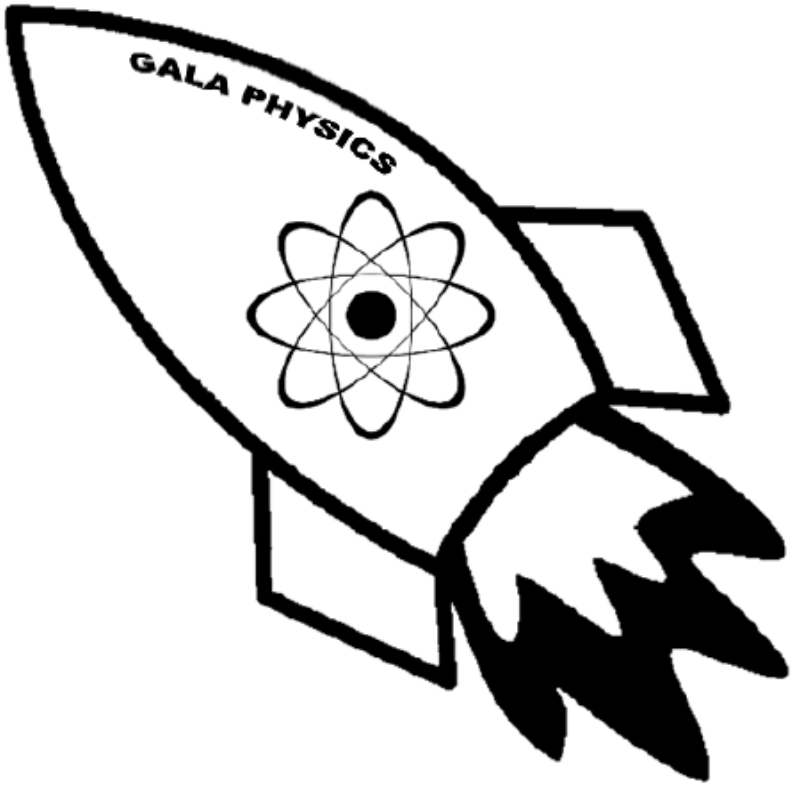
Galashiels Academy

National 4 Physics



Dynamics and Space
Consolidation and Revision Questions

Name:	**Class:**

Dynamics and Space Questions

1. **Average Speed**
2. **Instantaneous Speed**
3. **Acceleration and Speed-time graphs**
4. **Simple Forces**
5. **Resultant Forces**
6. **Newton's 2nd Law**
7. **Weight**
8. **Satellites**
9. **Cosmology**
10. **The Light Year**
11. **Space Exploration**

Exercise 1: Average Speed

1. A car travels a distance of 2 000 metres in a time of 160 seconds. Calculate the average speed of the car in metres per second.

2. Jane jogs to work every day at an average speed of 4 m/s. Most days it takes her 600 seconds to reach work. Calculate how far she jogs.

3. A model train travels round 10 m of track at an average speed of 1·5 m/s. How long does this take?

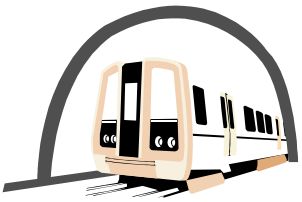
4. Christopher takes 26 seconds to swim one length of a swimming pool. If the pool is 50 metres long, calculate his average speed.

5. How far will a cyclist travel in 60 seconds if he is travelling at an average speed of 13 metres per second?

6. Calculate a hurdler's time if she completes the 400 m hurdle race at an average speed of 7 m/s.

7. How far will a jet aircraft travel in 5 minutes (300 seconds) if it flies at 400 metres per second?

8. The Channel Tunnel is approximately 50 km (50 000 m) long. How long will it take a train travelling at 90 m/s to travel from one end of the tunnel to the other?



9. A hill walker walks at an average speed of 1·5 m/s. How long will it take her to cover a distance of 27 km (27000 m)?

10. Richard Noble captured the world land speed record in 1983 in his vehicle Thrust 2. The car travelled one kilometre (1000m) in 3·5 seconds. Calculate the average speed of the car.

11. Andy Green broke the world land speed record in 1997 in his vehicle Thrust SSC. He travelled at an average speed of 340 m/s over a distance of 1000 m. Calculate what time he took to travel this distance.

12. On a motorway a car has a speed of 130 km/h. If it travels for 2 hours, calculate the distance it travels in km.

13. A lorry takes 4 hours to travel 160 km. Calculate the average speed of the lorry in km/h.

14. In 1889 the first Daimler car reached a speed of 20 km/h. How far would the car travel in 3 ½ hours if it travelled at a constant speed of 20 km/h?

Exercise 2: Instantaneous Speed

1. A car has a length of 4 m and passes a point in 0.5 s. Calculate the car's instantaneous speed.

2. A card of length 0.05m is attached to a trolley. The card takes 0.2 s to pass a light gate. Calculate the instantaneous speed of the trolley at this point.

3. The same equipment is used again for measuring the instantaneous speed of a trolley as it travels down a runway.

   Use the equation

   $$instantaneous\ speed = \frac{length\ of\ mask}{time\ to\ cut\ beam}$$

   to find the missing values in the following table:

	instantaneous speed (m/s)	*mask length* (m)	*time* (s)
(*a*)		0·02	0·1
(*b*)		0·015	0·1
(*c*)	4·1	0·03	
(*d*)	3·5		0·05
(*e*)	2·0		0·2
(*f*)	1·86	0·01	

4. An observer wants to find the instantaneous speed of a car as it passes a pedestrian crossing. He measures the length of the car and finds it to be 3·5 m. He then stands with a stop watch at the crossing, starts timing as the front of the car passes him and stops when the back of the car has passed. The time recorded is 2·4 s. Calculate the instantaneous speed of the car.

5. Civil engineers need to know the speeds of a train as it enters a tunnel which they are planning to build. They set up their equipment to measure the length of a section of the train and time how long that section takes to pass the planned point of entry to the tunnel. The length of train is 150 m and the time to pass the point of entry is recorded as 1·42 s. Calculate the instantaneous speed of the train.

6. A coin is dropped from a height so that it passes through a light gate connected to a computer. The coin has a width of 0·02 m and it takes 0·005 seconds to pass through the light gate. Find its instantaneous speed.

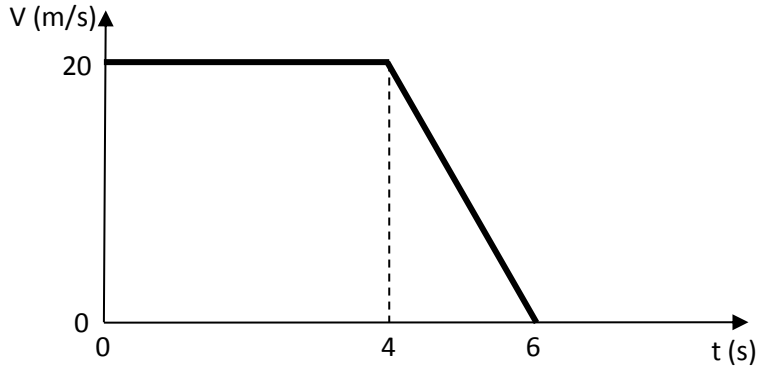
Exercise 3: Acceleration and Speed Time Graphs

1. If a car is accelerating, what is happening to its speed?

2. If a car is decelerating, what is happening to its speed?

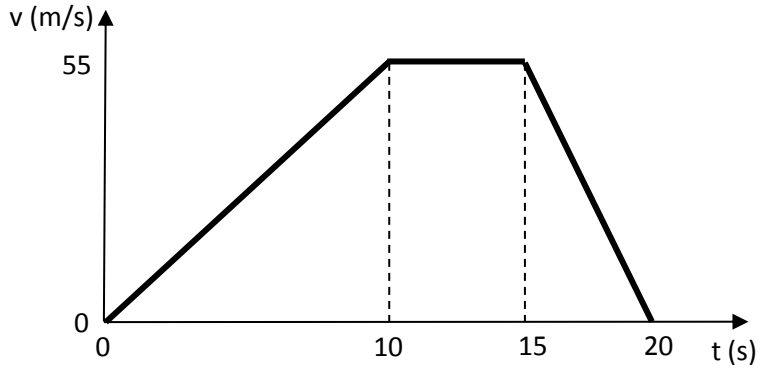
3. If a car is travelling at a constant speed, what is the acceleration?

4. Look the speed time graphs drawn below and describe the motion of the vehicle in each section.



State if the speed is increasing, decreasing or constant at the following parts of the graph.
(a) Between 0 and 4 s
(b) Between 4 and 6 s

5. Look the speed time graphs drawn below and describe the motion of the vehicle in each section.

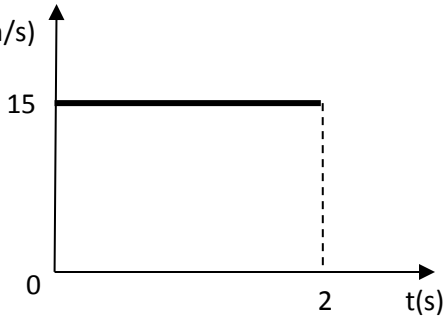


What is the speed:
(a) At 0 s
(b) At 10 s
(c) At 15 s
(d) At 20 s

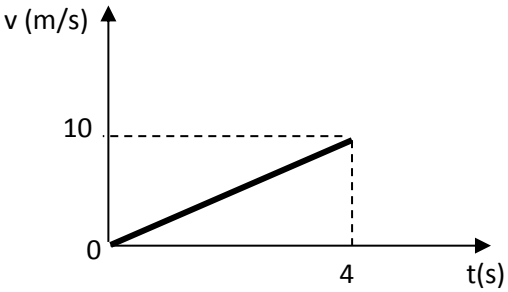
State if the speed is increasing, decreasing or constant at the following parts of the graph.
(e) Between 0 and 10 s
(f) Between 10 and 15 s
(g) Between 15 and 20 s

6. Calculate the distance travelled in the following graphs.

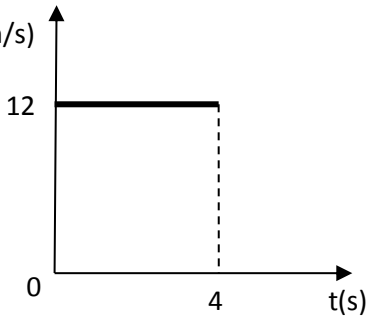
a)



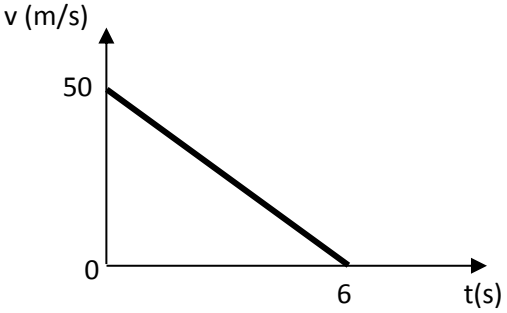
b)



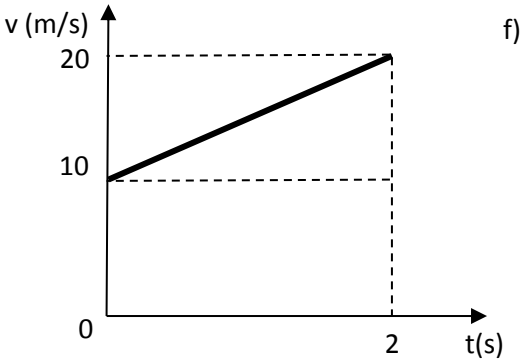
c)



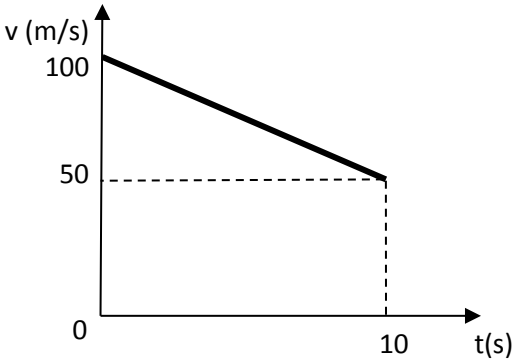
d)



e)

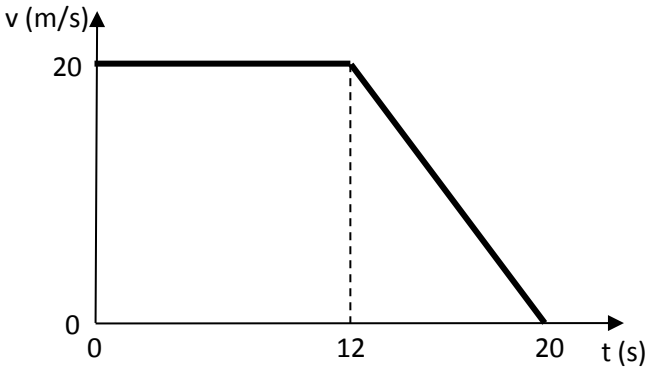


f)

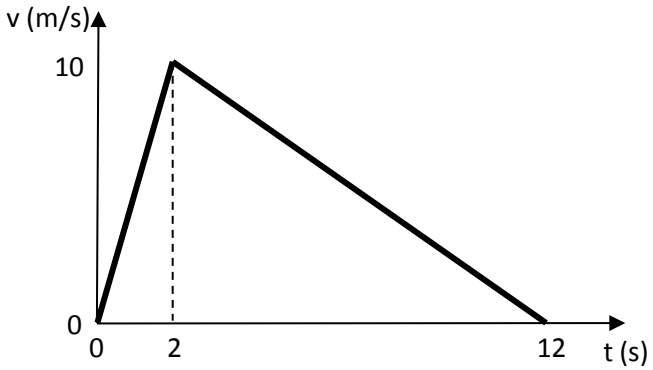


7. Calculate the total distance travelled in the following graphs.

(a)



(b)



Exercise 4: Simple Forces

1. When a box is pulled along a floor there is a force between the box and the floor. This force tries to stop them moving.

   (a) What is the name of this force?

   (b) What direction does this force act?

2. A new aircraft is designed to reduce the air friction acting on it. What is the name of the design change which reduces the effect of air friction?

3. A car is being designed to travel at high speeds. State two ways in which the design of the car would allow the air to flow over it more easily.

4. Why is braking a car on a wet road more difficult than on a dry road?

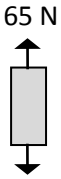
5. State if the following diagrams show balanced or unbalanced forces?

(*a*)

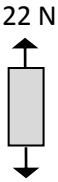
(*b*)

(*c*)

(*d*)

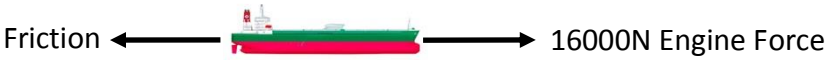


(*e*)



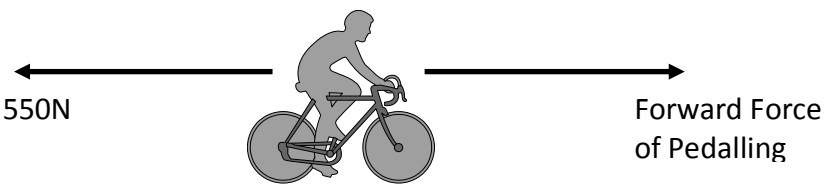
(*f*)

6. A fully loaded oil tanker moves at a constant speed of 12 m/s. Its engines produce a constant forward force of 16 000 N. What is the size of the friction force acting on the tanker?



7. A clock hangs from a peg on a wall. If the weight of the clock is 2 N what is the size of the upward force provided by the peg?

8. David cycles along the road at a constant speed of 8 m/s. The total friction force acting on David and the bike is 550 N.



What size is the forward force provided by David pedalling?

Exercise 5: Resultant Forces

1. Calculate the resultant force of the following giving both the size and direction of the resultant force:

(a) 

(b) 

(c) 

(d) 

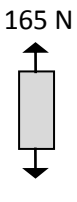
(e) 

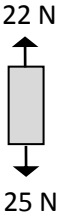
(f) 

(g) 

(h) 

2. Calculate the resultant force of the following giving both the size and direction of the resultant force:

(a) 

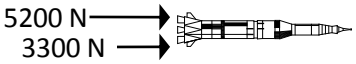
(b) 

(c) 

3. Calculate the resultant force of the following giving both the size and direction of the resultant force:

(a) 

(b) 

(c) 

(d) 

4. If the forward force produced by a car engine is 2000 N and the total friction force is 600 N. Calculate the resultant force giving both the size and direction.

5. A man pushes a box to the right with a force of 40N, but the box has a frictional force of 35N. Calculate the resultant force giving both the size and direction.

6. The weight of a parachute is 800N and the air resistance upwards is 1200N. Calculate the resultant force giving both the size and direction.

Exercise 6: Newton's 2nd Law

1. Calculate the force required to accelerate a mass of 12 kg at 2 m/s^2.

2. Calculate the force required to accelerate a car of mass 1000 kg at 5 m/s^2.

3. If a force of 500 N is applied to a mass of 20 kg, calculate its acceleration.

4. A man pushes a stacked trolley of mass 25 kg with a force of 25 N. Calculate the acceleration of the trolley.

5. Find the mass of a boy and his bike if they accelerate at 1·5 m/s^2 when pushed with a force of 65 N.

6. A car on an automatic wash machine is pulled by a force of 500 N and accelerates at 0·25 m/s^2. What is the mass of the car?

7. A fork lift truck applies a force of 2000 N to move a crate of mass 1700 kg. Calculate the acceleration of the crate.

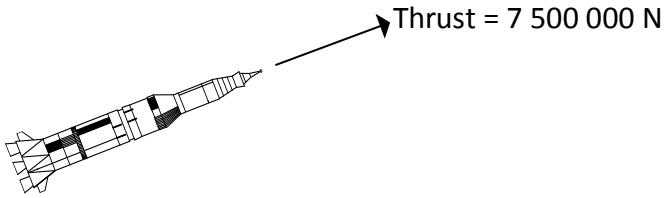
8. A bus applies a braking force of 2400 N in order to avoid a road accident ahead. The mass of the bus and the people on board is 4000 kg. Calculate the deceleration of the bus.

9. A table tennis ball of mass 30 g (0.03 kg) is found to accelerate at 150 m/s^2 when hit with a bat. Calculate the force causing the ball to accelerate.

10. Calculate the acceleration of a steel ball bearing of mass 100 g (0.1 kg) when fired with a force of 1·5 N in a pin ball machine.

11. A 70 kg sledge is pulled along as shown below. There is assumed to be no friction. Calculate the acceleration of the sledge.

12. The forces acting on a 40000kg rocket in space are as shown below. Calculate the acceleration of the rocket.



Exercise 7: Weight

Planet	g (N/kg)
Mercury	3.7
Venus	8.8
Earth	10
Mars	3.8
Jupiter	26.4
Saturn	11.5
Uranus	11.7
Neptune	11.8
Pluto	4.2
The Moon	1.6

1. Calculate the weight of each of the following on Earth :

   (a) a girl whose mass is 50 kg
   (b) a dog of mass 20 kg
   (c) a 9 kg box
   (d) a ball of mass 0.5 kg
   (e) an insect whose mass is 0.00005 kg
   (f) a particle of mass 2×10^{-27} kg.

2. Calculate the mass of each of the following weighed on Earth:

   (a) a man who weighs 750 N
   (b) a tin of peas which weighs 4.5 N
   (c) a chair which weighs 350 N
   (d) a rabbit which weighs 40 N
   (e) a car which weighs 14000 N
   (f) a thread which weighs 0.003 N.

3. What does a 500 g packet of cornflakes weigh:

   (a) (a) on Earth (b) on the Moon (c) in Space?

4. An astronaut has a weight of 800 N on Earth. What is his mass:
   (a) on Earth?
   (b) on the Moon?
   (c) in Space?

5. A question in a Physics examination asked, 'What is meant by the weight of an object?'
   Two pupils, Steven and Nicola, answered as follows
   Steven - 'The weight of an object is the gravitational field strength.'
   Nicola - ' The weight of an object is the force of gravity acting on the object.'

   (a) Who was correct?

   (b) What does the term 'gravitational field strength' mean?

6. A rocket of mass 2 000 000 kg travels from Saturn to Earth.
   (a) What is the weight of the rocket on Saturn?
   (b) What is the weight of the rocket on Earth?

7. A small tin of oil has a mass of 300 g.
   (a) What does the tin of oil weigh on Earth?
   (b) What would be the mass of the tin of oil on Jupiter?

8. If a man has a weight of 700 N on Earth, what will he weigh on Neptune?

9. A snail has a weight of 0.5 N on Earth. What would be its mass on the Moon?

Exercise 8: Satellites

1. When the signal from the transmitter reaches a satellite, why does it have to be amplified?

2. What part in a satellite provides electrical power to operate the satellite?

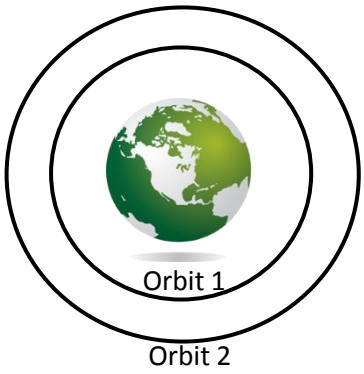
3. Copy and complete the following diagram to show how a telecommunications signal is sent from the USA to the UK.

4. Copy and complete:

   (a) The higher the orbit of a satellite the _____ its period.

   (b) Orbit 1 is closer to the Earth so the period is long / short.

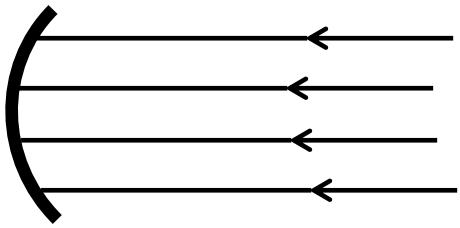
   (c) Orbit 2 is further away from the Earth so the period is longer / shorter.



5. A satellite TV receiver dish is curved. Why is the dish curved?

6. Why is a curved reflector used to transmit signals to a satellite?

7. Copy and complete the diagram to show the signals after they reach the curved reflector.



8. Copy and complete the diagram to show the path of the signals sent from the transmitter (T) to the receiver (R).

Exercise 9: Cosmology

You many need to do further research to find the answers to some of the following questions.

1. One day on Earth takes 24 hours. What does planet Earth do in this time?

2. One year on Earth is 365.25 days. What does planet Earth do in this time?

3. What happens to the moon every lunar month?

4. Why is Scotland warmer in the summer and colder in the winter? You should mention the Earth and the Sun in your answer.

5. What is the name of the largest planet in the solar system?

6. How many planets are in the Solar System?

7. Name the planets in order, starting from closest to the sun.

8. Pluto was declassified from being a planet in 2006. What is it classified as now?

9. In addition to Pluto, name at least 3 other Dwarf Planets?

10. What are the following objects?

    (a) Comet
    (b) Meteor
    (c) Meteorite
    (d) Asteroid

11. Put the following parts of the universe into order, from smallest to largest.
    Moon, Planet, Sun, Solar System, Galaxy, Universe

12. The observable Universe is estimated to contain 100 billion galaxies. Our galaxy is estimated to contain 300 billion stars. Assuming all galaxies are the same as our own, calculate the number of stars in the Universe. (1 billion = 1 000 000 000).

	MERCURY	VENUS	EARTH	MOON	MARS	JUPITER	SATURN	URANUS	NEPTUNE
Mass (10^{24}kg)	0.330	4.87	5.97	0.073	0.642	1899	568	86.8	102
Diameter (km)	4879	12,104	12,756	3475	6792	142,984	120,536	51,118	49,528
Density (kg/m^3)	5427	5243	5515	3340	3933	1326	687	1270	1638
Gravity (N/kg)	3.7	8.9	9.8	1.6	3.7	23.1	9.0	8.7	11.0
Length of Day (hours)	4222.6	2802.0	24.0	708.7	24.7	9.9	10.7	17.2	16.1
Distance from Sun (10^6km)	57.9	108.2	149.6	0.384*	227.9	778.6	1433.5	2872.5	4495.1
Orbital Period (days)	88.0	224.7	365.2	27.3	687.0	4331	10,747	30,589	59,800
Mean Temperature (C)	167	464	15	-20	-65	-110	-140	-195	-200
Number of Moons	0	0	1	0	2	67	62	27	13

Use the data table above to answer the following questions:

13.
   (a) Apart from Venus, What is the warmest planet?
   (b) Why do you think that is?

14.
   (a) What is the coldest planet?
   (b) Why do you think that is?

15. Why do you think planet Venus has a higher mean temperature compared to Mercury?

16. Which planet has the most moons orbiting it?

17. Which planets have no moons?

18. Which planet has the smallest diameter?

19. Compare the densities of Mercury, Venus, Earth and Mars with the densities of Jupiter, Saturn, Uranus and Neptune.

   (a) Which group of planets has the highest density?

   (b) Why do you think this is?

20. What is meant by orbital period? (Hint: look at the value for Earth)

21. Which planet has the longest year and how long is it?

22. Which planet has a length of day closest to the Earth's length of day?

Exercise 10: The Light Year

1. Light travels a distance of 300 000 000 meters in one second.
   (a) A minute contains 60 seconds. How far will light travel in one minute?
   (b) An hour contains 3600 seconds. How far will light travel in one hour?
   (c) A day contains 86400 seconds. How far will light travel in one day?
   (d) A year contains 31536 000 seconds. How far will light travel in one year?

2. Which distance from question 1 is a light year?

The following data table gives the time that it takes light to travel from the Sun to various other objects in the Universe.

Object	Light-travel distance
Mercury	3.22 light-minutes
Venus	6.01 light-minutes
Earth	8.32 light-minutes
Mars	12.7 light-minutes
Jupiter	43.3 light-minutes
Saturn	1.32 light-hours
Uranus	2.66 light-hours
Neptune	4.16 light-hours
Farthest comets	1.58 light-years
Proxima Centauri (nearest star)	4.3 light-years
Sirius (the brightest star of the night sky)	8.6 light-years
Orion Nebula	1500 light-years
Centre of the Milky Way	26 000 light-years
Diameter of the Milky Way	100 000 light-years
Andromeda Galaxy (farthest naked-eye object)	2.36 million light-years
The edge of the observable universe	45.7 billion light-years

Use the data table to answer the following questions:

3. How long would it take for light to travel from the Sun to Earth?

4. How long would it take for light to travel from the Sun to Neptune?

5. How long would it take for light to travel from the Sun to the next nearest star?

6. How long would it take for light to travel from the Sun to the next nearest galaxy?

7. How long would it take for light to travel from the Sun to the edge of the observable universe?

Exercise 11: Space Exploration

You many need to do further research to find the answers to some of the following questions.

1. What was the first animal from Earth that went into space?

2. What was the first animal from to orbit the Earth?

3. What was the name of the first ever man-made satellite to orbit the Earth?

4. What was the name of the first man in space?

5. What year did this happen?

6. How many people have walked on the moon?

7. What was the name of the space mission which first landed man on the moon?

8. What was the name of the craft which first landed on the surface of the moon?

9. What year did man first walk on the moon?

10. Man has had a continuous presence in space on-board the International Space Station since what year?

11. NASA is the United States of America's government agency that is responsible for space exploration. What does NASA stand for?