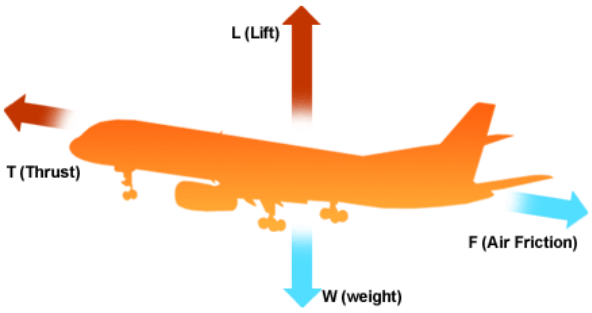
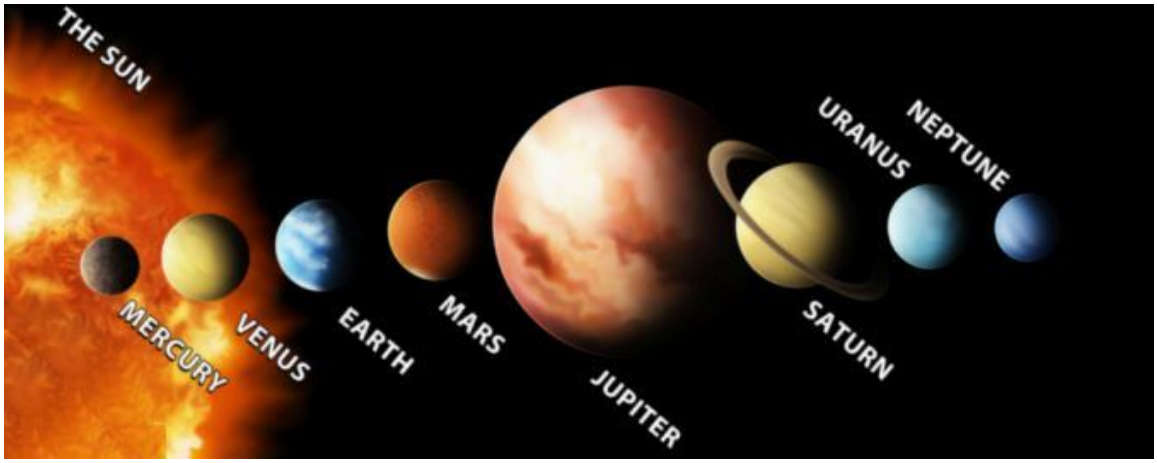


Nat 4 Dynamics and Space

Self Checks

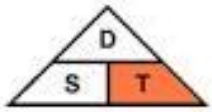


Self check 1 : Average Speed

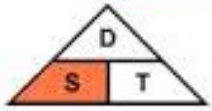
1. A runner completes a 200 m race in 25 s.

   What is his average speed in m/s?

Distance = Speed x Time



$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$



$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$

2. A friend asks you to measure his average cycling speed along flat road. Describe which measurements you would take and the measuring instruments you would use.

3. An athlete takes 4 minutes 20 s to complete a 1500 m race. What is the average speed?

4. On a fun run, a competitor runs 10 km in 1 hour. What is her average speed in

   a) km/h b) m/s?

5. A jet plane can travel at 680 m/s (twice the speed of sound). How far will it travel in 25 s at this speed?

6. A girl can walk at an average speed of 2 m/s. How far will she walk in 20 minutes?

7. How long will it take a cyclist to travel 40 km at an average speed of 5 m/s?

8. How long will the Glasgow to London shuttle take if it flies at an average speed of 220 m/s for the 750 km flight?

9. How long will a car take to travel 50 km if its average speed is 20 m/s?

Self check 2 : Instantaneous Speed

1. Describe the difference between average speed and instantaneous speed.

2. Do police radar guns measure average or instantaneous speed? Why?

3. (a) Read the speed from the speedometer on the right.
   (b) Is this an average or instantaneous speed?

4. (a) Draw a sketch of the apparatus you would use to measure the instantaneous speed of a vehicle as it reached the bottom of a slope in the laboratory.
   (b) Describe how the apparatus is used to measure the instantaneous speed.

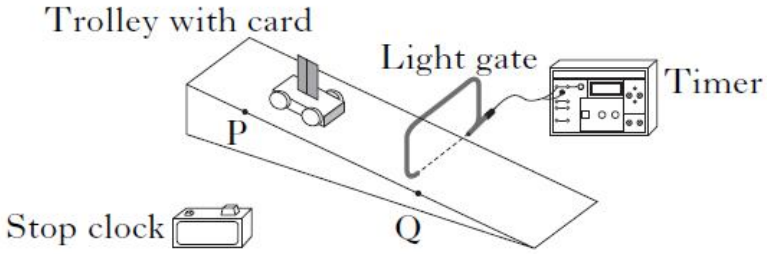
5. In an experiment to measure instantaneous speed, these measurements were obtained:-

   Reading on timer = 0.125 s

   Length of car = 5 cm

   Calculate the instantaneous speed of the vehicle in m/s.

6. A student investigates the speed of a trolley as it moves down a slope as shown.



   The following measurements were recorded.

   distance from P to Q = 1·0m

   length of card on trolley = 0·04m

   time taken for trolley to travel from P to Q = 2·5 s

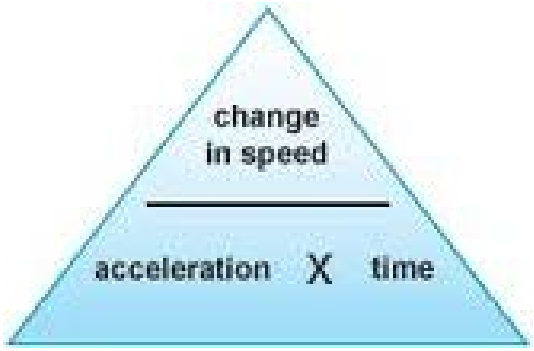
   time taken for card to pass through light gate = 0·05 s

   What is the speed at Q ?

Self check 3 : Acceleration

1. A Jaguar can reach 27 m/s from rest in 9.0 s.

   What is its acceleration?



2. The space shuttle reaches 1000 m/s, 45 s after launch. What is its acceleration?

3. A car reaches 30 m/s from a speed of 18 m/s in 6 s. What is its acceleration?

4. A train moving at 10 m/s increases its speed to 45 m/s in 10 s.

   What is its acceleration?

5. A car travelling at 20 m/s brakes and slows to a halt in 8 s. What is the deceleration?

6. A bullet travelling at 240 m/s hits a wall and stops in 0.2 s. What is its deceleration?

7. (a) Draw a sketch of the apparatus you would use to measure the acceleration of a vehicle as it runs down a slope in a laboratory.

   (b) Describe how the apparatus is used to measure the acceleration.

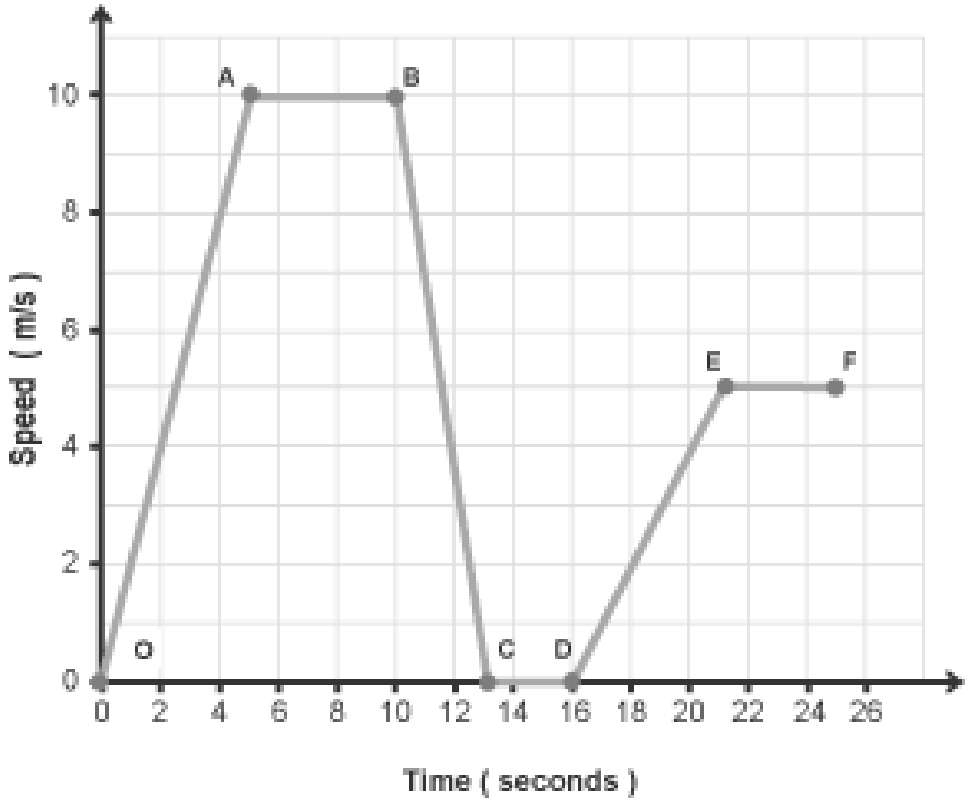
8. On approaching a roundabout, a car slows from 30 m/s to 12 m/s in 5 s.

   What is its deceleration?

9. A dragster accelerates from rest to 40 m/s in a time of 4.5 s. Calculate the acceleration.

Self check 4 : Speed-Time Graphs

1. A speed-time graph below shows the motion of an object.



(a) Which stages of the graph show the object travelling a constant speed?

(b) At which stage is the object still?

(c) Which stages show the object accelerating?

(d) Which stage shows the object decelerating?

(e) What is the instantaneous speed of the object at 8 seconds?

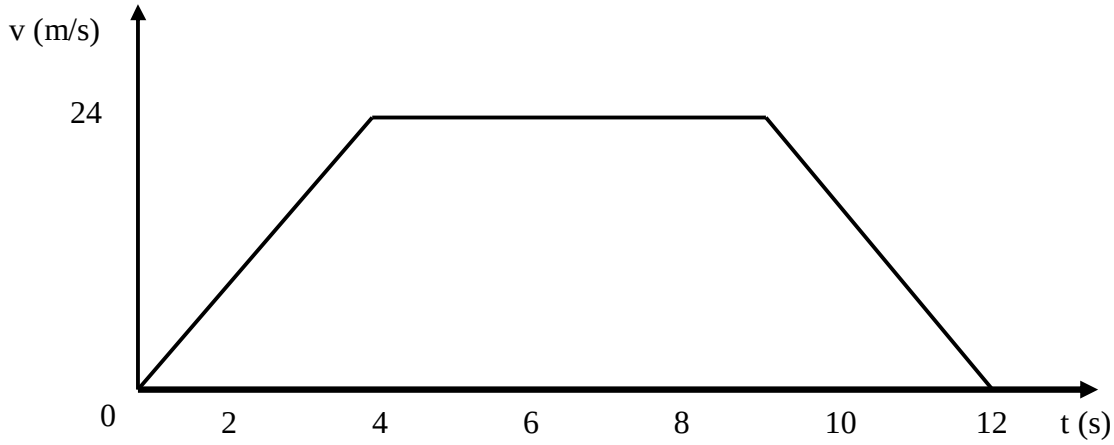
(f) What is the instantaneous speed of the object at 20 seconds?

2. Draw a speed-time graph using the following information:

A car starts from rest and accelerates to a top speed of 14m/s. This acceleration takes 5 seconds. The car then travels at this speed of 14m/s for a further 6 seconds. The car then brakes suddenly and comes to a stop in 4 seconds.

Self check 4: continued

3. The speed-time graph below shows the motion of a given object:

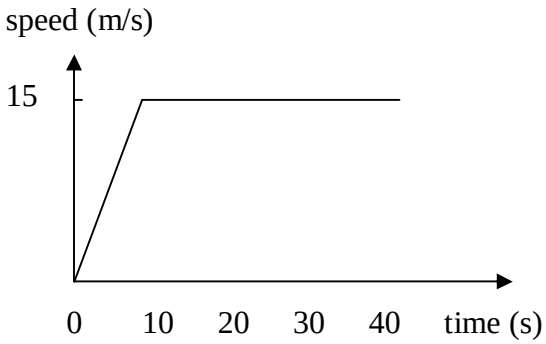


(a) What is the acceleration of the car over the first 4 seconds of the journey?

(b) What is the acceleration of the car over the final 3 seconds of the journey?

(c) Calculate the distance travelled by the car between 4 and 9s.

4. The graph below shows how the velocity of a car varies over a 40 s period.



(a) Describe the motion of the car during this 40 s period.

(b) Calculate the acceleration of the vehicle.

(c) How far does the car travel while accelerating?

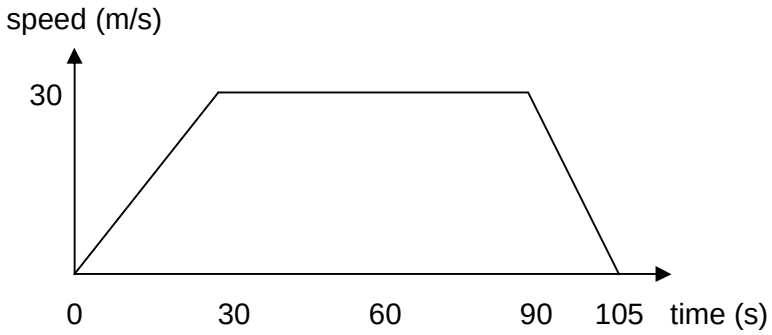
5. A police reports details the motion of a car as follows:

'A car accelerates from rest to 16 m/s in 8 s, then travels at a constant speed for 12 s, finally slowing steadily to a halt in 4 s.'

Draw a speed-time graph to show the motion of the car.

Self check 4 : continued

6. Use the graph below to answer the following questions.



(a) During which time is the vehicle accelerating?

(b) Calculate the values of:

(i) The initial acceleration.

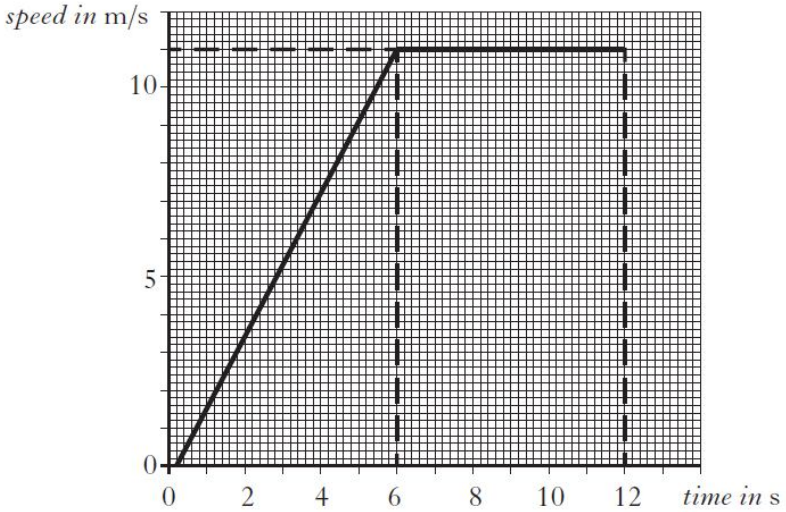
(ii) The final deceleration.

(c) What is the braking distance of the car?

(d) What is the total distance travelled by the car?

(e) What is the average speed of the car?

7. The graph below shows the motion of a runner during the first 12 s of a race.



(a) Calculate the acceleration of the runner.

(b) Calculate the distance travelled by the runner in the first 12 s.

Self check 5 : Weight and Mass

1. Describe how to use a Newton balance. Use a diagram in your answer.

2. Calculate the weights of the following objects:
   (a) 1kg bag of sugar
   (b) a person of mass 75kg
   (c) 0.1 kg apple
   (d) 420g can of beans

3. What is the weight of a 250 g bag of sweets?

4. What is the mass of a 450 N girl?

Use the data in the table to answer the following questions:

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

5. What is the weight of a 10,000 kg spacecraft on:

   (a) Earth (b) Mars (c) Venus ?

6. What would a 60 kg man weigh on Jupiter?

7. An astronaut who weighs 700 N on Earth goes to a planet where he weighs 266 N.
   (a) Calculate the mass of the astronaut.
   (b) Show by calculation which planet the astronaut is on.

8. What would an astronaut weigh on Earth, if his weight on Venus was 528 N?

9. Copy and complete the table below -

Weight (N)	Mass (kg)	Gravitational Field Strength (N/kg)
	200	1.6
75		5
870	35	

Self check 6 : Friction

1. Copy and complete the following:
   Friction is a force caused by the _____ of two surfaces. Friction opposes the _____ of an object. Friction can also keep objects from starting to _____.

2. Friction is not always a bad thing. In many situations we want to use the force of friction. What role does the force of friction play in the following cases?

   (a) Opening a tight bottle top or jam lid
   (b) Sanding wood
   (c) Sports shoes on gym floors
   (d) Walking on icy pavements
   (e) Warming hands by rubbing
   (f) Striking a match
   (g) Car tyres for wet conditions

3. Often we want to reduce the force of friction. How is it reduced in the following cases?

   (a) Metal engine parts moving against each other
   (b) A hovercraft
   (c) Skates on ice
   (d) Door hinges
   (e) Air resistance of a racing cyclist

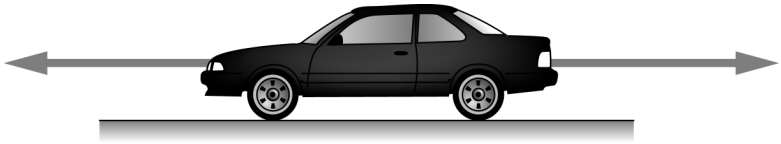
4. What force is streamlining designed to reduce?

5. Car manufacturers try to improve the streamlining of their cars.
   (a) Why is it useful to be streamlined?
   (b) What are the two main things done to a car to improve streamlining?

Self check 7 : Newton I

1. The diagram below shows the forces acting on a car.

   The length of line representing each force is proportional to the size of the force.



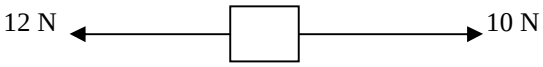
   How would you describe the forces acting upon this car ?

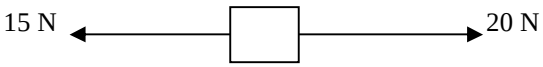
2. The diagram shows the forces acting on a skydiver as he falls through the air. The air resistance and weight of the skydiver are the same size.

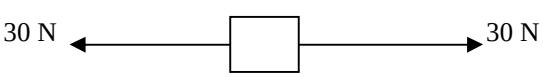
   (a) How would you describe the forces acting on the skydiver?

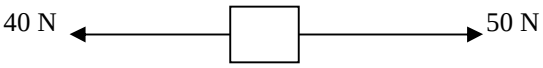
   (b) How is the skydiver moving at this time?

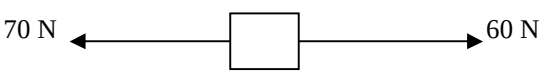
3. Which of the following shows an object being acted on by a pair of balanced forces?

A 

B 

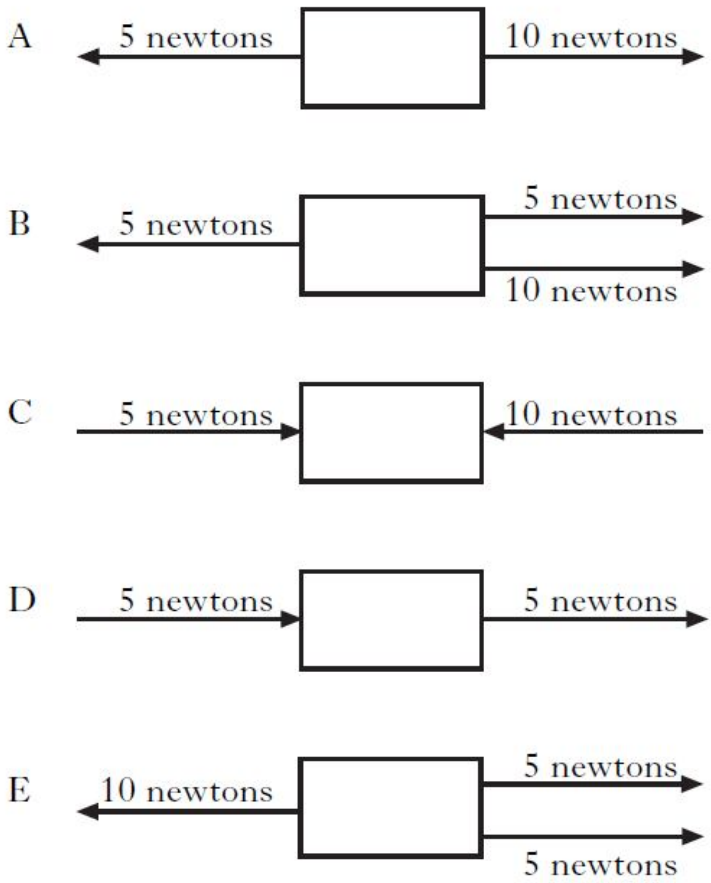
C 

D 

E 

Self check 7 : continued

4. The diagrams show forces acting on moving objects.
Which object is moving at constant speed?



5. A car moves along a street at a constant speed of 20 mph

(a) What can you say about the forces acting upon the car?

(b) What forces are acting upon the car?

(c) What does the driver have to do to increase the speed of the car?

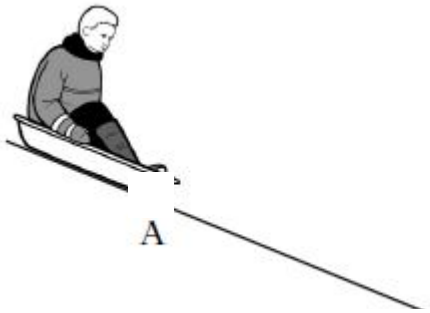
(d) What word do physicists use to describe the increase in speed over time?

Self check 8 : Newton II

1. Calculate the force needed to accelerate a luggage trolley of mass 90 kg at 0.8 ms^{-2}.

2. A space station has a mass of 6000 kg. What force is needed to give it an acceleration of 3 ms^{-2}?

3. A child sledges down a hill.



The child and sledge have a mass of 40 kg.

(a) What is the weight of the child and the sledge?

(b) If the child and sledge accelerate down the slope at 2 ms^{-2}, calculate the unbalanced force acting on them.

4. Four boxes**,** A, B, C and D, having different masses, are pushed with the resultant forces shown.

box	mass (kg)	force (N)
A	2	4
B	3	4.5
C	4	8
D	1.5	6

(a) Which mass has the biggest acceleration?

(b) Which mass has the smallest acceleration?

(c) Which masses have the same acceleration?

5. A block is pulled across a horizontal surface as shown.

Calculate the acceleration of the 5 kg block if it is pulled with a force of 20 N.

Self check 8 : continued

.6. A car's engine provides a thrust of 6000 N. The total force resisting its motion is 1200 N. The mass of the car is 1600 kg. What is its acceleration?

12. The designers of Formula 1 racing cars keep their mass as small as possible. Suggest why.

13. Explain why a gymnast bends her knees when landing.

Self check 8 : Satellites

Satellites

1. What force keeps the planets in orbit around the Sun?

2. What is the name given to objects which orbit a planet?

3. What is the name of our only natural satellite?

4. State three functions of man-made satellites.

5. Explain why are some satellites placed in orbits at different heights?

6. What measurement must you know to work our the period of a satellite?

7. What is meant by a **geostationary** satellite?

   Give **one** use for such a satellite.

8. What instrument is used for sending and receiving signals in satellite communication?

9. Sketch a receiving aerial and show how the instrument from 8. helps to make the signals stronger.

10. Draw a diagram to show how geostationary satellites and curved reflectors are used to send and receive signals in intercontinental telecommunications.

11. A radio and TV signal mast are located in a police station so that radio and TV messages can be sent to and from a police helicopter involved in criminal searches.

    State the speed at which radio and TV signals travel.

12. If the helicopter is 15 km from the transmitter, how long does it take for a radio signal to reach the helicopter ?

13. If it takes 8 minutes for light to travel from the Sun to the Earth, how far away is the Sun from Earth ?

14. How long does it take for a TV signal to travel a distance of 50 km from a transmitter to a receiver ?

15. Describe how satellites are used in environmental monitoring.

16. Describe how satellites are being used to help understand mankind's impact upon the Earth.

Self Check 9 : Cosmology

Cosmology

1. Place the following objects into the correct size order, starting with the smallest -
Sun, solar system, moon, galaxy, planet, universe, star

2. Name the planets of the Solar System in the correct order.

3. Copy and complete the table below.

Object	Definition
Moon	A natural satellite of a planet
Sun	
	A large body in orbit around a star
Star	A large body of matter undergoing nuclear fusion.
Solar System	
Galaxy	A large cluster of many hundreds of thousand of stars.
Universe	

4. Why are “light years” used to measure distances in space?

5. How long does it take light to travel from the earth to the sun?

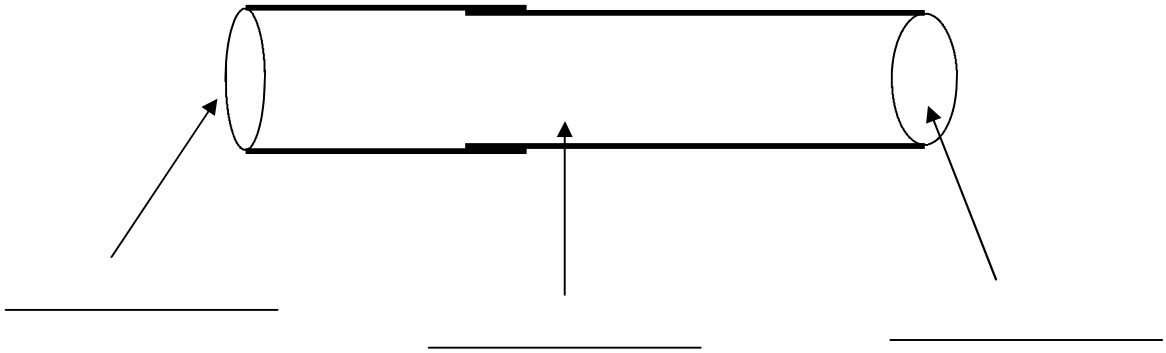
(a) 8 seconds (b) 8 minutes (c) 8 hours (d) 8 days

6. How long does it take light to travel from Proxima Centurai, the nearest star (after the sun)?

(a) 43 hours (b) 4.3 days (c) 43 days (d) 4.3 years

Self Check 10 : Telescopes

1. Draw a diagram of a refracting telescope, labelling the objective lens, the eyepiece and the light-tight tube.



2. State the function of the objective lens.

3. What happens to an image when the diameter of an objective lens is increased?

4. Which type of telescope would you use to detect the following signals -

   (a) light from the nearest star
   (b) a radio wave containing a message from an ET

5. When using an optical telescope, what signals are we not detecting?

6. Give an advantage of using a radio telescope instead of an optical telescope.

7. Why are the images from the Hubble Space Telescope more detailed than the telescopes used on Earth?

Self Check 11 :

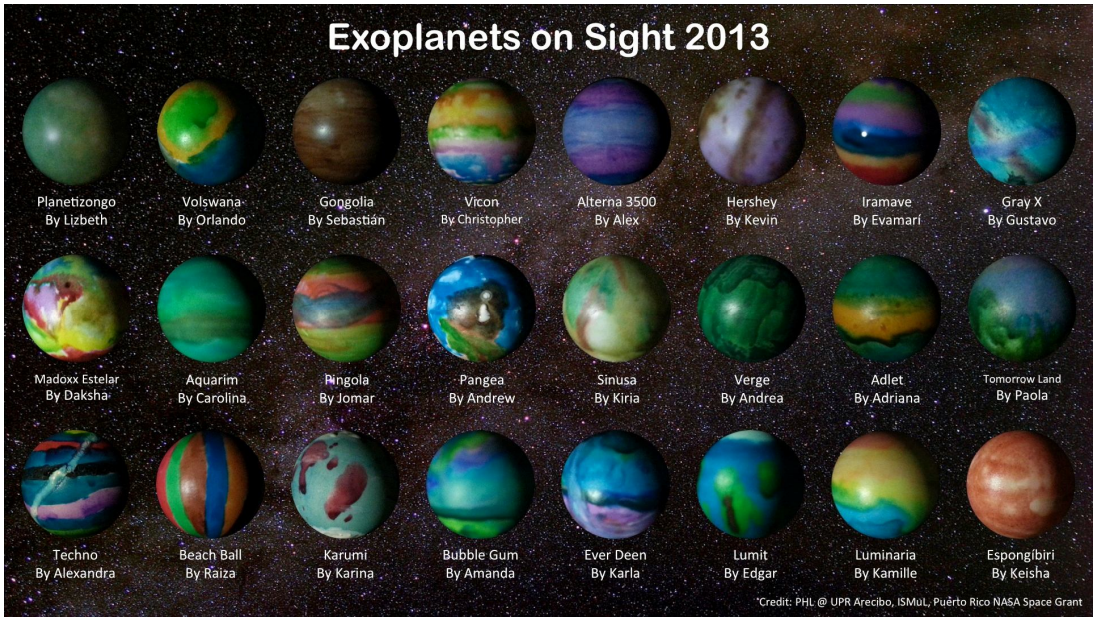
1. Explain how telescopes and space exploration have helped us to better Understand -

   (a) Earth
   (b) The Universe

2. Describe the risks associated with space travel/exploration.

3. Describe the challenges of re-entry to a planet's atmosphere.

4. Describe how spacecraft are protected on re-entry to a planet's atmosphere as kinetic energy changes to heat energy.



5. What is an exo-planet?

6. Describe the conditions required for an exo-planet to sustain life.

Extra Self Check : Acceleration

1. An airplane accelerates down a runway at 3.20 m/s^2 for 32.8 s until is finally lifts off the ground. Determine the distance traveled before takeoff.

2. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

3. Upton Chuck is riding the Giant Drop at Great America. If Upton free falls for 2.60 seconds, what will be his final velocity and how far will he fall?

4. A race car accelerates uniformly from 18.5 m/s to 46.1 m/s in 2.47 seconds. Determine the acceleration of the car and the distance traveled.

5. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m/s^2. Determine the time for the feather to fall to the surface of the moon.

6. Rocket-powered sleds are used to test the human response to acceleration. If a rocket-powered sled is accelerated to a speed of 444 m/s in 1.83 seconds, then what is the acceleration and what is the distance that the sled travels?

7. A bike accelerates uniformly from rest to a speed of 7.10 m/s over a distance of 35.4 m. Determine the acceleration of the bike.

8. An engineer is designing the runway for an airport. Of the planes that will use the airport, the lowest acceleration rate is likely to be 3 m/s^2. The takeoff speed for this plane will be 65 m/s. Assuming this minimum acceleration, what is the minimum allowed length for the runway?

9. A car traveling at 22.4 m/s skids to a stop in 2.55 s. Determine the skidding distance of the car (assume uniform acceleration).

10. A kangaroo is capable of jumping to a height of 2.62 m. Determine the takeoff speed of the kangaroo.

Extra Self Check

1. If Michael Jordan has a vertical leap of 1.29 m, then what is his takeoff speed and his hang time (total time to move upwards to the peak and then return to the ground)?

2. A bullet leaves a rifle with a muzzle velocity of 521 m/s. While accelerating through the barrel of the rifle, the bullet moves a distance of 0.840 m. Determine the acceleration of the bullet (assume a uniform acceleration).

3. A baseball is popped straight up into the air and has a hang-time of 6.25 s. Determine the height to which the ball rises before it reaches its peak. (Hint: the time to rise to the peak is one-half the total hang-time.)

4. The observation deck of tall skyscraper 370 m above the street. Determine the time required for a penny to free fall from the deck to the street below.

5. A bullet is moving at a speed of 367 m/s when it embeds into a lump of moist clay. The bullet penetrates for a distance of 0.0621 m. Determine the acceleration of the bullet while moving into the clay. (Assume a uniform acceleration.)

6. A stone is dropped into a deep well and is heard to hit the water 3.41 s after being dropped. Determine the depth of the well.

7. It was once recorded that a Jaguar left skid marks that were 290 m in length. Assuming that the Jaguar skidded to a stop with a constant acceleration of -3.90 m/s^2, determine the speed of the Jaguar before it began to skid.

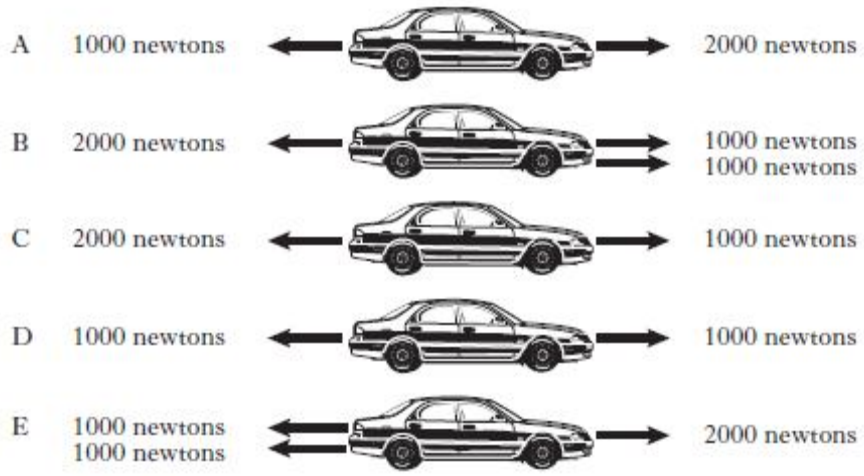
8. A plane has a takeoff speed of 88.3 m/s and requires 1365 m to reach that speed. Determine the acceleration of the plane and the time required to reach this speed.

9. A dragster accelerates to a speed of 112 m/s over a distance of 398 m. Determine the acceleration (assume uniform) of the dragster.

10. With what speed in miles/hr (1 m/s = 2.23 mi/hr) must an object be thrown to reach a height of 91.5 m (equivalent to one football field)? Assume negligible air resistance.

Extra Self Check

1. State the resultant force for each car, and whether is it balanced or unbalanced -



2. (*a*) Complete the sentences below using some of these words.

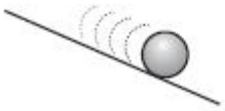
Earth **force** **kilogram** **newtons** **weight**

Weight is the force due to gravity and it is measured in _____.

Weight is the pull of the _____ on an object.

(*b*) A ball has a mass of 0·5 kilograms.

Calculate the weight of the ball.



(*c*) The ball rolls down a hill.

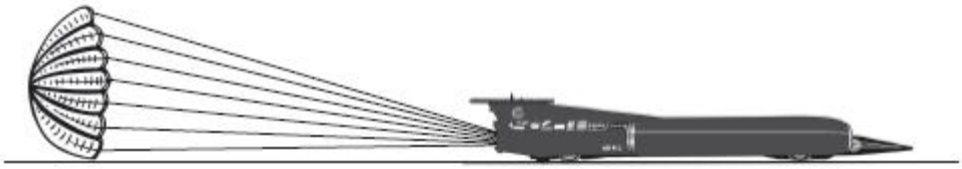
There is a force due to friction acting on the ball.
In which direction is the force of friction acting?

3. A vehicle called Thrust SSC broke the land speed record in 1997 in the Nevada Desert, USA.

(a) The mass of Thrust SSC is 10 500 kg.
Calculate the weight of Thrust SSC.

(*b*) The diagram below shows Thrust SSC travelling at a constant speed.
Draw and label the horizontal forces acting on the vehicle.

Extra Self Check



(*c*) At the end of the run, Thrust SSC uses a parachute as shown.

(i) What effect does the parachute have on the motion of the vehicle?
(ii) Explain your answer.

Extra Self Check

Extra Self Check

Extra Self Check

Extra Self Check

Extra Self Check

Extra Work Self Check

Extra Work Self Check continued

Extra Work Self Check

1. On approaching the speed limit signs, a car slows from 30 m/s to 12 m/s in 5 s. What is its deceleration?
2. A bowling ball is accelerated from rest at 3 m/s 2 for 1.2 s. What final speed will it reach?
3. How long will it take a car to increase its speed from 8 m/s to 20 m/s if it accelerates at 3 m/s 2?
4. A cyclist can accelerate at 0.5 m/s 2 when cycling at 4 m/s. How long will she take to reach 5.5 m/s ?

The maximum deceleration a car's brakes can safely produce is 8 m/s 2. What will be the minimum stopping time if the driver applies the brakes when travelling at 60 mph