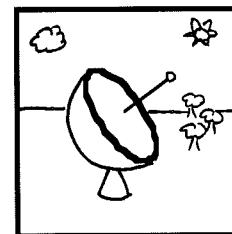
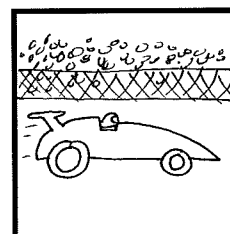
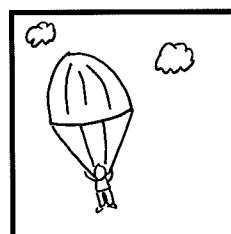
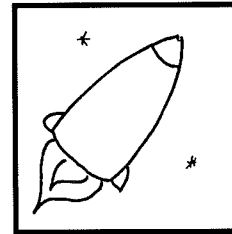
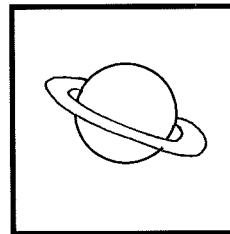
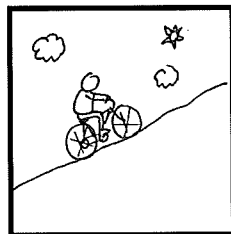
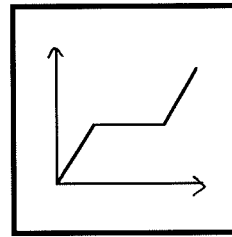
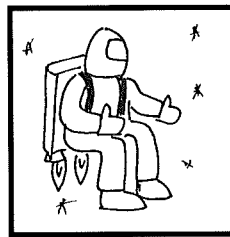
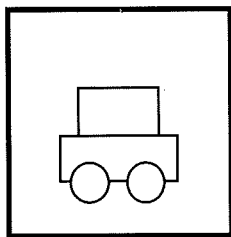


NQ 5 Physics

Unit 2

Dynamics and Space



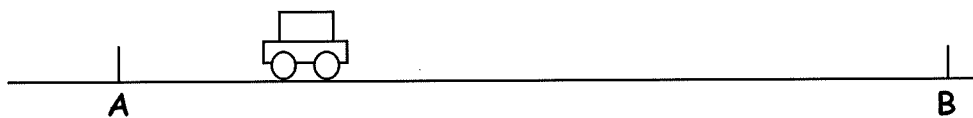
Summary Notes

A. Vectors and Scalars

1. Average speed.

Speed is a measure of the distance an object covers in a set _____.
Over a certain distance the speed could change so the average speed is the constant speed required to cover the same distance in the same time.

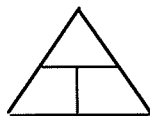
To find the average speed of this car between A and B



Measure the distance between A and B with a _____ stick and the time taken for the car to travel from A to B with a _____.

$$\text{average speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

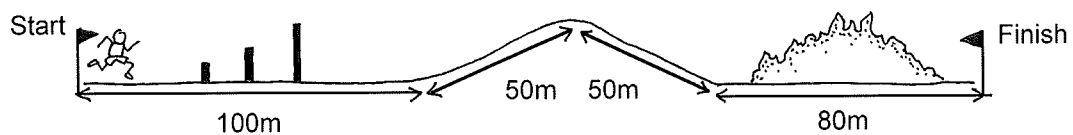
$$\bar{v} = \frac{d}{t}$$



term	units
d	
t	
\bar{v}	

Within this distance the speed at any point could have varied. If it travelled from A to B with this constant average speed it would have taken ____s.

Example An athlete completes the following assault course in 100s.



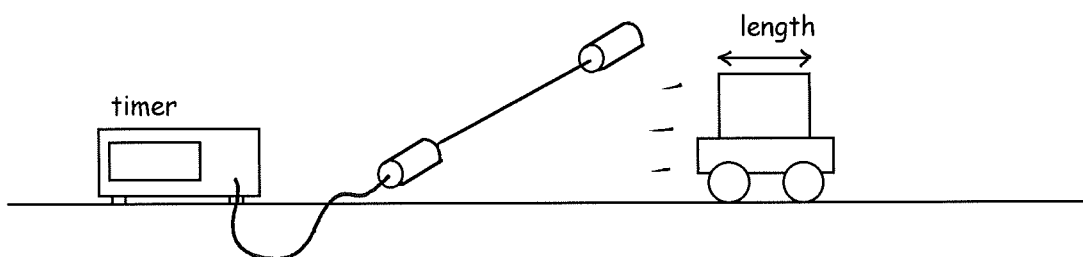
(a) Calculate his average speed

2. Instantaneous Speed

The instantaneous speed is the speed of an object at one particular _____ in the journey. It is the average speed over a very small _____.

We usually measure instantaneous speed using a _____ gate or in a car a _____ is used.

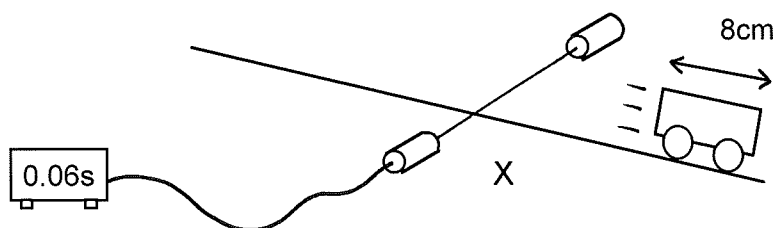
Connect the light gate to a _____. Measure the length of the trolley with a ruler. When the trolley cuts the beam it is travelling a distance equal to its own _____ in a time measured by the _____.



instantaneous speed = $\frac{\text{length of _____}}{\text{time it takes to cut the _____}}$

$$v = \frac{d}{t}$$

Example Calculate the instantaneous speed of the trolley at point X?



3. Vectors and Scalars

Scalars are quantities which are defined by their _____

Vectors are quantities which are defined by their size and _____.

Fill in the table as you meet new quantities in this unit

Scalar quantity	Vector quantity

4. Distance and Displacement

Distance is defined as the total _____ of a journey.

The symbol for distance is _____. It is a _____ quantity.

The displacement is defined as the shortest _____ between two points in a given _____ from the starting point.

The symbol for displacement is _____. It is a _____ quantity.

If there are two separate parts of the journey we add the distance vectors together to get the resultant displacement. We add vectors together nose to _____.

Example A jogger ran 60m East then 40m North.

- (a) What distance did she travel?
- (b) What was her displacement from the starting point?

5. Speed and Velocity

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$v = \frac{d}{t}$$

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$

$$v = \frac{s}{t}$$

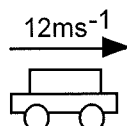
Velocity is the speed of an object in a particular direction

Example The runner from the last example ran the 60m East then 40m North in a time of 20s.

- (a) What was her average speed?
- (b) What was her average velocity?

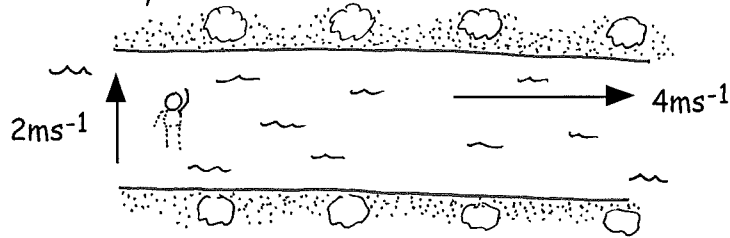
6. Velocity Vectors

When indicating the direction of an object, whether it's moving up or down or left or right we choose a direction to be positive. In the following example we have chosen to the _____ as the positive direction. The velocity of an object can be shown using a velocity vector. The following diagram indicates the car is travelling to the _____ with a velocity of _____.

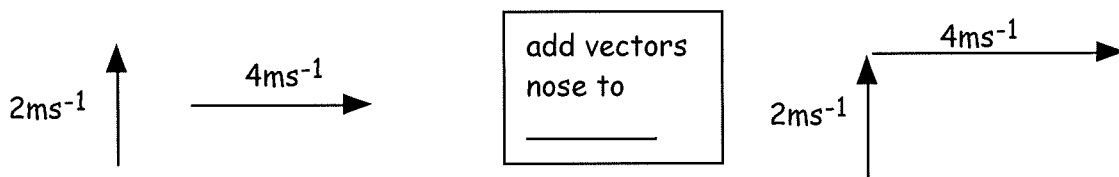


7. Adding Velocity Vectors.

Example A boy swims across a river with a velocity of 2ms^{-1} (North). The river is flowing with a velocity of 4ms^{-1} (East.) What is the resultant velocity of the boy?



velocity vectors



Magnitude of Resultant velocity

Direction of Resultant velocity

Velocity = _____

8. Acceleration

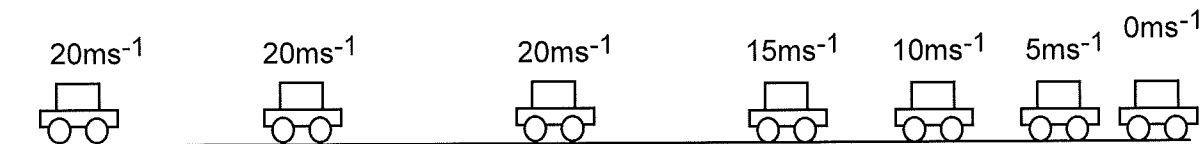
Acceleration tells you by how much the _____ of an object has changed each second. The velocity of the following car is increasing by 4ms^{-1} each second.



so the acceleration = 4m/s/s or 4ms^{-2}

If an object has an acceleration of -4ms^{-2} then its velocity is decreasing at a rate of 4ms^{-1} each second.

This car is travelling a constant velocity of 20ms^{-1} . The brakes are applied and the car decelerates at 5ms^{-2} .



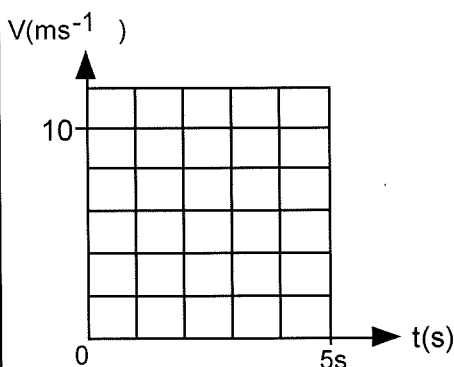
Its acceleration = -5m/s/s or -5ms^{-2}

If the object's velocity changes by the same amount each second we say that the object has a _____ acceleration.

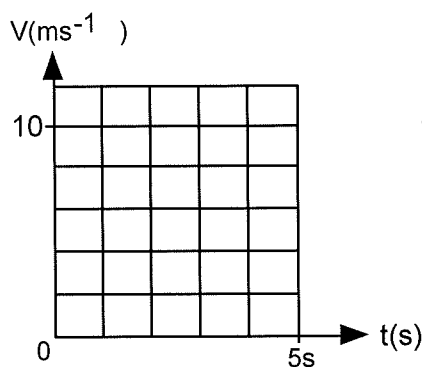
9. Velocity-Time Graphs.

A velocity time graph describes the motion of an object.

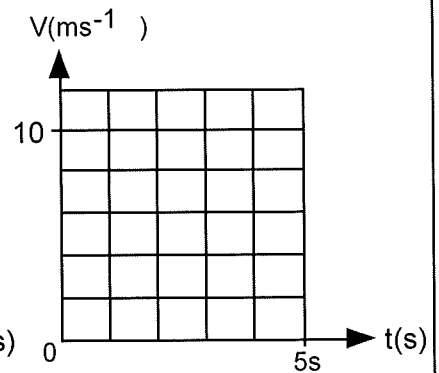
These velocity-time graphs show 3 important motions. Draw the graph which describes the motion indicated underneath



Object travelling at a constant velocity of 10ms^{-1} for 5s.



Object accelerating at a constant rate from rest to 10ms^{-1} in 5s.



Object decelerating at a constant rate from 10ms^{-1} to rest in 5s

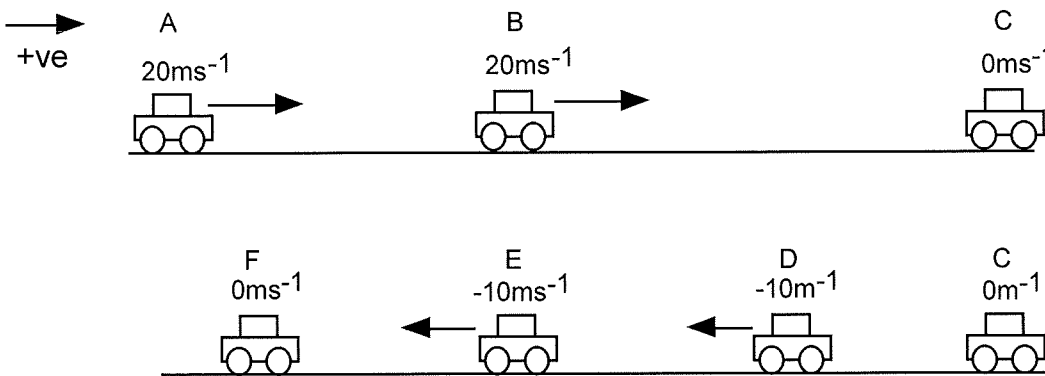
10. Velocity-Time Graphs when Object Changes Direction.

Velocity is a vector quantity so a velocity time graph can show an object changing direction. When looking at an object changing direction it is important to say which direction is positive and which is _____.

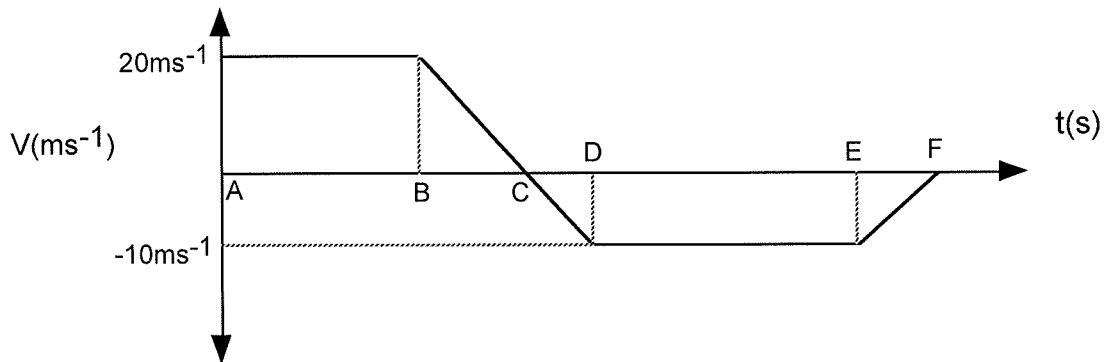
In the following example we have chosen to the "right" as the positive _____.

The diagram shows a car travelling along the road at a constant velocity of $+20\text{ms}^{-1}$.

It decelerates to rest. It then reverses until its velocity reaches -10ms^{-1} then it continues on at this constant velocity for a few seconds before decelerating to rest.



The following velocity time graph describes the motion of the car. Positive velocities are shown above the time axis. The negative velocities are shown _____ the axis.



We can tell from the graph that the car changed direction at point _____ because the velocities changed from positive to _____.

A to B shows the car travelling at a constant velocity of _____.

B to C car slows down to _____.

C to D car reverses from rest to _____.

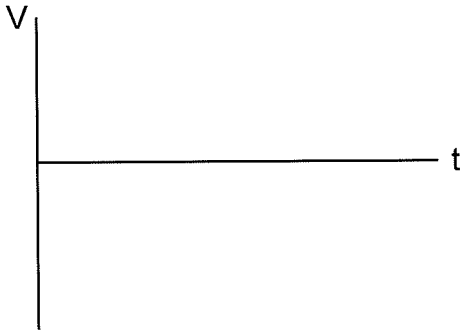
D to E car continues to reverse at a constant velocity of _____.

E to F car slows down to _____.

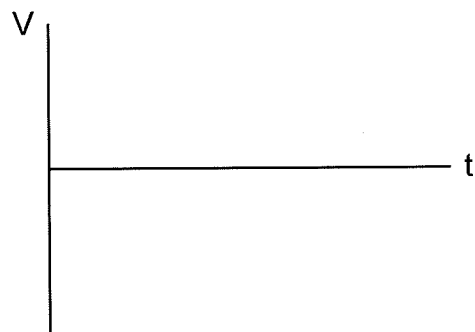
Example

Draw the velocity time graphs to describe the following motion.
In these examples up is positive

↑
+ve



Ball dropped from rest and bouncing once



Ball thrown up in the air and caught.

11. Acceleration Formula

We know that acceleration is the change in the velocity of an object each second.

acceleration = $\frac{\text{change in the object's } \underline{\hspace{2cm}}}{\underline{\hspace{2cm}} \text{ for the change}}$

We can write this in a simpler form using letters

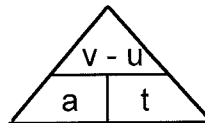
u = $\underline{\hspace{2cm}}$ velocity of the object

v = $\underline{\hspace{2cm}}$ velocity of the object

a = acceleration

t = time for the $\underline{\hspace{2cm}}$ of velocity to take place.

$$a = \frac{v - u}{t}$$



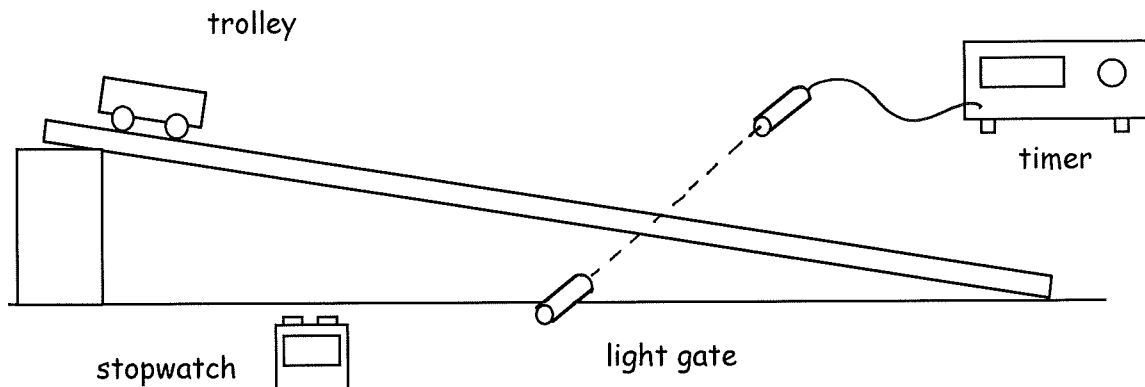
Term	Units
u	
v	
a	
t	

Example

A car accelerates from rest to 24ms^{-1} in a time of 3s.
Calculate its acceleration.

12. Measuring Acceleration

Use a light gate, a ruler and a stopwatch. Set up the following apparatus



initial speed $u = 0$ (the trolley starts from rest)

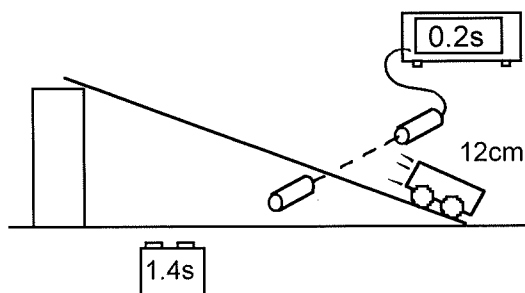
final speed $v =$ instantaneous speed at light gate $v = \frac{\text{length of } \underline{\hspace{2cm}}}{\text{time to cut the } \underline{\hspace{2cm}}}$

Stopwatch records the time t between velocities u and v .

Then we use $a = \frac{v - u}{t}$ to calculate the acceleration of the trolley

Example

Look at this experiment. Use the information to calculate the acceleration of the trolley. The trolley starts from rest and accelerates down the slope at a constant rate.



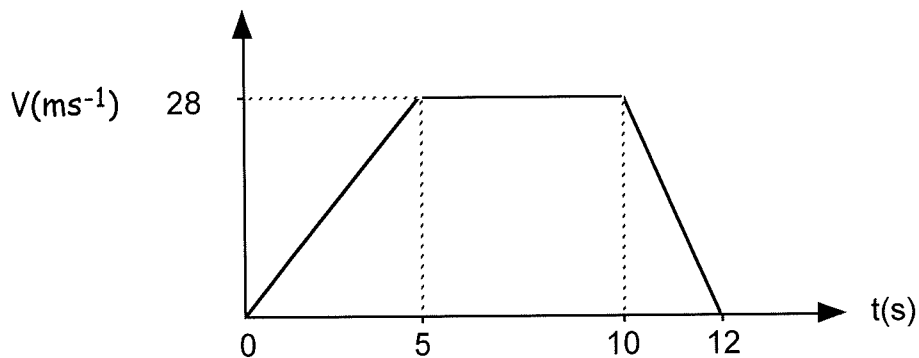
13 Rearranging uvat

Example A cyclist accelerates from 3ms^{-1} at a rate of 2.6ms^{-2} . Calculate his final speed if he accelerates for 4s?

14. Acceleration from Velocity Time Graphs.

This velocity time graph represents the velocity of a skier travelling down a slope.

Example Calculate the acceleration during 0 - 5s and 10 - 12s



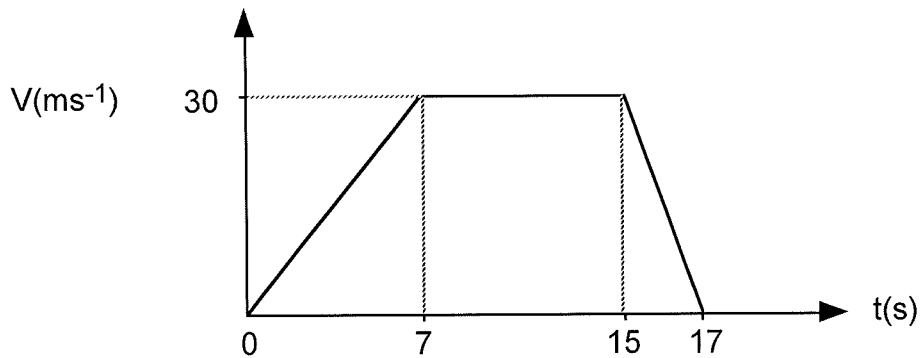
Acceleration between
____s and ____s

Acceleration between
____s and ____s

15. Calculating the Displacement From a Velocity-Time Graph

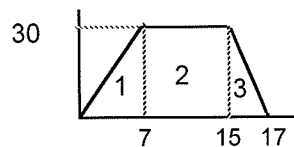
The displacement of an object = the _____ under the velocity time graph

Example The following graph shows how the velocity of a car varied over a 17s journey. (a) Calculate how far the car travelled during the 17s?
(b) What was its average velocity?



displacement = area under the graph.

Split the area up into shapes whose areas we can easily work out.



Displacement s = Area 1 + Area 2 + Area 3

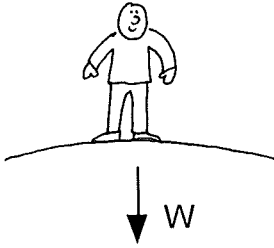
$$\text{Average velocity } \bar{v} = \frac{s}{t}$$

B. Newtons Law's of Motion

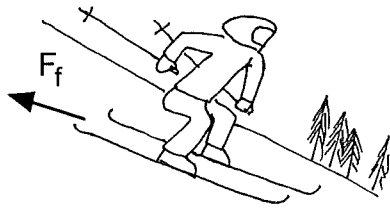
16. What is a Force?

Force changes the speed _____ or _____ of an object.
 Force is a vector quantity because it is important to state its size and _____
 Force is measured in units called _____ or _____ for short.
 Force is measured using a _____ balance.

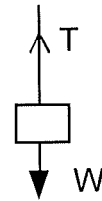
There are many different types of forces. Here are some important forces.



The force that pulls objects down to the centre of the Earth is called _____



The force which acts between touching surfaces and tries to stop them moving is called _____



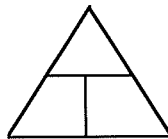
The force carried through a stretched rope or wire is called _____

17. Mass and Weight

The mass of an object is a measure of how much stuff or _____ an object contains. Mass is measured in _____ or _____ for short.
 Your mass stays the _____ no matter where in the universe you are.

The weight of an object = mass of the object x gravitational field strength.

$$W = mg$$



Term	Unit
W	
m	
g	

The gravitational field strength, g , is the downward _____ acting on 1kg of mass. Here are the g values of different bodies.

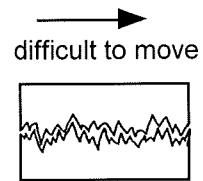
Body	g (Nkg ⁻¹)
Earth	9.8
Moon	
Mars	
Venus	
Jupiter	

Compared to Earth we would feel _____ on Jupiter and _____ on the moon.

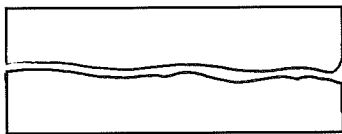
Example An astronaut of mass 86kg travels to Mars. What is his weight on Mars.

18. Friction

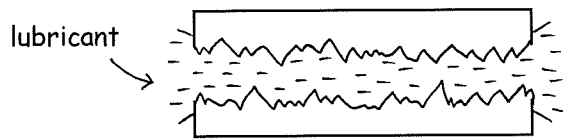
Friction is a force which acts between _____ surfaces. It is caused by the surfaces being rough. It tries to stop the surfaces _____. It always acts _____ the direction of motion.



Decreasing friction by



S _____ surfaces

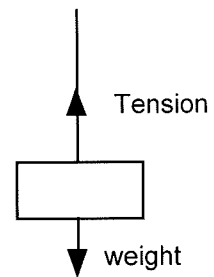


S _____ surfaces.

If an object moves through a fluid like air or water, friction can be decreased by making the object _____. A streamlined object has a _____, rounded surface. It cuts through the fluid with little turbulence.

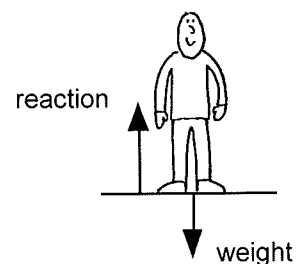
19. Tension

If you hang a box from a rope or a wire. The upward force stopping it falling is delivered through the r _____ or wire. This force is called _____.



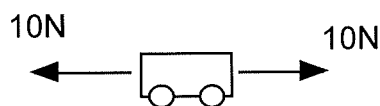
20. Reaction Force

When you stand on the floor your _____ pulls you downwards. However you don't crash through the floor. This is because the floor applies an equal and upward force on you called the _____ force.



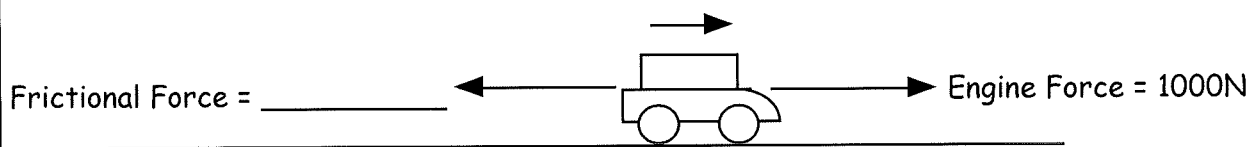
21. Newton's 1st Law

When the forces on an object are equal in size but opposite in direction we say the forces are _____.



Newton's 1st Law - If the forces on an object are zero or balanced the motion of the object does not _____.

Example This car is travelling along the road at a constant speed. State the size of the frictional force.

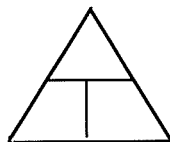


22. Newtons' 2nd Law

If the forces on an object are unbalanced we can calculate the _____ force. It is this unbalanced force which makes the object _____.

Newton's 2nd Law - If an unbalanced force, F_u , acts on a mass m , the mass accelerates at a ms^{-2}

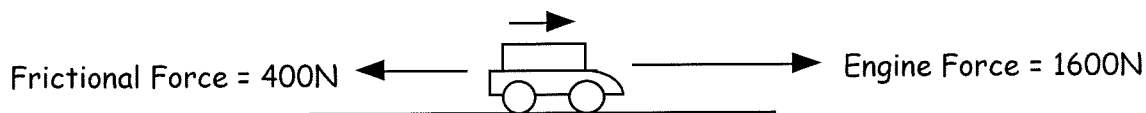
$F_u = ma$



Term	Unit
F_u	
m	
a	

The bigger the unbalanced force the _____ the acceleration.
The bigger the mass the _____ the acceleration.

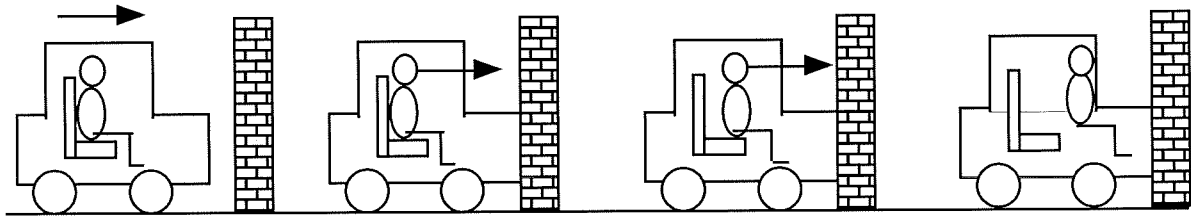
Example The forces acting on this car are shown. The mass of the car is 800kg



- (a) Calculate the unbalanced force $F_u = \text{_____} - \text{_____} = \text{_____}$
- (b) Calculate the acceleration of the car.

23. Newton's Laws and Seat Belts

When a car crashes into a wall, the wall applies an _____ force to the car to decelerate it. If you are **NOT** wearing a seat belt you will continue to move at a _____ speed until the windscreen applies an _____ force to decelerate you. A seat _____ is designed to apply this unbalanced force to you to decelerate you to rest.



NO SEAT BELT WORN

24. Newton's Laws and Space Travel

At lift off a rocket accelerates upwards. So the upward thrust has to be bigger than the _____ of the rocket.

Example The thrust on this 2000kg rocket shown is 32,000N at lift off from Earth.

Calculate (a) the weight of the rocket. (hint $g=9.8\text{Nkg}^{-1}$).

32000N



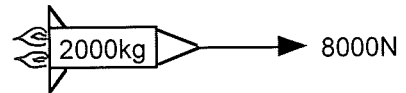
(b) the unbalanced force on the rocket.

(c) the acceleration of the rocket.

Example

In deep space a stationary probe's rockets are fired.


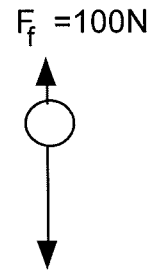
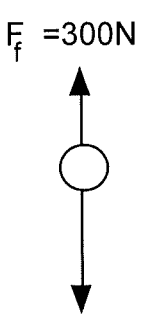
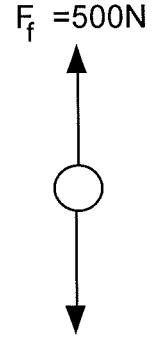
The rocket thrust created is 8000N
(assume friction is negligible)



- (a) Calculate the acceleration of the probe.
- (b) After 3s the rockets are switched off. The probe's been accelerating from rest for 3s. What is the speed of the probe at 3s?
(Do this in your head)
- (c) Describe the motion of the probe 20s after the rockets have been switched off?
- (d) Using Newton's laws describe why you arrived at your answer to question (c)

25. Newton's Laws and Freefall

When a 50kg skydiver jumps from a plane her weight W , pulling her downwards, stays _____ but the upwards frictional forces, F_f _____ as she speeds up. For each diagram calculate the unbalanced force acting on her and her acceleration at that point. (We are going to take $g = 10\text{Nkg}^{-1}$ for simplicity)

<p>Just as she jumps.</p> <div style="text-align: center;">  </div> <p>$W = 500\text{N}$</p> <p>$F_u =$</p> <p>$a = \frac{F_u}{m}$</p> <p>$a = \underline{\hspace{2cm}}$</p> <p>$a = \underline{\hspace{2cm}}$</p>	<p>She's picked up some speed.</p> <div style="text-align: center;">  </div> <p>$F_f = 100\text{N}$</p> <p>$W = 500\text{N}$</p>	<p>She's still getting faster</p> <div style="text-align: center;">  </div> <p>$F_f = 300\text{N}$</p> <p>$W = 500\text{N}$</p>	<p>She's going so fast friction has increased to equal her weight</p> <div style="text-align: center;">  </div> <p>$F_f = 500\text{N}$</p> <p>$W = 500\text{N}$</p>
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As she steps out of the plane her velocity is fairly low, so the air resistance acting on her can be considered to be almost _____.

As she falls, her velocity _____, therefore the air resistance acting on her also _____. The difference between her weight and the air resistance is called the _____ force. As time progresses the unbalanced force _____ therefore the acceleration _____.

At one point the size of the air resistance is the same size as the weight. The forces are now _____. Therefore by Newton's 1st law, the object will now fall at a _____ velocity. This is called _____ velocity.

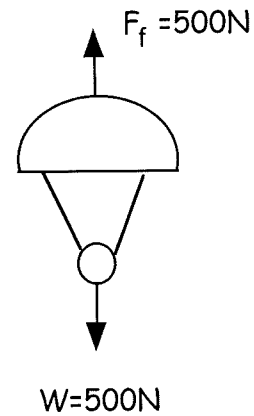
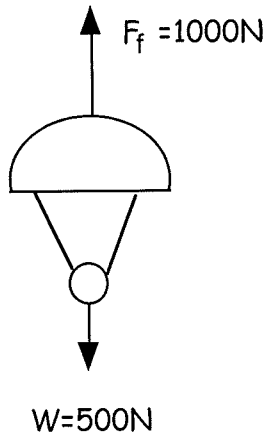
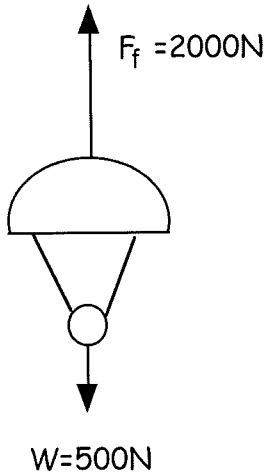
It is important to realise that even though her acceleration is decreasing she is still getting faster but by a smaller amount each second.

When she puts up her parachute the upward frictional force becomes much _____ than her weight so she _____. As she slows down her velocity _____ and therefore so does the _____ force acting on her. After a few seconds the upward frictional force balances her _____ and again she falls at a reduced _____ velocity.

very fast

slowing down

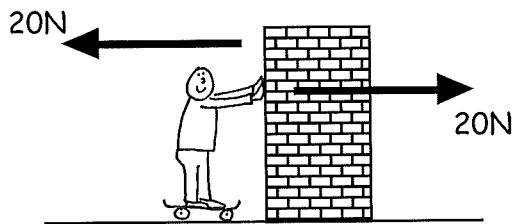
constant _____



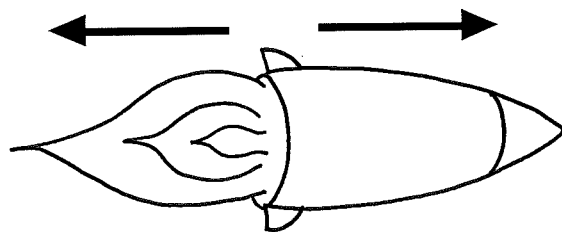
26. Newton's 3rd Law of Motion.

When you apply a force to an object the object will apply an _____ and _____ force back on you. These forces are sometimes called Newton's _____.

Boy applies a force of 20N to wall
 Wall applies a force of _____ to _____



Rocket applies a force of 20,000N on the exhaust gas
 Exhaust applies a force of _____ on the _____



Newton's pairs are NOT balanced forces because they are acting on different objects. In the first example the 20N is being applied separately to the wall and to the boy.

In the 1st example above, there is now an unbalanced force of _____N acting on the boy. Therefore the boy will _____ to the _____.

In the rocket example there is an unbalanced force of _____N acting on the rocket. Therefore the rocket will _____ to the _____.

27. Projectile Motion

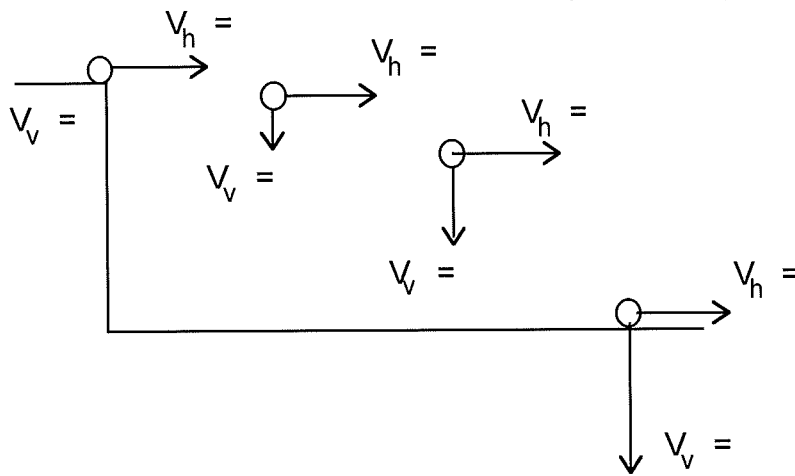
A projectile is an object which has both a horizontal and _____ motion.

In the horizontal direction the object travels at a _____ speed.

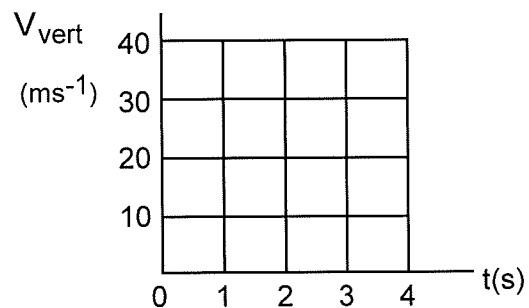
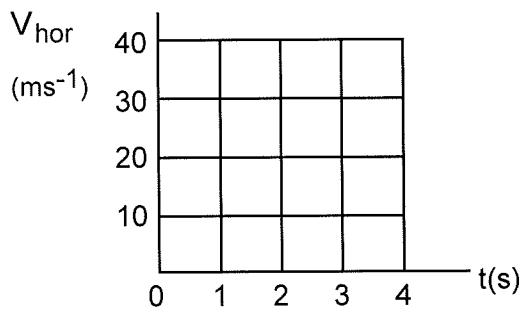
In the vertical direction, on Earth, the object accelerates downwards at _____ ms^{-2} .

This ball is kicked off a cliff with a horizontal velocity of 20ms^{-1} . It takes 3s to hit the ground. It is travelling horizontally for ___s and accelerating downwards for 3s at a rate of _____ ms^{-2} .

On the diagram state the horizontal and vertical velocity of the object each second as it falls.



The horizontal and vertical motion of a projectile can be described on two velocity time graphs.



To find the horizontal distance travelled we use $d_h = v_h \times t$

To find the final vertical velocity at time t we use $v_v = u + \text{_____}$

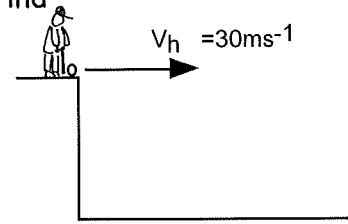
On different planets g is different so acceleration caused by g will be different. The g force and the acceleration caused are numerically _____.

On Jupiter $g = 25\text{Nkg}^{-1}$ and therefore acceleration caused by this gravity = 25ms^{-2}

On the moon $g = \text{_____Nkg}^{-1}$ so acceleration caused by this gravity = _____ ms^{-2}

Example.

A golfer hits a ball from the top of a raised tee with a horizontal velocity of 30ms^{-1} . It takes the ball 4.5s to hit the ground. Find

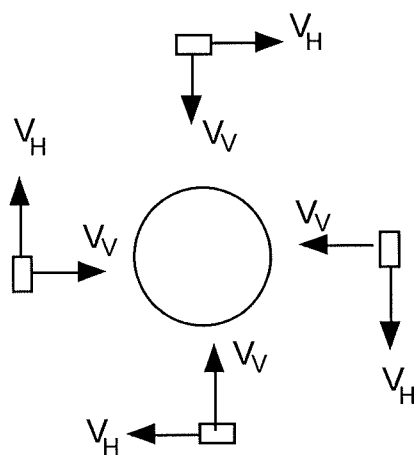
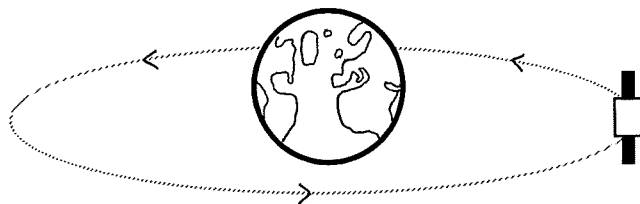


- (a) the horizontal distance the ball travels.
- (b) the final horizontal speed of the ball when it lands.
- (c) the final vertical speed of the ball when it lands.
- (d) How would your answers to (b) and (c) be different if we did not ignore air friction?

28. Satellites

A satellite is an object which orbits another object. The moon is a satellite of _____ . The Earth is a satellite of the _____ .

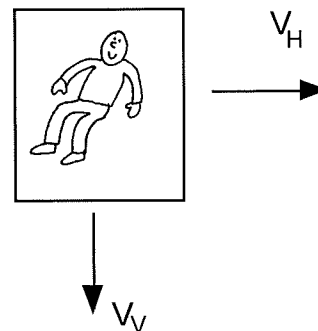
A satellite moves as a _____. It has a vertical velocity, as it is accelerating towards the ground at a rate of nearly _____ ms^{-2} . However the reason it does not hit the ground is because it is given a _____ velocity. The resultant velocity means that although it falls towards the Earth the Earth is curving away from it.



Draw actual or resultant velocity vector for each picture in red

For each orbital height it is important to calculate the _____ velocity required to keep the satellite in orbit.

Astronauts appear to be "floating" about in the space station as if they are in _____ gravity. However they, and the space station are both in free _____, hurtling towards the Earth. However the space station is given a horizontal velocity and this prevents the station crashing back to Earth.



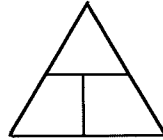
The space station is a satellite of E _____ and is moving as a p _____.

29. Work Done

If you pull a box across the floor the box moves. You have transferred energy from yourself to the box. We call this energy transfer _____ done. We measure Work Done in _____ or _____ for short

Work Done = Force applied x distance force is applied

$$E_w = Fd$$



Term	Unit
E_w	
F	
d	

Example A boy pulls a box a distance of 4m across the floor with a force of 20N. How much work is done by this action?

If there is no friction acting, the box will now have ____ of _____ energy

Work can also be done when a force is applied over a distance to slow an object down. The force is being used to remove or transfer its kinetic energy to heat.

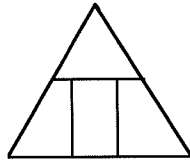
Example A car has 4000J of kinetic energy.
(a) How much work requires to be done to bring the car to a halt?
(b) What braking force must be applied to bring the car to a halt in 50m?

Work is only done if the force is applied over a distance. No work is done by simply applying a force to hold a shopping bag in a stationary position.

30. Kinetic Energy E_k

Kinetic energy is the energy possessed by _____ objects.

$$E_k = \frac{1}{2} mv^2$$



Term	Unit
E_k	
m	
v	

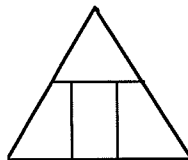
Example

A car of mass 800kg moves with a speed of 5ms^{-1} .
Calculate the kinetic energy of the car.

31. Gravitational Potential Energy E_p

When work is done to lift an object up, it gains gravitational potential energy. Gravitational potential energy is possessed by objects which are _____ a certain datum point.

$$E_p = mgh$$



Term	Unit
E_p	
m	
g	
h	

Example

A boy of mass 54kg stands on a diving platform 6m above the water. How much gravitational potential energy does he have relative to the water?

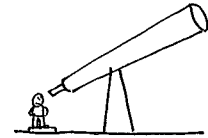
C. Space Exploration & Cosmology

32. Looking into Space.

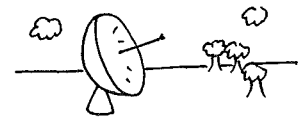
Up until the 1950s we studied the universe from Earth using terrestrial telescopes which could pick up visible light and _____ waves . However lots of interesting parts of the electromagnetic _____ cannot penetrate our _____ and this affected our understanding of the universe.

1. Terrestrial (On Earth) Telescopes

Optical Telescopes - allow us to study the v_____ light being emitted from distant stars and galaxies



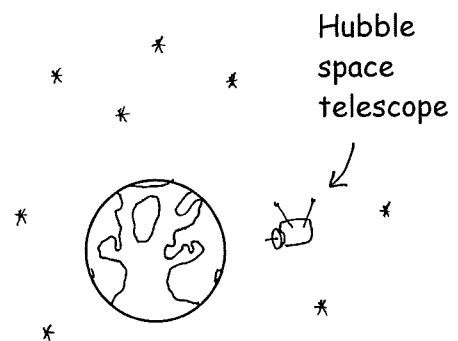
Radio Telescopes - allow us to study the r_____ waves being emitted from distant stars and galaxies.



Since the 1950's our understanding of the universe has improved vastly due to the following advancements.

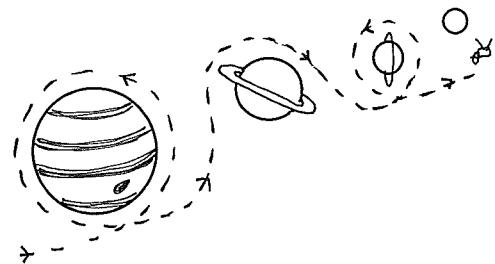
2. Space Telescopes

A lot of interesting electromagnetic radiation like UV, X rays and gamma rays cannot get through the Earth's atmosphere so telescopes like the _____ telescope are positioned on _____ in orbit around the Earth. They provide extremely clear and detailed images of distant galaxies and can detect signals from all parts of the _____ spectrum.



3. Space Probes

Space probes are sent on journeys of many billions of km to distant _____ such as Mercury and Jupiter, and out through the solar _____. The space probes _____ and _____ were launched in _____ and took amazing photographs of Jupiter's _____ and the _____ of Saturn. Voyager _____ is now beyond _____ but is still sending information back to Earth.



33. Benefits of Space Travel.

1 Technologies Developed through Space Exploration:

The smoke d_____ and LCD s_____ which have low energy consumption. Dried and frozen f_____ which stay fresh for months in space. Here are some more examples of other technologies which have been developed as a result of space exploration.

2. Satellites

Satellites orbiting the Earth have improved our understanding of our own p_____ as well as improving communications.

Satellites are placed in orbit around the Earth. A satellite which stays above the same point on the planet is called a _____ satellite. It has a period of _____ hours. The higher the orbit the longer its _____.

Weather Satellites

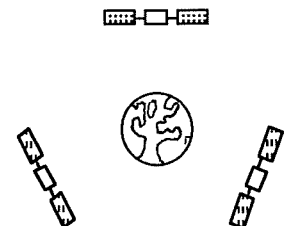
Weather satellites allow us to understand the w_____ on Earth. We can predict and study dangerous storms called h_____. We can study the impact of global w_____ on the planet.

Global Positioning Satellites (GPS)

Global _____ satellites or GPS make use of _____ satellites to allow the position of a receiver on _____ to be pinpointed to within 10cm. It can be used by

Communications Satellites

Communications satellites allow t_____ calls, and T____ and radio programmes to be broadcast around the world. It also allows worldwide i_____ communication.



Agriculture and Forestry.

Satellites allow governments to monitor the quality of the s_____ and the health, quantity and quality of c_____. This allows farmers to p_____ ahead to maximise production.

Defence and Security.

Satellites allow governments to monitor the a_____ and nu_____ capabilities of other countries, to ensure that they are not becoming a threat. During war, satellites allow armies to locate and track enemy p_____.

Geology.

Satellites allow geologists to locate deposits of o_____ and m_____. They can be used to monitor how land masses are moving due to _____ tectonics.

Cartography.

Satellites are an accurate method of m_____ the planet. As satellites are continually monitoring the Earth, maps can be continually u_____.

34. Reentry 1 - Frictional Heating

Future space travel will involve space shuttles flying into space and returning safely to _____. If the space shuttle reenters the Earth's atmosphere at too shallow an angle it will _____ off the upper atmosphere. If it reenters at too steep an angle it will _____ up.



35. Energy Conservation during Reentry.

When an object reenters the Earth's atmosphere it is travelling very _____. It has a lot of movement or _____ energy.

The shuttle uses the force caused by air resistance during reentry to _____ itself to a safe landing speed.

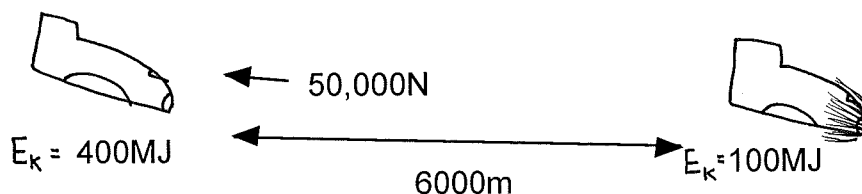
The kinetic energy it is losing is transferred to _____ due to a air resistance.

We say that the force caused by air resistance has done _____ over a distance to transfer kinetic energy to _____ energy.

$$E_k \text{ lost} = E_w \text{ (work done by air friction)}$$

$$\frac{1}{2} m v^2 = Fd$$

This diagram shows air friction acting on a shuttle as it enters the Earth's atmosphere.

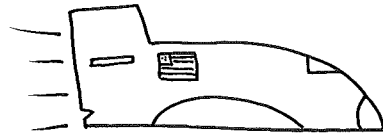


This shuttle has lost _____ of kinetic energy. It has been transferred to _____ energy by a force of _____ N being applied for _____ m

The metal body of a spacecraft is covered in a material which prevents the metal _____. This material is called a _____ shield. The heat shield protects the metal body by absorbing the heat, and heating up instead of the _____ body.

Example

The diagram shows a space shuttle of mass 96,000kg entering the lower atmosphere at a speed of 8000ms^{-1}



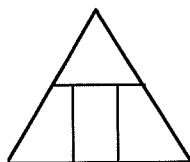
- (a) How much kinetic energy does it have at this point?
- (b) After travelling through the atmosphere for 20km its kinetic energy has reduced to 1.2×10^{12} J. How much kinetic energy has been transferred to heat over this distance?
- (c) What is the name of the force which has done the work to transfer the kinetic energy to heat energy?
- (d) Calculate the size of the frictional force which transfers this energy or does this work during the 20km?

36. Specific Heat Capacity.

We need a heat shield which absorbs a lot of _____ energy, but for only a small rise in its temperature, because you are trying to prevent the shields melting.

The specific heat capacity of a substance tells you the amount of heat energy required to raise the temperature of 1kg of the substance by _____ °C.

$$E = mc\Delta T$$



Term	Unit
E	
m	
c	
ΔT	

The specific heat capacity of water is _____. This means that to heat 1kg of water by 1°C, the water needs to absorb _____ of heat energy.

A heat shield has a high specific heat capacity so it can absorb a huge amount of _____ energy for only a small change in its _____. As the shuttle's shields are absorbing most of the heat, the metal body of the shuttle stays intact.

Example

On reentry the temperature of the heat shields covering the shuttle's nose cone rose by 4000°C. If the mass of the nose cone shields is 260kg and its specific heat capacity is 3800Jkg⁻¹°C⁻¹ then calculate the heat energy it absorbed.

37. Reentry II - Heat Shields Melt.

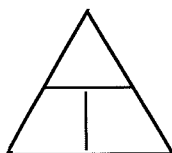
After a few minutes heating up, the shielding material may reach its melting point. The process in which the shields melt requires even more _____ energy. The shields absorb more _____ energy and melt and so prevent the m_____ body of the shuttle absorbing the heat and melting. The amount of heat energy required to change the state of 1kg of material is the Specific Latent heat of the material.

38. Specific Latent Heat.

The specific Latent heat of fusion L_f of a material is the amount of _____ energy required to change 1kg of solid to 1kg of liquid at a _____ temperature.

The specific latent heat of vaporisation L_v of a material is the amount of _____ energy required to change 1kg of liquid into 1kg of gas at a _____ temperature.

$$E = mL_f \text{ or } E = mL_v$$



Term	Unit
E	
m	
L	

If the liquid substance then freezes or the gaseous substance condenses the energy E is _____ by the substance.

Example At one point during the re entry 5kg of shield material begins to melt. If the latent heat of fusion of the shield material is $4.8 \times 10^5 \text{ Jkg}^{-1}$ calculate the energy absorbed by the shields while melting.

39. Cosmology

A light year is the distance light travels in a year. It also tells us how long it would take a beam of _____ to travel that distance. The distance from Earth to the Sun is 8 light minutes. This means it takes a beam of light _____ minutes to travel from the sun to Earth.

The distance to the centre of our galaxy is 25,000 light years. So it would take a beam of light _____ years to travel from the centre of the galaxy to Earth. So in effect when the light arrives at us we are seeing the centre of the galaxy as it was _____ years ago.

40. Converting Light Years to Metres

The nearest star to the Sun is Proxima Centauri. It is 4.2 light years from the Sun. So it takes the light 4.2 years to reach us from Proxima Centauri. What distance, in metres has it travelled in this time?

Light travels 3×10^8 m in 1 second. So how far will it travel in 4.2 years.

We need to find out what 4.2 light years is in seconds.

No of days - 4.2 years \times 365 = 1533 days

No of hours - _____

No of minutes - _____

No of seconds - _____

So the question is. How far will light travel in this _____seconds

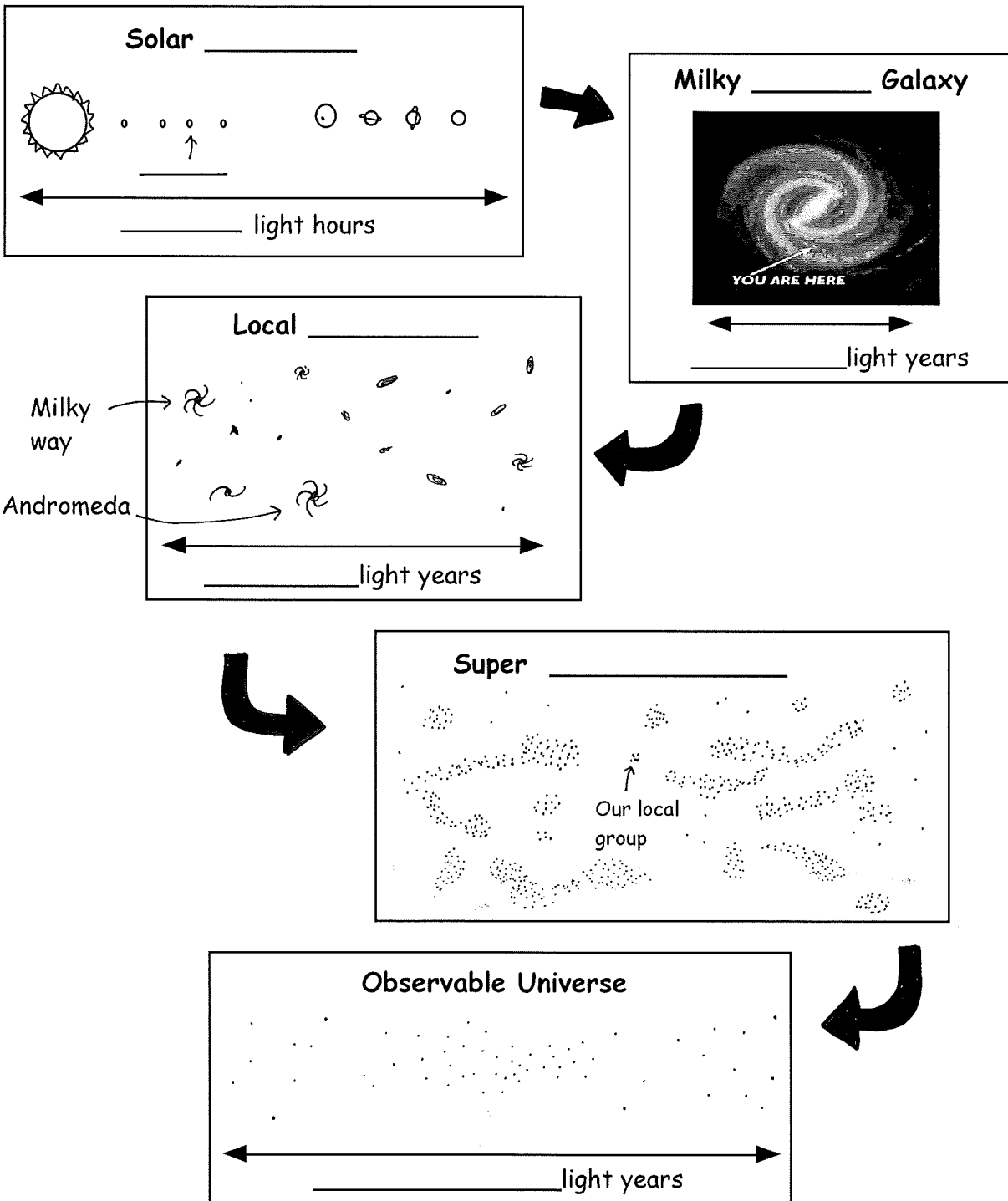
v =

t =

d = ?

41. The Observable Universe

Earth is part of a family of ____ planets which orbit a star called the _____.
This star family is called the _____ system. The solar system is located on the
outer arm of a s_____ galaxy called the _____.
The Milky Way contains about _____ billion stars.
There are _____ nearby galaxies, for example _____.
This group of nearby galaxies is called the _____ group.
Astronomers estimate that there are _____ billion galaxies in the vast universe, mostly
clustered together in _____ clusters. Some parts of the universe are so far
away that light has not had time to reach us, so this part of the universe is unobserved.



Location	Distance
to moon	_____ light seconds
to sun	_____ light mins
to Jupiter	
to edge of solar system	
to proximi centauri	
across milky way	
to Andromeda	
to furthest galaxy	

42. The Big Bang.

In the 1920s Edwin _____ observed that all the galaxies were moving a _____. If all these galaxies were moving apart then at one time they must have all been squashed together. Scientists concluded that all the matter and energy and space in the Universe must have been, at one time, squashed into an extremely small space called a s _____. About 13.7 _____ years ago this tiny ball must have exploded apart in a hot, dense fireball. As the Universe expanded it cooled down, and some energy turned to _____. A new force called _____ started to clump the mass together to form a _____, then stars, then g _____. When the stars exploded, p _____ formed out of the debris.

43. Exo Planets

Exo planets are planets which exist outside our _____ system. We can detect them because they cause their star to d _____ as they pass in front of it. Planets orbiting a star also cause the star to w _____ on its axis. For life similar to that on Earth to develop the planet would require

- A. to be close to a long lived s _____ which is a stable source of e _____.
- B. not to be too close to the centre of its _____ as the planet would be zapped by too much dangerous radiation.
- C. to have a s _____ surface and a supply of a liquid like w _____.
- D. to be the correct distance from its s _____. Too close, and all the liquid would _____. Too far away and the temperature would be too _____ for life to form.
- E. to be the correct size. Too small, and the atmosphere would be too t _____. Too big and the atmosphere would be too d _____.
- F. a protective _____ field to deflect the solar wind from the star.

44. Electromagnetic Spectrum.

People have been studying the visible light coming from stars and galaxies for thousands of _____. However stars, galaxies and even planets are constantly emitting waves at all wavelengths of the electromagnetic _____. The Earth's atmosphere absorbs many of these waves.

The first non-visible radiation we picked up from the universe were _____ waves in the 1930s. Since then we have found clever ways of detecting all the electromagnetic waves the universe emits.

Microwave radiation comes from every corner of the _____. It is believed that this radiation is the heat left over from the _____ bang. The microwaves started off as infra red heat but as the universe expanded the infra red was stretched to microwaves.

Infra red radiation or _____ energy is given off by most objects in the universe.

UV, X rays and Gamma rays are high f _____ waves which therefore are high energy waves. These waves are given off by hot stars and extreme astronomical events, for example exploding stars called _____ and Black _____.

45. Continuous Emission Spectra.

When a solid or liquid is heated it gives off a complete range of wavelengths of visible light. This is called a _____ emission spectrum. The sun and light bulbs give off _____ emission spectra.

We can analyse the light given off by stars using a _____.

A spectroscope splits light up into a spectrum according to the different wavelengths or frequencies in the light.

Continuous Emission Spectrum

_____ frequency waves



_____ frequency waves

46. Judging the Temperature of a Star.

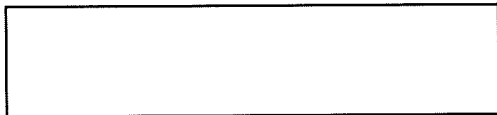
As a star becomes hotter it gives off increasingly shorter _____ of light. We can use this fact to judge how _____ a star is.

So, cool stars give off mostly long wavelengths so appear _____ in colour. A yellow star is hotter because it gives off more yellow wavelengths and a bluish white star is very hot as it gives off all the colours but with a lot of the very short wavelength _____ light. Our Sun is yellow so it is a medium _____ star.

47. Line Emission Spectra.

Each gaseous element, when heated, gives off only certain _____ of light. If we look at this light using a spectroscope we see a _____ emission spectrum. Each line indicates a different _____ of light. We can use the line spectra of elements to identify the elements present in a _____.

Line Emission Spectra



line emission spectra of hydrogen

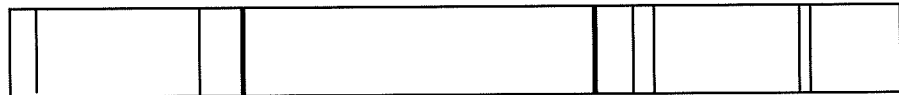


line emission spectra of mercury

Stars are usually made from many elements, so the line spectra of all these hot elements are usually mixed up. A trained eye is able to pick out the individual _____ present

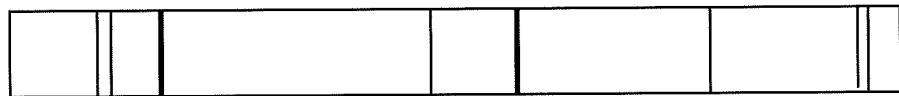
Example The first diagram shows the line spectrum from a distant unknown star.

unknown star

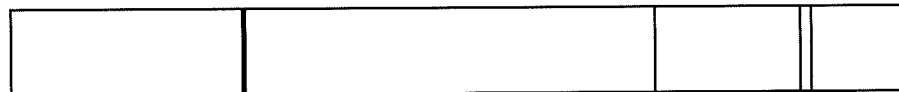


The next 3 diagrams show the spectra from 3 different elements

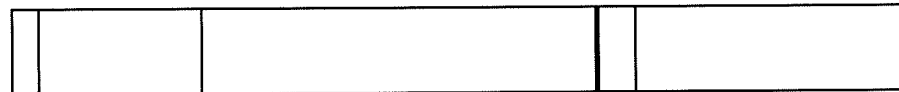
Element 1



Element 2



Element 3



Which elements are present in the unknown star?

Ans: _____

