purpose and basic operation of each
- 3.8 identify the input components that drive a mechanism and the output components that are driven by it

#### Grade 5 Forces Acting on Structures and Mechanisms

- 3.1 identify internal forces acting on a structure and describe their effects on the structure
- 3.2 identify external forces acting on a structure and describe their effects on the structure, using diagrams
- 3.3 explain the advantages and disadvantages of different types of mechanical systems

#### Grade 6 Flight

- 3.3 identify and describe the four forces of flight – lift, weight, drag, and thrust
- 3.4 describe, in qualitative terms, the relationships between the forces of lift, weight, thrust, and drag that are required for
- 3.5 describe ways in which flying devices or living things use unbalanced forces to control their flight
- 3.6 describe ways in which the four forces of flight can be altered

# CURRICULUM CONNECTIONS

## SCIENCE AND TECHNOLOGY

### Grade 7 Form and Function

- 1.1 evaluate the importance for individuals, society, the economy, and the environment of factors that should be considered in designing and building structures and devices to meet specific needs
- 3.1 classify structures as solid structures frame structures or shell structures
- 3.2 describe ways in which the centre of gravity of a structure affects the structure's stability
- 3.3 identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure
- 3.4 distinguish between external forces and internal forces (tension, compression, shear, and torsion) acting on a structure
- 3.5 describe the role of symmetry in structures
- 3.6 identify and describe factors that can cause a structure to fail
- 3.7 identify the factors that determine the suitability of materials for use in manufacturing a product

### Grade 8 Systems in Action

- 3.1 identify various types of systems
- 3.2 identify the purpose, inputs, and outputs of various systems

# CURRICULUM CONNECTIONS

## SCIENCE AND TECHNOLOGY

### Grade 11U Physics

#### Kinematics

- B1.1 analyse, on the basis of research, a technology that applies concepts related to kinematics

#### Forces

- C1.1 analyse, with reference to Newton's laws, a technology that applies these laws and propose ways to improve its performance

### Grade 12U Physics

#### Dynamics

- B1.1 analyse a technological device that applies the principles of linear or circular motion

#### Energy and Momentum

- C1.1 analyse, with reference to the principles of energy and momentum, and propose practical ways to improve, a technology or procedure that applies these principles
- C3.4 explain the implications of the laws of conservation of energy and conservation of momentum with reference to mechanical system

### Grade 12C Physics

#### Mechanical Systems

- C3.1 identify and describe, in quantitative and qualitative terms, applications of various types of simple machines
- C3.2 explain the operation and mechanical advantage of compound machines and biomechanical systems
- C3.3 explain, with reference to force and displacement, the conditions necessary for work to be done C3.4 explain the concept of mechanical advantage

#### Energy Transformations

- E3.2 explain the energy transformations in a system using principles related to kinetic energy, gravitational potential energy, conservation of energy, and efficiency

# CURRICULUM CONNECTIONS

## THE ARTS

Leonardo's magnificent notebooks, drawings, and paintings on display in the exhibit are reproductions, created from original commissioned copies. A visit to the exhibit, therefore, is an ideal art appreciation opportunity for students, especially as an opportunity to recognize the connections between art and science.

### INTEGRATED ARTS, GRADE 9 OR 10

- B2.1 describe the role of the arts as a vehicle for both cultural expression and the individual expression of the artist, with reference to works from both the past and the present
- B2.2 communicate an understanding of the ability of the arts to inform and instruct and to contribute to social change

### VISUAL ARTS, GRADE 9

- A3.3 demonstrate an understanding of some of the ways in which art works can be presented to reach a variety of audiences
- B1.2 identify, on the basis of examination, elements and principles of design used in various art works, and describe their effects
- B1.3 interpret a variety of historical and/or contemporary art works
- B2.1 identify the functions of various types of art works in past and present societies
- B2.2 identify ways in which various art works reflect the society in which they were created
- C2.1 demonstrate an understanding of some techniques that artists use to achieve specific effects

### VISUAL ARTS, GRADE 10

- A3.3 demonstrate an understanding of a variety of ways in which art works can be presented to reach different audiences
- B2.1 identify and describe the function of various types of art work
- B2.2 identify and describe ways in which various art works reflect the society in which they were created
- C2.1 demonstrate an understanding of a variety of techniques that artists use to achieve specific effects

# CURRICULUM CONNECTIONS

## THE ARTS

### VISUAL ARTS, GRADE 11, UNIVERSITY/COLLEGE PREPARATION

- A3.2 explore a range of traditional and current materials, technologies, techniques, and tools used by visual artists
- B1.3 explain, with reference to particular works, both historical and contemporary, how knowledge of an art work's cultural and historical context, achieved through research, has clarified and enriched their understanding of the work's intent and meaning
- B2.1 analyse the function and social impact of different kinds of art works in both past and present societies
- B2.2 explain, on the basis of research, ways in which various art works are a response to and a reflection of the society in which they were created
- C2.1 demonstrate an understanding of a wide variety of techniques that artists use to achieve a range of specific effect

### VISUAL ARTS, GRADE 11, OPEN

- A3.3 demonstrate an understanding of a variety of ways in which art works can be presented to reach a variety of audiences and to suit a range of purposes
- B1.1 describe their initial reactions to a variety of art work
- B1.3 communicate their understanding of the meanings of a variety of historical and contemporary art works, based on their interpretation of the works and an investigation of their historical and/or social context
- B2.1 explain the functions of various types of art in past and present societies
- B2.2 identify and explain ways in which various art works are a response to and a reflection of the society in which they were created

# CURRICULUM CONNECTIONS

## THE ARTS

### VISUAL ARTS, GRADE 12, UNIVERSITY/COLLEGE PREPARATION

- A3.4 demonstrate an understanding of curatorial considerations, including those relating to the purpose of and audience for an exhibition, and explain the impact curatorial judgements can have on a collection of art works
- B1.3 explain in detail, with reference to a variety of historical and contemporary art works, how knowledge of a work's cultural and historical context, achieved through extensive research, has clarified and enriched their understanding and interpretation of a work's intent and meaning
- B2.1 analyse, on the basis of research, the function and social impact of different kinds of art works in both past and present societies
- B2.2 assess the impact of socio-economic, political, cultural, and/or spiritual factors on the production of art works
- C2.1 extend their understanding of a wide variety of techniques that artists use to achieve a range of specific effects

### VISUAL ARTS, GRADE 12, WORKPLACE PREPARATION

- A3.3 demonstrate an understanding of the variety of ways in which art works, including applied and commercial art works, can be presented to reach a variety of audiences
- B1.3 interpret the meanings of art works, including applied and commercial art works, from different historical periods
- B2.2 explain ways in which art works, particularly applied or commercial art works, reflect the values of the society in which they were created

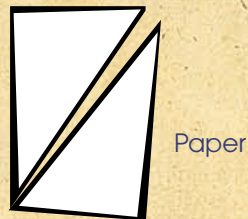
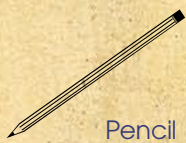
# HANDS-ON ACTIVITIES

## THE SCREW

Try This!

Leonardo's aerial screw invention is really just a giant screw. It's hard to imagine that a screw is really just a kind of inclined plane. This activity will help you see what we mean!

Things you need:

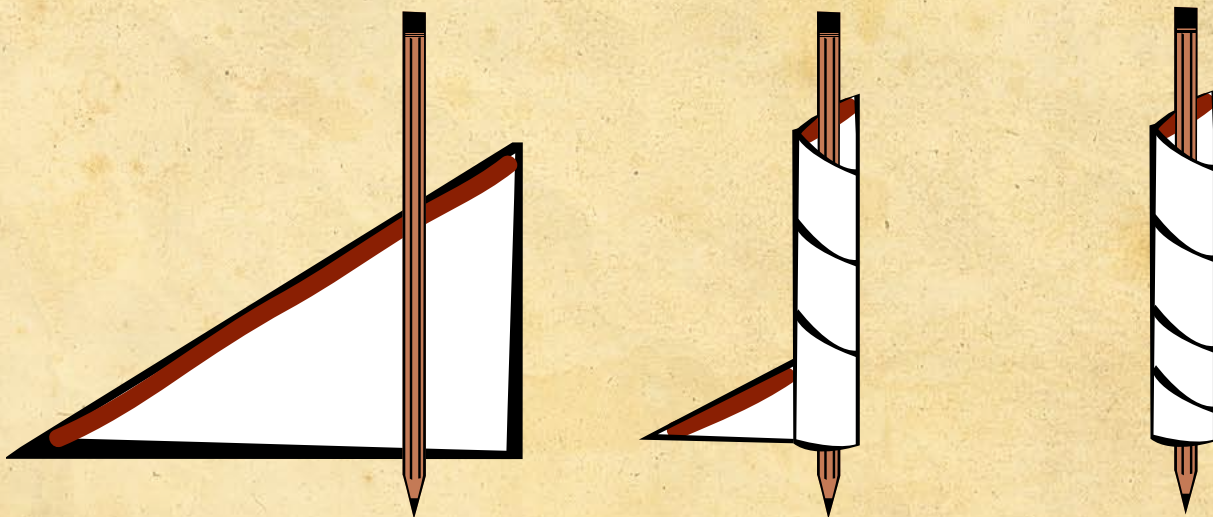


Directions:

1. Cut a right triangle from the paper. The dimensions should be about 5 inches, by 9 inches, by 10.3 inches.
2. Use the felt tip marker to colour the longest edge (10.3 inches) of the triangle.
3. Position the shortest side (5 inches) of the triangle along the side of the pencil and then evenly wrap the paper around the pencil by rolling the pencil.

Notice:

The coloured edge of the inclined plane (triangle) forms the curve that causes the circular motion which moves the cylinder (pencil) forward in a linear motion.



# HANDS-ON ACTIVITIES

## THE PULLEY

### Try This!

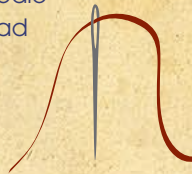
Look closely at Leonardo's Robot-Knight and you'll see the important role that pulleys play in that invention. Try this activity to see how a simple pulley transfers energy from one end to the other.

### Things you need:

Two identical buttons



Sewing needle and thread

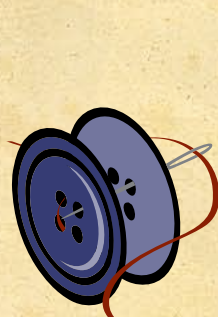


Spool of heavy cotton thread



### Directions:

1. Thread the sewing needle with regular sewing thread.
2. Hold the buttons with their smooth sides together, sew them together and knot the thread.
3. Cut a piece of heavy cotton thread about 10-12 inches long.
4. Wind the heavy cotton thread between the connected buttons two or three times and tie a knot.
5. Pull the cotton thread tight and wind it all around the center of the buttons.
6. Tie a finger sized loop in the end of the thread.
7. Place your finger in the loop and flick your new button yo-yo up and down!



### Notice:

A yo-yo is a simple pulley system that transfers the energy from your arm to the buttons and back again.

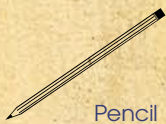
# HANDS-ON ACTIVITIES

## VITRUVIAN MAN

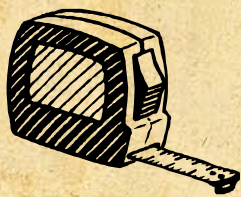
### Try This!

Vitruvian Man drawn by Leonardo da Vinci in 1492 shows how the proportions of the human body fit into the geometric forms of a square and a circle. According to the theory described by Vitruvius, a Roman architect from the first century B.C., the distance from fingertip to fingertip (arm span) should be equal to the distance from head to heel (height).

Things you need:



Pencil



Measuring tape



Vitruvian Man image

Directions:

1. Test Vitruvius' theory of human proportions: The span of a person's arms is equal to their height.
2. Working with a partner, measure your arm span by standing against a wall and stretching your arms outwards as far as possible. Have your partner measure the distance from longest finger on one hand to the tip of the longest finger on the other hand. Record your measurements.
3. Remove your shoes and have your partner measure your height as you stand against a wall. Measure the distance from the top of your head to the floor.
4. Calculate the difference between your arm span and your height and express as a ratio. For example, if your height is 160 cm and your arm span is 170 cm, your height to arm span ratio is 1:1.06.
5. Gather data from all students in your classroom. What is the average of the ratios from all the students in your class?

Notice:

The Vitruvian theory contains several other ratios between different parts of the body including:

- Length from the elbow to the end of the hand is equal to one quarter of height (1:4)
- Length of the hand is one tenth of height (1:10)
- Length of the foot is one seventh of height (1:7)

Continue your exploration by determining these measurements on yourself and your partner. Calculate the 4 ratios listed above to determine if your ratios match those stated in Vitruvius' theory.

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## ADDITIONAL RESOURCES

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Ontario Science Centre da Vinci Adventure and Hunt – These engaging activities will tease your brain and challenge your problem-solving skills as you explore the exhibition and hunt for other specially-marked exhibits here at the Ontario Science Centre!

<http://www.ontariosciencecentre.ca/davinci/default.asp>

Universal Leonardo – Explore games, resources and exhibitions dedicated to uncovering Leonardo da Vinci's life and thoughts.

<http://www.universalleonardo.org>

Online Game – Help Leonardo da Vinci to configure the system of cannonball movement towards the designated urns with the help of different types of objects.

<http://armorgames.com/play/10964/fun-da-vinci>

Leonardo3 – Producer of Leonardo da Vinci's Workshop – The Exhibition currently at the Ontario Science Centre

[http://www.leonardo3.net/leonardo/leonardo\\_eng.htm](http://www.leonardo3.net/leonardo/leonardo_eng.htm)

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If you have questions or comments about this educational guide, please contact School Bookings:

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