Dalí Museum, Saint Petersburg, Florida

Integrated Curriculum Tour Form

Education Department, 2015

TITLE:

“Salvador Dalí: High School Dalínian Science”

SUBJECT AREA:

(Visual Art, Language Arts, Science, Mathematics, Social Studies)

Visual Art, Science (Next Generation Sunshine State Standards listed at the end of this document)

GRADE LEVEL(S):

Grades: 9-12 and General Audience

DURATION: (Number of Sessions, Length of Session)

One session (30 to 45 minutes)

Resources: (Books, Links, Films and Information)

Books:

• The Dalí Museum Collection: Oil Paintings, Objects and Works on Paper.
• The Dalí Museum: Museum Guide.
• The Dalí Museum: Building + Gardens Guide.

Links:

• Florida Art Education Association: www.faea.org
Films:

- *Dali Condensed*: 5 lecture series, Peter Tush, Curator of Education Dali Museum You Tube Site.
- *The Dali Dimension, Decoding the Mind of a Genius*, Psychoanalysis, Relativity Theory, DNA & Genetics, Mathematics, Nuclear Physics.

Information:

Leonardo da Vinci (1452-1519)
- Italian polymath, scientist, mathematician, engineer, inventor, anatomist, painter, sculptor, architect, botanist, musician and writer. Leonardo has often been described as the archetype of the Renaissance man.
- Painstaking observations and carried out research in fields ranging from architecture and civil engineering to astronomy to anatomy and zoology to geography, geology and paleontology.
- Leonardo had a device for waking.
- Spring Device, geometric perspective.
- c. 1478: Studies of Self-Propelled cart, Codex Atlanticus.
- 1480: Parachute.
- 1480: Archimedes screws and pumps to draw up water.
- 1485: Drawing of a flying machine.
- 1485: Scythed Assault Chariot.
- 1487: Canon Foundry.
- 1490: Study of Horses.
- 1492: *Vitruvian Man*.
- 1500: Scuba.
- 1502: Armored Tank.
- 1503-04: Study of battles on horseback and foot.
- 1503-05: The Battle of Anghiari (detail), copy by Peter Paul Reubens.
- 1504-05: Head Studies.
- 1505: *The Battle of Anghiari*.
- 1505: Studies of wing for glider, Codex on the Flight of Birds.
- 1509-10: Muscles of the Shoulder, Geometric proportions applied to the human figure, Windsor.
- 1510-13: Catapult drawings.
- 1510-13: Old man with studies of the action of water.
- 1510-13: Studies of anatomy, including embryos.
- 1513-14: Anatomy of bird wing.
- 1515: Study of Dancers.
- 1651: *Treatise on Painting* published. In the posthumous *Treatise on Painting* (1550), Leonardo advocates the visual study of stains on walls, ashes in a fire place, or mottled and grainy stones, mud, or clouds – things that are formless and "confused." He says that in and of themselves they are meaningless. However, through visual subjective fantasy, "a new invention of speculation" emerges by which "if you consider them well, you will find really marvelous ideas."

Sigmund Freud
- Vienna was the center of Medical Research.
- Freud as Scientist.
- The Dream Subjected to Rational Inquiry.
- Dreams have Meaning: ‘The Royal Road’ to the Unconscious.
- Freud’s Theory of Dream Construction:
  1. The purpose of the dream is to preserve sleep.
  2. The dream expresses a concealed wish.
  3. Manifest versus latent content.
  4. The dream content is instigated by something in the past day or so. (Day Residue)
  5. The Day Residue is also used to express a wish from the past, often childhood.
  6. Latent wish attaches to day residue.
  7. Censor employs the Dream Work to disguise the wish.
  8. In dreaming there is also a 'topographical regression' to primary process expression in the dream work.
- The Dream Work:
  1. Displacement.
  2. Condensation.
  5. Secondary Revision upon awakening.
Freud and Surrealism.
Dali reads *Interpretation of Dreams* in art school and the rest of Freud’s work in the 20’s.
Paranoiac-Critical method influenced by psychoanalysis.
Salvador Dalí, Drawings of Freud.
1929: Salvador Dalí, *First Days of Spring*.
1934: Salvador Dalí, *Skull with Its Lyric Appendage Leaning on a Night Table Which Should Have the Exact temperature of a Cardinal Bird’s Nest*.
Scientific Status of Freud’s Dream Theory Now.
1. REM Studies: Dement (Stanford)
2. Human Lesion Studies.
3. PET and fMRI studies.
Controversy.
2. No manifest v. latent distinction.
3. Dreams express no latent instinctual wish.
4. Dreams derive from Pons region of brain and only during REM sleep.
5. Mark Solms (London)
6. REM and Dreaming comes from activation of different areas.
8. Hobson pulls back.
Neuroanatomical Studies: Calvin Wu (Hong Kong)
1. Dream work: Parietal lobule (supramarginal gyrus).
2. Topographical regression: infero temporal cortex (BA 37) is pathway for transforming motivated urges (wishes) into perceptual hallucinatory satisfactions.

Salvador Dalí (1904-1989)
• Key scientific areas of interest to Dalí:
  1. Scientists and Inventions.
  2. Psychoanalysis.
  4. Physics (Optics, Atomic Theory, Quantum Mechanics, and Holography Fourth Dimension).
When asked if scientists believe him to be mad, Dalí responded: “Quite the opposite, they all find me pleasant and say some of my statements: ‘Well, he doesn’t talk as much rubbish as it seemed.’ My only advantage is that I don’t know anything about anything, so I can give rein to my most capricious and irrational little whims on the basis of my light reading. And I am blessed with a certain amount of genius, from time to time I say something that doesn’t strike them as all that improbable.”
  “Scientists give me everything, even the immortality of the soul.”
Dalí had a device for remembering dreams.
1925: Albrecht Durer, Perspective Machine.
1920’s: Erwin Schrodinger, Viennese theoretical physicist who achieved fame for his contributions to quantum mechanics in the 1920’s, specifically his discovery of a new form of atomic theory – wave mechanics.
1927: Werner Heisenberg, German theoretical physicist who laid the foundation for quantum mechanics. Heisenberg Uncertainty Principle: In quantum physics, an electron is both a particle and a wave simultaneously as it moves around a nucleus. But we are unable to know both the position and the momentum of an electron atom simultaneously. We can only know one or the other, never both (this is called wave-particle duality).
Dalí’s illustration of a viewing device from *50 Secrets*.
Andre Breton, the leader of the Surrealists, felt that poets have the same right to explore and experiment with the unconscious as scientists did.
1929: Salvador Dalí, *First Days of Spring* employs attacks on rationality.
1929: *The Great Masturbator*.
1931: Salvador Dalí, *The Persistence of Memory*, Camembert cheese was the inspiration for the melted watches.
1933-35: *Archeological Reminiscence of Millet’s Angelus*, For Dali, the female figure’s posture is “...symbolic of the exhibitionistic eroticism of a virgin in waiting, the position before the act of aggression such as that of a praying mantis prior to her cruel coupling with the male that will end with his death.”
1935: Salvador Dalí, *Conquest of the Irrational*, Dali described himself as a fish swimming between “the cold water of art and the warm water of science.”
Albert Einstein, German theoretical physicist. One of the most influential scientists of all time, best known for his theories of special relativity and general relativity. Einstein developed a theory of the universe based on a space-time continuum. Gravity was an integral part, and light and other electromagnetic signals propagated through it at a constant speed – the speed of light.
Consequences of Einstein’s theory of relativity:
1. Two events, simultaneous for one observer, may not be simultaneous for another observer if the observers are in relative motion.
2. Rays of light bend in the presence of a gravitational field.
3. A moving clock ticks more slowly than an observer's "stationary" clock.
4. Time goes more slowly in higher gravitational fields.

- The Observer Effect: In science, the observer effect refers to changes that the act of observing has on the phenomenon being observed. For example: observing an electron will change its path because the observing light or radiation contains enough energy to disturb it. In quantum mechanics, if the outcome of an event has not been observed, it exists in a state of superposition, which is being in all possible states at once. The most famous example is the thought experiment Schrodinger's cat, in which the cat is neither alive or dead until observed – until that time, the cat is both alive and dead (technically half-alive and half-dead in probability terms).

- **1935:** Paranoiac Critical Visage, Based on a postcard of an African Village.
- **1935-72:** Dalí hired Murcian architect Emilio Perez Pinero, a young architect who shared Fuller's enthusiasm for geodesic domes.
- **1936/1957:** Harold Edgerton, Milk Drop Coronet, Stroboscopic image. Dalí’s stylized signature adopted Edgerton’s image.
- **1938:** Salvador Dalí, The Picture Disappears.
- **1945:** August 6, 1945 “Little Boy” bomb dropped on Hiroshima by the Enola Gay B-29. The world changed with the explosion of the first atomic bomb. For Jean-Paul Sartre, this was the moment that founded Existentialism. For Jackson Pollock and his peers, painting became about process rather than representation. In the mid 1940’s, Dalí shifts from a Freudian symbolic language system to a Catholic symbolic language system, expanding his audience while remaining true to his symbolic approach to art.
- **1945:** Salvador Dalí, Atomic Idyll and Melancholic Uranium.
- **1945:** Dalí read a Spanish translation of Reverend Monsignor Ronald Knox’s essay, God and the Atom, which helped him envision reconciliation between God and science.
- **1946:** Nuclear testing on Bikini Atoll, July 24, 1946.
- **1947:** Salvador Dalí, The Sphinxes of Bikini.
- **1948:** Philippe Halsman, Dalí Atomicus, Photograph.
- **1949:** Salvador Dalí, Study for Madonna of Port Lligat.
- **1949:** Salvador Dalí, Leda Atomica.
- **1951:** Dalí states that he is a Nuclear Mystical artist. In his Manifeste Mystique, he writes: “...for the first time in the history of science, physics was providing proof of the existence of God.”
- **1951:** Salvador Dalí, Raphaelesque Head Exploding, The Wheelbarrows (Cupola Consisting of Twisted Carts), employing the dome in the Pantheon, Rome, and site of Raphael’s grave.
- **1952:** Salvador Dalí, Assumpta Corpuscularia Lapislazulina. “If Nietzsche’s Superman has not come into being, a Nietzsche’s Superwoman exists in the Assumption. She rises to heaven pushed by anti-matter angels.”
- **1953:** James Watson and Francis Crick, American and British molecular biologists who co-discovered the double helix structure of DNA.
- **1952-54:** Salvador Dalí, The Disintegration of the Persistence of Memory.
- **1954:** Salvador Dalí, Soft Watch at the moment of First Explosion, Sketch for Soft Watch Exploding into 888 Pieces After Twenty Years of Complete Motionlessness.
- **1954:** Salvador Dalí, Crucifixion (Corpus Hypercubus), “I want my Christ to be the painting containing the most beauty and joy of anything that anyone has painted up to the present day. I want to paint the Christ who will be the absolute antithesis of the materialistic and anti-mystical Christ of Grunewald.” (Mathis Grunewald, 1470-1528, Isenheim Alterpiece, 1515)
- **1955:** Salvador Dalí, Nature Morte Vivante (Still Life–Fast moving), similar to Floris van Schooten (1590-1655), Table with Food, 1617. Dalí describes this painting as “[an] explanatory painting where one can observe the dynamic and irrational dividing of a fruit dish following the coefficients of uncertainty of Heisenberg in opposition to the positive security which cubist pictures once tried to offer us.” Logarithmic spirals are found in the rhino horn on the left and in the cauliflower on the right, double helix spiral structure of the DNA molecule found in the balcony’s baluster and in the disintegrating fruit dish. The stars on the table are a reference to those in the cloisters of the Santiago de Compostela, the Spanish hospital built at the end of the Pilgrim’s Way (“Milkyway”) by Isabelle and Ferdinand. The star shape is found in the cloister’s heart-shaped groin. “... [the color shards at the lower left represent the] final bits of meaningless particles left over from [my] singe-handed assault on Abstract-Expressionism.”
- **1958:** Salvador Dalí, Anti-Matter Manifesto, Dalí proclaims that “Today the exterior world – that of physics – has transcended the one of psychology. [Instead of Freud,] my father today is Dr. Heisenberg.”
- **1958:** Dalí employs Ben Day dot pattern.
- Fibonacci sequence: 0 1 1 2 3 5 8 13 21 34 55... Fibonacci numbers can be seen in the spirals of the pine cones, in the spirals of the artichokes, and – above all – in the spirals of the sunflowers.
- **1960:** Salvador Dalí, The Ecumenical Council.
- **1963:** Roy Lichtenstein, Drowning Girl.
- **1963:** Salvador Dalí, Fifty Abstract Pictures Which as Seen from Two Yards Change into Three Lenins Masquerading as Chinese and as Seen from Six Yards Appear as the Head of a Royal Bengal Tiger.
- **1963:** Salvador Dalí, Galactalienacidosoxiribunucleicacid (Homage to Crick and Watson), soldiers as double helix DNA molecule [life], inorganic mineral molecule made of soldiers pointing guns [non-life]. The September 1962 flood of the Rio Llobregat killed 450 poor immigrants, with another 300 missing. God reaching down, in his foreshortened head, the image of Mary and Christ’s silhouette in blessing, Christ after death being pulled up to Heaven for rebirth, Gala/Madonna’s hair like Catalan bread.
- **1963:** Pierre Teilhard de Chardin, French Jesuit priest who trained as a paleontologist and geologist who took part in the discovery of Peking Man. He was interested in integrating religion and natural science, particularly Christian theology.
with theories of evolution. He came into conflict with the Catholic Church and several of his books were censured.

- 1965: Salvador Dalí, *The Railway Station at Perpignan*.
- 1973: Salvador Dalí, "The atomic explosion of August 6, 1945, shook me seismically. Thenceforth, the atom was my favorite food for thought." An atom consists of a centrally located nucleus, made up of neutrons and protons surrounded by orbiting electrons. Most importantly, atoms are tiny particles suspended in a vast vacuum, more space than particle.
- 1973: Salvador Dalí, *First Cylindric Chromo-Hologram Portrait of Alice Cooper's Brain*, Dalí produced the first three dimensional hologram with Alice Cooper wearing a 2 million dollar tiara. Dennis Gabor, Hungarian electrical engineer who invented holography.
- Buckminster Fuller, American architect, author, designer, inventor, and futurist. He developed numerous architectural inventions, the best known of which is the geodesic dome.
- Teatro Museo, Dalí's geodesic dome and the Torre Galatea, designed by Emilio Perez Pinero.
- The geodesic shape of the Enigma surrounding the east side of our new Dalí Museum refers back to the Teatro’s dome and ultimately back to Fuller.
- 1975: Dalí met with Thomas F. Banchoff, American geometry and professor at Brown University who assisted Dalí in his understanding of the fourth dimension. Dalí was photographed holding a "hypercube."
- 1976: Salvador Dalí, Gala Contemplating the Mediterranean Sea Which at Twenty meters Becomes the Portrait of Abraham Lincoln (Homage to Rothko) (Second Version). The Scientific American photo by Leon Harmon collaged in the lower left of Dalí's work.
- 1983: Salvador Dalí, The Swallow’s Tail, Dalí’s last painting inspired by Rene Thom, French mathematician who made his reputation as a topologist. He is celebrated as the founder of catastrophe theory, a new field of mathematics. A theory of mathematical structure in which smooth continuous inputs lead to discontinuous responses. Catastrophe means the loss of stability in a dynamic system. The major method of this theory is sorting dynamic variables into slow and fast. Then stability features of fast variables may change slowly due to dynamics of slow variables.
- 1985: One of Dalí's last public acts was to host the Symposium, "Culture and Science: Determinism and Freedom” at his Dali Theater-Museum.
- 1989: When Dalí passed away, there were four books on his bedside table. They were works by Stephen Hawking, Matils Ghykya, Rene Thom and Erwin Schrodinger.

Youth and Origin of Scientific Interests

- 1901: Salvador Galo Anselmo Dalí, Born on October 12, 1901, he died on August 1, 1903.
- Philippe Halsman: *Dalí in an Egg*, 1942
- 1919: Dalí contributed an essay on Leonardo da Vinci to the student magazine Studium. "Above all Leonardo was a passionate soul, in love with life; he studied and applied everything with the same ardor and the same pleasure; in life everything appeared to him positive and attractive." Da Vinci's paintings are exemplary in the "reflective, constant, loving work" that went into them.
- Both Dalí and Da Vinci had fathers who were notaries.

Freud’s Leonardo

- Sigmund Freud: Austrian neurologist who founded the psychoanalytic school of psychology.
- 1910: Freud published the analysis of Da Vinci’s *Virgin and St. Anne* under the title *Leonardo da Vinci, A Memory of His Childhood*. Later Freud said that it was “the only beautiful thing I have ever written.”
- 1932-34: Dalí wrote *The Tragic Myth of Millet’s Angelus*.
- 1963: Dalí painted *Portrait of My Dead Brother*. Dalí states, "The Vulture, according to the Egyptians and Freud, represents my mother's portrait. The cherries represent the molecules, the dark cherries create the visage of my dead brother, the sun-lighted cherries create the image of Salvador living thus repeating the great myth of the Dioscures Castor and Pollux."

Invention

- 1480: Leonardo da Vinci, Skis with which one can walk on water.
- 1513-14: Leonardo da Vinci, Studies on flight of birds in relation to the wind.
- 1493: Leonardo da Vinci, Study for helicopter and lifting wing.
- Dalí's school master, Senor Trayter, introduced him to scientific mysteries and inventions in his apartment of curiosities. Dalí loved Trayter's "optical theater," probably a stereoscope or an early slide projector, where he saw images that "were to stir me most deeply, for the rest of my life."
- 1862: Narcis Monturiol i Estarriol, Catalan engineer, artist and intellectual who invented the first combustion engine driven submarine, El Ictineo.
- 1936: Dalí in London at the International Surrealist Exhibition dressed in a deep sea diving suit.
• Scientific American was Dalí’s favorite magazine.
• 1959: Dalí demonstrates his new invention, the Ovocipede.
• Dalí explains his interest in science, “Because artists scarcely interest me at all. I believe that artists should have some notions of science in order to tread a different terrain, which is that of unity.”

Optics & Perspective
• 1480: Leonardo da Vinci, Sketch with bellows machine for drawing up water and a man using a perspectograph. A point X on the subject image is projected to a point x on the image plane via a straight ray from X to the viewer’s eye.
• Salvador Dalí, Illustration of viewing device with sea urchin from 50 Secrets.
• 1481: Leonardo da Vinci, Perspective study for Adoration of the Magi.
• 1925: Salvador Dalí, Single point perspective Study for Girl Sewing.
• 1926: Salvador Dalí, Woman at Window in Figueres.

Mathematics & the Golden Section
• 1495: Jacopo de Barbari, Portrait of Fra Luca Pacioli with Young Man.
• 1496: Luca met Leonardo.
• 1509: Luca Pacioli, Divine Proportion, Polyhedra, including a Rhombicuboctahedron, illustrated by Leonardo da Vinci.
• Dalí’s parody transformation of Leonardo’s polygons in 50 Secrets of Magic Craftsmanship.
• 1946: Prince Matila Costiesco Ghyka met Dalí while a visiting professor of aesthetics at the University of San Diego. Ghyka was a poet, novelist, mathematician, historian, diplomat, and the Romanian Plenipotentiary Minister in the United Kingdom during the late 1930’s until 1940.
• The Geometry of Art and Life, Matila Ghyka, “Inspiration, even passion is indeed necessary for creative art, but the knowledge of the Science of Space, of the Theory of Proportions, far from narrowing the creative power of the artist, opens for him an infinite variety of choices within the realm of symphonic composition. There is a geometry of art as there is a geometry of life, and, as the Greeks had guessed, they happen to be the same.”
• 1956: Nature Morte Vivante (Still Life-Fast Moving), Salvador Dalí, Transcription of Ghyka’s golden section diagram used to align images.
• 1960: The Ecumenical Council, Employs an inverted grid of dynamic triangles as illustrated in Geometry of the Greek Vase by Dr. Caskey. (Greek Vase, Stamnos, Harmonic Analysis)
• Golden Spiral: A Fibonacci spiral created by drawing arcs connecting the opposite corners of squares in the Fibonacci tiling. (1,1,2,3,5,8,13,21,34, etc.)
• Columbus, Salvador Dalí, Spiral composition, harmony.

Architecture
• 1488: Leonardo da Vinci, Sketch of a square church with central dome and minaret, as well as study of a central church.
• 1943: Salvador Dalí, The Esthetic is the Greatest of Earthly Enigmas including sketches similar to Da Vinci’s churches.
• 1945: Salvador Dalí, My Wife, Nude, Contemplating Her Own Flesh Becoming Stairs, Three Vertebrae of a Column, Sky and Architecture.
• 1949: Salvador Dalí, Project for Icosahedral Studio, Port Lligat. Regular Icosahedron has 20 identical equilateral triangular faces.
• Teatro Museo: Dalí’s geodesic dome and the Torre Galatea. Dalí wanted a dome on his museum designed by Buckminster Fuller.

Anatomy & Proportion in Nature
• 1492: Vitruvian Man, For Da Vinci, man was the perfect proportion of all things. He also applied geometric proportions to the human face.
• 1509-10: Leonardo da Vinci drew the muscles of the shoulder.
• 1504-07: Leonardo da Vinci drew a grotesque head recording the features accurately.
• 1936: Salvador Dalí painted The Great Paranoiac with figures showing muscular structure.

Paranoiac Criticism
• c. 1550: Treatise on Painting, a compilation of Leonardo’s instructional writings on drawing and painting, compiled by Francesco Melzi, one of his pupils.
• 1503: Leonardo da Vinci, Battle Study, Leonardo advocated the study of stains on walls, ashes, grainy stones, mud or clouds – things that are formless, in order to see a subjective fantasy. “…if you consider them well, you will find really marvelous ideas.”
• 1938: Dalí wrote, in an exhibit catalog, that Leonardo’s Treatise and Freud’s Leonardo study had contributed to the “epistemological and philosophical corner stone of the majestic edifice of imminent paranoiac painting.”
• 1935-36: Salvador Dalí, Paranoia.
• 1938: Salvador Dalí, Enchanted Beach with Three Fluid Graces including a horse similar to Da Vinci’s monument horse in the background.

Leda & the Swan
• 1506: Leonardo da Vinci, Studies of a woman’s head and coiffure, for Leda and the Swan.
• 1948: Salvador Dalí, Leda Atomica, Created with assistance from Matila Ghyka including sketches showing Ghyka’s grids.
**Last Supper**
- 1495-98: Leonardo da Vinci, *The Last Supper* is on the rectory wall of the former Dominican monastery of the Santa Maria delle Grazie, Milan. The mural employs grid lines based on the golden sections and with the perspective vanishing point located at Christ's right eye.
- 1955: Salvador Dalí, *Last Supper*, "The Communion must be symmetrical" under the dodecahedron. Regular Dodecahedron is a platonic solid composed of 12 regular pentagonal faces, with three meeting at each vertex.

**Mona Lisa**
- 1919: Marcel Duchamp, *L.H.O.O.Q. (Elle a chud au cul).*

**Suggested Illustrations:**

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<td>Figueres, Spain, Ampuridan Plain, Province of Geron</td>
<td>Map of Italy</td>
<td>Palazzo Vecchio, Florence</td>
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<td>Leonardo da Vinci</td>
<td>1452 - 1519</td>
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<td>1480 Parachute</td>
<td>1480 Skis With Which One Can Walk On Water</td>
<td>1480 Detail of Man Using a Perspectograph</td>
<td>Illustration of Leonardo’s Perspectograph</td>
<td>1480 Archimedes Screws and Pumps to Draw up Water</td>
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<td>1480-82 Machine Gun</td>
<td>1480-82 Giant Crossbow</td>
<td>1481 Perspective Study for Adoration of the Magi</td>
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<td>J. de Barbari, Portrait of Fra Luca Pacioli</td>
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<td>Duke Ludovico Sforza (Detail from the Sforzesca Alterpiece, Master of the Pala Sforzesca, Brera, Milan)</td>
<td>1495-98</td>
<td>Copy of The Last Supper</td>
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<td>The Last Supper with Vanishing Point at Christ’s Right Eye</td>
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<td>The Last Supper, Santa Maria delle Grazie, Milan</td>
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<td>The Last Supper, Detail of Christ Before Cleaning</td>
<td>1502</td>
<td>Scythe Chariot and Armored Tank</td>
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<td>Study of Battles on Horseback and on Foot</td>
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<td>Head Studies and A Grotesque Head</td>
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<td>Studies of a Woman’s Head and Coiffure, for Leda and the Swan</td>
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**Salvador Dalí  1904-1989  Figueres, Spain**

Artworks numbered in red (1-53) include descriptions below.
Year, Title, Description, Links to Science Curriculum.
Next generation Sunshine State Standards.

Oct. 12, 1901 – Aug. 1, 1903 Salvador Galo Anselmo Dalí
S. Dalí
<table>
<thead>
<tr>
<th>10. 1929 The Great Masturbator, Freudian Symbolic Language</th>
<th>11. 1931 The Persistence of Memory</th>
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<tr>
<td>8. 1927 First Days of Spring</td>
<td>9. 1929 Un Chien Andalou</td>
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<td>6. 1926 Anna Maria</td>
<td>7. 1926 Woman at a Window in Figueres</td>
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<td>Sigmund Freud, Austrian Neurologist who Founded the Psychoanalytic School of Psychology</td>
<td>1910 Freud Published the analysis of Da Vinci’s Virgin and St. Anne under the title Leonardo da Vinci, A Memory of His Childhood</td>
<td>1915 P. Picasso</td>
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<td>1919 M. Duchamp, L.H.O.O.Q. (“Elle a chaud au cul”)</td>
<td>Dalí’s school master, Senor Trayter, Apartment of Curiosities</td>
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<td>17. 1938 The Image Disappears</td>
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<td>50 secrets of Magic Craftsmanship</td>
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<td>Vermeer, 176 Raphael, 166 Leonardo, 153 Valazquez, 138 Dalí, 107 Picasso, 85 Ingres, 47 Meissonier, 37 Manet, 29 Bouguereau, 3.5 Mondrian</td>
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<td>Scientific American, Dali’s Favorite Magazine</td>
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<td>1973 Scientific American</td>
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<td>1973 Recognition of Faces</td>
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<td>1976 Scientific American</td>
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### Suggested Tour Artworks: (Title, Date, Medium, Scale and Description)

### Suggested Number of Artworks per Tour: (Eight to Twelve)

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<tr>
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<td>- Dalí Museum, St. Petersburg, FL (Y. Weymouth)</td>
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<td>- New Building opened 1.11.11 at 11:11 am.</td>
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<td>- Theatro-Museo (E.P. Pinero)</td>
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<th>Artwork 5:</th>
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<td><strong>Salvador Felipe Jacinto Dalí</strong></td>
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**Artwork 6:**

*Anna Maria*, 1926.
- Portrait of Dalí’s sister sewing.

**Artwork 7:**

*The Girl of Figueres*, 1926.
- Strong lines and structure of form.
- Solidarity of presence.
- This painting of his sister Ana Maria can be seen as an early attempt by Dalí to re-work *The Lacemaker*.
- The painting by the seventeenth-century Dutch painter Jan Vermeer, became an obsession with Dalí during the fifties.
- She is turned away from the viewer so you cannot see her face.
- The balcony overlooks the town of Figueres, Dalí’s home town.
- The blue color of the distant mountains and of the sky contrasts with the sunlit stone of the buildings to capture the viewer’s eye.
- This blue is repeated in the shimmering blue-black hair of Ana Maria.

**Artwork 8:**

*The First Days of Spring*, 1929, oil and collage on panel, 19 ¾ x 25 5/8 in.
- This painting is considered Dalí’s first surrealist painting.
- With this painting, Dalí makes a strong impression on André Breton.
- This piece is constructed in a semiautobiographical narrative that indulged his fantasies.
- Dalí’s portrait appears twice in the painting; once using collaged elements.
- Dalí uses techniques illustrated by De Chirico, Magritte and Ernst to insist that the subject matter is real.
- Everything about this painting is calculated to shock the viewer.

**Artwork 9:**

- Fledging director Luis Buñuel and painter Salvador Dalí create this ultimate surrealist film, which is essentially a barrage of striking and irrational images designed to shock and provoke.
- During the course of the film, we witness a close-up of a woman’s eye being slashed open with a razor; a man dragging a piano, two bishops, and a pair of rotting asses across a room; ants swarming around a hole in a man’s palm; and sundry severed limbs and gratuitous slayings.
- Though this was originally a silent film, Buñuel later added a recorded score consisting of Liebestod from Wagner’s opera *Tristan und Isolde* and a number of popular tangos of the time.

**Artwork 10:**
**The Great Masturbator**, 1929, oil on canvas.

- *The Great Masturbator* is a self-portrait painted in July 1929.
- Dalí’s head has the shape of a rock formation near his home and is seen in this form in several paintings dating from 1929.
- The painting deals with Dalí’s fear and loathing of sex.
- He blamed his negative feelings toward sex as partly a result of reading his father’s extremely graphic book on venereal diseases as a young boy.
- The head is painted “soft”, as if malleable to the touch: it looks fatigued, sexually spent: the eyes closed, the cheeks flushed.
- Under the nose a grasshopper clings, its abdomen covered with ants that crawl onto the face where a mouth should be.
- From early childhood, Dalí had a phobia of grasshoppers and the appearance of one here suggests his feelings of hysterical fear and a loss of voice or control.
- Emerging from the right of the head, a woman moves her mouth toward a man’s crotch.
- The man’s legs are cut and bleeding, implying a fear of castration.
- The woman’s face is cracked, as though the image that Dalí’s head produces will soon disintegrate.
- To reiterate the sexual theme, the stamen of a lily and tongue of a lion appear underneath the couple.
- This work takes as its central image the profile of a strangely distorted figure.
- This painting was included in Dalí’s first solo exhibition.
- It derives from the shape of a rock formation located at Cap Creus and appears in many of Dalí’s works as a self-portrait.
- The figure is soft and represented as sleeping, its softness suggesting the condensation of the dream-work as explained in Freud’s writings.
- Freud’s *On Dreams* (1911) explained this mechanism: “the dream-work has carried out work of compression or condensation on a large scale. It is impossible at first to form any judgement of the degree of this condensation: but the deeper we plunge into a dream-analysis the more impressive it seems. From every element in a dream’s content associative threads branch out in two or more impressions or experiences.”

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**Artwork 11:**

**The Persistence of Memory**, 1931, oil on canvas, 9.5 x 13 in.

- Many of Dalí’s paintings were influenced and inspired by the landscapes of his youth. Several in particular were painted on the slopes of Mount Pani, which was covered in beautiful umbrella pines at the time.
- Many of the strange and foreboding shadows in the foreground of many Dali paintings is a direct reference to and result of Dalí’s love of this mountain near his home.
- Even long after he had grown up, Dalí continued to paint details of the landscape of Catalonia into his works, as evidenced by such works as the Persistence of Memory, completed in 1931.
- Note the craggy rocks of Cape Creus in the background to the right. One of Dalí’s most memorable Surrealist works, indeed the one with which he is most often associated is *The Persistence of Memory*.
- It shows a typical Dalinian landscape, with the rocks of his beloved Cape Creus jutting up in the background. In the foreground, a sort of amorphous self portrait of Dalí seems to melt.
- Three Separate Melting Watch images even out the foreground of the work. The melting watches are one symbol that is commonly associated with Salvador Dalí’s Surrealism.
- They are literally meant to show the irrelevance of time.
- When Dalí was alone with Gala and his paintings in Cape Creus, he felt that time had little, perhaps no significance for him.
- His days were spent eating, painting, making love, and anything else he wanted to do.
- The warm, summery days seemed to fly by without any real indication of having passed.
- One hot August afternoon, in 1931, as Dalí sat at his work bench nibbling at his lunch, he came upon one of his most stunning paranoiac-critical hallucinations.
- Upon taking a pencil, and sliding it under a bit of Camembert cheese, which had become softer and runnier than usual in the summer heat, Dalí was inspired with the idea for the melting watches.
- They appear often throughout Dalí’s works, and are the subject of much interest.
- In short, this particular work, is an important referral back to Dalí’s Catalan Heritage, that was so very important to him.
- The well-known surrealist piece introduced the image of the soft melting pocket watch.
- It epitomizes Dalí’s theory of “softness” and “hardness”, which was central to his thinking at the time.
- As Dawn Ades wrote, ”The soft watches are an unconscious symbol of the relativity of space and time, a Surrealist meditation on the collapse of our notions of a fixed cosmic order”.
- This interpretation suggests that Dalí was incorporating an understanding of the world introduced by Albert Einstein’s Special Theory of Relativity.
- Asked by Ilya Prigogine whether this was in fact the case, Dalí replied that the soft watches were not inspired by the theory of relativity, but by the surrealist perception of a Camembert cheese melting in the sun.
- Although fundamentally part of Dalí's Freudian phase, the imagery precedes his transition to his scientific phase by fourteen years, which occurred after the atomic bombings of Hiroshima and Nagasaki in 1945.
- It is possible to recognize a human figure in the middle of the composition, in the strange "monster" that Dalí used in several contemporary pieces to represent himself – the abstract form becoming something of a self-portrait, reappearing frequently in his work.
- The orange clock at the bottom left of the painting is covered in ants. Dalí often used ants in his paintings as a symbol of decay.
- The picturesque image of the picture can be read as a "fading" creature, one that often appears in dreams where the dreamer cannot pinpoint the creature's exact form and composition.
- One can observe that the creature has one closed eye with several eyelashes, suggesting that the creature is also in a dream state.
- The iconography may refer to a dream that Dalí himself had experienced, and the clocks may symbolize the passing of time as one experiences it in sleep or the persistence of time in the eyes of the dreamer.
- The Persistence of Memory employs "the exactitude of realist painting techniques" to depict imagery more likely to be found in dreams than in waking consciousness.
- The craggy rocks to the right represent a tip of Cap de Creus peninsula in north-eastern Catalonia.
- Many of Dalí's paintings were inspired by the landscapes of his life in Catalonia. The strange and foreboding shadow in the foreground of this painting is a reference to Mount Pani.
- Dalí returned to the theme of this painting with the variation The Disintegration of the Persistence of Memory (1954), showing his earlier famous work systematically fragmenting into smaller component elements, and a series of rectangular blocks which reveal further imagery through the gaps between them, implying something beneath the surface of the original work; this work is now in the Dalí Museum in St. Petersburg, Florida, while the original Persistence of Memory remains at the Museum of Modern Art in New York City.
- Dalí also produced various lithographs and sculptures on the theme of soft watches late in his career. Some of these sculptures are the Persistence of Memory, the Nobility of Time, the Profile of Time and the Three Dancing Watches.

**Artwork 12:**

**Object of Symbolic Function (also known as Scatalogical Object Functioning Symbolically – Gala's Shoe), 1931 lost; reconstructed 1973, assemblage of objects, 19 x 11 x 15 in.**

- Surrealism projected the Object into the public arena in 1936 through the Surrealist Exhibition of Objects presented at Galerie Charles Ratton.
- Breton provided a genealogy of the Surrealist Object, arguing that Surrealist Objects transformed our understanding of the sensible world.
- The object revealed a new inner logic lying beyond the surface of appearance.
- Anti-metaphysical and materialistic.
- The hidden real was there to be discovered in the object, only to unmask internal laws of natural structures.
- The aim of the Surrealist Object was to dislocate one’s false sense of rational certainty and thrust the viewer into the disorienting realm of enigmatic doubt.
- The subversive goal of discrediting reality, reaching its paramount example in Dalí’s deliberately bizarre objects, captured an essential element of the revolutionary surrealist project.

**Artwork 13:**

**Archaeological Reminiscence of Millet’s “Angelus,” 1933-35, oil on panel, 12 ½ x 15 ½ in.**

- Millet's Angelus painting had a profound impact on Salvador Dalí.
- He had first seen the work as a child in school, but in 1932, he has a series of experiences that led him to have several paranoiac-critical transformations on the subject.
- The original painting shows several peasants, working in a field, who have stopped for an afternoon prayer.
- Their heads are bowed reverently, and there is a wheelbarrow between them, with field scenery stretching out behind them.
- This painting is a continuation on that theme, but has several instances of Dalinian continuity included as well.
- The original two Angelus figures have been transformed into towering architectural ruins, which probably were inspired by Dalí’s visits to the Roman ruins near his childhood home.
- The third figure of the dead son is absent in this rendition of Dalí’s obsession with the original Millet painting.
- Instead, the female has been made to look even more like a praying mantis, thus reinforcing Dalí's association of sex with death.
- Dalí spent time on the plain of Ampurdan, and has added elements from that landscape into this one.
- In the foreground, however, is another example of Dalinian continuity.
Here we see yet again the tiny father/son figure that began to show up in Dali’s works starting in 1929 with *The First days of Spring.*

- Inspired by obsession with Jean-François Millet’s *Angelus.*
- *Angelus* obsession: male terrified of female, who will cannibalize him after mating.
- For Dalí, the theme of Millet’s work: sexual anxiety.
- *Angelus* was a childhood image of escape from Dalí’s classroom.
- Female resembles a praying mantis who devours the male after mating.
- Male as terrified victim.
- Female a femme fatale, like succubus or a vampire.
- Female tries to distract male by hiding arousal.
- Millet couple in ruins: this terrifying relationship has existed for generations.
- Psychological landscape.
- Ruins of Empúries.
- Father is showing son “this is who we are.”
- Lucia with young Dalí.
- Cypress trees do not regenerate = death.
- Moonlight or twilight setting.
- Two enormous figures suggesting geological formations and the ruins of ancient towers dominate the vast open plain of the Empordà.
- The petrified pose of the figures that resemble the "Angelus" couple alludes to a theme of predatory aggression and death, death being both literal and symbolic.
- Groups of figures contemplate the couple, which is the reminiscence to which the title refers.
- The dual petrification and erosion of the male figure suggests both a literal death (of the peasant couple’s child—a likely surrogate for Dalí himself—and of the father figure at the hands of his mate) and a symbolic death referring to the Oedipal interdiction and the child’s separation from the maternal body.

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**Artwork 14:**

**Paranoiac Critical Visage,** 1935.

- In the 1930’s Breton was still unsure about visual Surrealism. Until then Breton believed that Surrealism was primarily a literary movement.
- Dalí invented his paranoic-critical method and revealed it with this piece in the journal *Le Surréalisme au Service de la Révolution.*
- The image is a photograph of African people in front of a hut which arrived at Dalí’s house as a postcard sent by Pablo Picasso.
- Dalí instantly recognized the double image of a “phantom head” when the postcard is turned 90º.
- Just as clinical paranoia involves the obsessive reinterpretation of external phenomena, Dalí’s method also involved obsessive reinterpretation.
- The resulting back-and-forth between the reality of the African people and illusionary visage creates a “mental crisis” in the viewer.
- Dalí reproduced this effect many times in numerous artworks. A few of these have been featured here.
- Breton was convinced, but as Dalí’s popularity grew, Breton criticized Dalí, calling his work “puzzle-paintings” where the only purpose was to decipher the image. Dalí, being rich, famous, and an egomaniac, didn’t seem to notice Breton’s criticism.

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**Artwork 15:**

**Paranoia,** 1935-36, oil on canvas, 15 x 18 ½ in.

- Belongs to a series of “anthropomorphic landscapes” of the 1930s in which Dalí explores the visual conceit of dual or multiple figurations.
- Dalí challenges the viewer’s visual mastery of form and opens the interpretative process to multiple and often conflicting significations.
- The head of the woman/bust simultaneously configures a scene of horsemen in battle.
- Reading Leonardo’s recipe for visual inspiration through the grid of Freud’s psychobiography of the artist’s life and work, Dalí suggested that the motivation for and the meaning of hisfiguration was anything but arbitrary: “The ‘paranoiac phenomenon’ is consubstantial with the human phenomenon of sight.”
- The theoretical roots of Dalí’s obsession with multiple images can be traced to 1929 with references to Rene Magritte.
- The paranoiac-critical method provided a means for Dalí to test his hypothesis that desire is always/already implicated in the structure of the visual field, and to reproduce that structure symbolically in painting while simultaneously exploring its latent content.
- The horses in the background are reminiscent of Da Vinci’s horse studies.
Artwork 16:

_The Great Paranoiac,_ 1936.

- “_The Great Paranoiac_” is another in a long line of double-image strokes of genius by Salvador Dalí – but this one holds special significance.
- A cluster of human figures of both genders appears in a sort of dry, barren landscape. Some stand, some recline, some sit, some kneel. But the two largest figures in the foreground – both appearing to be female, one kneeling with head bowed, the woman to her left standing and seen from behind – form the face of a man looking downward and rather anguished or ashamed.
- The lighter space just above those two figures, together with the mélange of figures above and to the right of that space, completes the head of the at once visible and invisible man.
- The same basic double-image is repeated in smaller dimension at the upper left part of this remarkable picture.
- But what do we notice about all of the figures in “_The Great Paranoiac_”? None of them show their faces! Not one. In fact, their postures and demeanors suggest a sense of shame. Every human figure is either turning away or hiding their face in shame.
- In all probability, this was the 32-year-old Dalí examining his own obsessions and neuroses, much as he did in his important 1929 canvas, “_The Great Masturbator._” Not only did Dalí candidly paint his dream world without any restraint, but he sometimes laid bare his inner-most concerns, obsessions, and preoccupations. Perhaps this painting could just as well have been titled “_The Great Shame._”
- Of course, the illusionary characteristics of this painting are consistent with Dalí’s fascination with double- and hidden-imagery, an interest surely derived from his admiration of the 16th century artist, Arcimboldo – famous for assembling fruits and vegetables and other objects to form human portraits. It also reminds us of how Dali revered Leonardo DaVinci, who had proclaimed that even random water stains on a wall could yield great battles and other hidden images to a creative artist’s mind.
- What’s more, Dalí recognized – from reading Freud and studying the tenets of psychoanalysis – that the true paranoid person “sees” in a very different way - often detecting hidden images, or at least imagining they’re there. This was the basis of Dalí’s Paranoiac-Critical creative method, where he was able to envision things the way an actual paranoiac does, but then transformed them onto canvas for the rest of us to see. That was the critical part of his method.
- “_The Great Paranoiac_” demonstrates just how honest Dalí was in sometimes holding a mirror up to himself – providing us with fascinating glimpses into the mind of the greatest of all the Surrealists. The important painting was among the many gems at the 2012-2013 Dalí retrospective at the Centre George Pompidou in Paris, France.

Artwork 17:

_The Image Disappears,_ 1938, oil on canvas, 22.24 x 19.88 in.

- Double image painting.

Artwork 18:

_Enchanted Beach with Three Fluid Graces,_ 1938, oil on canvas, 25 5/8 x 32 in.

- Belongs to Dalí’s extended series of “anthropomorphic landscapes” of the mid – late 1930s.
- Contains the visual conceit of a woman’s face composed of figures and horsemen, and the configuration of a head composed of landscape elements: a boulder in the case of the figure to the left, and an open cavity in a rock formation in the case of the figure to the right.
- As Dalí continued to exploit the fluid passage between objects and ambient space, he increasingly resorted to a vocabulary of stock images and familiar visual puns.
- The classical reference to the three Graces, symbols of ideal beauty, may be interpreted as an allegory of Dalí’s assault on the Renaissance tradition of form, which locates a unitary subject at the origin of a rational spatial system.
- As Dalí collapses perspective and dismantles familiar figure/ground relationships, a different conception of the subject engenders the visual field: the mobile subject of desire whose precise coordinates cannot be mapped.

Artwork 19:
Dream of Venus Pavilion at the New York World’s Fair, 1939.

- Dali’s pavilion was entitled “Dream of Venus,” and was a surrealist dream world.
- Patrons entered through a pair of women’s legs (John Malkovich copied this for his Lisbon Nightclub called “Lux”- it is a weird place), and purchased tickets from a fish head booth.
- Dali designed two pools where topless sirens and mermaids swam about, women dressed as pianos and lobsters cavorted amongst paintings and props in front of a giant four paneled painting by Dalí, and other tableaus with costumes designed by Dalí.
- Sadly, creative compromise happened even then.
- The fair organizers made major modifications to Dalí’s original ideas, which caused him to dramatically write a pamphlet called, “Declaration of the Independence of the Imagination and the Rights of Man to His Own Madness.”
- Although Dali wasn’t thoroughly satisfied, the exhibition brought Surrealism and Dalí’s creative ideas out of the artistic world and to the masses.

Artwork 20:

Dali in an Egg, Phillipe Halsman, photograph, 1942.

- Philippe Halsman and Salvador Dalí lived and worked in Paris in the 1930s, when surrealism flourished.
- But they first met in New York in 1941, when both were new émigrés. They had arrived within months of each other – Dalí in August 1940, and Halsman three months later.
- During the previous ten years, their paths must have criss-crossed frequently in the narrow streets of Montparnasse, where Halsman had a studio at 22 Rue Delambre, and Dalí was part of the surrealist enclave at 54 Rue du Chateau.
- In 1936, Halsman exhibited photographs at the Galerie de la Pleiade, where surrealist photographer Man Ray also showed his work.
- But until 1941, Halsman and Dalí had never met.
- Within a year of his arrival in New York, Halsman had re-established himself.
- His iconic portrait of model Connie Ford silhouetted against an American flag had been featured in a major Elizabeth Arden advertising campaign.
- In April, 1941, Halsman was assigned by the Black Star Agency to photograph the installation of Dalí’s first New York exhibit — at the Julien Levy Gallery.
- Halsman’s relationship with Dalí deepened in October, when he photographed the outsize costumes Dalí created for the Ballets Russes production of “Labyrinth” at the Metropolitan Opera House — with music by Franz Schubert, choreography by Leonid Massine, and scenery and costumes by Salvador Dalí.
- Lacking a large studio, Halsman took the company’s prima ballerina, Tamara Toumanova, and another dancer dressed as a giant white rooster, to a nearby rooftop.
- When Halsman photographed bird and ballerina against the soaring towers of Rockefeller Center, he produced a photograph that evoked one of Dalí’s own sharply-focused, surreal works of art.
- The photo became LIFE’s “Picture of the Week,” the artists became inspired friends, and their creative rapport would last for the next 37 years.
- Several weeks later they collaborated again; this time they produced a collaged photograph of Dalí lying naked in the embryo pose within an enlarged photo of an egg.
- The image, entitled “Pre-Natal Memory,” was published the following year in Dalí’s autobiography, “The Secret Life of Salvador Dalí.”
- In the decades ahead, Halsman and Dalí would “play” together at least once a year — “an elating game,”Halsman wrote in 1972, “creating images that did not exist, except in our imaginations.
- Whenever I needed a striking protagonist for one of my wild ideas, Dalí would graciously oblige. Whenever Dalí thought of a photograph so strange that it seemed impossible to produce, I tried to find a solution.”
- Usually they conspired in Halsman’s large, strobe-equipped studio at 33 West 67th Street, around the corner from St. Nicholas Arena in Manhattan.
- Other “sittings” took place at Dalí’s home in Cadaques, in Los Angeles, and at the St. Regis Hotel, where Dalí invariably stayed when he was in New York.
- Their intense, prolific, 37-year collaboration is unique in the history of 20th Century art.
The title comes from the larger block of text in the lower right of the composition, and the marginal notations along the right side describe in some detail both the decorative pedestal that the central figure is standing on, as well as the fantastically decorated religious structure in the middle ground.

Architecture was always a subject of fascination for the artist, and he wrote in *50 Secrets of Magic Craftsmanship* that it is “the first art with which the painter must make himself familiar.”

The elaborately detailed element in the top right is a pendant from the collection of jewelry items that Dalí was working on in collaboration with Duke Fulco di Erdura.

Dalí was a voracious reader and student of art history from an early age, and his works from this period are a physical reflection of the artist’s desire to “continue the conquest of the irrational by becoming classic and pursuing the research in *Divina Proportione* interrupted since the Renaissance.”

As a young artist, Dalí expressed his admiration for classical painters such as da Vinci, Raphael, Velazquez and Durer in essays published in the student magazine *Studium* in the spring of 1919.

These early interests waned during his participation in the surrealist movement, were to resurface again in a vigorous manner starting in 1941.

Artwork 22:


- Dalí had a thing for backs – his wife Gala’s back, to be sure, but backs in general.
- Many of his portraits of Gala and, earlier, of his sister Ana Maria, show the sitters from behind.
- Indeed, in a clear stroke of Dalínian Continuity – where certain imagery in Dalí’s paintings gets repeated from one year or even from one decade to another – virtually the same view of Gala seen in the present work was to appear 15 years later in *Gala Nude, Seen from behind*.
- In the 1945 picture, Gala sits aristocratically, nearly naked, save for a beautifully handled white cloth and the same pearl-studded barrette in her hair as in the 1960 work.
- Gala contemplates the same image of her back-to-the-viewer pose, only now it’s formed by architectural columns and other details surrounding a tiny figure of a man.
- Her left shoulder and arm become what looks like they could be both a tower and a rocket ship.
- A detail in her hair serves as both a balcony railing of an edifice and the aforementioned pear-studded barrette.
- The undeniably classic look to the work – it almost looks like it could have been painted during the Renaissance! – is accentuated by the classical figure on the stone wall, while authors Elizabeth Keevil and Kevin Eyres have noted that the dandelion is “a symbol of transience that is reinforced by the struggle of its roots to find a home in the rock.”
- Was Dalí trying to convey how beauty itself is transient?
- How the lovely Gala of 1945 (she would have been about 51 then) would perhaps see her looks fade with time?
- This remarkable painting was reproduced on the dust jacket of the first hardcover edition of Dalí’s important book, *Fifty Secrets of Magic Craftsmanship*, and is a fitting work for that purpose, given the sheer perfection with which the Catalan Master painted it.

Artwork 23:


- In 1945 Salvador Dalí, a well-known artist, painted an abstract piece that takes reality to another deep, dark place in his mind.
- Although the painting looks like it represents a bazar dream, it could also tell a story about a man’s favorite pastime and fears during a time of war.
- The lighting in the painting is very obscure with many well-lit objects to emphasize their importance. Most of the colors are cool versus warm.
- This element creates a cold, depressing, and nightmarish setting for the audience.
- The sky is exposed in two areas: one representing the daytime and one in the evening.
- There are various objects throughout and the lighting plays a large part in telling a story.
- There are several objects painted throughout the piece that seem to be random, but are in fact relevant to the whole picture.
- The focal point is on the bottom left corner, where there is an old man looking up at the whole image in fear.
- There are baseball players throughout who are creating clouds of dust and one who is holding up a baseball bat.
- He is facing an object that at first appears to be a person in a hooded robe holding a bat, but it if one looks closer, it turns out to be a melting clock.
- Right next to the melting objects there is an explosion from a bomb. There are also airplanes dropping bombs throughout.
the painting.

- All of these are in a room of some kind because there is a hard wood floor and shadows on the walls.
- On the upper right, there is an opening where the roof would be and the outside world is exposed.
- There are elephants with extremely long legs with gold balls falling out of their torsos.
- There are so many different images throughout the painting that may not make sense or have multiple meanings behind them; such as elephants with very tall legs or objects that seem to represent human faces.
- Images like this are why some may think this painting could be a dream with no meaning behind it.
- Life changing events can make the mind perceive the world differently.
- In the story being told, the man in the bottom right corner could be hallucinating during a war.
- The painting tells a story about man’s favorite pastime, baseball, and the idea of time melting away as he fears his death.
- There is a war obviously going on around him, and he is trying to hold onto the life he knew.
- The whole story is about a man fearing what the world is becoming.
- Clocks and faces melting show what happens when a bomb drops. Familiar faces and ways of life disappear.
- In one rather large part of the painting, there is a face with a tongue sticking out with razor sharp teeth and an eye ball melting out of its socket.
- It isn’t as graphing as it sounds because the object is all one color and blends with the dark background.
- The old man staring into the painting probably symbolizes the artist overlooking his confusing feelings about the world around him.
- It depends on personal life experience, culture, and philosophies on life.
- This painting was probably intended for those with the ability to use their imagination as well as people who have knowledge of events that occurred in the 1940’s; such as World War II.
- The painting may seem like a dream to some, but it is a representation of how a man views fear. When people express their emotions with art, it often reveals their passions, fears, and moods.
- Those who are exposed to abstract art such as this can usually use their own experience in life to relate to the meaning and interpret.
- The painting shows Dalí’s personal fears and the inability to grasp onto the precious life he has when he is consumed by the fear.

Artwork 24:

Three Sphinxes of Bikini, 1947.

- Between the years of 1946 and 1958 (AFTER world war two), the United States conducted 23 nuclear tests at the Micronesian atoll, Bikini.
- The tests caused the radioactive contamination of the entire system of islands.
- The (roughly) two hundred Micronesians who inhabited the islands were relocated by the US before the tests, and eventually brought back in 1968.
- The US lost a lawsuit to the Micronesians in the amount of $100 million when it was discovered, ten years later in 1978, that the levels of radioactivity were still dangerously high.
- These experimental explosions on the atoll of Bikini inspired Dalí to paint the Three Sphinxes of Bikini.
- Dalí himself was a surrealist painter.
- If you look at the point of view of “expressionism,” then paintings in general are supposed to emphasize the expression of inner experience rather than a solely “photographic” portrayal of reality.
- It is subjective emotions and responses that objects and events arouse in the artist. In surrealism, it goes one step further: it’s the unconscious that is emphasized, and paintings express the workings of the mind by using symbolic imagery and interesting juxtaposition of subject matter.
- The painting consisted of one head, one tree and one nuclear mushroom.
- The head might represents humanity, while the tree represents nature and mushroom cloud represents destruction.
- When nuclear exploded, the tree was the one closest to it then come to the head, which could mean that impact on nature is far greater than impact on human.

Artwork 25:

Leda Atomica, 1947.

- Renaissance inspired perspective using architectural elements as well as classical figure proportions, based on the Golden Ratio.
- Intentional use of a pentagon whose angles intersect with a circle to create the optimum aesthetic organization of visual elements.
- Reminiscent of Leonardo da Vinci’s Vitruvian Man, 1490, based on the work of the architect Vitruvius.
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His iconic portrait of model Connie Ford silhouetted against an American flag had been featured in a major Elizabeth Arden advertising campaign.

In April, 1941, Halsman was assigned by the Black Star Agency to photograph the installation of Dalí’s first New York exhibit — at the Julien Levy Gallery.

Halsman’s relationship with Dalí deepened in October, when he photographed the outsize costumes Dalí created for the Ballets Russes production of “Labyrinth” at the Metropolitan Opera House — with music by Franz Schubert, choreography by Leonid Massine, and scenery and costumes by Salvador Dalí.

Lacking a large studio, Halsman took the company’s prima ballerina, Tamara Toumanova, and another dancer dressed as a giant white rooster, to a nearby rooftop.

When Halsman photographed bird and ballerina against the soaring towers of Rockefeller Center, he produced a photograph that evoked one of Dalí’s own sharply-focused, surreal works of art.

The photo became LIFE’s “Picture of the Week,” the artists became inspired friends, and their creative rapport would last for the next 37 years.

Several weeks later they collaborated again; this time they produced a collaged photograph of Dalí lying naked in the embryo pose within an enlarged photo of an egg.

The image, entitled “Pre-Natal Memory,” was published the following year in Dalí’s autobiography, “The Secret Life of Salvador Dalí.”

In the decades ahead, Halsman and Dalí would “play” together at least once a year — “an elating game,” Halsman wrote in 1972, “creating images that did not exist, except in our imaginations.

Whenever I needed a striking protagonist for one of my wild ideas, Dalí would graciously oblige. Whenever Dalí thought of a photograph so strange that it seemed impossible to produce, I tried to find a solution.”

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Other “sittings” took place at Dalí’s home in Cadaques, in Los Angeles, and at the St. Regis Hotel, where Dalí invariably stayed when he was in New York.

Their intense, prolific, 37-year collaboration is unique in the history of 20th Century art.

Artwork 27:

50 Secrets of Magic Craftsmanship, 1948.

Important volume in which famed Surrealist expounds — in his inimitably eccentric fashion — on what painting should be, the history of painting, what is good and bad painting, the merits of specific artists, and more.

Includes his 50 "secrets" for mastering the craft, including "the secret of the painter’s pointed mustaches."

Artwork 28:

Project for Icosahedral Studio, Port, Ligat, 1949.

Design for a studio based on a plantonic solid form.
The Madonna of Port Lligat, 1949.

- The Madonna of Port Lligat is the name of two paintings by Salvador Dalí.
- The first was created in 1949, measuring 49 x 37.5 centimetres (19.3 x 14.8 in), and is housed in the Haggerty Museum of Art at Marquette University in Milwaukee, Wisconsin, USA.
- Dalí submitted it to Pope Pius XII for approval, which was granted.
- Dalí created a second painting in 1950 with the same title and same themes, with various poses and details changed, measuring 144 x 96 centimetres (57.7 x 37.8 in); As of 2008, the 1950 Madonna is exhibited at the Fukuoka Art Museum in Japan.
- The paintings depict a seated Madonna (posed by Dalí’s wife, Gala) with the infant Christ on her lap.
- Both figures have rectangular holes cut into their torsos, suggestive of their transcendent status.
- In the 1950 version Christ has bread at the center of his figure.
- They are posed in a landscape, with a view of Port Lligat, Catalonia seashore in the background, with surrealist details, including nails, fish, seashells, and an egg.
- The 1949 Madonna has a sea urchin; the 1950 Madonna has a rhinoceros and figures of angels, also posed by Gala.


Exploding Raphaelesque Head, 1949-51.

- The face in this painting is influenced by a Madonna by the Renaissance artist, Raphael.
- Dalí has fragmented the head to show how the sense of order from the past, illustrated by the balance and reason of a classical icon, has been shattered by the advent of nuclear weapons.
- The motif of the shattered head was a common one amongst artists in the post-war years.
- This reflects the emotional turmoil of a period when nuclear war seemed like a reality, following the use of nuclear weapons in Hiroshima and Nagasaki.
- In this context, the delicate halo of the Madonna now suggests a nuclear mushroom cloud and her expression, with eyes downcast in prayer, seems particularly appropriate.

The Wheelbarrows. 1951, wash and pencil on paper, 40 x 30 in.

- Dalí executed The Wheelbarrows the same year as the publication of his tract, the Manifeste Mystique, which signaled the official beginning of his "Nuclear mysticism."
- Dalí brings together the dome and part of the interior of the Pantheon; a large superimposed figure, portrayed from the chest upward; and many wheelbarrows in various states of segmentation.
- The wheelbarrows in the bottom half of the picture give definition to the upper arms and chest of the large figure.
- The central role of the Pantheon in the composition further underlines the picture’s spiritual dimension and its connection to classicism.
- There are elongated shapes that bear resemblance to both wheelbarrow handles and rhinoceros horns.
- To Dalí, the logarithmic spiral of the rhinoceros horn was an example of spiritual order in the universe.
- The wheelbarrow had long been interpreted by Dalí as a sexual symbol, representing in its configuration a popular sexual position and thus having an “erotic personality [that] is among the most unquestionable ones.”
- Dalí’s mysticism was inseparable from erotic deliria.

Assumpta Corpuscularia Lapislazulina, 1952, oil on canvas, 90 1/2 x 56 3/4 in.

- This painting has not been exhibited publicly since 1959.
- The subject is Dalí’s imaginative explanation for the Assumption of the Virgin Mary.
- When Pope Pius XII established the ‘Blessed Virgin’s Assumption’ as infallible dogma in 1950, Dalí set to work trying to understand how this miracle might have scientifically taken place.
- He even wrote a letter to the Pontiff asking how exactly the Virgin levitated into Heaven and, once elevated, how she stayed aloft.
The Pope did not answer Dalí’s inquiry – unsurprising since the Church demanded “unquestionable belief” and “supernatural faith” -- though the artist’s ultimate conclusion was imaginative: it was not miraculous that the Virgin ascended to Heaven, but the product of a spiritually guided atomic reaction.

- He wrote in *Diary of a Genius*: “The Virgin does not ascend to heaven while praying. She ascends by the very strength of her antiprotons.”
- With this work, the artist juxtaposed a recent event of the regarding the Church with contemporary physics: anti-protons had only just been discovered in 1952, when it was found scientists learned that protons had an associated antiparticle with the same mass and opposite electric charge.
- As in other particle-antiparticle pairs, protons and anti-protons can annihilate one another in a burst of energy.
- When Dalí theorized that the Virgin ascended through the “very strength of her antiprotons,” he insinuated that a subatomic reaction had taken place in which colliding protons and anti-protons had created enough energy to rocket the Virgin into Heaven.
- Once in Heaven, he continued, the Virgin’s body was “reintegrated” and held in place by “cosmic glue,” a notion he credited in 1952 to physicist Enrico Fermi, who he said had given him the idea for a “gelatinous universe.”

Artwork 33:

**The Disintegration of the Persistence of Memory**, 1952-54, oil on canvas, 10 x 13 in.

- Dalí expresses his interest in the exterior world of physics and Werner Karl Heisenberg.
- Dismantled his earlier surrealist masterpiece to reveal a new structure that visualizes quantum mechanics.
- Extreme use of perspective employed in the grid like construction throughout the foreground and extending into the middle ground, also referencing the mathematical concept of fractals.
- Reinterpretation of Dalí’s most famous painting, *The Persistence of Memory*, 1931 (Museum of Modern Art, New York), showing how in two decades Dalí and the world moved from Surrealism to Nuclear Mysticism.
- By showing the disintegration of the familiar composition, Dalí indicates how he has changed, and indeed how the world has changed, over the two decades between 1931 and 1952. Where once the mysteries of the universe were explained through psychoanalysis, now they are explained through quantum mechanics.
- Original title: “The chromosome of a highly colored fish’s eye starting the harmonious disintegration of the persistence of memory.”
- The fish bears witness to the end of the world.
- The atomic bomb dissolves objects into elemental particles, a metaphor for the material world dissolving into its atomic structure.
- Rhinoceros horns, containing perfect mathematical spirals, are like the bombs being dropped. For Dalí, even explosions have an underlying harmonious nature.
- Dalí’s great masturbator self-portrait dissolves into jellied skin.
- The watches have become unanchored, with their melting oozing form becoming more brittle like smashed glass or ice.
- During the surrealist period Dalí created the iconography of the interior world of Sigmund Freud.
- With this painting, the exterior world has transcended the one of psychology, the world of physics and Werner Karl Heisenberg.
- Dalí has dismantled his earlier surrealist masterpiece at the figurative level, pulling back the skin of the distant seascape to reveal a new structure that is meant to visualize quantum mechanics.

Artwork 34:

**Crucifixion (Corpus Hypercubus)**, 1954, oil on canvas, 76.5 x 43.75 in.

- Depicts the Crucifixion of Jesus, though it deviates from traditional portrayals of the Crucifixion by depicting Christ on the polyhedron net of a hypercube and adding elements of Surrealism.
- It is one of his most well-known paintings from the later period of his career.
- Dalí’s inspiration for *Corpus Hypercubus* came from his change in artistic style during the 1940s and 1950s.
- Around that time, his interest in surrealism diminished and he became fascinated with nuclear science, feeling that “thenceforth, the atom was [his] favorite food for thought.”
- His interest grew from the bombing of Hiroshima at the end of World War II which left a lasting impression on him.
- In his 1951 essay “Mystical Manifesto”, he introduced an art theory he called “nuclear mysticism” that combined Dalí’s interests in Catholicism, mathematics, science, and Catalan culture in an effort to reestablish Classical values and techniques, which he extensively utilizes in *Corpus Hypercubus*.
- That same year, to promote nuclear mysticism and explain the "return to spiritual classicism movement" in modern art, he traveled throughout the United States giving lectures.
- Before painting *Corpus Hypercubus*, Dalí announced his intention to portray an exploding Christ using both classical painting techniques along with the motif of the cube and he declared that “this painting will be the great metaphysical work of [his] summer.”
Soft Watch at the Moment of First Explosion, 1954

Created in 1954, Dalí used the presence of a dreamlike quality and ghostly appearance to accentuate the mysterious and unexplainable in his painting.

Surrealism rejects logic, reason and natural order. It uses techniques such as dreamlike or ghostly qualities, juxtaposition (a method for rejecting harmony in their work) and incorporates surreal objects and subject matter.

Dalí uses these same techniques in his painting Soft Watch at the Moment of Explosion to intrigue his viewers and provoke thought.

In his painting, Dalí assimilates shadowy outlines of objects and uses the dreamlike quality in the way the watch twists and its broken pieces unexplainably float above it.

Also, the ghostly way the watch drapes over one edge of the box as if melting.

The watch seems to be pulling apart and stretching. It may denote Dalí’s belief that time passing brings eventual destruction.

In Soft Watch at the Moment of Explosion, Dalí incorporates a great deal of color juxtaposition.

Most of the background consists of deep browns and gold and is contrasted by the white clock in the center of the painting.

Dalí’s painting also displays surreal objects, although most of these are in the foreground (a moth, a fly and a bizarre clock). In the background we see a small cluster of mountains.

As Dawn Ades wrote: The soft watches are an unconscious symbol of the relativity of space and time, a Surrealist meditation on the collapse of our notions of a fixed cosmic order.

This interpretation suggests that Dalí was incorporating an understanding of the world introduced by Albert Einstein’s Special Theory of Relativity.

Asked by Ilya Prigogine whether this was in fact the case, Dalí replied that the soft watches were not inspired by the...
theory of relativity, but by the surrealist perception of a Camembert cheese melting in the sun

Artwork 36:

Self-Portrait as Mona Lisa, 1954, photograph, P. Halsman and Dalí.

- Philippe Halsman and Salvador Dalí lived and worked in Paris in the 1930s, when surrealism flourished.
- But they first met in New York in 1941, when both were new émigrés. They had arrived within months of each other – Dalí in August 1940, and Halsman three months later.
- During the previous ten years, their paths must have criss-crossed frequently in the narrow streets of Montparnasse, where Halsman had a studio at 22 Rue Delambre, and Dalí was part of the surrealist enclave at 54 Rue du Chateau.
- In 1936, Halsman exhibited photographs at the Galerie de la Pleiade, where surrealist photographer Man Ray also showed his work.
- But until 1941, Halsman and Dalí had never met.
- Within a year of his arrival in New York, Halsman had re-established himself.
- His iconic portrait of model Connie Ford silhouetted against an American flag had been featured in a major Elizabeth Arden advertising campaign.
- In April, 1941, Halsman was assigned by the Black Star Agency to photograph the installation of Dalí’s first New York exhibit — at the Julien Levy Gallery.
- Halsman’s relationship with Dalí deepened in October, when he photographed the outsize costumes Dalí created for the Ballets Russes production of “Labyrinth” at the Metropolitan Opera House — with music by Franz Schubert, choreography by Leonid Massine, and scenery and costumes by Salvador Dalí.
- Lacking a large studio, Halsman took the company’s prima ballerina, Tamara Toumanova, and another dancer dressed as a giant white rooster, to a nearby rooftop.
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- The photo became LIFE’s “Picture of the Week,” the artists became inspired friends, and their creative rapport would last for the next 37 years.
- Several weeks later they collaborated again; this time they produced a collaged photograph of Dalí lying naked in the embryo pose within an enlarged photo of an egg.
- The image, entitled “Pre-Natal Memory,” was published the following year in Dalí’s autobiography, “The Secret Life of Salvador Dalí.”
- In the decades ahead, Halsman and Dalí would “play” together at least once a year — “an elating game,” Halsman wrote in 1972, “creating images that did not exist, except in our imaginations.
- Whenever I needed a striking protagonist for one of my wild ideas, Dalí would graciously oblige. Whenever Dalí thought of a photograph so strange that it seemed impossible to produce, I tried to find a solution.”
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Artwork 37:

The Sacrament of the Last Supper, 1955, oil on canvas, 105 x 66 in.

- This painting is designed with connections to the number twelve including: the 12 Apostles, Dodecahedrons and references to numerology.
- The Communion Must be Symmetrical under the Dodecahedron

Artwork 38:

Nature Morte Vivante (Still Life – Fast Moving), 1956, oil on canvas, 49 ¼ x 63 in.

- This is a key painting that shows Dalí’s intense interest in the geometry of art, the science of beauty and the spiral form.
- Inspired by Matila Ghyka, a Romanian mathematician, who explored “dynamic symmetry” in art and nature using simple mathematical formulas (such as Phi) to explore natural forms.
Dalí incorporated several of these symmetrical grids as the compositional basis for many paintings, such as the harmonic rectangle (the Phi rectangle) and the dynamic triangle (from Greek canons of proportion).

The ideas of geometry of art and life are further expanded with the connection of the Fibonacci spiral; the numerical sequence of the Golden spiral: (1,1,2,3,5,8,13,21...).

Werner Karl Heisenberg's work on quantum theory is linked with a basic conception of atomic physics.

DNA double-helix molecular structure represented in the railing post.

The mathematical concept of fractals is evident in the repeated pattern within the painting of the sea.

One of Dalí's most accomplished paintings of the postwar years.

He produced numerous preparatory sketches and oil studies.

Emblematic of Nuclear mysticism.

Post-atomic variation on Dutch artist Floris Van Schooten's *Table with Food* (1617), in the Prado Museum.

Dalí breaks down the composition into smaller particles.

Dalí proposes the idea of a "Fast-moving" still life in which matter is suspended within a dynamic space-time continuum.

Word play "still life – fast moving."

Dalí had become friends with Romanian mathematician Matila Ghyka, whose studies of the Golden Section helped Dalí to create his compositions. This painting laid out rigorously according to the Golden ratio.

Dalí: *Nature Morte Vivante* is "(an) explanatory painting where one can observe the dynamic and irrational dividing a fruit dish following the coefficients of uncertainty of Heisenberg in opposition to the positive security which cubist pictures once tried to offer us."

Werner Karl Heisenberg's work on quantum theory is linked with a rudimentary conception of atomic physics. By referring to Heisenberg, Dalí declares his interest in modern physics.

Heisenberg's Uncertainty Principle: In quantum mechanics, a fundamental limit to the precision with which the position and momentum of a particle cannot be known simultaneously. The more precisely the position of a particle is determined, the less precisely its momentum can be known, and vice versa.

Dalí shows this several times with doubled objects (the fruit dish, apple, and cherry) where the located version of the objects casts a shadow, the momentum of the same object just resemble the shooting of the object through space.

Dalí's pseudoscientific approach extends to an analysis of the double-helix structure of the DNA molecule and, more generally, of the logarithmic spiral.

In 1953, Watson and Crick had just proposed that the DNA molecule should have a double helix spiral shape. Here Dalí includes a twisting banister and a rhino horn, with its own perfect spiral, in reference.

The cauliflower floret on the right looks like the top of a mushroom cloud or a meteor, but Dalí uses it because of its growth patterns of perfect Golden spirals.

Artwork 39:

**The Discovery of America by Christopher Columbus**, 1958-59, oil on canvas, 161 ½ x 122 1/8 in.

- The structure of the painting is based on the harmonic rectangle calculated by Matila Ghyka in *The Geometry of Art and Life*.
- Two symmetric mirrored images of Dalí's *Christ of Saint John of the Cross*, 1951.
- Repeated linear pattern of crosses, staffs and weapons create movement throughout the canvas.
- One-point perspective employed in the angled crosses and shadows to create the illusion of depth.
- Originally titled "The Dream of Columbus."
- A late Nuclear Mystical painting.
- Commissioned for Huntington Hartford's New Gallery of Modern Art which opened on Columbus Avenue in New York in 1962.
- Composition device is a Golden Spiral starting with gala's face, spiraling clockwise up and sweeping back down through the crosses and out where St. Narciso stands.
- Dalí had read a historian who believed that Columbus was from Catalonia, thus the great discovery of the new world parallels Dalí's own discovery of the new world.
- Columbus shown as a Grecian youth in toga discovering New World, so it is like he is in a dream.
- Circle at top contains: 1. Michelangelo’s *Pieta*, 2. Michelangelo’s *Moses*, 3. King and Queen of Spain with Columbus prior to voyage – blessed by secular and spiritual power.
- On right: Vertical lances, quoted from Velazquez's *Lances of Breda*, hold the image of Christ on the cross, a Spanish mystical image inspired by Spanish mystic St. John drawing of Christ seen from God's point of view.
- Dalí signs work by painting himself in as a monk holding the same cross found in the lances.
- Gala appears twice: First in the banner as The Immaculate Conception and second as the shrouded figure in the lower right who had removed herself from the three ring circus of Dalí's public life.
- The ship is the Santa Maria – the crow's nest becomes the Catholic chalice (holding the blood of Christ) and the circle in the upper cross is the Catholic Eucharist (the Body of Christ).
- St. Narciso and the Miracle of the Flies: On three occasions French invaders came over the Pyrenees to capture the city of Girona, the capital of Catalonia. According to the folk legend, large gadflies rose from St. Narciso's crypt, bringing pestilence and disease to the French, keeping the city free.
- Depicts Columbus stepping ashore on the New World and planting the banner of the Inmaculada on its soil.
- Dalí worked on his largest canvas to date for six months, assisted by Isador Bea.
- Weaves historical sources with popular legends.
- The bishop, a portrait of Bea, represents Saint Narciso, the patron of the medieval city of Girona.
- Images also include gadflies, Ferdinand and Isabella receiving Columbus, scene of the pieta in a mandorla, as well as references to his Christ of St. John of the Cross.
- The sea urchin surrounded by cosmic rings is an illusion to the new age of space travel, depicted without spines but with celestial spheres rotating it – looks like some sort of cosmic satellite.
- It is a “sputnik” sea urchin, probably chosen by Dalí because its name suggests Sputnik, the unmanned Russian Satellite shot into space the previous year.
- The sea urchin suggests that the discovery of new worlds does not end with America, but continues into space.
- The structure of the painting is based on the harmonic rectangle calculated by Matila Ghyka in The Geometry of Art and Life.

**Artwork 40:**

*The Pope’s Ear,* 1958.

- Pope John XXIII.
- Dalí employs Ben Day dot pattern.
- Action painting technique produces representational image.
- Trompe-l’œil detail of cherry.

**Artwork 41:**

*The Ecumenical Council,* 1960, oil on canvas, 118 x 100 in.

- Matila Ghyka’s investigation of proportion leads him to a study in Greek proportion from various Greek vase designs.
- Greek vases have specific mathematic ratios that can be studied in terms of geometry.
- Dalí utilized the analysis of the Greek vase "Stamnos" and used its reversed direction as a compositional basis for this monumental painting.
- Dalí’s last epic painting on the theme of religious mysticism.
- The scene is divided into two zones: an earthly realm and a vast heavenly paradise, interceding between them is Gala as Saint Helena, discoverer and defender of the True Cross.
- Gala appears as a muse through which the artist’s religious and creative energies are channeled.
- Refers to Pope John XXIII’s historic meeting with the archbishop of Canterbury in 1960 in a gesture of religious ecumenism.
- Dalí represents the Pope’s coronation four times as well as God, the Son and the Holy Ghost.
- The rendering of St. Peter’s Basilica, the work of Dalí’s assistant Isador Bea, adds a note of historical accuracy.

**Artwork 42:**

*Galacidalacidesoxribonucleicacid (Homage to Crick and Watson),* 1963, oil on canvas, 120 x 163 ½ in.

- Dalí combined his name, the name of his wife Gala, Allah, and Cid Campeador (the feminine Cid) with desoxiribonucleic acid.
- Dalí weaves his beliefs on nuclear mysticism into a complex and often esoteric historical narrative.
- DNA molecule represents the building-block of life (Dr. Francis Crick and Dr. James Watson, 1953).
- Group of Arab gunmen in “molecular” formations in a geometric cube design.
- 1962 Rio Llobregat floods filling hundreds.
- Commerates the Riu Llobregat flooding just outside of Barcelona, killing more than four hundred people.
- Dalí combined his name, the name of his wife Gala, Allah, and Cid Campeador (the feminine Cid) with desoxiribonucleic acid (DNA).
- Dalí weaves his beliefs on nuclear mysticism into a complex and often esoteric historical narrative.
- Elaborate cycle of birth, death, and rebirth.
- Left - DNA molecule represents the building-block of life (Dr. Francis Crick and Dr. James Watson, 1953) and the persistence of genetic human memory.
- Watson & Crick receive Nobel Prize for proposal that DNA has a double helix shape.
- Right - Group of Arab gunmen in “molecular” salt formations signify death and self-annihilation (nonlife – one pulls trigger, all die) in addition to the scientific legacy of the Arabs in Spain.
- Middle - God the Father reaches down to lift the body of Christ back to heaven to be reborn, as Gala looks on.
- God’s head contains the Madonna and Christ (consubstantial).
- Bottom – Gala as Madonna witnesses Christ’s ascension.
- Christ forms arch around Gala, his head is upside down.
- Upper left – Michelangelo’s Prophet Isaiah holds scroll with painting title – he foretold Christ’s birth.

**Artwork 43:**

*Portrait of My Dead Brother*, 1963, oil on canvas, 69 x 69 in.

- Dalí’s older brother, Salvador, died and Dalí inherited his brother’s name.
- Dalí imagined himself as one-half of a double whose unity was irretrievable and kept him in a state of perpetual crisis.
- Cherries joined in a molecular structure of a cube design representing platonic solids.
- Geometric pattern of dots/cherries create his dead brother’s imaginary visage.
- Dalí returns to the theme of mythic autobiography recounting the traumatic events surrounding his older brother’s death.
- Dalí, his brother, and his father all shared the name “Salvador.”
- The death of his brother haunted Dalí throughout his life.
- Dalí imagined himself as one-half of a double whose unity was irretrievable and kept him in a state of perpetual crisis.
- The visage of the child suggests a generic image of wholeness and completion.
- The maternal vulture, Freud’s essay on Leonardo da Vinci, is an image of incestuous desire and restates the theme of predatory female aggression.
- Images of Spanish guards, cherries joined in a molecular structure, and the *Angelus*.
- Dalí forges an elaborate network of associations redefining his past in relation to myth, psychoanalysis, art history and modern science to shore up a divided self.

**Artwork 44:**

*Fifty Abstract Paintings Which Seen from Two Yards Change into Three Lenins Masquerading as Chinese and as Seen from Six Yards Appear as the Head of a Royal Bengal Tiger*, ca. 1963, oil on canvas.

- Each of the fifty panels of this painting is a separate abstract painting, which as seen from two yards away, change into three Lenins masquerading as Chinese.
- When seen from six yards away, the whole painting comes together to appear as the head of a royal tiger.
- This is an excellent use of geometry, based on the square, employing the mathematical concept of tiling.

**Artwork 45:**

*The Railway Station at Perpignan*, 1965, Oil on canvas. 116 x 160 in.

- Salvador Dalí was an eccentric Catalan artist of the Surrealist movement.
- His persona was as unruly and unconventional as the art he created.
- Born in Figueres, Spain, not far from the French border, Dalí developed a deep love for Catalonia during childhood. Dalí traveled throughout the world, but had an interest in the city of Perpignan because of its evident Catalan roots.
- Dalí used to claim that he gained the most inspiration simply by sitting in the train station’s lobby.
- On August 27, 1963 Dalí made a proclamation that changed the reputation of La Gare de Perpignan.
- “It all became clear in a flash: There, right before me, was the center of the universe,” Dalí said. Dalí publically declared that the Perpignan train station was the “centre du monde,” the center of the world.
- Dalí later created a painting entitled “La Gare de Perpignan.”
- The work of art is considered to be an exceptional example of the Surrealist movement.
- The piece, which features a small image of the train station amid figures of rural farm workers, is intensely symbolic of Dalí’s obsessive concern with immortality.
- Lluís Colet, a local historian and Dalí expert, believes that there are numerous reasons Dalí chose Perpignan’s train station as the center of the world.
- “In an emotional way, in a historic way and in a scientific way, many things can show that Perpignan is the centre of the world,” said Colet. “For all those reasons the master thinks the center of the universe is here.”
- Dalí’s curiosity for the train station stemmed from his belief in the philosophy of cosmogony.
• Cosmogony is the theory there is a single universal origin from which all existence and reality emerged.
• It is said that when this origin is found, one may come to understand the meaning of existence.
• In order to name a location a cosmogony, Colet said, there must be many different energies surrounding that place.
• Perpignan’s geographical location invites many of the world’s civilizations to gather there, which creates an undeniably unique energy.
• Perspectives of life and creation, existence and reality meet when passing through the seemingly insignificant train station, according to Colet.
• Today arriving at La Gare de Perpignan is like entering the center of Salvador Dalí’s psyche.
• The ceilings are painted in large swirls of bright yellows, oranges and blues in a fashion that makes one question if there is such a thing as too much color.
• The swirls create enormous butterflies, an homage to Dalí’s art, and tempt the imagination to see how many butterflies can be found among the flurry of color.
• The boarding platform displays the words “Perpignan Centre du Monde” painted in chalky white paint across the black pavement.
• Travelers do not seem to notice the references to Dali or note the station’s immeasurable importance to the great artist.
• They hurry through the center of the world in a flash.
• Dalí did not contribute any art to the station, but with his declaration he transformed La Gare de Perpignan into his personal masterpiece.

Artwork 46:


• Portrait of Leonardo da Vinci.

Artwork 47:

**First Cylindric Chrono – Hologram Portrait of Alice Cooper’s Brain**, 1973,
white light integral hologram, 16 inches diameter x 10 inches height.

• Dalí questioned the traditional ways that an image represents a subject, and he responded to advances in technology.
• By experimenting with double images, he discovered ways to multiply the meaning of his paintings.
• By working in animation, he found a way to bring his metamorphic visions to life for others to share.
• In the early 1970’s, Dalí was one of the first artists to explore holography.
• Holography is a photographic medium proposed by Dr. Dennis Gabor in 1947 using lasers to record an object so that it can appear as a three-dimensional image.
• Choosing Alice Cooper as the focus of the project was a clear indication of Dalí’s enthusiasm for pop culture.
• Working with South African artist holographer Sewyn Lissac, Dalí created a rotating three-dimensional image of the rock star.
• Cooper seated cross-legged and bare-chested on a rotating base, “shish kebabbed” Venus de Milo statue, real million dollar diamond tiara (armed guards), fake plaster brain stuffed with a chocolate éclair and real ants suspended behind his head.
• Through holography Dalí was able to capture the continuity and discontinuity of the image of a real person in real time.

Artwork 48:

**Gala Contemplating the Mediterranean Sea which at Twenty Meters Becomes the Portrait of Abraham Lincoln-Homage to Rothko (Second Version)**, 1976, oil and collage on canvas,
99 ¼ x 75 ½ in.

• Carefully calibrated square cells that form a complex network of multiple images and two for one optical illusions.
• Dalí understood the implications of Harmon’s research for the growing fields of neuroscience and computer imaging.
- This painting is designed with a grid-like pattern of squares of color employing the mathematical concepts of tessellations, tiling and platonic solids.
- Inspiration Source: 1973 issue of Scientific American containing Leon Harmon’s “The Recognition of Faces” about perception and image recognition. He applied distortions to various familiar images, including the Mona Lisa and Lincoln, to see what the minimal conditions were to how much information our mind needs to recognize a face.
- Harmon’s computer generated block portrait Demonstrated the minimal conditions needed to recognize a face.
- Dalí’s fascination with double images led to this larger self-imposed challenge: to create a completely new composition out of the distorted image of Lincoln.
- There is an earlier version in the Teatre-Museu Dalí in Figueres, Spain, painted on a large photo.
- The vast size made it difficult to see the face of Lincoln unless viewed by special glasses that reduce the image. Dalí gave visitors binoculars and asked them to look through the “wrong side” of the lens.
- Painted when Dalí was 72, just after he completed his Museum in Spain.
- Theme of passing time.
- Gala is depicted nude, except for her familiar Chanel bow, standing before an open window in a composition Dalí repeatedly painted over the years. She was 82 years old when this was painted, so she has become much younger.
- The rising sun also contains Christ in ascension, reminiscent of Dalí’s 1951 painting titled Christ of St. John of the Cross, where Christ has died and is being resurrected.
- The location of the sun, Christ’s head, is possibly where Lincoln was shot.
- Dalí’s title references Mark Rothko (1903-1970), a leading Abstract Expressionist painter who had recently committed suicide.
- Dalí was competing with the Latvian-born American artist Mark Rothko in terms of the size, scale, and chromatic brilliance of his work.
- Carefully calibrated square cells of colors in varying progression of hues is evocative of the meditative “color field” paintings of Rothko, as well as forming a complex network of multiple images and optical illusions.
- The skill and ingenuity required to produce the double image of Lincoln/Gala before the window is matched by Dalí’s exquisite employment of trompe-l’oeil effects.
- Affixed a copy of an altered Lincoln photograph directly to the canvas, underscoring Dalí’s interest in collage as well as photographic and reproduction technologies.
- Dalí wed science with psychoanalysis and religious mysticism by means of an extended process of “paranoiac” associations and interpretation, simultaneously engaging the perceptual and critical faculties of the spectator.
- Dalí understood the implications of Harmon’s research for the growing fields of neuroscience and computer imaging.
- Dalí returns to the major themes of his surrealist years declaring in the process his receptivity to new developments in the science of human perception.
- Dalí spent many years living between Spain and the United States and considered America his second home.
- Dalí painted this for America’s Bicentennial in 1976.
- Painted in Dalí’s hotel room at the St. Regis Hotel in New York.

Artwork 49:

**Gala’s Foot**, 1974-76.

- Stereo-optic painting.

Artwork 50:

**The Chair**, 1975.

- Stereo-optic painting.

Artwork 51:

**The Chair**, 1975.
Stereo-optic painting.

**Artwork 52:**

*The Swallow's Tail — Series on Catastrophes*, 1983, oil on canvas, 28.7 x 36.3 in.

- Salvador Dali's last painting.
- It was completed in May 1983, as the final part of a series based on René Thom’s catastrophe theory.
- Thom suggested that in four-dimensional phenomena, there are seven possible equilibrium surfaces, and therefore seven possible discontinuities, or “elementary catastrophes”: fold, cusp, swallowtail, butterfly, hyperbolic umbilic, elliptic umbilic, and parabolic umbilic.
- "The shape of Dali’s Swallow’s Tail is taken directly from Thom’s four-dimensional graph of the same title, combined with a second catastrophe graph, the s-curve that Thom dubbed, "the cusp".
- Thom’s model is presented alongside the elegant curves of a cello and the instrument’s f-holes, which, especially as they lack the small pointed side-cuts of a traditional f-hole, equally connote the mathematical symbol for an integral in calculus: ∫.
- In his 1979 speech, "Gala, Velázquez and the Golden Fleece", presented upon his 1979 induction into the prestigious Académie des Beaux-Arts of the Institut de France, Dali described Thom’s theory of catastrophes as ‘the most beautiful aesthetic theory in the world’.
- He also recollected his first and only meeting with René Thom, at which Thom purportedly told Dali that he was studying tectonic plates; this provoked Dali to question Thom about the railway station at Perpignan, France, which the artist had declared in the 1960s as the centre of the universe.
- Thom reportedly replied, "I can assure you that Spain pivoted precisely — not in the area of — but exactly there where the Railway Station in Perpignan stands today".
- Dali was immediately enraptured by Thom’s statement, influencing his painting *Topological Abduction of Europe — Homage to René Thom*, the lower left corner of which features an equation closely linked to the ‘swallow’s tail’:

\[ V = x^5 + ax^3 + bx^2 + cx \]  

an illustration of the graph, and the term ‘queue d’aronde’.

- The seismic fracture that transverses *Topological Abduction of Europe* reappears in *The Swallow’s Tail* at the precise point where the y-axis of the swallow’s tail graph intersects with the S-curve of the cusp.

**Artwork 53:**

*Topological Abduction of Europe — Homage to René Thom*, 1983. oil on canvas.

- René Thom was a French mathematician who worked in topology.
- Topology is the branch of mathematics that studies shapes and symmetries of abstract geometric figures.
- Thom’s research culminated in his 1972 book *Structural Stability and Morphogenesis* in which he unveiled his catastrophe theory.
- Thom concluded that in four-dimensional phenomena there are seven possible equilibrium, and thus, seven possible breaks in equilibrium, which Thom called elementary catastrophes.
- Thom called these: fold, cusp (s-curve), swallow’s tail, butterfly, hyperbolic umbilic, elliptic umbilic, and parabolic umbilic.

- **Topological Abduction** features Thom’s equation for the swallows tail in the lower left corner:  

\[ V = x^5 + (ux^3)/3 + (vx^2)/2 + wx \]  

- The words *queue d’aronde*, which are French for swallows tail, appear in the lower left corner and a small graph of the swallow’s tail shape follows the equation.
- The canvas is fractured by a large seismic crack, which relates to the catastrophe.
- This was Dali’s penultimate painting, and certainly one of his most conceptual.

**Vocabulary:**

Dali Museum  
Salvador Dali
Alberti’s grid
Anamorphic Art
Background
Baroque
Board
Buckminster Fuller
Burlap
Cadaqués
Canvas
Catalonia
Chaos Theory
Chiaroscuro
Collage
Cubism
DNA
Double helix
Double image
Elena Ivanovna Diakononova (Gala)
Glass Enigma
Fibonacci’s sequence
Figueres
Foreground
Foreshortening
Fractals
Geodesic dome
Geometry
Golden spiral
Golden triangle
Golden rectangle
Horizon line
Hypercube
Illusion
Impressionism
Irrational number
Irregular tessellation
Juxtaposition
Labyrinth
Landscape
Leon Battista Alberti
Leonardo da Vinci
Marcus Vitruvius Pollio
Master work
Matila Ghyka
Maze
Middle ground
Nuclear mysticism
Oil painting
Orthogonal lines
Paranoiac critical method
Perspective
Phi (Golden ratio)
Pi
Platonic solids
Polyhedral
Port Lligat
Portrait
Raphael
Renaissance
Rene Thom
Reynolds and Eleanor Morse
Salvador Felipe Jacinto Dalí
Spain
Surrealism
Symmetry
Tessellation
Tiling
Transformation
Trompe l’œil
Vanishing point
Vermeer
Werner Karl Heisenberg
### Declarative Knowledge: (Students will Know/Understand)

<table>
<thead>
<tr>
<th>Students/group will know/understand: the scientific theory of atoms (also known as atomic theory) by describing the structure of atoms in terms of protons, neutrons and electrons, and differentiate among these particles in terms of their mass, electrical charges and locations within the atom.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students/group will know/understand: the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time.</td>
</tr>
<tr>
<td>Students/group will know/understand: and recognize the role of creativity in constructing scientific questions, methods and explanations.</td>
</tr>
</tbody>
</table>

### Procedural Knowledge: (Students/Group will be able to do)

<table>
<thead>
<tr>
<th>Students/group will be able to: describe atomic theory and how it relates to Salvador Dalí’s artwork and “Nuclear Mysticism.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students/group will be able to: discuss Salvador Dalí’s artwork in relationship to Werner Karl Heisenberg’s work on quantum theory. Especially the Uncertainty Principle: In quantum mechanics, a fundamental limit to the precision with which the position and momentum of a particle cannot be known simultaneously. The more precisely the position of a particle is determined, the less precisely its momentum can be known, and vice versa.</td>
</tr>
<tr>
<td>Students/group will be able to: demonstrate how Salvador Dalí expresses the role of creativity in constructing scientific questions, methods and explanations.</td>
</tr>
</tbody>
</table>

### NGSSS: Next Generation Sunshine State Standards (Florida)

**Visual Art (VA), Language Arts (LA), Science (SC), Mathematics (MA) and Social Studies (SS)**

[http://tools.fcit.usf.edu/sss/](http://tools.fcit.usf.edu/sss/)

| SC.912.P.8.4 | **Physical Science, Standard 8: Matter,** Benchmark: 4. Explore the scientific theory of atoms (also known as atomic theory) by describing the structure of atoms in terms of protons, neutrons and electrons, and differentiate among these particles in terms of their mass, electrical charges and locations within the atom. |
| --- |
| SC.912.P.12.2 | **Physical Science, Standard 12: Motion,** Benchmark: 2. Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time. |
| SC.912.N.1.7 | **Nature of Science, Standard 1: The Practice of Science,** Benchmark: 7. Recognize the role of creativity in constructing scientific questions, methods and explanations. |

### Formative Assessments:

1. Observation of student engagement.
2. Monitoring student progress and “Teachable Moments.”
3. Discussion participation and responses.
**Summative Assessments: (Scoring Scales/Rubrics)**

<table>
<thead>
<tr>
<th>LEARNING GOAL(S)</th>
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<td><strong>PERSONAL</strong></td>
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<td><strong>APPLICATION</strong></td>
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<td><strong>TARGET</strong></td>
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<td><strong>SUCCESS for all Students</strong></td>
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<td><strong>SIMPLER</strong></td>
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<td><strong>LIMITED SUCCESS</strong></td>
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<td><strong>PARTIAL</strong></td>
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<td><strong>MINIMAL SUCCESS</strong></td>
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<td><strong>NO SUCCESS</strong></td>
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<td><strong>Unsatisfactory</strong></td>
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**Students/group**

**will:** describe atomic theory and how it relates to Salvador Dalí’s artwork and “Nuclear Mysticism.”

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<tbody>
<tr>
<td></td>
<td>Able to link atomic theory with a deep understanding of Dalí’s artwork and philosophy.</td>
<td>Able to link atomic theory with a good understanding of Dalí’s artwork and philosophy.</td>
<td>Able to link atomic theory with some understanding of Dalí’s artwork and philosophy.</td>
<td>Unable to demonstrate an understanding of atomic theory or Dalí’s artwork and philosophy.</td>
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</tr>
<tr>
<td></td>
<td>Able to discuss Dalí’s artwork combined with a complete understanding of the relationship with Heisenberg’s Uncertainty Principle.</td>
<td>Able to discuss Dalí’s artwork combined with a good understanding of the relationship with Heisenberg’s Uncertainty Principle.</td>
<td>Able to discuss Dalí’s artwork combined with a limited understanding of the relationship with Heisenberg’s Uncertainty Principle.</td>
<td>Unable to discuss Dalí’s artwork or the Uncertainty Principle.</td>
<td></td>
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<tr>
<td></td>
<td>Able to reveal Dalí’s expression of creativity as related to scientific questions, methods and explanations with personal style.</td>
<td>Able to reveal Dalí’s expression of creativity as related to scientific questions, methods and explanations.</td>
<td>Able to reveal Dalí’s expression of creativity with limited connections as related to scientific questions, methods and explanations.</td>
<td>Unable to demonstrate any understanding of Dalí’s expression of creativity.</td>
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</table>

**Students/group**

**will:** discuss Salvador Dalí’s artwork in relationship to Werner Karl Heisenberg’s work on quantum theory, especially the Uncertainty Principle.

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<td>Unable to demonstrate any understanding of Dalí’s expression of creativity.</td>
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**Students/group**

**will:** demonstrate how Salvador Dalí expresses the role of creativity in constructing scientific questions, methods and explanations.

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</tbody>
</table>
REFERENCE SCALE/RUBRIC USED TO ASSESS: Visual Art, Design or any Creative Endeavor.

<table>
<thead>
<tr>
<th>FINE ART SCALE (RUBRIC)</th>
<th>4</th>
<th>3</th>
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<td>TARGET</td>
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<tr>
<td>PARTIAL</td>
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</tr>
<tr>
<td>NO SUCCESS</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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</tr>
</tbody>
</table>

**KNOWLEDGE**

- **4** Uses basic directions and concepts of the assignment in a unique way.
- **3** All basic directions and concepts of the assignment clearly evident.
- **2** Uses most assignment specific directions and concepts.
- **1** Minimal assignment specific directions and concepts evident.
- **0** No evidence of knowledge.

**REASONING**

- **4** Connecting information in introspective, logical and sequential choices throughout entire creative process.
- **3** Connecting information in logical and sequential choices throughout entire creative process.
- **2** Connecting some information in choices throughout entire creative process.
- **1** Minimal connection of information in choices throughout entire creative process.
- **0** No evidence of reasoning.

**TECHNICAL SKILLS**

- **4** Demonstrates high level of expertise in techniques appropriately employed.
- **3** Uses all relevant techniques appropriately.
- **2** Uses most relevant techniques appropriately.
- **1** Minimal use of appropriate and relevant techniques.
- **0** No evidence of technical skills.

**CREATIVITY**

- **4** Exceptional evidence of personal style continued throughout creative process and product.
- **3** Solid evidence of personal style continued throughout creative process and product.
- **2** Some evidence of personal style continued throughout creative process and product.
- **1** Limited evidence of personal style continued throughout creative process and product.
- **0** No evidence of creativity.
ADDITIONAL REFERENCE MATERIAL:

Elements of Art:

Line, Shape, Color, Value, Form, Texture, Space.

Principles of Design:

Balance, Contrast, Emphasis, Movement, Pattern, Rhythm, Unity.

National Core Art Standards:

www.nationalartstandards.org

Creating, Performing/Presenting/Producing, Responding, Connecting.

Anchor Standards:

Creating:
1. Generate and conceptualize artistic ideas and work.
2. Organize and develop artistic ideas and work.
3. Refine and complete artistic work.

Performing/Presenting/Producing:
4. Analyze, interpret, and select artistic work for presentation.
5. Develop and refine artistic work for presentation.
6. Convey meaning through the presentation of artistic work.

Responding:
7. Perceive and analyze artistic work.
8. Interpret intent and meaning in artistic work.
9. Apply criteria to evaluate artistic work.

Connecting:
10. Synthesize and relate knowledge and personal experiences to make art.
11. Relate artistic ideas and works with societal, cultural and historical context to deepen understanding.

Critical Thinking:


Bloom’s Taxonomy:

Remembering, Understanding, Applying, Analyzing, Evaluating, Creating.

Marzano’s Taxonomy:

Retrieval Recognizing, recalling, executing.
Comprehension Integrating, symbolizing.
Analysis Matching, classifying, analyzing errors, generalizing, specifying.
Knowledge Utilization Decision making, problem solving, experimenting, investigating.

Feldman’s Model of Art Criticism (1981):

Description What do you see in this work?
Analysis How is the work organized?
Interpretation What is the work about?
Judgment Is the work successful? Why?

Anderson’s Model of Art Criticism (1988):

Reaction What is it?
Description What does the work show? How, why, where was it made?
Interpretation What is the work about? How do we know?
Evaluation Is the work well done? How do we decide?
NGSSS: (Standard Numbers/Standards/Taxonomy Levels)

Next Generation Sunshine State Standards (Florida)

http://tools.fcit.usf.edu/sss/

Science 9-12

Life Science

**Standard 14: Organization and Development of Living Organisms**

A. Cells have characteristic structures and functions that make them distinctive.
B. Processes in a cell can be classified broadly as growth, maintenance, reproduction, and homeostasis.
C. Life can be organized in a functional and structural hierarchy ranging from cells to the biosphere.
D. Most multicellular organisms are composed of organ systems whose structures reflect their particular function. (SC.912.L.14)

**Benchmark: 1.** Describe the scientific theory of cells (cell theory) and relate the history of its discovery to the process of science. (SC.912.L.14.1)

**Benchmark: 2.** Relate structure to function for the components of plant and animal cells. Explain the role of cell membranes as a highly selective barrier (passive and active transport). (SC.912.L.14.2)

**Benchmark: 3.** Compare and contrast the general structures of plant and animal cells. Compare and contrast the general structures of prokaryotic and eukaryotic cells. (SC.912.L.14.3)

**Benchmark: 4.** Compare and contrast structure and function of various types of microscopes. (SC.912.L.14.4)

**Benchmark: 5.** Explain the evidence supporting the scientific theory of the origin of eukaryotic cells (endosymbiosis). (SC.912.L.14.5)

**Benchmark: 6.** Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health. (SC.912.L.14.6)

**Benchmark: 7.** Relate the structure of each of the major plant organs and tissues to physiological processes. (SC.912.L.14.7)

**Benchmark: 8.** Explain alternation of generations in plants. (SC.912.L.14.8)

**Benchmark: 9.** Relate the major structure of fungi to their functions. (SC.912.L.14.9)

**Benchmark: 10.** Discuss the relationship between the evolution of land plants and their anatomy. (SC.912.L.14.10)

**Benchmark: 11.** Classify and state the defining characteristics of epithelial tissue, connective tissue, muscle tissue, and nervous tissue. (SC.912.L.14.11)

**Benchmark: 12.** Describe the anatomy and histology of bone tissue. (SC.912.L.14.12)

**Benchmark: 13.** Distinguish between bones of the axial skeleton and the appendicular skeleton. (SC.912.L.14.13)

**Benchmark: 14.** Identify the major bones of the axial and appendicular skeleton. (SC.912.L.14.14)

**Benchmark: 15.** Identify major markings (such as foramina, fossae, tubercles, etc.) on a skeleton. Explain why these markings are important. (SC.912.L.14.15)

**Benchmark: 16.** Describe the anatomy and histology, including ultrastructure, of muscle tissue. (SC.912.L.14.16)

**Benchmark: 17.** List the steps involved in the sliding filament of muscle contraction. (SC.912.L.14.17)

**Benchmark: 18.** Describe signal transmission across a myoneural junction. (SC.912.L.14.18)

**Benchmark: 19.** Explain the physiology of skeletal muscle. (SC.912.L.14.19)

**Benchmark: 20.** Identify the major muscles of the human on a model or diagram. (SC.912.L.14.20)

**Benchmark: 21.** Describe the anatomy, histology, and physiology of the central and peripheral nervous systems and name the major divisions of the nervous system. (SC.912.L.14.21)

**Benchmark: 22.** Describe the physiology of nerve conduction, including the generator potential, action potential, and the synapse. (SC.912.L.14.22)

**Benchmark: 23.** Identify the parts of a reflex arc. (SC.912.L.14.23)

**Benchmark: 24.** Identify the general parts of a synapse and describe the physiology of signal transmission across a synapse. (SC.912.L.14.24)

**Benchmark: 25.** Identify the major parts of a cross section through the spinal cord. (SC.912.L.14.25)

**Benchmark: 26.** Identify the major parts of the brain on diagrams or models. (SC.912.L.14.26)

**Benchmark: 27.** Identify the functions of the major parts of the brain, including the meninges, medulla, pons, midbrain, hypothalamus, thalamus, cerebellum and cerebrum. (SC.912.L.14.27)

**Benchmark: 28.** Identify the major functions of the spinal cord. (SC.912.L.14.28)

**Benchmark: 29.** Define the terms endocrine and exocrine. (SC.912.L.14.29)

**Benchmark: 30.** Compare endocrine and neural controls of physiology. (SC.912.L.14.30)

**Benchmark: 31.** Describe the physiology of hormones including the different types and the mechanisms of their action. (SC.912.L.14.31)
Benchmark: 32. Describe the anatomy and physiology of the endocrine system. (SC.912.L.14.32)
Benchmark: 33. Describe the basic anatomy and physiology of the reproductive system. (SC.912.L.14.33)
Benchmark: 34. Describe the composition and physiology of blood, including that of the plasma and the formed elements. (SC.912.L.14.34)
Benchmark: 35. Describe the steps in hemostasis, including the mechanism of coagulation. Include the basis for blood typing and transfusion reactions. (SC.912.L.14.35)
Benchmark: 36. Describe the factors affecting blood flow through the cardiovascular system. (SC.912.L.14.36)
Benchmark: 37. Explain the components of an electrocardiogram. (SC.912.L.14.37)
Benchmark: 39. Describe hypertension and some of the factors that produce it. (SC.912.L.14.39)
Benchmark: 40. Describe the histology of the major arteries and veins of systemic, pulmonary, hepatic portal, and coronary circulation. (SC.912.L.14.40)
Benchmark: 41. Describe fetal circulation and changes that occur to the circulatory system at birth. (SC.912.L.14.41)
Benchmark: 42. Describe the anatomy and the physiology of the lymph system. (SC.912.L.14.42)
Benchmark: 43. Describe the histology of the respiratory system. (SC.912.L.14.43)
Benchmark: 44. Describe the physiology of the respiratory system including the mechanisms of ventilation, gas exchange, gas transport and the mechanisms that control the rate of ventilation. (SC.912.L.14.44)
Benchmark: 45. Describe the histology of the alimentary canal and its associated accessory organs. (SC.912.L.14.45)
Benchmark: 46. Describe the physiology of the digestive system, including mechanical digestion, chemical digestion, absorption and the neural and hormonal mechanisms of control. (SC.912.L.14.46)
Benchmark: 47. Describe the physiology of urine formation by the kidney. (SC.912.L.14.47)
Benchmark: 48. Describe the anatomy, histology, and physiology of the ureters, the urinary bladder and the urethra. (SC.912.L.14.48)
Benchmark: 49. Identify the major functions associated with the sympathetic and parasympathetic nervous systems. (SC.912.L.14.49)
Benchmark: 50. Describe the structure of vertebrate sensory organs. Relate structure to function in vertebrate sensory systems. (SC.912.L.14.50)
Benchmark: 51. Describe the function of the vertebrate integumentary system. (SC.912.L.14.51)
Benchmark: 52. Explain the basic functions of the human immune system, including specific and nonspecific immune response, vaccines, and antibiotics. (SC.912.L.14.52)
Benchmark: 53. Discuss basic classification and characteristics of plants. Identify bryophytes, pteridophytes, gymnosperms, and angiosperms. (SC.912.L.14.53)

Standard 15: Diversity and Evolution of Living Organisms

A. The scientific theory of evolution is the fundamental concept underlying all of biology.

B. The scientific theory of evolution is supported by multiple forms of scientific evidence.

C. Organisms are classified based on their evolutionary history.

D. Natural selection is a primary mechanism leading to evolutionary change. (SC.912.L.15)

Benchmark: 1. Explain how the scientific theory of evolution is supported by the fossil record, comparative anatomy, comparative embryology, biogeography, molecular biology, and observed evolutionary change. (SC.912.L.15.1)
Benchmark: 2. Discuss the use of molecular clocks to estimate how long ago various groups of organisms diverged evolutionarily from one another. (SC.912.L.15.2)
Benchmark: 3. Describe how biological diversity is increased by the origin of new species and how it is decreased by the natural process of extinction. (SC.912.L.15.3)
Benchmark: 4. Describe how and why organisms are hierarchically classified and based on evolutionary relationships. (SC.912.L.15.4)
Benchmark: 5. Explain the reasons for changes in how organisms are classified. (SC.912.L.15.5)
Benchmark: 6. Discuss distinguishing characteristics of the domains and kingdoms of living organisms. (SC.912.L.15.6)
Benchmark: 7. Discuss distinguishing characteristics of vertebrate and representative invertebrate phyla, and chordate classes using typical examples. (SC.912.L.15.7)
Benchmark: 8. Describe the scientific explanations of the origin of life on Earth. (SC.912.L.15.8)
Benchmark: 9. Explain the role of reproductive isolation in the process of speciation. (SC.912.L.15.9)
Benchmark: 10. Identify basic trends in hominid evolution from early ancestors six million years ago to modern humans, including brain size, jaw size, language, and manufacture of tools. (SC.912.L.15.10)
Benchmark: 11. Discuss specific fossil hominids and what they show about human evolution. (SC.912.L.15.11)
Benchmark: 12. List the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature. Use the Hardy-Weinberg equation to predict genotypes in a population from observed phenotypes.
Benchmark: 13. Describe the conditions required for natural selection, including: overproduction of offspring, inherited variation, and the struggle to survive, which result in differential reproductive success. (SC.912.L.15.13)

Benchmark: 14. Discuss mechanisms of evolutionary change other than natural selection such as genetic drift and gene flow. (SC.912.L.15.14)

Benchmark: 15. Describe how mutation and genetic recombination increase genetic variation. (SC.912.L.15.15)

Standard 16: Heredity and Reproduction

A. DNA stores and transmits genetic information. Genes are sets of instructions encoded in the structure of DNA.
B. Genetic information is passed from generation to generation by DNA in all organisms and accounts for similarities in related individuals.
C. Manipulation of DNA in organisms has led to commercial production of biological molecules on a large scale and genetically modified organisms.
D. Reproduction is characteristic of living things and is essential for the survival of species. (SC.912.L.16)

Benchmark: 1. Use Mendel's laws of segregation and independent assortment to analyze patterns of inheritance. (SC.912.L.16.1)
Benchmark: 2. Discuss observed inheritance patterns caused by various modes of inheritance, including dominant, recessive, codominant, sex-linked, polygenic, and multiple alleles. (SC.912.L.16.2)
Benchmark: 3. Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic information. (SC.912.L.16.3)
Benchmark: 4. Explain how mutations in the DNA sequence may or may not result in phenotypic change. Explain how mutations in gametes may result in phenotypic changes in offspring. (SC.912.L.16.4)
Benchmark: 5. Explain the basic processes of transcription and translation, and how they result in the expression of genes. (SC.912.L.16.5)
Benchmark: 6. Discuss the mechanisms for regulation of gene expression in prokaryotes and eukaryotes at transcription and translation level. (SC.912.L.16.6)
Benchmark: 7. Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology. (SC.912.L.16.7)
Benchmark: 8. Explain the relationship between mutation, cell cycle, and uncontrolled cell growth potentially resulting in cancer. (SC.912.L.16.8)
Benchmark: 9. Explain how and why the genetic code is universal and is common to almost all organisms. (SC.912.L.16.9)
Benchmark: 10. Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues. (SC.912.L.16.10)
Benchmark: 11. Discuss the technologies associated with forensic medicine and DNA identification, including restriction fragment length polymorphism (RFLP) analysis. (SC.912.L.16.11)
Benchmark: 12. Describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning). (SC.912.L.16.12)
Benchmark: 13. Describe the basic anatomy and physiology of the human reproductive system. Describe the process of human development from fertilization to birth and major changes that occur in each trimester of pregnancy. (SC.912.L.16.13)
Benchmark: 14. Describe the cell cycle, including the process of mitosis. Explain the role of mitosis in the formation of new cells and its importance in maintaining chromosome number during asexual reproduction. (SC.912.L.16.14)
Benchmark: 15. Compare and contrast binary fission and mitotic cell division. (SC.912.L.16.15)
Benchmark: 16. Describe the process of meiosis, including independent assortment and crossing over. Explain how reduction division results in the formation of haploid gametes or spores. (SC.912.L.16.16)

Standard 17: Interdependence

A. The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment.
B. Energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes.
C. Human activities and natural events can have profound effects on populations, biodiversity and ecosystem processes. (SC.912.L.17)

Benchmark: 1. Discuss the characteristics of populations, such as number of individuals, age structure, density, and pattern of distribution. (SC.912.L.17.1)
Benchmark: 2. Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature. (SC.912.L.17.2)
A. All living things are composed of four basic categories of macromolecules and share the same basic needs for life.

B. Living organisms acquire the energy they need for life processes through various metabolic pathways (primarily photosynthesis and cellular respiration).

C. Chemical reactions in living things follow basic rules of chemistry and are usually regulated by enzymes.

D. The unique chemical properties of carbon and water make life on Earth possible. (SC.912.L.18)
Standard 8: Matter

A. A working definition of matter is that it takes up space, has mass, and has measurable properties. Matter is comprised of atomic, subatomic, and elementary particles.

B. Electrons are key to defining chemical and some physical properties, reactivity, and molecular structures. Repeating (periodic) patterns of physical and chemical properties occur among elements that define groups of elements with similar properties. The periodic table displays the repeating patterns, which are related to the atom’s outermost electrons. Atoms bond with each other to form compounds.

C. In a chemical reaction, one or more reactants are transformed into one or more new products. Many factors shape the nature of products and the rates of reaction.

D. Carbon-based compounds are building-blocks of known life forms on earth and numerous useful natural and synthetic products. (SC.912.P.8)

Benchmark: 1. Differentiate among the four states of matter. (SC.912.P.8.1)
Benchmark: 2. Differentiate between physical and chemical properties and physical and chemical changes of matter. (SC.912.P.8.2)
Benchmark: 3. Explore the scientific theory of atoms (also known as atomic theory) by describing changes in the atomic model over time and why those changes were necessitated by experimental evidence. (SC.912.P.8.3)
Benchmark: 4. Explore the scientific theory of atoms (also known as atomic theory) by describing the structure of atoms in terms of protons, neutrons and electrons, and differentiate among these particles in terms of their mass, electrical charges and locations within the atom. (SC.912.P.8.4)
Benchmark: 5. Relate properties of atoms and their position in the periodic table to the arrangement of their electrons. (SC.912.P.8.5)
Benchmark: 6. Distinguish between bonding forces holding compounds together and other attractive forces, including hydrogen bonding and van der Waals forces. (SC.912.P.8.6)
Benchmark: 7. Interpret formula representations of molecules and compounds in terms of composition and structure. (SC.912.P.8.7)
Benchmark: 8. Characterize types of chemical reactions, for example: redox, acid-base, synthesis, and single and double replacement reactions. (SC.912.P.8.8)
Benchmark: 9. Apply the mole concept and the law of conservation of mass to calculate quantities of chemicals participating in reactions. (SC.912.P.8.9)
Benchmark: 11. Relate acidity and basicity to hydronium and hydroxyl ion concentration and pH. (SC.912.P.8.11)
Benchmark: 12. Describe the properties of the carbon atom that make the diversity of carbon compounds possible. (SC.912.P.8.12)
Benchmark: 13. Identify selected functional groups and relate how they contribute to properties of carbon compounds. (SC.912.P.8.13)

Standard 10: Energy

A. Energy is involved in all physical and chemical processes. It is conserved, and can be transformed from one form to another and into work. At the atomic and nuclear levels energy is not continuous but exists in discrete amounts. Energy and mass are related through Einstein’s equation E=mc².

B. The properties of atomic nuclei are responsible for energy-related phenomena such as radioactivity, fission and fusion.

C. In a chemical reaction, one or more reactants are transformed into one or more new products. Many factors shape the nature of products and the rates of reaction.

Changes in entropy and energy that accompany chemical reactions influence reaction paths. Chemical reactions result in the release or absorption of energy. (SC.912.P.10)

Benchmark: 1. Differentiate among the various forms of energy and recognize that they can be transformed from one form to others. (SC.912.P.10.1)
Benchmark: 2. Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity. (SC.912.P.10.2)
Benchmark: 3. Compare and contrast work and power qualitatively and quantitatively. (SC.912.P.10.3)
Benchmark: 4. Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or states of matter. (SC.912.P.10.4)
Benchmark: 5. Relate temperature to the average molecular kinetic energy. (SC.912.P.10.5)
Benchmark: 6. Create and interpret potential energy diagrams, for example: chemical reactions, orbits around a central body, motion of a pendulum. (SC.912.P.10.6)
Benchmark: 7. Distinguish between endothermic and exothermic chemical processes. (SC.912.P.10.7)
Benchmark: 8. Explain entropy’s role in determining the efficiency of processes that convert energy to work. (SC.912.P.10.8)
Benchmark: 9. Describe the quantization of energy at the atomic level. (SC.912.P.10.9)
Benchmark: 10. Compare the magnitude and range of the four fundamental forces (gravitational, electromagnetic, weak nuclear, strong nuclear). (SC.912.P.10.10)
Benchmark: 11. Explain and compare nuclear reactions (radioactive decay, fission and fusion), the energy changes associated with them and their associated safety issues. (SC.912.P.10.11)
Benchmark: 12. Differentiate between chemical and nuclear reactions. (SC.912.P.10.12)
Benchmark: 13. Relate the configuration of static charges to the electric field, electric force, electric potential, and electric potential energy. (SC.912.P.10.13)
Benchmark: 15. Investigate and explain the relationships among current, voltage, resistance, and power. (SC.912.P.10.15)
Benchmark: 16. Explain the relationship between moving charges and magnetic fields, as well as changing magnetic fields and electric fields, and their application to modern technologies. (SC.912.P.10.16)
Benchmark: 17. Explore the theory of electromagnetism by explaining electromagnetic waves in terms of oscillating electric and magnetic fields. (SC.912.P.10.17)
Benchmark: 18. Explore the theory of electromagnetism by comparing and contrasting the different parts of the electromagnetic spectrum in terms of wavelength, frequency, and energy, and relate them to phenomena and applications. (SC.912.P.10.18)
Benchmark: 19. Explain that all objects emit and absorb electromagnetic radiation and distinguish between objects that are blackbody radiators and those that are not. (SC.912.P.10.19)
Benchmark: 20. Describe the measurable properties of waves and explain the relationships among them and how these properties change when the wave moves from one medium to another. (SC.912.P.10.20)
Benchmark: 21. Qualitatively describe the shift in frequency in sound or electromagnetic waves due to the relative motion of a source or a receiver. (SC.912.P.10.21)
Benchmark: 22. Construct ray diagrams and use thin lens and mirror equations to locate the images formed by lenses and mirrors. (SC.912.P.10.22)

**Standard 12: Motion**

A. Motion can be measured and described qualitatively and quantitatively. Net forces create a change in motion. When objects travel at speeds comparable to the speed of light, Einstein's special theory of relativity applies.
B. Momentum is conserved under well-defined conditions. A change in momentum occurs when a net force is applied to an object over a time interval.
C. The Law of Universal Gravitation states that gravitational forces act on all objects irrespective of their size and position.
D. Gases consist of great numbers of molecules moving in all directions. The behavior of gases can be modeled by the kinetic molecular theory.
E. Chemical reaction rates change with conditions under which they occur. Chemical equilibrium is a dynamic state in which forward and reverse processes occur at the same rates. (SC.912.P.12)

Benchmark: 1. Distinguish between scalar and vector quantities and assess which should be used to describe an event. (SC.912.P.12.1)
Benchmark: 2. Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time. (SC.912.P.12.2)
Benchmark: 3. Interpret and apply Newton's three laws of motion. (SC.912.P.12.3)
Benchmark: 4. Describe how the gravitational force between two objects depends on their masses and the distance between them. (SC.912.P.12.4)
Benchmark: 5. Apply the law of conservation of linear momentum to interactions, such as collisions between objects. (SC.912.P.12.5)
Benchmark: 6. Qualitatively apply the concept of angular momentum. (SC.912.P.12.6)
Benchmark: 7. Recognize that nothing travels faster than the speed of light in vacuum which is the same for all observers no matter how they or the light source are moving. (SC.912.P.12.7)
Benchmark: 8. Recognize that Newton's Laws are a limiting case of Einstein's Special Theory of Relativity at speeds that are much smaller than the speed of light. (SC.912.P.12.8)
Benchmark: 9. Recognize that time, length, and energy depend on the frame of reference. (SC.912.P.12.9)
Benchmark: 10. Interpret the behavior of ideal gases in terms of kinetic molecular theory. (SC.912.P.12.10)
Benchmark: 11. Describe phase transitions in terms of kinetic molecular theory. (SC.912.P.12.11)
Benchmark: 12. Explain how various factors, such as concentration, temperature, and presence of a catalyst affect the rate of a chemical reaction. (SC.912.P.12.12)
Benchmark: 13. Explain the concept of dynamic equilibrium in terms of reversible processes occurring at the same rates. (SC.912.P.12.13)

**Earth and Space Science**
Standard 5: Earth in Space and Time
The origin and eventual fate of the Universe still remains one of the greatest questions in science. Gravity and energy influence the development and life cycles of galaxies, including our own Milky Way Galaxy, stars, the planetary systems, Earth, and residual material left from the formation of the Solar System. Humankind. (SC.912.E.5.)

Benchmark: 1. Cite evidence used to develop and verify the scientific theory of the Big Bang (also known as the Big Bang Theory) of the origin of the universe. (SC.912.E.5.1)
Benchmark: 2. Identify patterns in the organization and distribution of matter in the universe and the forces that determine them. (SC.912.E.5.2)
Benchmark: 3. Describe and predict how the initial mass of a star determines its evolution. (SC.912.E.5.3)
Benchmark: 4. Explain the physical properties of the Sun and its dynamic nature and connect them to conditions and events on Earth. (SC.912.E.5.4)
Benchmark: 5. Explain the formation of planetary systems based on our knowledge of our Solar System and apply this knowledge to newly discovered planetary systems. (SC.912.E.5.5)
Benchmark: 6. Develop logical connections through physical principles, including Kepler's and Newton’s Laws about the relationships and the effects of Earth, Moon, and Sun on each other. (SC.912.E.5.6)
Benchmark: 7. Relate the history of and explain the justification for future space exploration and continuing technology development. (SC.912.E.5.7)
Benchmark: 8. Connect the concepts of radiation and the electromagnetic spectrum to the use of historical and newly-developed observational tools. (SC.912.E.5.8)
Benchmark: 9. Analyze the broad effects of space exploration on the economy and culture of Florida. (SC.912.E.5.9)
Benchmark: 10. Describe and apply the coordinate system used to locate objects in the sky. (SC.912.E.5.10)
Benchmark: 11. Distinguish the various methods of measuring astronomical distances and apply each in appropriate situations. (SC.912.E.5.11)

Standard 6: Earth Structures
The scientific theory of plate tectonics provides the framework for much of modern geology. Over geologic time, internal and external sources of energy have continuously altered the features of Earth by means of both constructive and destructive forces. All life, including human civilization, is dependent on Earth's internal and external energy and material resources. (SC.912.E.6)

Benchmark: 1. Describe and differentiate the layers of Earth and the interactions among them. (SC.912.E.6.1)
Benchmark: 2. Connect surface features to surface processes that are responsible for their formation. (SC.912.E.6.2)
Benchmark: 3. Analyze the scientific theory of plate tectonics and identify related major processes and features as a result of moving plates. (SC.912.E.6.3)
Benchmark: 4. Analyze how specific geologic processes and features are expressed in Florida and elsewhere. (SC.912.E.6.4)
Benchmark: 5. Describe the geologic development of the present day oceans and identify commonly found features. (SC.912.E.6.5)
Benchmark: 6. Analyze past, present, and potential future consequences to the environment resulting from various energy production technologies. (SC.912.E.6.6)

Standard 7: Earth Systems and Patterns
The scientific theory of the evolution of Earth states that changes in our planet are driven by the flow of energy and the cycling of matter through dynamic interactions among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere, and the resources used to sustain human civilization on Earth. (SC.912.E.7)

Benchmark: 1. Analyze the movement of matter and energy through the different biogeochemical cycles, including water and carbon. (SC.912.E.7.1)
Benchmark: 2. Analyze the causes of the various kinds of surface and deep water motion within the oceans and their impacts on the transfer of energy between the poles and the equator. (SC.912.E.7.2)
Benchmark: 3. Differentiate and describe the various interactions among Earth systems, including: atmosphere, hydrosphere, cryosphere, geosphere, and biosphere. (SC.912.E.7.3)
Benchmark: 4. Summarize the conditions that contribute to the climate of a geographic area, including the relationships to lakes and oceans. (SC.912.E.7.4)
Benchmark: 5. Predict future weather conditions based on present observations and conceptual models and recognize limitations and uncertainties of such predictions. (SC.912.E.7.5)
Benchmark: 6. Relate the formation of severe weather to the various physical factors. (SC.912.E.7.6)
Benchmark: 7. Identify, analyze, and relate the internal (Earth system) and external (astronomical) conditions that contribute to global climate change. (SC.912.E.7.7)
Benchmark: 8. Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively. (SC.912.E.7.8)
Benchmark: 9. Cite evidence that the ocean has had a significant influence on climate change by absorbing, storing, and moving heat, carbon, and water. (SC.912.E.7.9)
### Nature of Science

**Standard 1: The Practice of Science**

A. Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B. The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C. Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D. Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations. (SC.912.N.1)

**Benchmark: 1.** Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following:

1. pose questions about the natural world,
2. conduct systematic observations,
3. examine books and other sources of information to see what is already known,
4. review what is known in light of empirical evidence,
5. plan investigations,
6. use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs),
7. pose answers, explanations, or descriptions of events,
8. generate explanations that explicate or describe natural phenomena (inferences),
9. use appropriate evidence and reasoning to justify these explanations to others,
10. communicate results of scientific investigations, and
11. evaluate the merits of the explanations produced by others. (SC.912.N.1.1)

**Benchmark: 2.** Describe and explain what characterizes science and its methods. (SC.912.N.1.2)

**Benchmark: 3.** Identify what is science, what clearly is not science, and what superficially resembles science (but fails to meet the criteria for science). (SC.912.N.2.1)

**Benchmark: 2.** Describe and explain what characterizes science and its methods. (SC.912.N.1.2)

**Benchmark: 3.** Identify which questions can be answered through science and which questions are outside the boundaries of scientific investigation, such as questions addressed by other ways of knowing, such as art, philosophy, and religion. (SC.912.N.2.2)

**Benchmark: 3.** Identify examples of pseudoscience (such as astrology, phrenology) in society. (SC.912.N.2.3)

**Benchmark: 4.** Explain that scientific knowledge is both durable and robust but open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability. (SC.912.N.2.4)

**Benchmark: 5.** Describe instances in which scientists' varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations) of scientists are a strength of science as they are a source of new, testable ideas that have the potential to add new evidence to support one or another of the explanations. (SC.912.N.2.5)
Standard 3: The Role of Theories, Laws, Hypotheses, and Models
The terms that describe examples of scientific knowledge, for example: "theory," "law," "hypothesis" and "model" have very specific meanings and functions within science. (SC.912.N.3)

Benchmark: 1. Explain that a scientific theory is the culmination of many scientific investigations drawing together all the current evidence concerning a substantial range of phenomena; thus, a scientific theory represents the most powerful explanation scientists have to offer. (SC.912.N.3.1)
Benchmark: 2. Describe the role consensus plays in the historical development of a theory in any one of the disciplines of science. (SC.912.N.3.2)
Benchmark: 3. Explain that scientific laws are descriptions of specific relationships under given conditions in nature, but do not offer explanations for those relationships. (SC.912.N.3.3)
Benchmark: 4. Recognize that theories do not become laws, nor do laws become theories; theories are well supported explanations and laws are well supported descriptions. (SC.912.N.3.4)
Benchmark: 5. Describe the function of models in science, and identify the wide range of models used in science. (SC.912.N.3.5)

Standard 4: Science and Society
As tomorrow's citizens, students should be able to identify issues about which society could provide input, formulate scientifically investigable questions about those issues, construct investigations of their questions, collect and evaluate data from their investigations, and develop scientific recommendations based upon their findings. (SC.912.N.4)

Benchmark: 1. Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making. (SC.912.N.4.1)
Benchmark: 2. Weigh the merits of alternative strategies for solving a specific societal problem by comparing a number of different costs and benefits, such as human, economic, and environmental. (SC.912.N.4.2)

Next Generation Sunshine State Standards (Florida)
http://tools.fcit.usf.edu/sss/

Visual Art

Big Ideas: Critical Thinking and Reflection (C),
Skills, Techniques, and Processes (S),
Organizational Structure (O),
Historical and Global Connections (H),
Innovation, Technology, and the Future (F)

Enduring Understandings: 9-12

Big Idea: CRITICAL THINKING AND REFLECTION

Enduring Understanding 1: Cognition and reflection are required to appreciate, interpret, and create with artistic intent. (VA.912.C.1)

Benchmark: 1. Integrate curiosity, range of interests, attentiveness, complexity, and artistic intention in the art-making process to demonstrate self-expression. (VA.912.C.1.1)
Benchmark: 2. Use critical-thinking skills for various contexts to develop, refine, and reflect on an artistic theme. (VA.912.C.1.2)
Benchmark: 3. Evaluate the technical skill, aesthetic appeal, and/or social implication of artistic exemplars to formulate criteria for assessing personal work. (VA.912.C.1.3)
Benchmark: 4. Apply art knowledge and contextual information to analyze how content and ideas are used in works of art. (VA.912.C.1.4)
Benchmark: 5. Analyze how visual information is developed in specific media to create a recorded visual image. (VA.912.C.1.5)
Benchmark: 6. Identify rationale for aesthetic choices in recording visual media. (VA.912.C.1.6)
Benchmark: 7. Analyze challenges and identify solutions for three-dimensional structural problems. (VA.912.C.1.7)
Benchmark: 8. Explain the development of meaning and procedural choices throughout the creative process to defend artistic intention. (VA.912.C.1.8)

Enduring Understanding 2: Assessing our own and others' artistic work, using critical-thinking, problem-solving, and decision-making skills, is central to artistic growth. (VA.912.C.2)
Benchmark: 1. Examine and revise artwork throughout the art-making process to refine work and achieve artistic objective. (VA.912.C.2.1)

Benchmark: 2. Assess the works of others, using established or derived criteria, to support conclusions and judgments about artistic progress. (VA.912.C.2.2)

Benchmark: 3. Process and apply constructive criticism as formative assessment for continued growth in art-making skills. (VA.912.C.2.3)

Benchmark: 4. Classify artworks, using accurate art vocabulary and knowledge of art history to identify and categorize movements, styles, techniques, and materials. (VA.912.C.2.4)

Benchmark: 5. Develop and use criteria to select works for a portfolio and defend one's artistic choices with a written, oral, and/or recorded analysis. (VA.912.C.2.5)

Benchmark: 6. Investigate the process of developing a coherent, focused concept in a body of work comprised of multiple artworks. (VA.912.C.2.6)

Benchmark: 7. Assess the challenges and outcomes associated with the media used in a variety of one's own works. (VA.912.C.2.7)

Benchmark: 8. Compare artwork, architecture, designs, and/or models to understand how technical and utilitarian components impact aesthetic qualities. (VA.912.C.2.8)

Enduring Understanding 3: The processes of critiquing works of art lead to development of critical-thinking skills transferable to other contexts. (VA.912.C.3)

Benchmark: 1. Use descriptive terms and varied approaches in art analysis to explain the meaning or purpose of an artwork. (VA.912.C.3.1)

Benchmark: 2. Develop and apply criteria to determine how aesthetic works are aligned with a personal definition of "art." (VA.912.C.3.2)

Benchmark: 3. Examine relationships among social, historical, literary, and/or other references to explain how they are assimilated into artworks. (VA.912.C.3.3)

Benchmark: 4. Use analytical skills to examine issues in non-visual art contexts. (VA.912.C.3.4)

Benchmark: 5. Make connections between timelines in other content areas and timelines in the visual arts. (VA.912.C.3.5)

Benchmark: 6. Discuss how the aesthetics of artwork and utilitarian objects have changed over time. (VA.912.C.3.6)

Big Idea: SKILLS, TECHNIQUES, AND PROCESSES

Enduring Understanding 1: The arts are inherently experiential and actively engage learners in the processes of creating, interpreting, and responding to art. (VA.912.S.1)

Benchmark: 1. Use innovative means and perceptual understanding to communicate through varied content, media, and art techniques. (VA.912.S.1.1)

Benchmark: 2. Investigate the use of technology and other resources to inspire art-making decisions. (VA.912.S.1.2)

Benchmark: 3. Interpret and reflect on cultural and historical events to create art. (VA.912.S.1.3)

Benchmark: 4. Demonstrate effective and accurate use of art vocabulary throughout the art-making process. (VA.912.S.1.4)

Benchmark: 5. Compare the aesthetic impact of images created with different media to evaluate advantages or disadvantages within the art process. (VA.912.S.1.5)

Benchmark: 6. Describe processes and techniques used to record visual imagery. (VA.912.S.1.6)

Benchmark: 7. Manipulate lighting effects, using various media to create desired results. (VA.912.S.1.7)

Benchmark: 8. Use technology to simulate art-making processes and techniques. (VA.912.S.1.8)

Benchmark: 9. Use diverse media and techniques to create paintings that represent various genres and schools of painting. (VA.912.S.1.9)

Enduring Understanding 2: Development of skills, techniques, and processes in the arts strengthens our ability to remember, focus on, process, and sequence information. (VA.912.S.2)

Benchmark: 1. Demonstrate organizational skills to influence the sequential process when creating artwork. (VA.912.S.2.1)

Benchmark: 2. Focus on visual information and processes to complete the artistic concept. (VA.912.S.2.2)

Benchmark: 3. Demonstrate visual-thinking skills to process the challenges and execution of a creative endeavor. (VA.912.S.2.3)

Benchmark: 4. Use information resources to develop concepts representing diversity and effectiveness for using selected media and techniques in a sketchbook or journal. (VA.912.S.2.4)

Benchmark: 5. Demonstrate use of perceptual, observational, and compositional skills to produce representational, figurative, or abstract imagery. (VA.912.S.2.5)

Benchmark: 6. Incorporate skills, concepts, and media to create images from ideation to resolution. (VA.912.S.2.6)

Enduring Understanding 3: Through purposeful practice, artists learn to manage, master, and refine simple, then complex, skills and techniques. (VA.912.S.3)
Benchmark: 1. Manipulate materials, techniques, and processes through practice and perseverance to create a desired result in two- and/or three-dimensional artworks. (VA.912.S.3.1)
Benchmark: 2. Demonstrate a balance between spontaneity and purpose to produce complex works of art with conviction and disciplined craftsmanship. (VA.912.S.3.2)
Benchmark: 3. Review, discuss, and demonstrate the proper applications and safety procedures for hazardous chemicals and equipment during the art-making process. (VA.912.S.3.3)
Benchmark: 4. Demonstrate personal responsibility, ethics, and integrity, including respect for intellectual property, when accessing information and creating works of art. (VA.912.S.3.4)
Benchmark: 5. Create multiple works that demonstrate thorough exploration of subject matter and themes. (VA.912.S.3.5)
Benchmark: 6. Develop works with prominent personal vision revealed through mastery of art tasks and tools. (VA.912.S.3.6)
Benchmark: 7. Use and maintain tools and equipment to facilitate the creative process. (VA.912.S.3.7)
Benchmark: 8. Develop color-mixing skills and techniques through application of the principles of heat properties and color and light theory. (VA.912.S.3.8)
Benchmark: 9. Manipulate and embellish malleable or rigid materials to construct representational or abstract forms. (VA.912.S.3.9)
Benchmark: 10. Develop skill in sketching and mark-making to plan, execute, and construct two-dimensional images or three-dimensional models. (VA.912.S.3.10)
Benchmark: 11. Store and maintain equipment, materials, and artworks properly in the art studio to prevent damage and/or cross-contamination. (VA.912.S.3.11)
Benchmark: 12. Develop competence and dexterity, through practice, in the use of processes, tools, and techniques for various media. (VA.912.S.3.12)
Benchmark: 13. Create three-dimensional modeled and rendered objects in figurative and nonfigurative digital applications. (VA.912.S.3.13)

Big Idea: ORGANIZATIONAL STRUCTURE

Enduring Understanding 1: Understanding the organizational structure of an art form provides a foundation for appreciation of artistic works and respect for the creative process. (VA.912.O.1)

Benchmark: 1. Use the structural elements of art and the organizational principles of design in works of art to establish an interpretive and technical foundation for visual coherence. (VA.912.O.1.1)
Benchmark: 2. Use and defend the choice of creative and technical skills to produce artworks. (VA.912.O.1.2)
Benchmark: 3. Research and use the techniques and processes of various artists to create personal works. (VA.912.O.1.3)
Benchmark: 4. Compare and analyze traditional and digital media to learn how technology has altered opportunities for innovative responses and results. (VA.912.O.1.4)
Benchmark: 5. Investigate the use of space, scale, and environmental features of a structure to create three-dimensional form or the illusion of depth and form. (VA.912.O.1.5)

Enduring Understanding 2: The structural rules and conventions of an art form serve as both a foundation and departure point for creativity. (VA.912.O.2)

Benchmark: 1. Construct new meaning through shared language, ideation, expressive content, and unity in the creative process. (VA.912.O.2.1)
Benchmark: 2. Solve aesthetic problems, through convergent and divergent thinking, to gain new perspectives. (VA.912.O.2.2)
Benchmark: 3. Investigate an idea in a coherent and focused manner to provide context in the visual arts. (VA.912.O.2.3)
Benchmark: 4. Concentrate on a particular style, theme, concept, or personal opinion to develop artwork for a portfolio, display, or exhibition. (VA.912.O.2.4)

Enduring Understanding 3: Every art form uses its own unique language, verbal and non-verbal, to document and communicate with the world. (VA.912.O.3)

Benchmark: 1. Create works of art that include symbolism, personal experiences, or philosophical view to communicate with an audience. (VA.912.O.3.1)
Benchmark: 2. Create a series of artworks to inform viewers about personal opinions and/or current issues. (VA.912.O.3.2)

Big Idea: HISTORICAL AND GLOBAL CONNECTIONS

Enduring Understanding 1: Through study in the arts, we learn about and honor others and the worlds in which they live(d). (VA.912.H.1)

Benchmark: 1. Analyze the impact of social, ecological, economic, religious, and/or political issues on the function or meaning of the artwork. (VA.912.H.1.1)
Benchmark: 2. Analyze the various functions of audience etiquette to formulate guidelines for conduct in different art venues.
Benchmark: 3. Examine the significance placed on art forms over time by various groups or cultures compared to current views on aesthetics. (VA.912.H.1.3)

Benchmark: 4. Apply background knowledge and personal interpretation to discuss cross-cultural connections among various artworks and the individuals, groups, cultures, events, and/or traditions they reflect. (VA.912.H.1.4)

Benchmark: 5. Investigate the use of technology and media design to reflect creative trends in visual culture. (VA.912.H.1.5)

Benchmark: 6. Create a timeline for the development of artists’ materials to show multiple influences on the use of art media. (VA.912.H.1.6)

Benchmark: 7. Research and report technological developments to identify influences on society. (VA.912.H.1.7)

Benchmark: 8. Analyze and compare works in context, considering economic, social, cultural, and political issues, to define the significance and purpose of art. (VA.912.H.1.8)

Benchmark: 9. Describe the significance of major artists, architects, or masterworks to understand their historical influences. (VA.912.H.1.9)

Benchmark: 10. Describe and analyze the characteristics of a culture and its people to create personal art reflecting daily life and/or the specified environment. (VA.912.H.1.10)

Enduring Understanding 2: The arts reflect and document cultural trends and historical events, and help explain how new directions in the arts have emerged. (VA.912.H.2)

Benchmark: 1. Identify transitions in art media, technique, and focus to explain how technology has changed art throughout history. (VA.912.H.2.1)

Benchmark: 2. Analyze the capacity of the visual arts to fulfill aesthetic needs through artwork and utilitarian objects. (VA.912.H.2.2)

Benchmark: 3. Analyze historical or cultural references in commemorative works of art to identify the significance of the event or person portrayed. (VA.912.H.2.3)

Benchmark: 4. Research the history of art in public places to examine the significance of the artwork and its legacy for the future. (VA.912.H.2.4)

Benchmark: 5. Analyze artwork from a variety of cultures and times to compare the function, significance, and connection to other cultures or times. (VA.912.H.2.5)

Benchmark: 6. Analyze artistic trends to explain the rationale for creating personal adornment, visual culture, and/or design. (VA.912.H.2.6)

Enduring Understanding 3: Connections among the arts and other disciplines strengthen learning and the ability to transfer knowledge and skills to and from other fields. (VA.912.H.3)

Benchmark: 1. Synthesize knowledge and skills learned from non-art content areas to support the processes of creation, interpretation, and analysis. (VA.912.H.3.1)

Benchmark: 2. Apply the critical-thinking and problem-solving skills used in art to develop creative solutions for real-life issues. (VA.912.H.3.2)

Benchmark: 3. Use materials, ideas, and/or equipment related to other content areas to generate ideas and processes for the creation of works of art. (VA.912.H.3.3)

Big Idea: INNOVATION, TECHNOLOGY, AND THE FUTURE

Enduring Understanding 1: Creating, interpreting, and responding in the arts stimulate the imagination and encourage innovation and creative risk-taking. (VA.912.F.1)

Benchmark: 1. Use divergent thinking, abstract reasoning, and various processes to demonstrate imaginative or innovative solutions for art problems. (VA.912.F.1.1)

Benchmark: 2. Manipulate or synthesize established techniques as a foundation for individual style initiatives in two-, three-, and/or four-dimensional applications. (VA.912.F.1.2)

Benchmark: 3. Demonstrate flexibility and adaptability throughout the innovation process to focus and re-focus on an idea, deliberately delaying closure to promote creative risk-taking. (VA.912.F.1.3)

Benchmark: 4. Use technological tools to create art with varying effects and outcomes. (VA.912.F.1.4)

Benchmark: 5. Create a digital or time-based presentation to analyze and compare artists, artworks, and concepts in historical context. (VA.912.F.1.5)

Enduring Understanding 2: Careers in and related to the arts significantly and positively impact local and global economies. (VA.912.F.2)

Benchmark: 1. Examine career opportunities in the visual arts to determine requisite skills, qualifications, supply-and-demand, market location, and potential earnings. (VA.912.F.2.1)

Benchmark: 2. Examine a broad spectrum of art-related careers to identify potential employment opportunities that involve
construction, management, and/or sale of aesthetic or utilitarian objects. (VA.912.F.2.2)

**Benchmark: 3.** Analyze the potential economic impact of arts entities to revitalize a community or region. (VA.912.F.2.3)

**Benchmark: 4.** Research ideas to plan, develop, and market art-related goods, artworks, or services that influence consumer beliefs and behaviors. (VA.912.F.2.4)

**Benchmark: 5.** Develop a personal artist statement, résumé, presentation, or digital portfolio to interview for an art-related position or exhibition. (VA.912.F.2.5)

**Benchmark: 6.** Research and discuss the potential of the visual arts to improve aesthetic living. (VA.912.F.2.6)

**Benchmark: 7.** Evaluate the effects of creating works of art for sale or donation to support local organizations for social or economic causes. (VA.912.F.2.7)

**Benchmark: 8.** Describe community resources to preserve, restore, exhibit, and view works of art. (VA.912.F.2.8)

**Enduring Understanding 3:** The 21st-century skills necessary for success as citizens, workers, and leaders in a global economy are embedded in the study of the arts. (VA.912.F.3)

**Benchmark: 1.** Use technology applications and art skills to promote social and cultural awareness regarding community initiatives and/or concerns. (VA.912.F.3.1)

**Benchmark: 2.** Examine the rationale for using procedural, analytical, and divergent thinking to achieve visual literacy. (VA.912.F.3.2)

**Benchmark: 3.** Discuss how the arts help students develop self-reliance and promote collaboration to strengthen leadership capabilities as priorities change. (VA.912.F.3.3)

**Benchmark: 4.** Follow directions and use effective time-management skills to complete the art-making process and show development of 21st-century skills. (VA.912.F.3.4)

**Benchmark: 5.** Use appropriately cited sources to document research and present information on visual culture. (VA.912.F.3.5)

**Benchmark: 6.** Identify ethical ways to use appropriation in personal works of art. (VA.912.F.3.6)

**Benchmark: 7.** Create a body of collaborative work to show artistic cohesiveness, team-building, respectful compromise, and time-management skills. (VA.912.F.3.7)

**Benchmark: 8.** Combine art and design skills with entrepreneurialism to provide community service and leverage strengths in accomplishing a common objective. (VA.912.F.3.8)

**Benchmark: 9.** Identify and apply collaborative procedures to coordinate a student or community art event. (VA.912.F.3.9)

**Benchmark: 10.** Apply rules of convention to create purposeful design. (VA.912.F.3.10)

**Benchmark: 11.** Demonstrate proficiency in creating individual and sequential images, animation, or media in motion with sound to solve visual problems. (VA.912.F.3.11)

**Benchmark: 12.** Use digital equipment and peripheral devices to record, create, present, and/or share accurate visual images with others. (VA.912.F.3.12)

**Observations and Notes:**

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