Grade 9 Science

Astronomy

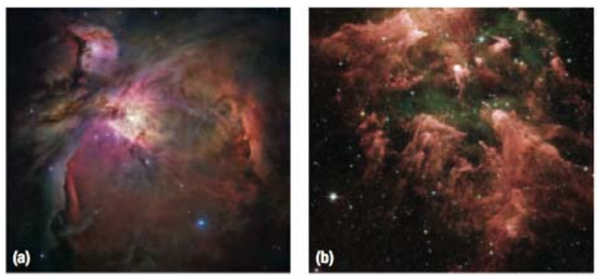
Class 17

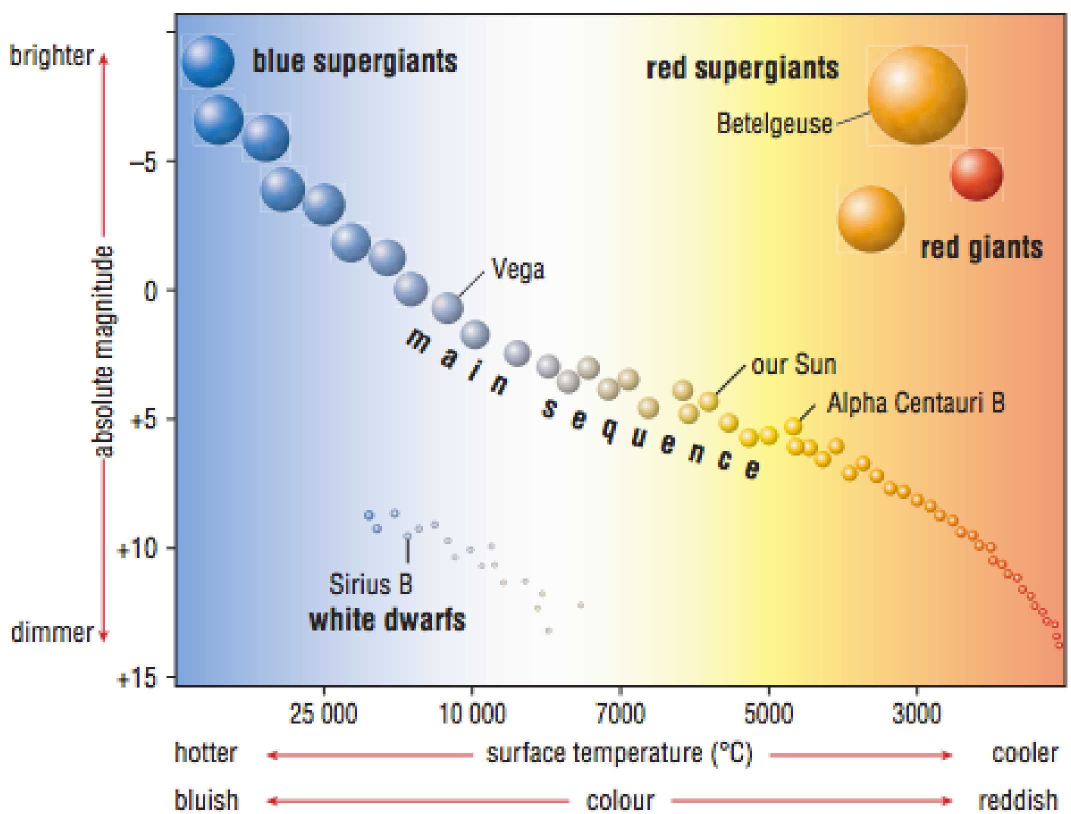
Star Cycles

Birth of a Star

- A star begins as a nebula – a massive cloud of interstellar gas and dust
- When a nebula reaches a certain density, gravitational forces pull the gas and dust particles forming a protostar

- As the protostar increases in mass and gravity, the core begins to get tightly packed raising the pressure and causing nuclear fusion
- Emits energy in the form of heat and light
- Hertzsprung-Russell Diagram
  - 90% of the stars fit in the main sequence
  - Hotter the stars, the more luminous the star





Death of a Star

- As all the hydrogen is converted into helium, the outward flow of energy slows down and the core begins to contract and the outer layers cool to become a red giant
- Nuclear fusion stops and the star becomes a white dwarf – small hot dim star and eventually a black dwarf

Figure 7 This Hubble Space Telescope image shows the Cat's Eye nebula, 3000 ly from Earth. The planetary nebula is illuminated by the white dwarf at its centre.

- For large stars, a supernova occurs and becomes a neutron star – star made of densely-packed neutrons (aka: pulsars)

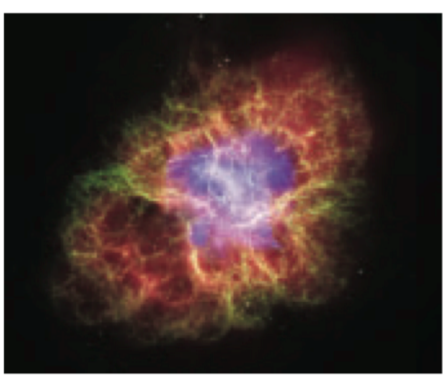
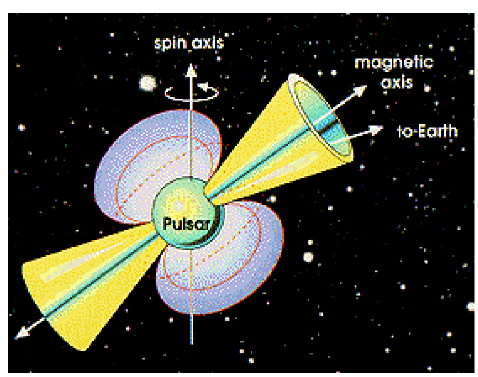
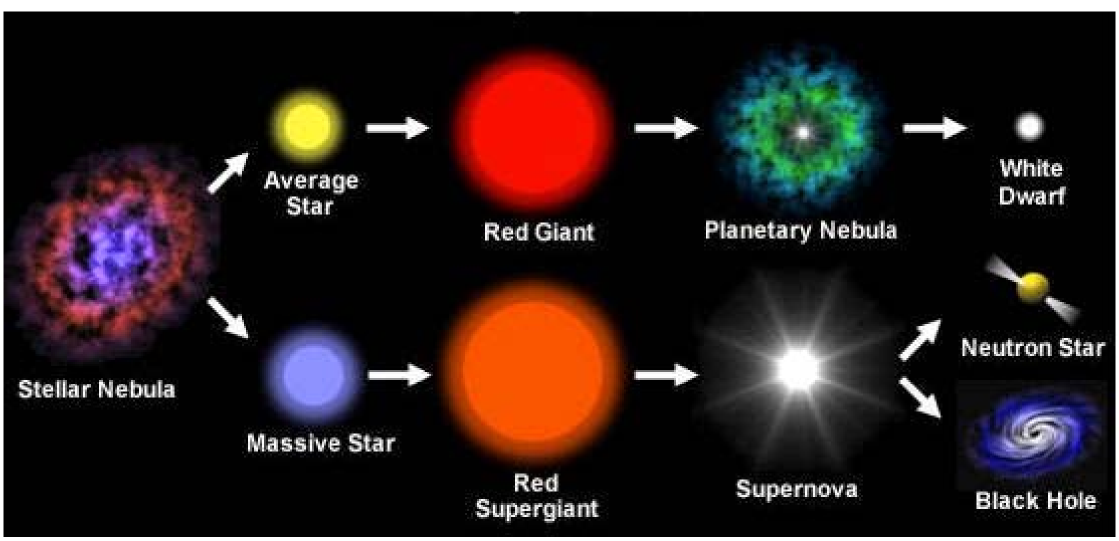


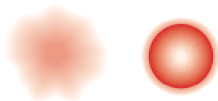
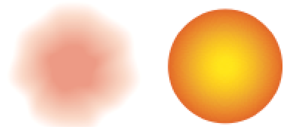
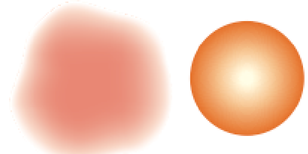
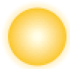
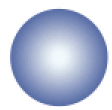
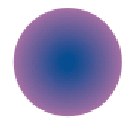
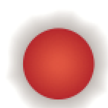
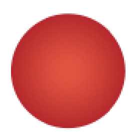
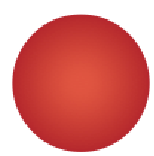
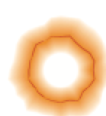
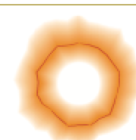
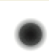
Figure 8 The supernova that formed the famous Crab Nebula was so bright that it was visible even during daylight hours.



Black Holes

- An extremely dense quantity of matter in space from which no light or matter can escape
- Gravity is so strong that it pulls in any nearby matter



	Small to medium star (<5 solar masses)	**Large star (10–30 solar masses)**	**Extremely large star (>30 solar masses)**
Birth and early life	 Forms from a small- or medium-sized portion of a nebula; gradually turns into a hot, dense clump that begins producing energy.	 Forms from a large portion of a nebula, and in a fairly short time turns into a hot, dense clump that produces large amounts of energy.	 Forms from an extremely large portion of a nebula, very quickly turning into a hot, dense clump that produces very large amounts of energy.
Main sequence phase	 Uses nuclear fusion to produce energy for about 10 billion years if the mass is the same as the Sun's, or 100 billion years or more if the mass is less than the Sun's.	 Uses nuclear fusion to produce energy for only a few million years. It is thousands of times brighter than the Sun.	 Uses nuclear fusion to produce energy for only a few million years. It is extremely bright.
Old age	 Uses up hydrogen and other fuels and swells to become a large, cool red giant.	 Uses up hydrogen and other fuels and swells to become a red supergiant.	 Uses up hydrogen and other fuels and swells to become a red supergiant.
Death	 Outer layers of gas drift away, and the core shrinks to become a small, hot, dense white dwarf star.	 Core collapses inward, sending the outer layers exploding as a supernova.	 Core collapses, sending the outer layers exploding as a very large supernova.
Remains	 White dwarf star eventually cools and fades.	 Core material packs together as a neutron star. Gases drift off as a nebula to be recycled.	 Core material packs together as a black hole. Gases drift off as a nebula to be recycled.

Formation of the Solar System

Solar Nebula Theory

- Solar system was formed 5 billion years ago from a massive cloud of gas and dust that begin to contract → protostar
- Counterclockwise spin of the protostar increased as more particles were attracted to it and formed a disc of dust and gas
- Formed the Sun and the outer gas giants
- Dense solid clumps of solid matter remained leaving the terrestrial planets

- Evidence of the Solar Nebula Theory
  - Explains how the planets orbit the sun in the same direction; in the same plane, and the location of the planets
  - We observe other planetary systems in various stages of this formation process
  - Computer simulations result in planetary systems that look like the systems we see today

Other Components of the Universe

- **Star Clusters** – Groups of stars that develop together from the same nebula, are gravitationally bound and travel together
  - Open star clusters – collection of 6 to 1000 young stars
  - Globular clusters – ball-shaped collection of thousands to million very old stars

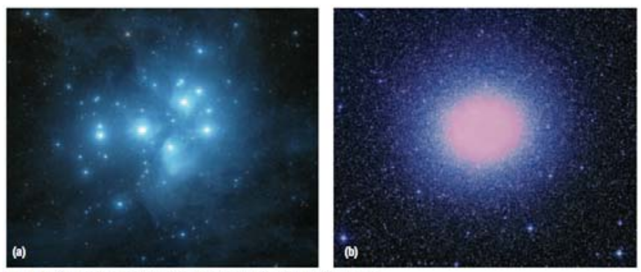


Figure 1 (a) The stars in the open cluster Pleiades can be seen with the unaided eye.
(b) Omega Centauri is an example of a globular cluster with a tightly packed group of stars.

- **Galaxy** – collection of millions to billions of stars, planets, gas and dust measuring up to 100 000 ly across
- Four Categories of Galaxies:
  - **Elliptical Galaxies** – older galaxies with little gas, dust or young stars
  - **Spiral Galaxies** – flattened discs with a central bulge with two to four spiral arms; barred spiral galaxies have a central bar running down the middle
  - **Lenticular Galaxies** – central bulge with a flattened disc of gas and dust with no spiral arms

– **Irregular Galaxies** – have no definite shape, no spiral arms or central nucleus


Figure 3 Elliptical galaxy


Figure 4 Spiral galaxy

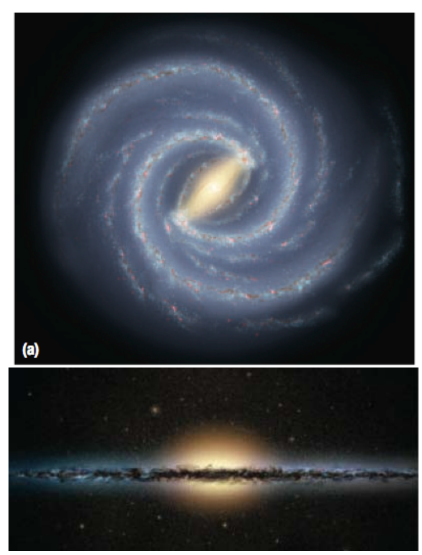

Figure 5 Barred spiral galaxy


Figure 6 Lenticular galaxy


Figure 7 Irregular galaxy

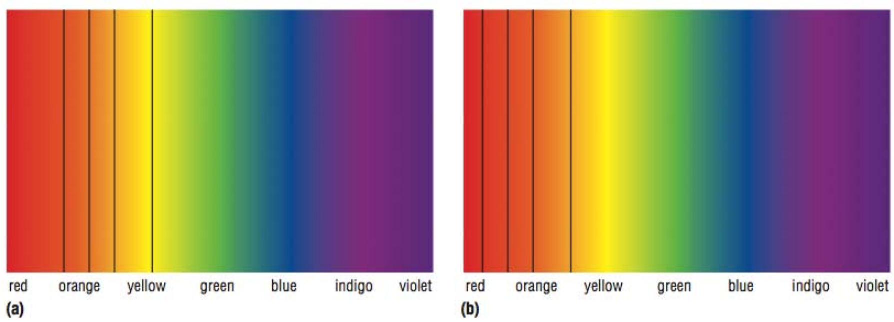
Milky Way Galaxy

- The Milky Way has two spiral arms and consists of stars of all ages
- Central bulge is a collection of older stars
- Our solar system is located on the inner edge of one of the spiral arms about 26 000 ly from the central core
- At the centre of the Milky Way is a supermassive black hole



Expanding Universe

- Hubble identified that galaxies appeared to be moving away from each other by studying patterns of light emitted from galaxies
  - **Red Shift** – the light from the galaxies shifted toward the red end of the spectrum



Space Exploration

- Telescopes both on ground and in the orbit detects electromagnetic radiation
  - Light telescopes
  - Radio telescopes – collect radio frequencies from starts and transmits the signal to a computer

– X-ray telescopes – X-rays emitted from dying stars like neutron stars and black holes
– Gamma ray telescopes – track gamma rays from distant regions in the Universe

- Hubble Space Telescope
  – Orbits the Earth and is able to view distances far greater than on ground
  – Spectral range extends from the UV rays to visible light to infrared radiation

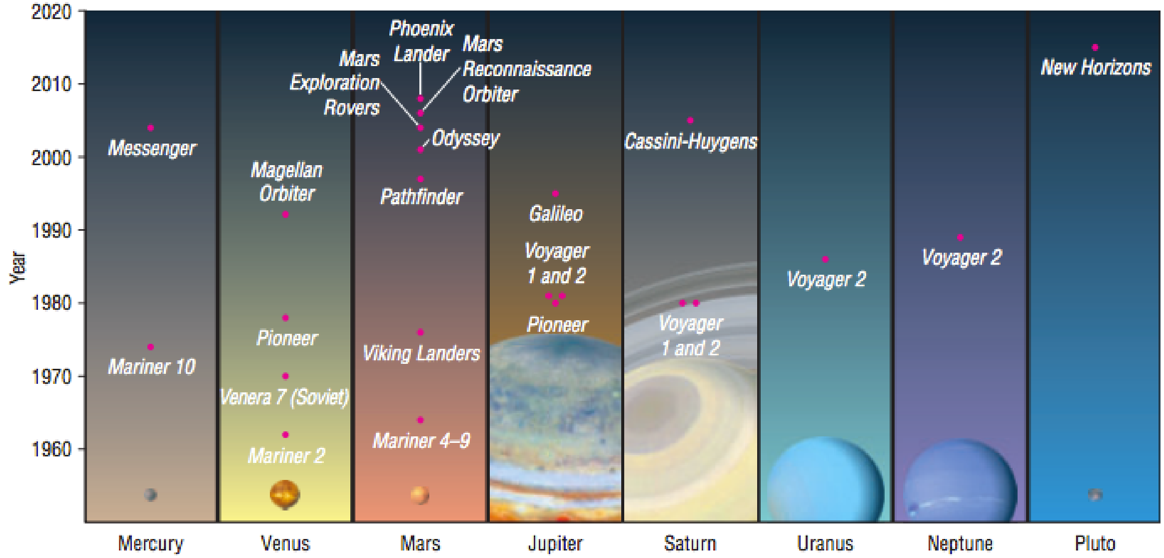
- Spacecraft – designed for travel in space
  – Rocket body to launch the object
  – Human-occupied area to pilot the spacecraft
  – Cargo storage, scientific supplies or rovers
- International Space Station
  – Completed in 2010
  – Ten astronauts at a time live on the ISS
  – Limited water supply; astronauts use special kinds of soap and shampoo that do not need water to rinse

Space Tools

- **Canadarm** – 15.2m long robotic arm used to lift parts, capture and deploy satellites and assist astronauts moving in space
- **Canadarm2** – 18m long arm used to move 115 tonnes of equipment, transfer cargo, assemble pieces and maintain the ISS
- **DEXTRE** – dexterous manipulator to do construction, repair, replace batteries on the outside walls of the space stations

Space Probes

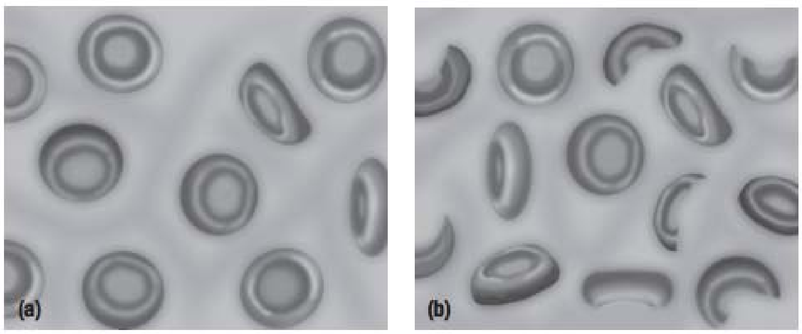
- Spacecrafts sent into space to explore celestial objects such as planets, moon, asteroids, and comets
- Sent to Mars, Venus, Jupiter, Saturn, Uranus and Neptune
- Mars rovers – *Spirit* and *Opportunity* found evidence that Mars was once covered by a vast body of salty water



Challenges of Space Travel

- Getting into Space
  - Needs to escape Earth's gravitational pull
  - Must travel at the right speed to maintain orbit
  - Use traditional fuels and alternative fuels
    - Traditional Fuel: fuel is heavy and most of it is used for takeoff
    - Alternative Fuel: Fire Xenon gas to provide thrust, Use Nuclear Energy to decrease weight and to decrease travel time

- Weightlessness
  - Continuous falling motion of the spacecraft gives the feeling of weightlessness
  - Health Risks
    - Dizziness, disorientation, nausea, dehydration
    - Blood cells change shape in space which affects their ability to function
    - Weakened bones and muscles



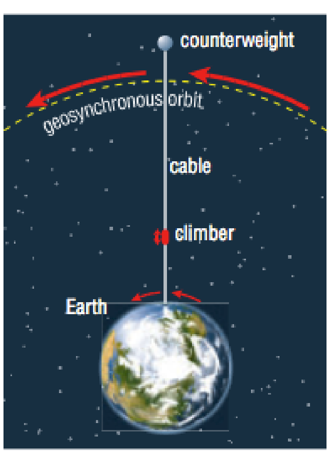
Space Junk

- Debris from old satellites, tools that were lost in space
- Can damage functioning satellites or the International Space Station
- Some debris lands on Earth

Future of Space Exploration

- Using the Moon as a testing ground for Mars exploration
- Similarities of Moon and Mars
  - Colder than Earth
  - Less gravity than Earth
  - Blanketed by silt-like dust particles

- Space Tourism
  - In 2001, US billionaire Dennis Tito was the world's first space tourist
  - Cost = $30 million



- Space Elevator
  - Extends 36,000km into space tethered to an ocean ship
  - Counterweight keeps the cable taut
  - Not possible yet