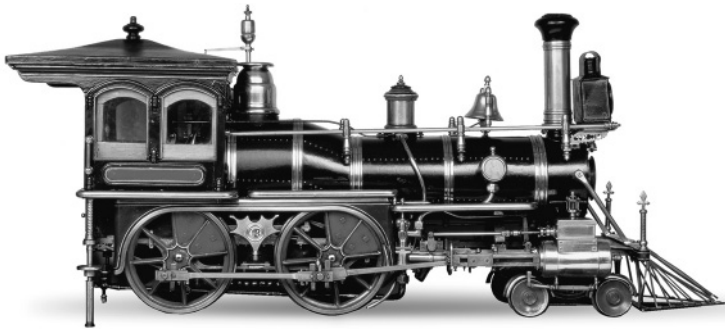


Space & Trains



Learn about three steam engine locomotives and three space vehicles. Cast the models that come in your kit for study and display.



Skulduggery, Inc.

TRANSPORTATION CASTING KIT

SPACE & TRAINS

★ Read directions thoroughly before starting. ★

The appearance of the first steam locomotives in the 1800's triggered an unparalleled explosive growth of industry, communications, and expansion of territories. Trains have contributed tremendously to the world's social, industrial, and economical growth and success. The Skullduggery Eyewitness Kit, "TRAINS", is a fascinating, educational and creative introduction to the realm of steam engines. In this section you will learn about the development of the steam locomotive and its importance to the growth of the United States. Cast and paint three very intricate and significant steam engines.

The first flight of the "Kitty Hawk" was man's first step in his quest to conquer the skies and ultimately outer space. Flight into space has opened up a new frontier and created endless opportunities for man to gain valuable knowledge in future technology. The Skullduggery Eyewitness Kit, "SPACE EXPLORATION", is an exciting and creative look at the very successful quest of space exploration. Learn about the rapid progression and expansion of the space program as you cast and paint an orbiter of a space shuttle, a Saturn V rocket and a command, service, and lunar spacecraft.

MATERIALS PROVIDED

- Information about three steam engines used in early America.
- Information about an orbiter of a space shuttle, a Saturn V rocket and a command, service, and lunar spacecraft.
- Casting (PerfectCast) material to make either the trains or space vehicles. To make additional models, PerfectCast is available from your local retailer.
- 2 mold trays containing models of three trains or space modules depending on the kit you purchased.
- Instructions explaining how to use the mold trays.
- Paints and paint brush with which to finish the models.
- Magnets used to attach the models to a steel background like a refrigerator.
- Bibliography.

MATERIALS NEEDED

- Disposable container to mix PerfectCast. A can or paper cup will work nicely.
- Mixing utensil.
- Glue to attach magnets to the models.

WARNING: Don't place hand in casting material while it is hardening. Don't pour excess material into drain or toilet bowl. Dispose of excess material in garbage.

★ Adult supervision suggested ★

INSTRUCTIONS

Find an area with a flat, level, stable working surface, such as a counter-top, desktop or table. Make sure the surface is waterproof; some excess water may spill out of your container. Use a disposable container to mix the PerfectCast and water.

1. Place the mold tray on a flat, stable surface.
2. In a disposable container, mix PerfectCast using a ratio (by volume) of 1 part cold water to 3 parts PerfectCast. *See tip below for suggestion on estimating the amount of PerfectCast to use for your cast.*
3. Stir the PerfectCast/water mixture with a spoon or mixing stick until it is evenly mixed (about 1½ minutes). Tap the container on the table several times to remove air bubbles. There should be no lumps.
4. Pour the PerfectCast mixture into the mold. Tap the mold on the work surface to remove the remaining bubbles.

WARNING: Do not pour excess material into the drain or toilet bowl. Dispose of excess materials in the garbage.

5. Let PerfectCast set for 30 to 40 minutes. If the object is delicate, allow at least one hour before demolding.
6. After the mixture hardens, carefully press each part out of the mold. If a section should break, use glue to repair it or cast additional sections.
7. Read the educational information on either the trains or space vehicles.
8. Let casts dry for 2 hours before painting. Consult color suggestions on page 11 for painting the casts. Separate the paint pots from each other with scissors before painting. Experiment with mixing paints on a palette or other surface to create the desirable colors. Adding a small amount of water to the paint will thin it for easier application as well as insure enough paint to cover the complete item.
9. Using the guide on page 11, glue the magnets on the steam engines or space vehicles, or glue them on a background of your choice.

Tip: How to measure the volume of the objects to be cast.

If you have purchased additional PerfectCast or don't want to mix all the PerfectCast included in your kit, follow the instructions below to determine how much PerfectCast to mix.

Fill all the cavities you intend to cast with water and pour into a measuring cup. This is the total volume of the finished casts.

For each fluid ounce needed, mix 1½ fluid ounces of PerfectCast and ½ fluid ounce of water. The mixture should have a consistency of a runny milkshake or melted ice cream.

SPACE TRAVEL

From the beginning of history man has dreamed about flight in one form or another. Mankind looked toward the skies and fantasized about what was at that time a mystery. Centuries before the first flight, people such as Newton, Galileo, Da Vinci, and Jules Verne wrote both fact and fiction about man's quest for adventure and exploration of the skies. Those writings fueled the imagination of generations of dreamers. It was those dreams and curiosities that nudged man towards space travel as we know it today.

The first successful powered, sustained, and controlled flight from earth occurred in 1903. On December 17th, Orville Wright flew his airplane, named the "Kitty Hawk", 120 feet in 12 seconds. Twenty-five years later, Charles Lindbergh made history by flying across the Atlantic Ocean. Men like Dr. Robert H. Goddard, Hermann Oberth, and Kanstantin Tsiolkovsky were all instrumental in working out the principles and designs of early rocketry.

The discovery of liquid fuel was a crucial step in the quest for space travel. Liquid fuel was much lighter than solid fuel and provided the power needed for launching rockets into space. Goddard was the first rocket pioneer to develop "systems engineering". Along with many other things, he developed fuel pumps for liquid fuel, and parachutes for recovering his instrumented rockets. With his patented design for a multistage rocket, Goddard held 213 other patents for rocket design.

During World War II, the Germans were developing the first successful ballistic rockets. Fortunately, the war was almost over, too late for the V-2, or "vengeance weapon" to have any effect on its outcome. In 1945, the German scientists, who were instrumental in the design of this rocket, defected to the safety of the United States and set up shop in White Sands, New Mexico, where they helped launch V-2 rockets for their adopted country.

With the end of WWII and the beginning of the Cold War, the race for space was crucial to the safety and prestige of the United States against its archenemy, the Soviet Union. The US Air Force began test flights designed to break the sound barrier. On October 14, 1947, Chuck Yeager, flying the X-1, was the first person to break the sound barrier.

It was the X-15, a research airplane, which made the first manned flights into the lower edges of space. The success of the X-15 project and its contributions laid the foundation for the success of the Mercury, Gemini, and Apollo projects.

It wasn't until 1958 that the USA launched *Explorer I* on top of a version of the Redstone rocket, known as the Jupiter C. This launch came after the Soviets had launched two satellites in 1957. The fact that the Soviets were the first to launch a satellite was a distinct incentive in speeding the race for the moon! The race for the moon became a national goal in the United States.

Project Mercury began in 1958. The objectives of this project were three-fold: to orbit a manned spacecraft around Earth; to investigate man's ability to function in space; and to safely recover both man and aircraft. This project proved very successful. In 1961, Alan Shepard was the first of six men who were sent into space. This flight lasted for fifteen minutes. In 1963, L. Gordon Cooper flew the last flight for Project Mercury, a flight which lasted 34 hours and 19 minutes.

With the successful completion of Project Mercury, the Gemini Program began. The goal of this project was to learn to maneuver the spacecraft in orbit and to rendezvous and dock with other vehicles. There were a total of

12 flights (10 manned and 2 unmanned) over a period of 20 months during 1965 and 1966.

In 1967, the Apollo Program began with tragedy. Three men, "Gus" Grison, Edward White, and Roger Chaffee were killed during a pre-flight test. As a result, many improvements were made, and the program continued with redesigned, safer equipment. In 1968, Apollo 7 was the first successful launch of the program. Apollo 8 was the first spacecraft to be propelled by the Saturn V rocket. The Apollo Program was a resounding success. Between 1968 and 1975, forty-five astronauts flew in the program and twelve of them walked on the moon.

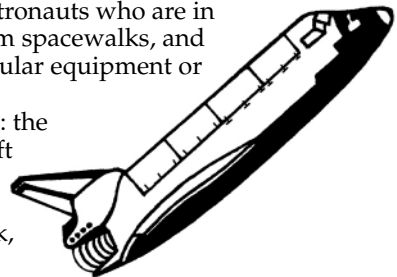
In 1981, the first space shuttle was launched. Space shuttles consist of a large fuel tank, two large rocket boosters which provide the power for the launch, and the orbiter which contains the flight crew. Once in orbit, the orbiter is piloted by a flight crew and can land on a runway like a jet plane. Two out of three of the shuttle's components are reusable: the rocket boosters and the orbiter. There have been 96 successful shuttle flights from 1981 to present day. The United States has developed a fleet of five orbiters: *Columbia*, *Discovery*, *Atlantis*, *Challenger*, and *Endeavour*. *Columbia* has flown twenty-six missions. The *Challenger* flew nine successful flights; but in 1986, a tragedy occurred just after the *Challenger X* was launched. This *Challenger* mission exploded shortly after the launch, killing all seven crewmembers. This accident halted the shuttle program for two years while engineers designed and integrated additional safety elements into the program. The orbiter *Discovery* has flown twenty-seven missions; *Atlantis* has flown twenty missions; and the *Endeavour* has flown fourteen missions.

The United States and Russia created a joint space experience and started scientific research using U.S. shuttles to access the Russian space station, *Mir*. The United States, along with fifteen other countries, has built and is utilizing an international space station as a base from which to gather knowledge and travel deeper into space. The shuttle missions have proven that humans can live and work in space for extended periods, and have expanded our knowledge of solar astronomy well beyond Earth-based observation.

SPACE SHUTTLE

Two solid rocket boosters, launch space shuttles from Earth. After two minutes of flight, the rocket boosters separate from the orbiter and the fuel tank located under the vehicle. The boosters then parachute into the ocean where they are recovered for use on an ensuing mission. The fuel tank is emptied in the first eight and a half minutes and is jettisoned just before the shuttle achieves orbit. The fuel tank disintegrates during the reentry into the atmosphere. Each orbiter can carry up to eight crewmembers. The crew consists of a pilot who flies the orbiter, astronauts who are in charge of the orbiter's system and perform spacewalks, and payload specialists who work with particular equipment or experiments on board.

The orbiter consists of three sections: the forward fuselage, mid-fuselage and the aft fuselage. The forward fuselage houses the three-level crew-compartment - which includes the flight deck, mid-deck, and the equipment bay. The flight deck is



the uppermost compartment of the cabin where the commander and the pilot's work-station are located. There are eleven windows in the forward deck, including two overhead and aft viewing windows for viewing orbital operations.

The mid-deck contains accommodations for dining, sleeping, maintenance, exercising, and data management. There is a side hatch through which the crew enters and exits the orbiter.

The mid fuselage structure connects the forward fuselage to the aft fuselage. The payload bay doors, hinges, tie-down fittings, and various orbiter system components and payload area are located in this area and form the payload bay area. The wings are on the outside of the mid fuselage. The mid fuselage is an aluminum structure 60 feet long, 17 feet wide, and 13 feet high. It weighs approximately 13,500 pounds.

The aft fuselage consists of an outer shell, a thrust structure, and an internal secondary structure. It is approximately 18 feet long, 22 feet wide and 20 feet high.

The aft fuselage contains the structural housing around all internal systems for protection from operational environments (pressure, thermal and acoustic) and controlled internal pressures during flight. It also contains the space shuttle main engines, aft heat shield, body flap, and vertical tail. The vertical tail consists of an aluminum structural fin surface, the rudder/speed brake surface, a tip and a lower trailing edge.

SATURN V LAUNCH VEHICLE

The Apollo missions were launched aboard a Saturn V vehicle. The Saturn V is the largest, most powerful U.S. expendable launch vehicle (ELV) ever built. The "V" following this Saturn's name stands for the Roman Numeral for the number five and signifies the five powerful rockets that power the first stage of the rocket.

The Apollo spacecraft including the command module (CM), the service module (SM), and the lunar module are positioned on top of the launch vehicle. There is an emergency escape system located above the command module.

The Saturn V launch vehicle consists of three stages. The first stage includes the five F-1 engines, which produce 7.7 million pounds of thrust. These engines initiate the lift off and last for about 2.5 minutes. After propelling the vehicle to an altitude of 38 miles, this first stage separates and burns up in the Earth's atmosphere.

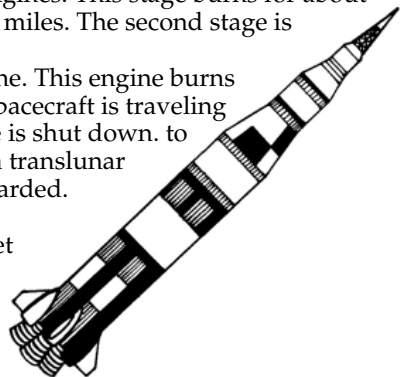
The second stage contains five F-2 engines. This stage burns for about six minutes and propels the vehicle to 115 miles. The second stage is also discarded.

The third stage contains one J-2 engine. This engine burns for about 2.75 minutes. At this point the spacecraft is traveling 17,500 miles per hour in orbit. This engine is shut down. to be reignited to propel the spacecraft into a translunar trajectory of 24,500 mph before being discarded.

The combined height of the Apollo spacecraft and the Saturn launch is 363 feet tall. The entire vehicle weighs over 6 million pounds.

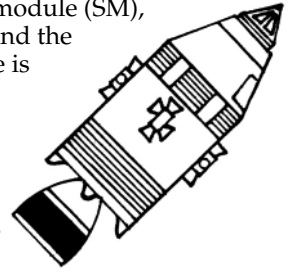
THE APOLLO SPACECRAFT

The Apollo spacecraft consists of



five parts: the command module (CM), the service module (SM), the lunar module (LM), the launch escape system, and the spacecraft-lunar module adapter. The entire vehicle is 82feet tall.

The CM, SM, and LM make up the basic spacecraft. The launch escape system serves as an escape rocket for the astronauts in the event of a malfunction during launch and early portion of boost. The adapter is an enclosure for lunar module during lift off and is a connecting link between the spacecraft and the launch vehicle. These components are jettisoned in the mission after they have fulfilled their function.



COMMAND MODULE

The CM is the area where the three-man crew lives and works. In it are the controls and displays for operation of the spacecraft, crew couches, and all the other equipment needed by the crew. The crew compartment is a sealed cabin with a habitable volume of 210 cubic feet. One person will spend the entire mission in it and the other two will leave it only during the lunar landing. The command module is the only part of the spacecraft that returns to earth from space.

The interior of the CM is very compact. It must serve as a combination cockpit, office, laboratory, radio station, kitchen, bedroom, bathroom, and den. Instrument panels and consoles line the walls. This panel consists of 24 instruments, 566 switches, 40 indicators, and 71 lights.

Although crewmen can move about from one station to another, much of their time will be spent on their couches. The couches can be adjusted so the crew can stand or move around. Space by the center couch permits two men to stand at one time. Control devices are attached to the armrests. The CM contains two side windows, two rendezvous windows, and a hatch window.

Separated from the crew compartment by a bulkhead is a compartment which is divided into four 90 degree segments and contains earth landing equipment (all the parachutes, recovery antennas, a beacon light, and sea recovery sling), two reaction control engines, and the forward heat shield release mechanism.

SERVICE MODULE

The service module contains the main spacecraft propulsion system and supplies most of the spacecraft's consumables (oxygen, water, propellant, hydrogen). It is not manned. The service module remains attached to the command module until just before entry, when it is jettisoned and destroyed. The service module supports the command module and its crew. It is strictly a servicing unit of the spacecraft, but it is more than twice as long and more than four times as heavy as the manned command module. About 75 percent of the service module's weight is in propellant for the service propulsion engine.

The SM is constructed of aluminum alloy. Fuel and oxidizers are contained within six wedge-shaped segments surrounding the main engine. The service module is attached to the command module until just before reentry. When the SM is jettisoned it disintegrates in the earth's atmosphere.

LUNAR MODULE

The lunar module is the section of the spacecraft that transports two

men from the orbiting command service module to and from the surface of the moon. It also provides a base of operations on the moon. The LM structure is divided into two components: the ascent stage (on top) and the descent stage (at the bottom). The descent stage has a descent engine and propellant tanks, landing gear assembly, a section to house scientific equipment for use on the moon, in addition to extra oxygen, water, and helium tanks.

The ascent stage houses the crew compartment (which is pressurized for a shirtsleeve environment like the command module), the ascent engine and its propellant tanks, and all LM controls. It has essentially the same kind of subsystems found in the command and service modules, including propulsion, environmental control, communications, and guidance and control. Portable scientific equipment is also carried in the LM.

TRAINS

The steam locomotive is one of the most fascinating machines ever to be invented. It wasn't until the appearance of the first locomotives that the world had seen any semblance of industrial technology. Before the advent of locomotion, horses and manpower were the only means of transportation.

In England in 1705, Thomas Newcomen designed the first stationary steam engine. This first steam engine was not designed for locomotion but to pump water out of flooded mine shafts. During the next 100 years it took the work and ingenuity of many engineers and inventors to create a steam locomotive powerful enough to become a viable vehicle for transportation. In 1814, George Stephenson designed and built his first locomotive. Known as "The Father of the Railways", he is credited with building the world's first public railroad between the English towns of Stockton-on-Tees and Darlington.

Although much of the development of the steam powered engine was engineered in England and Europe, Americans such as John Fitch and Oliver Evans were also experimenting with this new technology. Evans successfully designed a steam engine that powered a 21-ton scow in the water. In 1811, after seeing this first steam boat in operation, John Stevens began publicly advocating steam railroads. Stevens was able to obtain a charter to build a railway in New Jersey. This first attempt at a railroad was less than a success. Investors and politicians were more inclined to support transportation via canals than on rails. However, perseverance paid off for Stevens. In 1821, he built and successfully operated an experimental steam locomotive on his Hoboken, New Jersey estate. This demonstration attracted hundreds of visitors and created the necessary interest in the development of the railway system in America.

Railway systems began appearing in New Jersey, Massachusetts, Pennsylvania, Virginia and New York. In the early stages of railroad construction, materials for construction of rails and locomotives were scarce in America. American engineers went to England to purchase equipment and to investigate railway development. Locomotives weren't successfully manufactured in America until 1831.

On January 15, 1831, the first scheduled steam-hauled service took place in Charleston, South Carolina. By 1840, 2,800 miles of rails had been laid in the Eastern states. However, in just ten years the number of miles increased to 30,635 as the railways pushed westward. In 1862, Abraham

Lincoln signed an act enabling the creation of a railway to span from the Pacific to the Atlantic. The Central Pacific railroad was commissioned to build eastward, whereas the Union Pacific was to build westward. On May 10, 1869 the two rails met at Promontory Point, Utah. This was the first transcontinental railroad in the world.

Throughout America the railroad system expanded and all along its path, existing towns prospered. New towns developed along its route as the trains brought commerce and people to these newly accessible regions. The steam engine can be credited with being the single most important factor in the rapid and expansive growth of America.

How steam engines work

The basic design and concepts of steam locomotives have remained constant from the early models to the later models. Fire in the firebox heats up the water in the boiler producing steam. The pressure from the steam moves the pistons attached to the driving rod and crank, back and forth. This back and forth movement turns the driving wheel. The driving wheel makes a full rotation every time the piston moves back and forth.

Wood was used to fuel the fires in the fireboxes for the first three decades in America. Although wood proved a very good fuel source, the sparks and burning embers were hurled in the air through the smokestacks, which would damage equipment, merchandise, buildings along the tracks, as well as injure humans.

Fuel and the water were carried in the tender behind the locomotive. In the 1850's, bituminous coal began to replace wood as fuel. By the 1890's, 90% of all locomotives used coal. Coal burns at higher temperatures and provides much more heat resulting in more powerful locomotives.

It took two people to run a locomotive, the engineer and the fireman. The engineer controlled the speed of the train through the use of a throttle, reverse gear, and brake. The fireman stoked the fire to provide heat to make steam. He was also responsible for maintaining an adequate level of water.

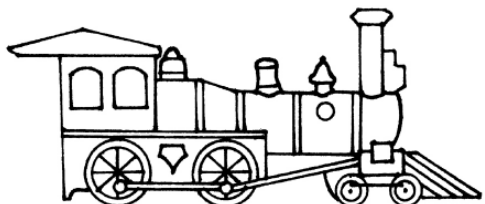
Locomotion Classification System

A simple system for classifying and identifying locomotives was devised by a Mr. Wythe. With the Wythe Classification System, locomotives were identified by the arrangement of their wheels, divided into three locations; leading (front), driving (middle), and trailing (end). For instance, a train with 4 lead wheels (2 on each side), 6 driving wheels (3 on each side), 2 trailing wheels (1 on each side), is classified as a 4-6-2.

1875 ALL AMERICAN LOCOMOTIVE

The All-American Locomotive, manufactured in the United States during the Victorian era, had a very distinctive style. Typically, the American Locomotives were not only very reliable, but they were a beautiful sight to behold. The cab of this locomotive was finished in fine wood, had arched windows, and was decorated with an elaborate pattern and gilded trim.

The sides of the headlights, front of the engines, tenders, and panels on the cab were sometimes decorated with detailed paintings of landscapes or portraits of significant personalities. These locomotives



had polished brass on the steam domes, bells, cylinder heads, whistles and cab controls.

The wheels were typically painted with bright colors; red, turquoise and occasionally yellow. The frames, located between the wheels, and cylinders were located outside the frames and were connected to the drive wheels by outside drive rods.

Every All-American Locomotive had its own character and was the pride of the crew who operated it. One of the most distinctive characteristics of these locomotives was the cowcatcher. Located in the very front, this gate-like structure was used to push large animals, such as cows, off the tracks.

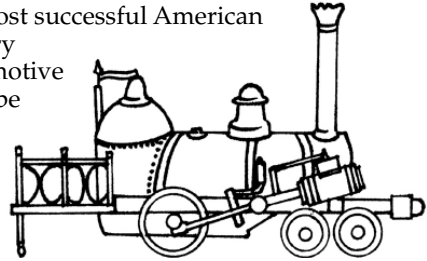
The burning of bituminous coal produced a lot of smoke and soot. Maintaining the polish of the colorful locomotives became very costly. By the 1890's, the trend for decorative locomotives gave way to plainness in locomotive design.

The 1875 All-American Locomotive, featured in this Eyewitness Kit, is classified as a 4-4-0.

1843 NORRIS STEAM LOCOMOTIVE

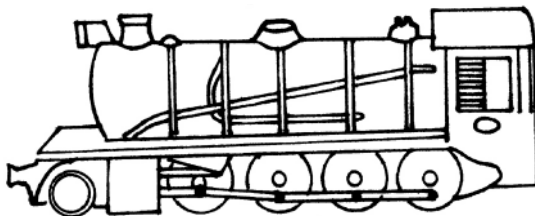
William Norris was one of the most successful American engine builders. He developed the very popular two cylinder 4-2-0. This locomotive was so popular that it was the first to be exported to Europe from the United States.

The 1843, Norris Locomotive, featured in the Eyewitness kit, was one of the first engines to be exported to Austria. Well suited for the terrain in Austria, this engine was designed for sharp curves and steep inclines.



1947 BRITISH STEAM LOCOMOTIVE

By 1947, steam engines were losing their popularity to diesel and electric locomotives. Air and automobile travel were also diminishing the demand for travel by rail. The 1947 British Steam locomotive featured in this Eyewitness kit was exported from Britain to India. The sunblinds were added to adapt to the East Indian climate. It is classified as a 2-8-0.



COLOR GUIDE



Space Vehicle

These vehicles are generally a combination of white, black and silver. See pictures on box for examples.









Train

The British Steam Locomotive is a combination of black and chrome. The other two Steam Engines should be painted brightly and elaborately with reds and greens. The wheels were typically painted with bright colors; red, turquoise and occasionally yellow. See pictures on box for examples.

IMPORTANT NOTE:

The non-grooved side of the magnet is the side that is most strongly attracted to metal. Magnets should be cut according to the following chart. Remember to glue the grooved side of the magnet (when in doubt test on metal) to the models.

Description	Inches
 Space Module	4
 Saturn V - top.....	2
Saturn V - bottom.....	3
 Space Shuttle.....	3
 1875 All American.....	3
 1843 Norris Steam.....	6
 1947 British Steam.....	3

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COLOR MIXING GUIDE

Kits come with different sets of colors depending on the title of the kit. Mixing instructions may include colors not included in your kit.

Acrylic paints can be thinned with water if they get too thick. Be sure to clean brushes with soap and water before the paint hardens or the paint will become permanent.

Primary colors can be mixed to obtain many other colors. Mix a small amount of two or more colors on a non-absorbent surface.

Always begin with more of the lighter color and a small amount of the darker color. To darken or lighten colors, add small amounts of black, brown or white and mix. Take your time and allow the paint to mix thoroughly before adding more paint.

- White skin - add small amounts of red and yellow to white
- Black/brown skin - add small amounts of white, yellow, red & black
- Army green - mix blue and yellow and a small amount of black
- Ammonite green - mix blue and yellow and a small amount of white
- Carmel - mix small amounts of brown and yellow to white
- Tan or beige - add small amounts of red, brown and yellow to white
- Brown - mix black, yellow, red and green
- Orange - add small amounts of red with yellow
- Gray - mix small amounts of black with white
- Pink - mix small amounts of red with white
- Purple - mix red and blue
- Gold - mix small amounts of yellow with silver
- The pot labeled GL is glue
- Some kits come with a pot labeled ST. This is stain that can be used to antique your creation after painting. Paint on and wipe off.

Download other Kit brochures at: <http://skullduggery.com>

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