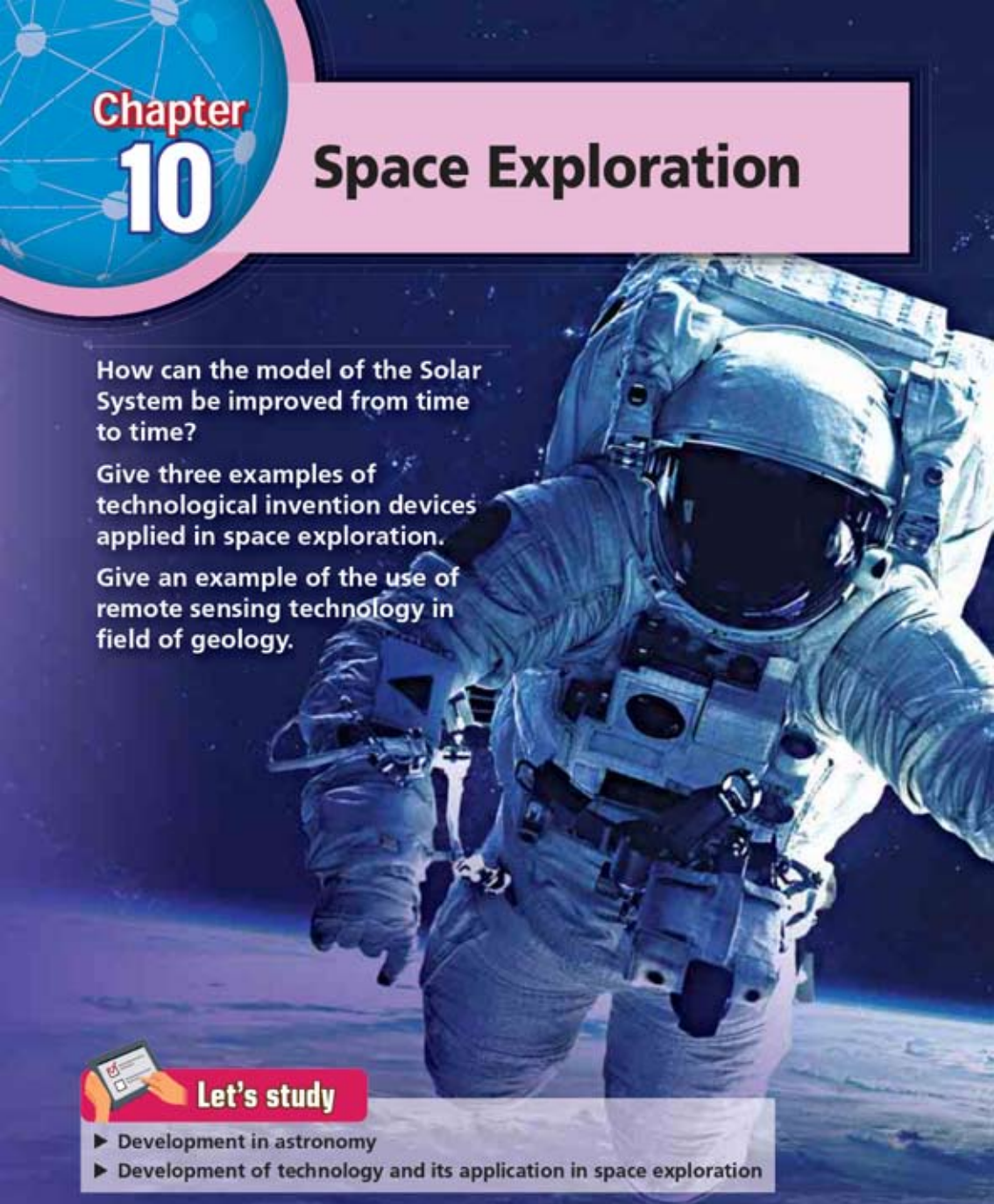
Chapter 10

Space Exploration



How can the model of the Solar System be improved from time to time?

Give three examples of technological invention devices applied in space exploration.

Give an example of the use of remote sensing technology in field of geology.

Let's study

- Development in astronomy
- Development of technology and its application in space exploration

Science Gallery

International Space Station, ISS

The International Space Station (ISS) is a station that facilitates international research in space. The function of this station is to carry out research in space and monitor space.

Dato' Dr Sheikh Muszaphar Shukor Al Masrie bin Sheikh Mustapha is the first astronaut from Malaysia to carry out experiments in space from 10 October to 21 October 2007.

Keywords

- Geocentric
- Heliocentric
- Kepler's Law
- Ellipse
- Focal point
- Rocket
- Satellite
- Space probe
- Remote sensing
- Geology
- Disaster management
- Space Telescope

10.1 Development in Astronomy

Historical Development of the Solar System Model

Study Figure 10.1. Then, carry out Activity 10.1.

History of the Solar System Model

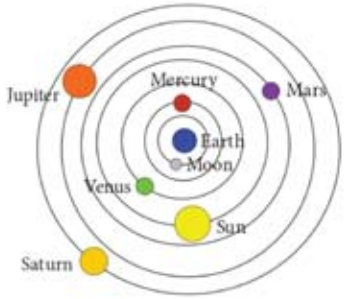
Ptolemy
(90 – 168 A.D.)

- Greek astronomer, astrologer and geographer
- Built the **geocentric** model with Earth at the centre and circular orbits

Copernicus
(1473 – 1543)

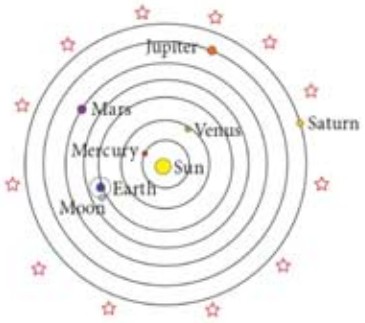
- Polish astronomer, mathematician, economist and doctor
- Built the **heliocentric** model with the Sun at the centre and circular orbits

Geocentric model



- 'Geo' means Earth
- 'Centric' means centre
- Earth is at the centre of the Solar System
- Earth is stationary and all the objects such as the Sun and other planets revolve around Earth in circular orbits

Heliocentric model



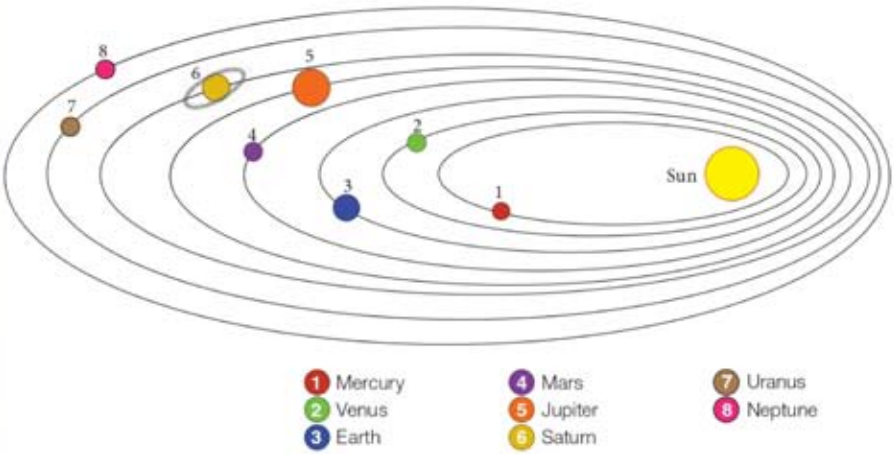
- 'Helio' means the Sun
- 'Centric' means centre
- The Sun is at the centre of the Solar System
- Earth rotates on its axis and revolves around the Sun in a circular orbit

Figure 10.1 *History of the Solar System model*

Kepler
(1571 – 1630)

- German astronomer, mathematician and astrologer
- Modified the **heliocentric** model with the Sun at one common focal point on the elliptical orbits of the planets according to **Kepler's Law**

Modified Heliocentric model according to Kepler's Law



10.1.1

Activity 10.1

21st Century Skills
- ICS
- Discussion Activity

To understand the development of the Solar System models built by Ptolemy, Copernicus and Kepler

Instructions

1. Work in groups.
2. Carry out active reading by visiting websites or going on a study tour to the National Planetarium to gather information on the development of the Solar System models built by:
   (a) Ptolemy
   (b) Copernicus
   (c) Kepler
   Examples of websites are as follows:

Watch these sections of the video
3.01 *Historical Solar System Models*
3.02 *Current Solar System Model*
http://bt.sasbadi.com/sc3272-1

Historical attempts to model the Solar System (Take a challenge)
http://bt.sasbadi.com/sc3272-2

History of the Solar System model
http://bt.sasbadi.com/sc3272-3

3. Discuss and present to the class how knowledge gained through scientific research is the product of human effort to obtain rational explanations about natural phenomena.
4. Present the outcome of your group discussion using multimedia presentation.

Formative Practice 10.1

1. Name the Solar System model built by the following astronomers:
   (a) Ptolemy
   (b) Copernicus
   (c) Kepler
2. Compare and contrast the Solar System models built by Ptolemy and Copernicus.
   (a) Similarities
   (b) Differences
3. Compare and contrast the Solar System models built by Copernicus and Kepler.
   (a) Similarities
   (b) Differences

10.2 Development of Technology and its Application in Space Exploration

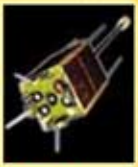
Development in Space Exploration

Figure 10.2 shows part of the early history of space exploration in terms of technology development and missions in space exploration.

2011: Construction of International Space Station (ISS) completed

2002: National Space Agency (*Agensi Angkasa Negara*) established

2000: Malaysia's first microsatellite TiungSAT-1 launched



1996: Malaysian satellites MEASAT 1 and 2 launched

1990: US launched Hubble Space Telescope from space shuttle Discovery

1989: First Neptune flyby – US Voyager 2

1981: First flight of US space shuttle – Columbia

1973: First Jupiter flyby – US Pioneer 10

1969: First human to set foot on the Moon – Neil Armstrong, US Apollo 11

1961: First human to orbit Earth – Yuri Gagarin, aboard USSR Vostok 1

11th century: Chinese invented gunpowder and used primitive rockets in battles

1609: First telescope used in the field of astronomy by Galileo Galilei

1957: First satellite – USSR Sputnik 1

Figure 10.2 *Some of the events related to the development of technology in space exploration*

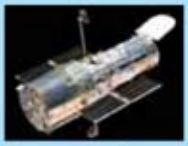
Applications of Technology in Space Exploration and their Importance

Space Telescope

Figure 10.3 shows the development of the telescope.

The astronomical **sextant** is used to measure the altitude of stars

Galileo's Telescope became the most widely used astronomical instrument



Hubble space telescope was placed in an orbit 500 km from the surface of Earth

Apart from optical telescopes, **radio telescopes** are also used to detect radio waves from space.

The **Spitzer space telescope** detects very distant activities in space.

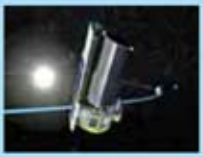
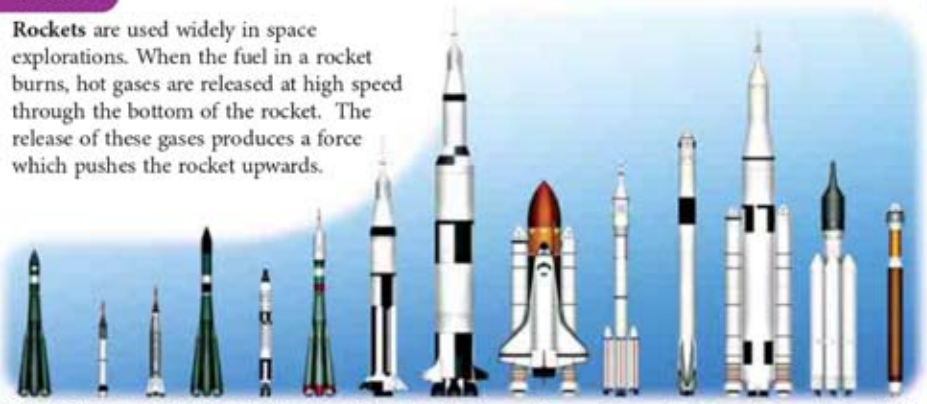


Figure 10.3 Space telescopes

Rocket

Rockets are used widely in space explorations. When the fuel in a rocket burns, hot gases are released at high speed through the bottom of the rocket. The release of these gases produces a force which pushes the rocket upwards.



Photograph 10.1 Rockets used to send humans to space

Based on Photograph 10.1, which rocket was used to send astronauts to the Moon?

Satellite

The first satellite, Sputnik 1 was sent to outer space in 1957. How many satellites are orbiting around Earth today? Which country has the largest number of satellites?

Photograph 10.2 *Weather satellite GOES-16 gathers data on solar flares*

Websites

Satellite launch

http://bt.sasbadi.com/sc3275

Space Probe

A **space probe** is a spacecraft that gathers information and sends it back to Earth. Space probes do not orbit Earth like satellites but travel further into and out of the Solar System. Space probes carry cameras and remote sensing instruments as well as radio transmitters and receivers for the purpose of communicating with scientists on Earth.

Photograph 10.3 *Space probe Cassini*

MARVELS OF SCIENCE

In 2017, space probe Cassini was still active orbiting Saturn even after 20 years in space.

Remote Sensing

Remote sensing is a method of gathering and recording information from a distance. In Malaysia, remote sensing instruments are fitted to TiungSAT-1 to receive or detect visible, ultraviolet and infrared lights produced by objects on the surface or below the surface of Earth. The information gathered by TiungSAT-1 is then sent to two data receiving stations at the National Planetarium Station, Federal Territory of Kuala Lumpur and the Mission Control Station (MCGS), Bangi, Selangor.

Photograph 10.4 shows the pattern and movement of clouds taken from TiungSAT-1's remote sensing camera. What is the use of the information obtained from this photograph?

Remote sensing technology is used in various fields in daily life as follows:

- **Agriculture** – To detect suitable regions for agricultural development
- **Geology** – To detect locations such as mineral sources, mass depletion and land depletion
- **Disaster management** – To identify pollution and forest fires
- **Defence** – To detect intrusions of enemy ships, aircraft and vehicles

Photograph 10.4 *A picture of the pattern and movement of clouds*

Activity 10.2

21st Century Skills
- ICS
- Discussion activity

To understand the development of technology in space exploration

Instructions

1. Work in groups.
2. Carry out active reading by visiting websites or going on a study tour to the National Planetarium, MACRES and National Space Agency to gather information on the development of technology in space exploration in:
   (a) early history of space exploration
   (b) the construction of rocket, satellite and space probe
   (c) remote sensing used in agriculture, geology, disaster management and defence
3. Discuss and present the development and technological applications in space exploration and their importance.
4. Present the findings of your group discussion using multimedia presentation.

Activity 10.3

21st Century Skills
- ISS, CPS
- Project-based activity

To debate the issue of continual space exploration

Instructions

1. Work in groups.
2. Gather information from the Internet, printed media and other electronic media on the importance of space exploration in the local and global context.
3. Share and discuss the gathered information.
4. Debate the issue of continual space exploration in the local and global context.

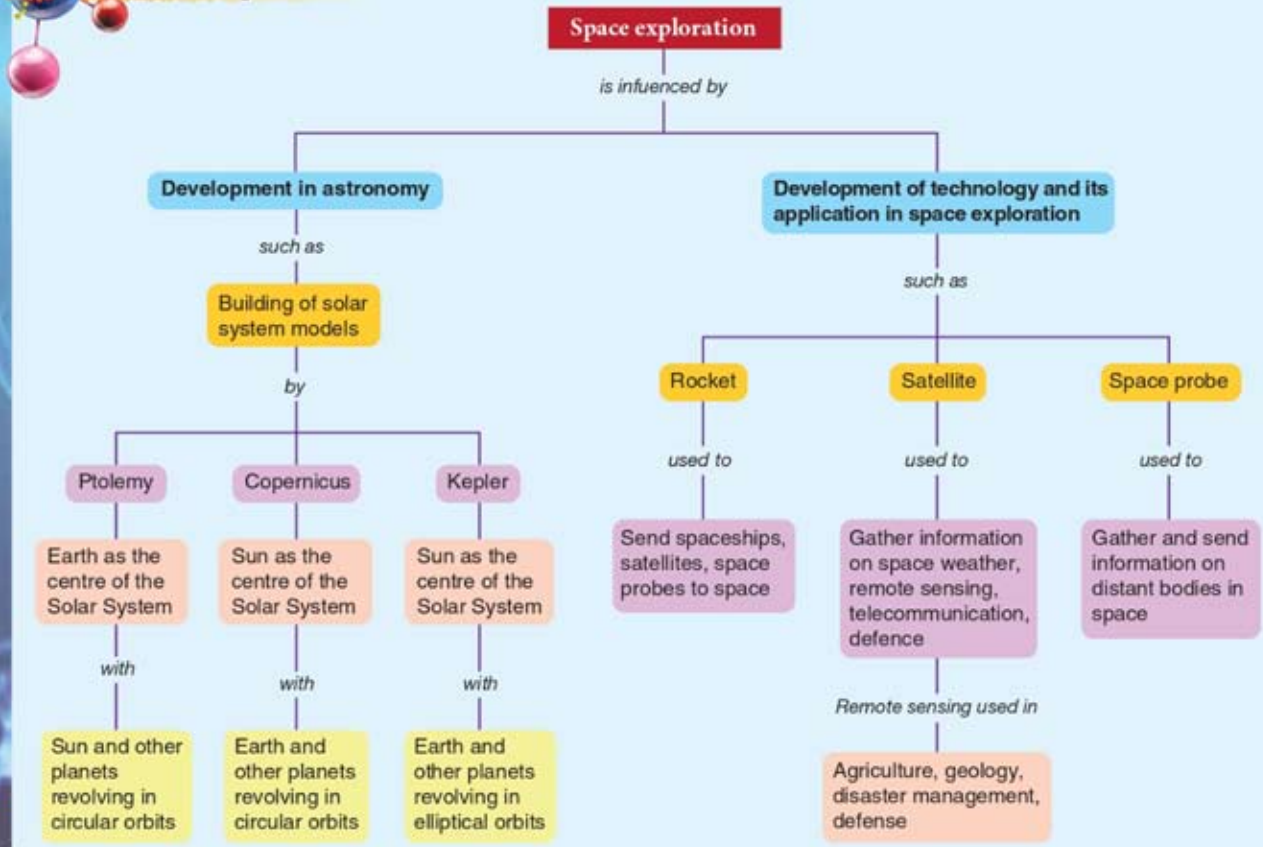
Formative Practice 10.2

1. Name the first technological device used in space exploration.
2. Study Figure 1.
   (a) What is Discovery?
   (b) What is Hape?
3. (a) Name the technology used to take aerial photographs.
   (b) What is the importance of taking aerial photographs during floods?
4. What is the role played by the Malaysian Remote Sensing Agency (MACRES)?

Figure 1

10.2.1 10.2.2

Summary


Space exploration
is influenced by
Development in astronomy
such as
Building of solar system models
by
Ptolemy
Copernicus
Kepler
Earth as the centre of the Solar System
Sun as the centre of the Solar System
Sun as the centre of the Solar System
with
with
with
Sun and other planets revolving in circular orbits
Earth and other planets revolving in circular orbits
Earth and other planets revolving in elliptical orbits
Development of technology and its application in space exploration
such as
Rocket
Satellite
Space probe
used to
used to
used to
Send spaceships, satellites, space probes to space
Gather information on space weather, remote sensing, telecommunication, defence
Gather and send information on distant bodies in space
Remote sensing used in
Agriculture, geology, disaster management, defense

Self-reflection

After studying this chapter, you are able to:

10.1 Development in Astronomy

☐ Explain the historical development of the Solar System model by drawing.

10.2 Development of Technology and its Application in Space Exploration

☐ Communicate the importance of the development of technology and its application in space exploration.

☐ Justify the need to continue space exploration.

Summative Practice 10

Answer the following questions:

1. Figure 1 shows the Spitzer space telescope.

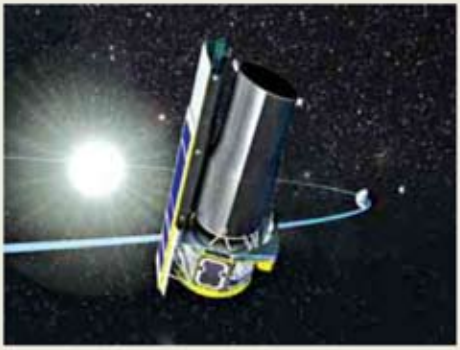


Figure 1

Mark '✓' for the correct statements and '×' for the incorrect statements.

(a) The Spitzer space telescope is located on the surface of Earth.	
(b) The Spitzer space telescope 'observes' better than ordinary telescopes.	
(c) The Spitzer space telescope is used to take photographs of Earth's surface.	
(d) The Spitzer space telescope is used as a remote sensing equipment.	

2. Match the Solar System model to the astronomer who built it.

Solar System model	Astronomer
(a) Earth is at the centre of the Solar System and the Sun revolves around Earth in a circular orbit.	Copernicus
	Kepler
(b) The Sun is at the centre of the Solar System and Earth revolves around the Sun in an elliptical orbit.	Ptolemy

3. How can knowledge about astronomy be acquired through scientific investigation?

4. Why are space probes not used to send astronauts into space?

5. Figure 2 shows a space probe sent to Saturn.

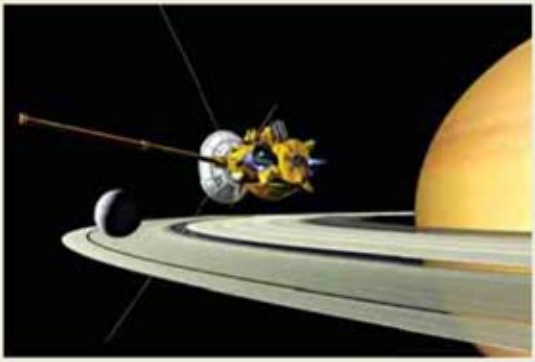


Figure 2

(a) What is the function of this space probe?

(b) State **one** example of a phenomenon that occurs on the surface of the Sun that might destroy the space probe.

(c) State the source of energy used by the space probe.

6. State **two** examples of the use of remote sensing technology in the following fields:
(a) Agriculture
(b) Geology
(c) Disaster management
(d) Defence

7. Figure 3 shows a rocket.

Figure 3

(a) What is a rocket?
(b) What is the function of rocket in space exploration?
(c) Explain **one** misuse of rocket in our daily life.

8. Astronomers have successfully discovered three planets revolving around the TRAPPIST-1 star which are suitable for all life on Earth.

As these three planets are extremely far, a special spacecraft needs to be invented to transfer life on Earth to these planets.

You are required to invent a model of the spacecraft using the following materials:

- Cardboard
- Cellophane tape
- Black plastic sheet
- Aluminium foil

Answer

Only selected answers are provided here

CHAPTER 1 Stimuli and Responses

Summative Practice 1

1. (a) × (b) ✓ (c) × (d) ✓
2. P: Brain
   Q: Spinal cord
   R: Peripheral nerve
3. (a) Changes in the size of the pupil of the eye.
   (b) Intensity of light which enters the eye.
   (c) The lower the intensity of light directed towards the eye, the larger the size of the pupil of the eye.
   (d) During a solar eclipse, the bright rays of the Sun will enter the eye and damage the cells of the retina.
4. (a) Sound → Earlobe → Ear canal → Eardrum → Ossicles → Oval window → Cochlea → Auditory nerve → Brain
   (b) Light → Cornea → Aqueous humour → Pupil → Eye lens → Vitreous humour → Retina → Optic nerve → Brain
5. (a) X: Touch receptor
   Y: Pain receptor
   (b) Fingertip is more sensitive towards touch stimuli compared to the palm of the hand. Fingertip has a thinner layer of epidermis and more touch receptors compared to the palm of the hand.
   (c) Agree. The tongue is a sensory organ that has receptors known as taste buds on the surface of the tongue which is protected by skin epidermis.
6. (a) The sense of smell helps us to detect danger such as leakage of gas that might occur in the science laboratory. For example, we can detect the presence of dangerous gases such as chlorine and ammonia from their smell.
   (b) Dogs have a very sensitive sense of smell because they have more sensory cells for smell than human and are more efficient to analyse smell than human.
7. (a) – Positive phototropism
   – Positive hydrotropism
   (b) Positive phototropism ensures shoots and leaves of plants obtain sufficient sunlight to make food through photosynthesis.
   Positive hydrotropism allows roots of plants to grow towards water so that they can absorb water to enable plants to carry out photosynthesis.

CHAPTER 2 Respiration

Summative Practice 2

1. (a) Alveolus
   (b) Bronchus
   (c) Nasal cavity
2. P: Trachea
   Q: Bronchus
   R: Alveolus
3. (a) ✓ (b) ✓ (d) ✓
4. (a) higher (b) lower
5. (a) Haemoglobin transports oxygen from the red blood cell to body cells.
   (b) Oxyhaemoglobin easily decomposes into haemoglobin and oxygen when it reaches body cells so that oxygen can diffuse into the cells.
6. (a) Azura may be allergic to pollen. In Spring, more pollen is released from anthers. When Azura inhales air containing pollen, there is a higher risk of her getting an asthma attack.
   (b) Any place that is hazy and dusty. Examples: industrial areas, construction sites and others. Haze and dust also cause asthma attacks in asthma patients.
7. (a) – Thickness of the wall
   – Moisture of the wall
   – Surface area
   – Network of capillaries
   (b) (i) Asthma
   Symptom: Shortness of breath
   Cause: Excessive release of mucus on the surface of alveolus reduces the surface area and rate of gaseous exchange in the alveolus thereby causing shortness of breath.
   (ii) Bronchitis
   Symptom: Shortness of breath
   Cause: Inflammation of the bronchus in bronchitis patients caused by tar and irritants in cigarette smoke reduces the rate of movement of air from the nose to the lungs through the bronchus. This causes

bronchitis patients to be frequently breathless.

(iii) Emphysema
Symptom: Shortness of breath
Cause: The alveolus in emphysema patients is damaged by dangerous substances in the air such as irritants in cigarette smoke. Hence, the surface area for gaseous exchange in the alveolus is reduced causing shortness of breath.

8. – Stop smoking.
To avoid harmful substances found in cigarette smoke from entering the lungs and harming the respiratory system.
– Avoid places with polluted air.
To avoid inhaling air that contains harmful substances such as cigarette tar, carbon monoxide, sulphur dioxide, nitrogen dioxide, haze, dust and pollen which are harmful to the respiratory system.
– Have proper exercise and lead a healthy lifestyle.
To maintain a healthy respiratory system.

CHAPTER 3: Transportation

Summative Practice 3

1. (a) PULSE (d) PHLOEM
(b) TRANSPIRATION (e) HEART
(c) CAPILLARY (f) ANTIGEN
2. (a) ✓ (b) × (c) × (d) ×
3. (a) Valve
(b) Transport oxygenated blood
(c) (i) Blood vessel Q has thick walls to withstand high blood pressure.
(ii) Blood vessel R has walls which are one cell thick to increase the efficiency of exchange of substances between blood and body cells through diffusion.
4. (a) Oxygen, carbon dioxide, water, digested food, waste products
(b) Oxygen, carbon dioxide, water
(c) During the day, plant cells carry out photosynthesis and produce oxygen. Hence, plant cells do not need oxygen supply.
5. (a) (i) dub
(ii) lub
(iii) systolic
(iv) diastolic
(b) Systolic pressure reading is higher than diastolic pressure reading. Systolic pressure reading is reading of blood pressure which is higher when heart ventricle contracts to force blood out of the heart to be distributed to the whole body.
Diastolic pressure reading is reading of blood pressure which is lower when heart ventricle slackens to facilitate blood flowing from the whole body back to the heart.
6. (a) (i) Eric, Roy
(ii) Blood will coagulate.The victim may die.
(b) (i) Individual 2.
This is because she fulfils the age condition of 18 years and above but less than 60 years. She also fulfils the body mass condition of more than 45 kg.
(ii) Pregnant women are not suitable to donate blood.

CHAPTER 4 Reactivity of Metals

Summative Practice 4

1. (a) Elements: Iron, Silver, Potassium, Tin
Compounds: Quartz, Bauxite, Galena, Hematite, Limestone
(b) Bauxite, Aluminium and oxygen
2. (a) Tin(IV) oxide
(b) Carbon
(c) Tin + oxygen → Tin(IV) oxide
3. (b) ✓ (c) ✓
4. (a) Oxygen
(b) Potassium and sodium are very reactive metals. Paraffin prevents potassium and sodium from reacting with oxygen and water vapour in the air.
5. (a) Oxygen
(b) To provide oxygen for the reaction.
(c) Heat the powdered metal until it glows before heating potassium manganate(VII) to provide oxygen for the reaction.
(d) To construct a reactivity series of metals.

CHAPTER 5 Thermochemistry

Summative Practice 5

1. (a) Exothermic reaction
(b) Endothermic reaction
(c) Exothermic reaction
(d) Endothermic reaction
(e) Exothermic reaction
(f) Exothermic reaction
2. (a) released (c) hot
(b) increases (d) absorbed
3. (a) THERMOCHEMISTRY
(b) PHOTOSYNTHESIS
(c) RESPIRATION
(d) THERMOMETER
(e) ENDOTHERMIC
(f) EXOTHERMIC
4. Heating of calcium carbonate is an endothermic reaction. Heat is absorbed by the chemical reaction that occurs during the decomposition of calcium carbonate.

5. The reaction between hydrochloric acid and sodium carbonate is an exothermic reaction whereas the reaction between hydrochloric acid and sodium hydrogen carbonate is an endothermic reaction.

CHAPTER 6 Electricity and Magnetism

Summative Practice 6

1. (a) True (b) False (c) True
2. (a) Non-renewable energy source
   (b) Renewable energy source
   (c) Renewable energy source
   (d) Renewable energy source
3. (a) Magnetic field lines are cut
   (b) Induced current
   (c) LED lights up. Induced current flows through the LED. The flow of current through the LED causes the LED to light up.
   (d) Generator
4. (a) Cathode Ray Oscilloscope
   (b) Shape of graph, direction of current and voltage changes for direct current and alternating current.
   (c) (i) Alternating current
   (ii) Direct current
5. (a) Step-down transformer
   (b) Number of turns in the primary coil is more than the number of turns in the secondary coil.
   (c) To reduce eddy current and increase the efficiency of the transformer
   (d) Using the formula, $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

$$\frac{10\text{ V}}{V_s} = \frac{100\text{ turns}}{20\text{ turns}}$$

$$\text{Secondary voltage, } V_s = 10\text{ V} \times \frac{20\text{ turns}}{100\text{ turns}}$$

$$= 2\text{ V}$$

CHAPTER 7 Energy and Power

Summative Practice 7

1. (a) Energy possessed by an object is due to its position or condition.
   (b) Energy possessed by a moving object.
2. (a) N m (b) Work
   (c) stationary (d) can
   (e) acceleration
3. (a) $W = Fs$
   $= 5\text{ kg} \times 10\text{ m s}^{-2} \times 2\text{ m}$
   $= 100\text{ J}$
   (b) Energy used by motor = work done
   $= 100\text{ J}$
4. (a) Gravitational potential energy = mgh
   where m is the object mass
   g is the gravitational acceleration
   h is the height
   (b) Elastic potential energy = $\frac{1}{2}Fx$,
   where F is the compression or stretching force
   x is the displacement from equilibrium position
   (c) Kinetic energy = $\frac{1}{2}mv^2$,
   where m is the mass
   v is the velocity

CHAPTER 8 Radioactivity

Summative Practice 8

1. (a) ✓ (b) × (c) ✓
2. Radioactive decay is a spontaneous process by which an unstable nucleus emits radioactive radiation until the nucleus becomes more stable.
3. sodium-24 (Na-24)
4. 0 hours, 32 g → 5.2 hours, 16 g → 10.4 hours, 8 g → 15.6 hours, 4 g → 20.8 hours, 2 g

   Therefore the remaining mass of Pa-234 after 20.8 hours is 2 g.

CHAPTER 9 Space Weather

Summative Practice 9

1. A: Convection zone
   B: Chromosphere
   C: Photosphere
   D: Radiation zone
   E: Core
   F: Corona
2. 11 years
3. Sunspots
4. – Smartphone (mobile)
   – Internet
   – TV broadcast
   – Global positioning system (GPS)

CHAPTER 10 Space Exploration

Summative Practice 10

1. (a) × (b) ✓ (c) × (d) ×
2. (a) Ptolemy (b) Kepler
3. Student's answers
4. Because space probes are not built to return to Earth.
5. (a) To gather information about Saturn to be sent back to Earth.
   (b) Solar wind
   (c) Solar energy

Complete answers for teachers
http://bt.sasbadi.com/sc3283