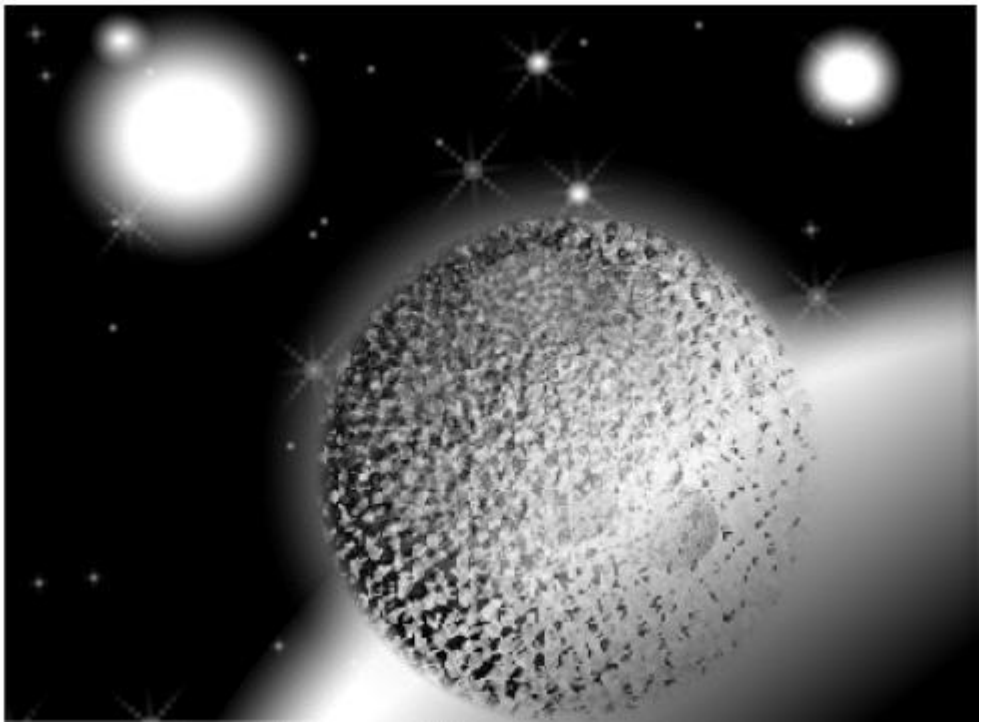
Grove Academy

National 5 Physics

Area: Space

Problems



Space Exploration

1. A space shuttle is about to be launched from the surface of the Earth. It has a mass of $7{\cdot}9 \times 10^4$ kg.
   a) Calculate the weight of the space shuttle at launch.
   b) Describe and explain what happens to the weight of the space shuttle as it gets further away from the surface of the Earth.

2. A space rocket has a mass of $9{\cdot}0 \times 10^4$ kg. Calculate the engine thrust required to make the rocket accelerate at 25 ms^{-2} at take-off.

3. A spacecraft of mass 9000 kg is to re-enter Earth's atmosphere. Just before re-entry it has a speed of 7500 ms^{-1}. At a point during re-entry, the speed of the spacecraft drops to 700 ms^{-1}. Calculate the heat energy gained by the spacecraft up to this point in re-entry.

4. A pupil in a physics class makes the following statement:
   "The material used to protect space shuttles during re-entry needs to have a low specific heat capacity".
   Use your knowledge of physics to comment on this statement.

5. A 50 kg piece of space junk orbits the Earth with a speed of 1200 ms^{-1}. It re-enters the Earth's atmosphere and its speed drops to 400 ms^{-1}. The specific heat capacity of the piece of space junk is 850 J kg^{-1} $°C^{-1}$. Calculate the temperature change of the space junk during re-entry.

6. A NASA scientist has to choose a suitable material to construct heat tiles on the outside of a space shuttle. The possible materials are shown.

Material	Density (g cm^{-3})	Specific Heat Capacity (J kg^{-1} $°C^{-1}$)	Melting Point (°C)
Aluminium	2·700	897	660
Copper	8·960	385	1085
Iron	7·874	450	1538
Silica	2·448	703	1725
Titanium	4·506	523	1668

   State which material is best suited to protect a space shuttle during re-entry to the Earth's atmosphere. Justify your answer.

7. Satellites which orbit the Earth are of great use to society. State two examples of everyday use of satellites.

8. The Hubble Space Telescope orbits the Earth and is used to look at far away stars and galaxies. State why the Hubble Space Telescope gets clearer images of space than telescopes on the surface of the Earth.

9. As a result of space exploration, many 'spin-off' technologies have been developed that have gone on to be of great use on Earth. State one benefit from each of the areas below:

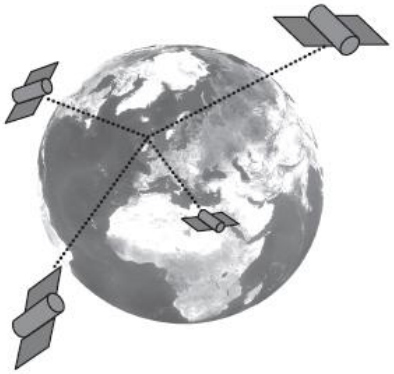
Environment & Agriculture
Home
Industry
Medicine
Transport

10. State one quantity that determines the period of a satellite.

11. One of the most useful types of satellites is a **geostationary** satellite.
    (a) State the meaning of a geostationary satellite.
    (b) State the period of a geostationary satellite.
    (c) State the orbital height of a geostationary satellite.
    (d) State how many geostationary satellites are needed to give communication between all points on the Earth.

12. The first satellite – Sputnik 1 was launched on 4/10/1957. There are now a very large number of satellites orbiting the Earth using cutting edge technologies to collect signals from tracking devices, to take photographs and temperature readings as well as many other functions.
    (a) State the effect that increasing the height above the Earth's surface has on the period of the satellite.
    (b) State what GPS is and what is it used for.

13. A satellite navigation system receives radio signals transmitted by satellites in orbits around the Earth.



    (a) In addition to the speed of the signals, state which other quantity must be known to calculate distance.
    (b) Copy and complete the passage below using words from the list in **bold.**

    greater ***sound*** ***light*** ***energy*** ***height*** ***mass*** ***less***

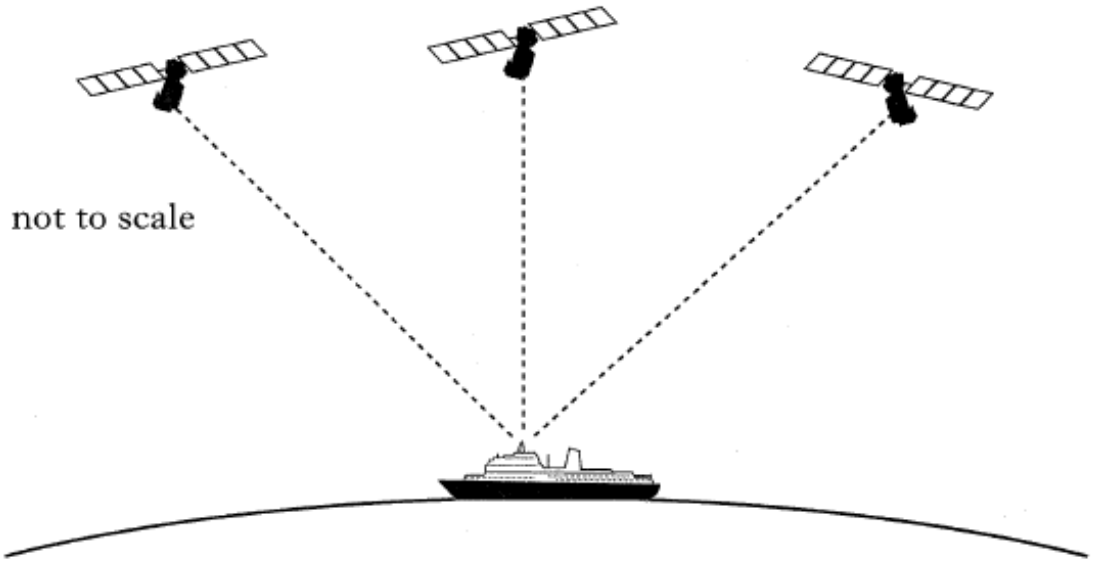
    Radio signals are waves which transfer _____. The radio signals travel at the speed of light, which is _____ than the speed of sound. The period of a satellite orbit depends on its _____ above the Earth.

14. A mountain climber carries a device which receives radio signals to determine the climber's position. The device can also be used to send the emergency services in the event of an accident.

(a) One satellite sends a radio signal that is received by the device 0.068 s after transmission. State the speed of the **radio** signal.

(b) Calculate the distance between the satellite and the climber.

15. A ship has a satellite navigation system. A receiver on the ship picks up signals from three global positioning satellites which are orbiting at a height of 20,200 km.



These satellites transmit radio signals to the boat.

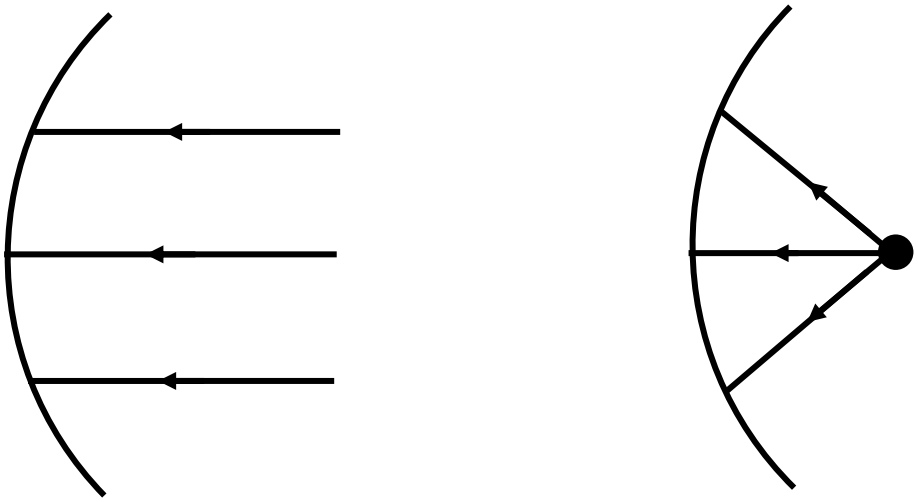
(a) State the speed of these **radio** signals.

(b) One of these satellites is directly above the ship at a height of 20,200 km.
Calculate the time it takes for the radio signal to travel from the satellite to the ship.

(c) A geostationary satellite orbits at a height of 36,000 km and has a period of one day.
A satellite which is a few hundred kilometres above the Earth has a period of one hour.
Suggest a period for the global positioning satellites which are in communication with the ship.

16. Explain why a curved reflector is needed:
(a) at the aerial transmitting signals to a satellite,
(b) at the aerial receiving signals from a satellite.

17. Copy and complete the following diagrams for waves striking a curved reflector:



Label the curved reflectors:

TRANSMITTING or **RECEIVING**

Cosmology

1. Calculate how far a light year is, in metres.

2. Copy and complete this table by calculating the missing values.

Celestial Body	Average distance from the Earth (m)	Time taken for light from the body to reach Earth
Sun		8 minutes
Neptune	$4{\cdot}503 \times 10^{12}$	
Proxima Centauri		4·3 years
Betelgeuse	$6{\cdot}079 \times 10^{18}$	
Polaris		434 years

3. On average, Jupiter is around $7{\cdot}78 \times 10^{11}$ metres from the Sun. Calculate how long it takes for light from the Sun to reach Jupiter.

4. By using detailed analysis of the stars and galaxies that surround us, astronomers have made some theories about the observable universe, all of which have been backed up by experimental evidence.
   a) State why are there parts of the universe that can't be observed from Earth.
   b) Explain the 'Big Bang' theory regarding the origin of the universe.
   c) State the approximate age of the Universe. Explain how astronomers came to this estimate.

5. Copy and complete this sequence to show the electromagnetic spectrum in order of increasing wavelength.

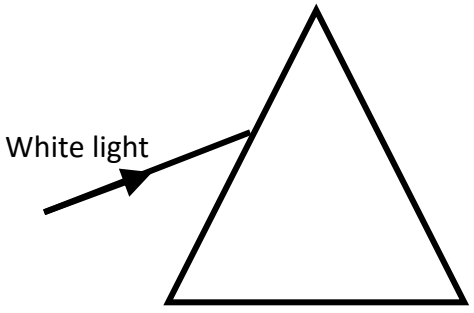
(a)	**X Rays**	**(b)**	**Visible**	**(c)**	**Microwaves**	**(d)**

6. State why is it useful to study electromagnetic radiation from stars and galaxies which have wavelengths outside of the visible spectrum.

7. State why are radio telescopes often found in large groups called 'arrays'.

8. COBE (Cosmic Background Explorer) is a satellite that detects infrared and microwave 'background' radiation in space. State why is COBE collecting this data.

9. A beam of white light is shone through a Perspex prism as represented in the diagram.



Copy and complete the diagram to show what happens to the light as it passes through the prism.

10. State the meaning of a solar system.

11. The moon orbits the Earth.
    Complete this sentence. The moon is an example of a natural _____.

12. State the names of the eight planets in our solar system, **in order**, from closest to the sun to furthest away from the sun.

13. State which of the planets is the largest.

14. State which planets have no moons.

15. State the difference between the four planets nearest the Sun compared to the four furthest away from the sun.

16. State the category that Pluto fits into.

17. State what is a star mostly made of.

18. State the meaning of a galaxy.

19. State the name of our galaxy.

20. State the name of the nearest star to the Sun.

21. State the name given to the beginning of the Universe.

22. State the meaning of 'the Universe'.

23. State one piece of evidence that supports the theory behind the beginning of the Universe.

24. State three conditions which must exist for life, as found on Earth, to exist on another planet.

25. State the name given to a planet which orbits around another star (but not our Sun).

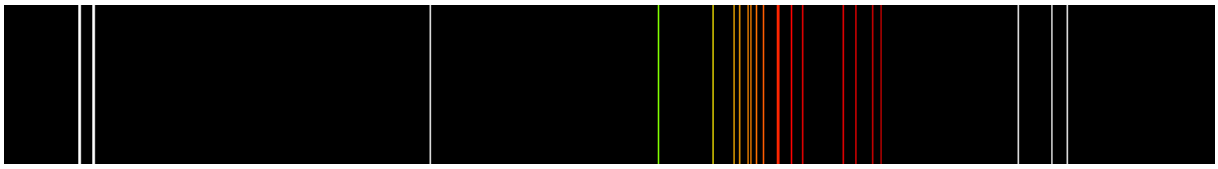
Emission Spectra

Hydrogen

Helium

Lithium

Neon



Carbon

Sodium

Beryllium

Use the Emission Spectra sheet to identify the elements present in each of the following stars.

a)

b)

c)

d)

e)