ANDERSON HIGH SCHOOL

Physics

Dynamics and Space

Name____________________ Class _____

4/5

Content Level 4

SCN 4-06a
By researching developments used to observe or explore space, I can illustrate how our knowledge of the universe has evolved over time.

SCN 4-07a
I can use appropriate methods to measure, calculate and display graphically the speed of an object, and show how these methods can be used in a selected application.

SCN 4-07b
By making accurate measurements of speed and acceleration, I can relate the motion of an object to the forces acting on it and apply this knowledge to transport safety.

SCN 4-16a
I have carried out research into novel materials and can begin to explain the scientific basis of their properties and discuss the possible impacts they may have on society.

SCN 4-20a
I have researched new developments in science and can explain how their current or future applications might impact on modern life.

SCN 4-20b
Having selected scientific themes of topical interest, I can critically analyse the issues, and use relevant information to develop an informed argument.

Content National 4

Speed and acceleration

- Calculations involving the relationship between speed, distance, and time.
- Determination of average and instantaneous speed.
- Interpretation of speed-time graphs to describe motion including calculation of distance (for objects which are speeding up, slowing down, stationary and moving with constant speed.)Motion in one direction only.
- Use of relationship of acceleration, change in speed and time.

Relationship between forces, motion and energy

- The use of Newton's first law and balanced forces to explain constant speed, making reference to frictional forces.
- The use of Newton's second law to explain the movement of objects in situations involving constant acceleration.
- Calculations using the relationship between force, mass and acceleration in situations where only one force is acting.
- Calculations using the relationship between weight, mass and gravitational field strength within our solar system.
- Risks and benefits associated with space exploration including challenges of re-entry to a planet's atmosphere.
- The use of thermal protection systems to protect spacecraft on re-entry.

Satellites

- The range of heights and functions of satellites in orbit around the earth, including geostationary and natural satellites.
- The dependence of period of orbit on height.
- The use of parabolic reflectors to send and receive signals.
- Use of the relationship between distance, speed and time applied to satellite communication.
- Range of applications of satellite including telecommunications; weather monitoring; the use of satellites in environmental monitoring.
- The use of satellites in developing our understanding of the global impact of mankind's actions.

Cosmology

- Description of planet, moon, star, solar systems, exo-planet, galaxy and universe.
- Scale of the solar system and universe measured in light years.
- Space exploration and its impact on our understanding of the universe and planet Earth.
- Conditions required for an exo-planet to sustain life.

Content National 5

Velocity and displacement — Vectors and scalars

- Vector and scalar quantities: force, speed, velocity, distance, displacement, acceleration, mass, time and energy.
- Calculation of the resultant of two vector quantities in one dimension or at right angles.
- Determination of displacement and/or distance using scale diagram or calculation.
- Use of appropriate relationships to calculate velocity in one dimension

Velocity–time graphs

- Velocity–time graphs for objects from recorded or experimental data.
- Interpretation of velocity–time graph to describe the motion of an object.
- Displacement from a velocity–time graph.

Acceleration

- Acceleration of a vehicle between two points using appropriate relationships with initial and final velocity and time of change.
- Acceleration from a velocity–time graph.

Newton's laws

- Applications of Newton's laws and balanced forces to explain constant velocity, making reference to frictional forces.
- Calculations involving the relationship between unbalanced force, mass and acceleration for situations where more than one force is acting.
- Calculations involving the relationship between work done, unbalanced force and distance/displacement.
- Calculations involving the relationship between weight, mass and gravitational field strength during interplanetary rocket flight.
- Newton's second law and its application to space travel, including rocket launch and landing.
- Newton's third law and its application to explain motion resulting from a 'reaction' force.
- Use of Newton's laws to explain free-fall and terminal velocity

Projectile motion

- Explanation of projectile motion.
- Calculations of projectile motion from a horizontal launch using appropriate relationships and graphs.
- Explanation of satellite orbits in terms of projectile motion.

Content National 5

Space exploration

- Evidence to support current understanding of the universe from telescopes and space exploration.
- Impact of space exploration on our understanding of planet Earth, including use of satellites.
- The potential benefits of space exploration including associated technologies and the impact on everyday life.
- Risks and benefits associated with space exploration, including challenges of re-entry to a planet's atmosphere.

Cosmology

- Use of the term 'light year' and conversion between light years and metres.
- Observable universe — description, origin and age of universe.
- The use of different parts of the electromagnetic spectrum in obtaining information about astronomical objects.
- Identification of continuous and line spectra.
- Use of spectral data for known elements, to identify the elements present in stars.

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Speed, Distance, Time

Example 1

What is the speed of a car that travels 2880m in 60 seconds?

Example 2

What is the speed of a car which travels 6 kilometres in 4 minutes?

Example 3

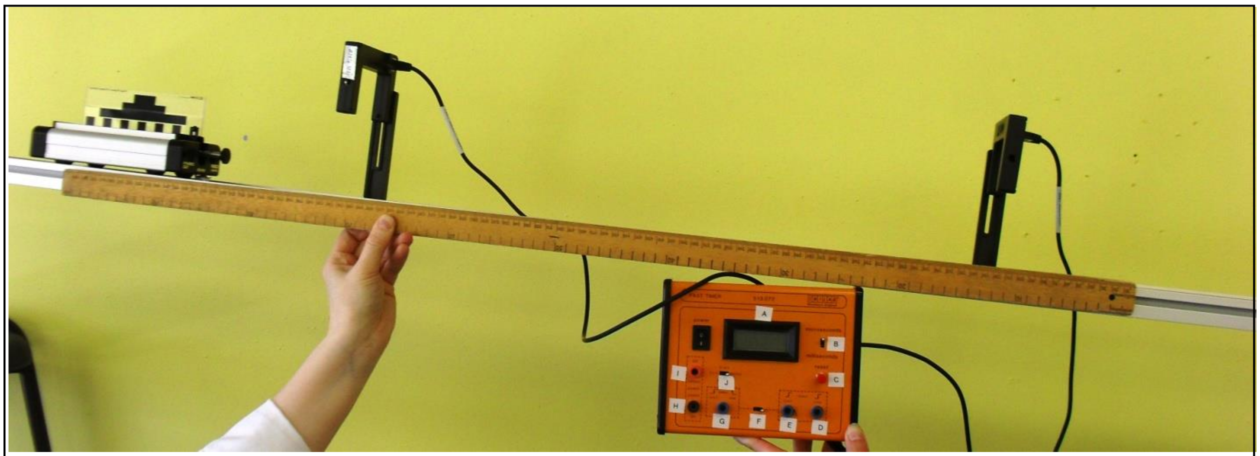
How long does it take to travel 7125m at 75m/s?

Example 4

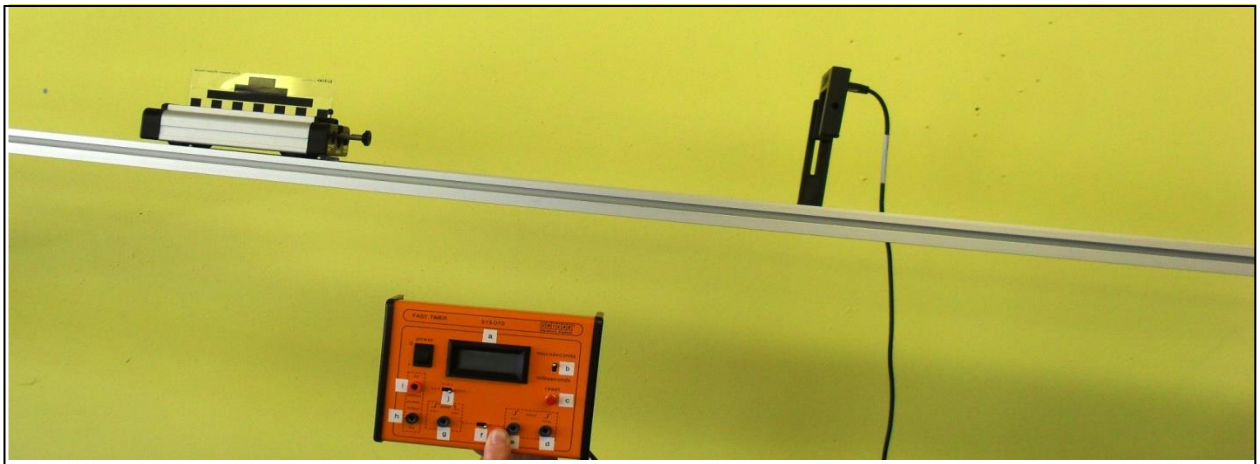
How far does a car travelling at 25m/s travel in 30 minutes?

Average Speed

Average Speed using Light Gates

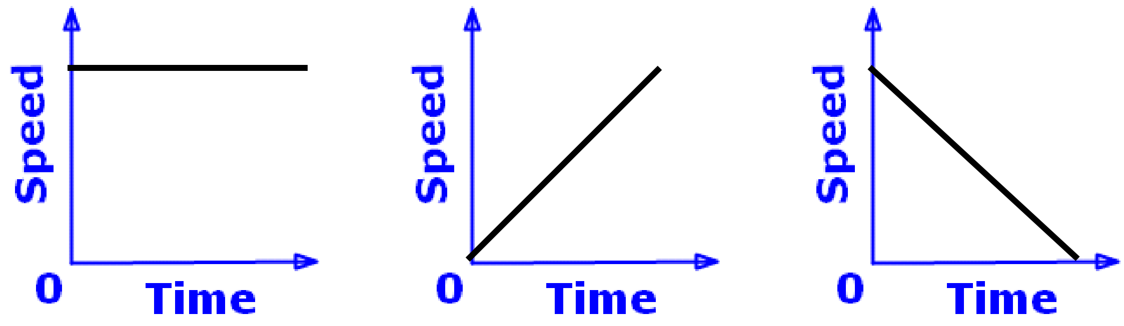


Instantaneous Speed



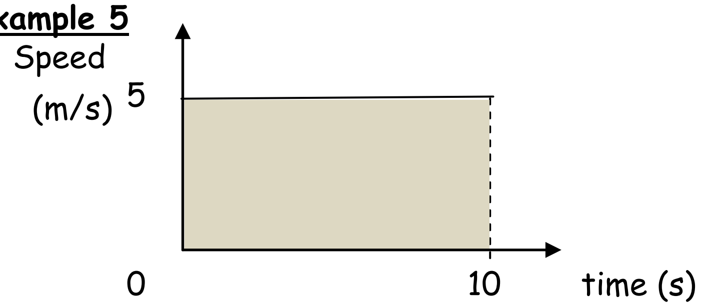
Speed Time Graphs

Speed time graphs can help to describe the motion of an object.

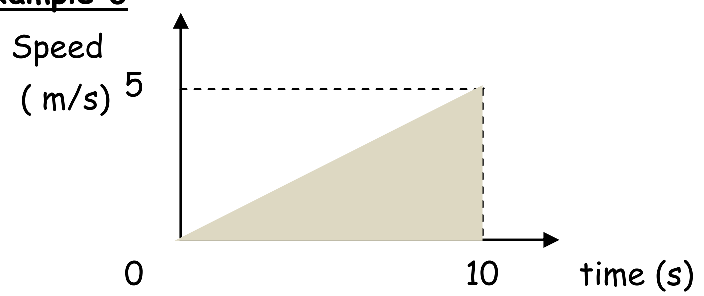


DISTANCE = AREA UNDER A SPEED TIME GRAPH

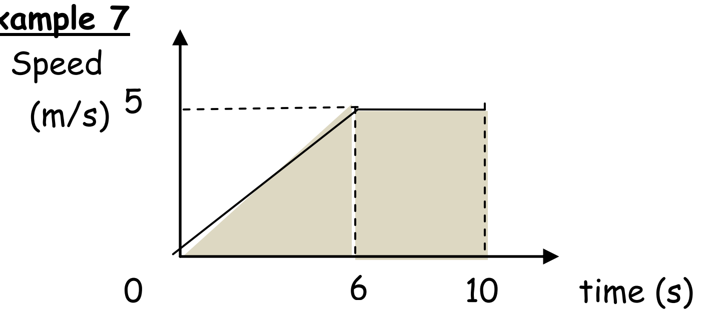
Example 5



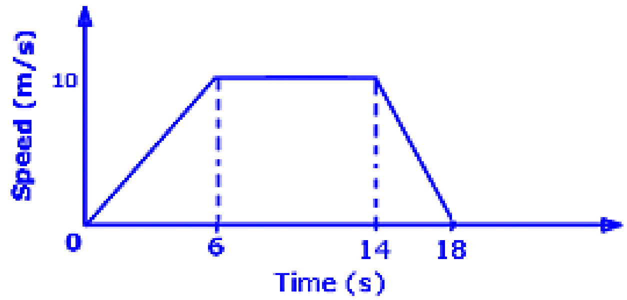
Example 6



Example 7

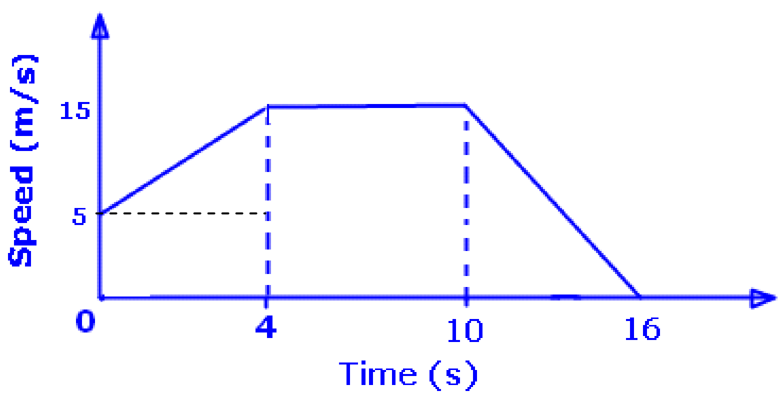


Example 8



Calculate the total distance travelled.

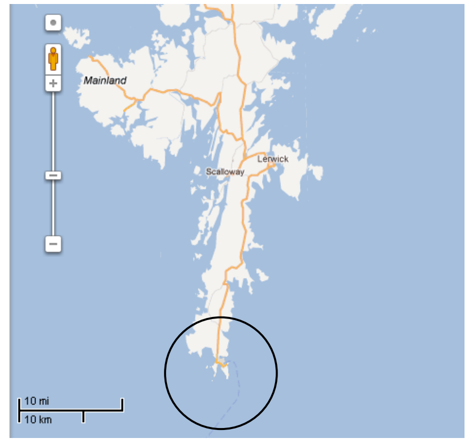
Example 9

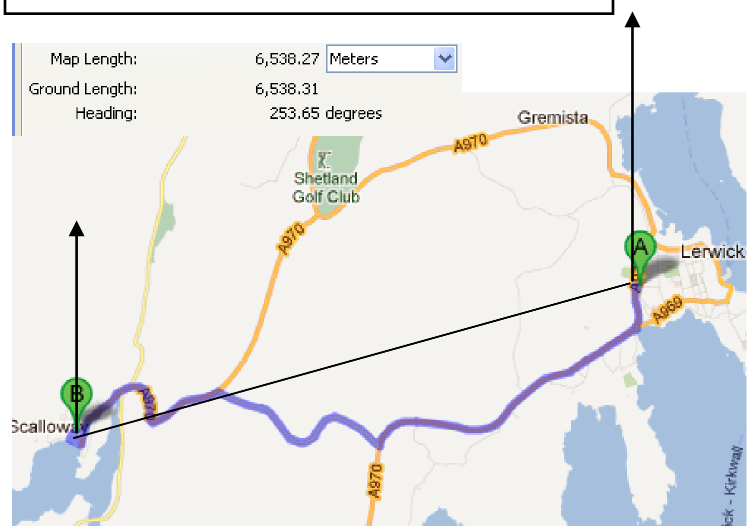


Calculate

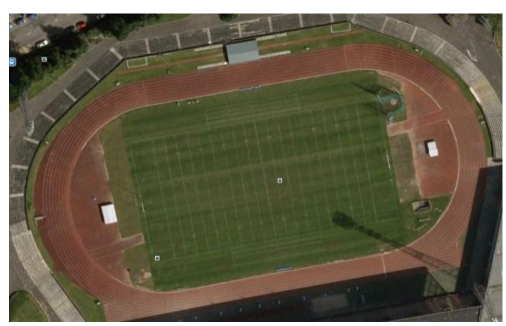
(a) The distance travelled
(b) The average speed

Distance and Displacement





B9073 and A970	**9.0 km, 16 mins**
A970	10.6 km, 19 mins

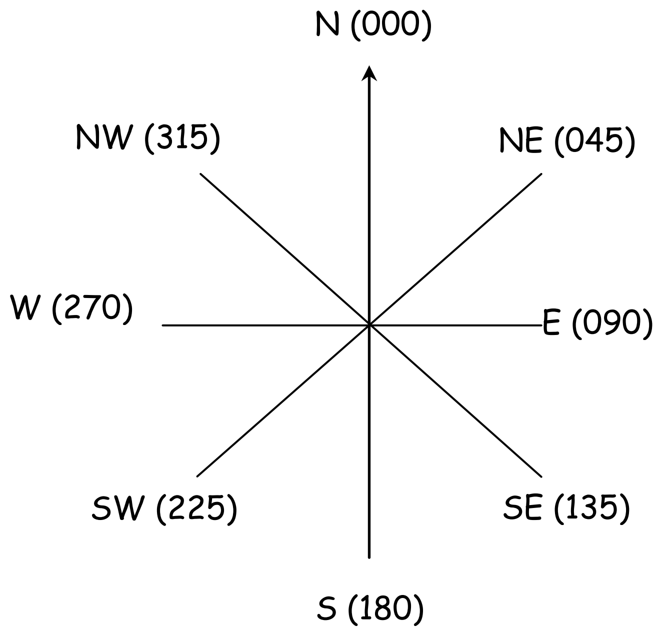


Direction

Direction can be given in two ways

1.

2.



Vectors and Scalars

Definition

A **scalar** quantity has

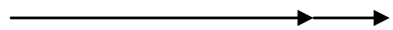
A **vector** quantity has

Scalar	Vector

Adding Vectors

Example 10

A dog walks 2m E followed by 0.5m E. What is it's displacement? (Scale = 2cm = 1m)

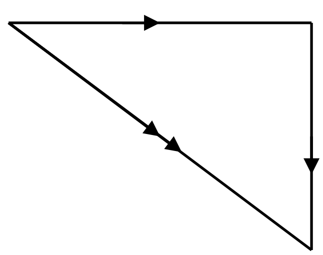


Example 11

A cat walks 2m W followed by 0.5m E. What is its displacement? (Scale = 2cm = 1m)

Example 12

(Scale 1 cm = 1m)



A person walks 4m East followed by 3m South. What is their displacement from the starting point?

Example 13

A person walks 12m East followed by 5m North. What is their displacement from the starting point?

(Scale 1cm = 1m)

Velocity

Example 14

A car travels 10m due S, stops at traffic lights then carries on for another 10m. This takes 5s.

What was the velocity?

Scale 1cm = 10m

Example 15

A car travels 8m E along a road, then has to reverse 3m to let the ambulance past. This takes 10s.

What was the velocity?

Scale 1cm =2m

Example 16

A cyclist completes a 400m circuit of a track in a velodrome in 50s. What is their velocity? (Think very carefully!!)

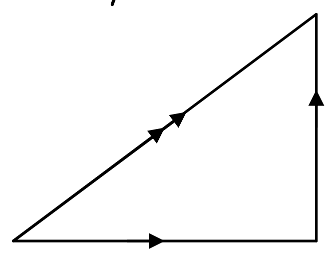
Resultant Vectors - Velocity

Example 17

A plane flies South at 100m/s, but the wind blows at 10m/s East. What is the plane's velocity?

Example 18

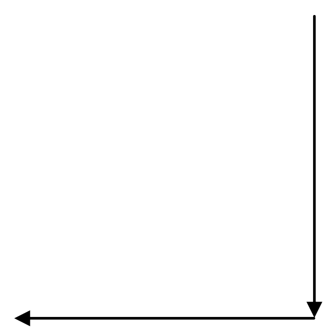
A car travels 30m E, followed by 40m N. This takes 10s. What is its velocity?



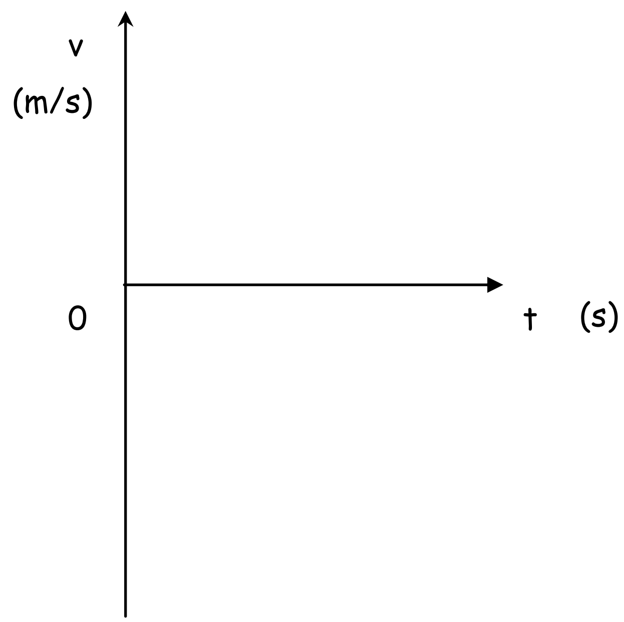
Scale 1cm = 10m

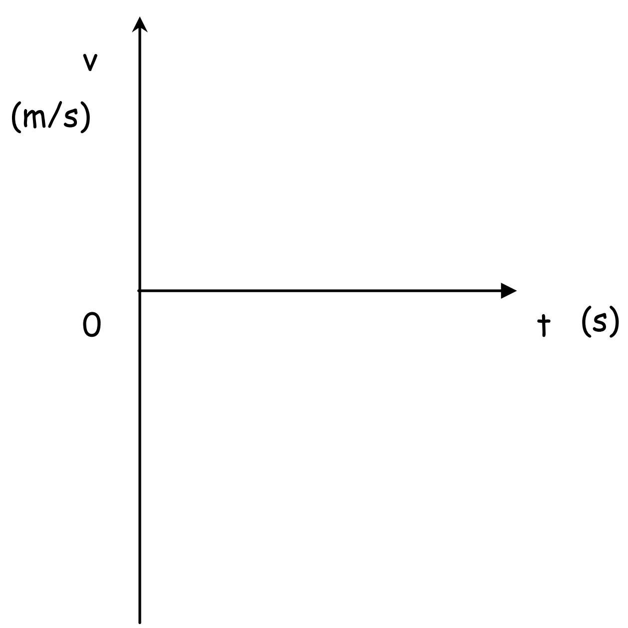
Example 19

A car travels 400m S then 400m W. This takes 20s. What is its velocity?

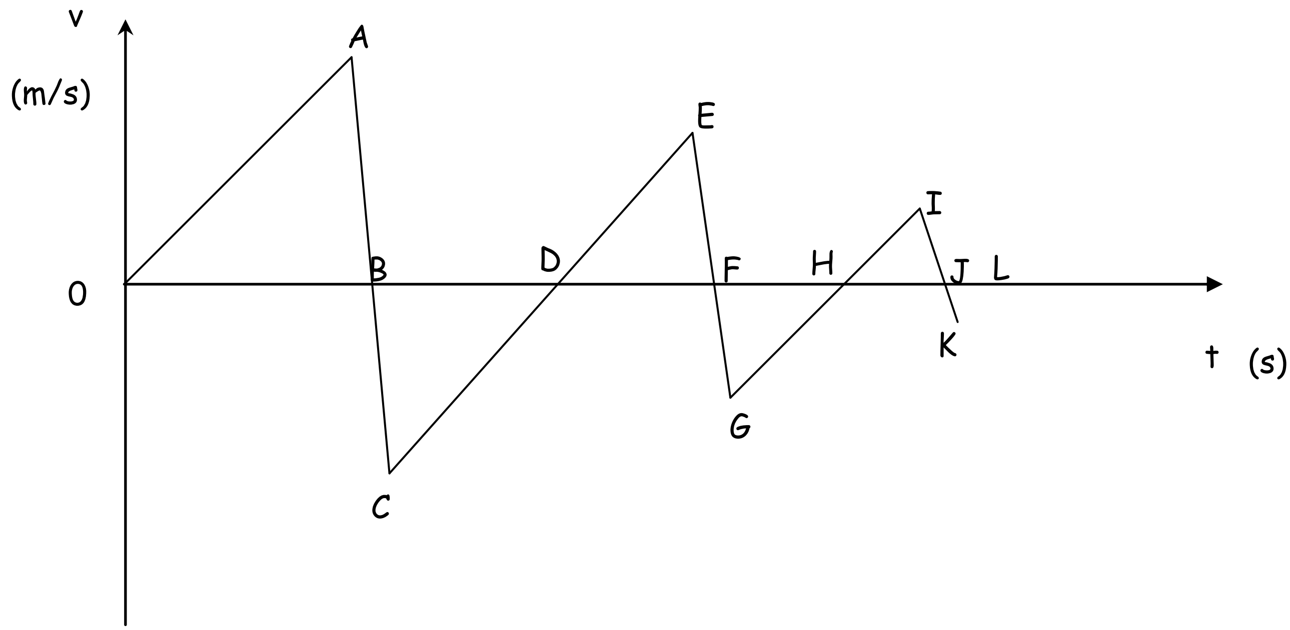


Velocity Time Graphs



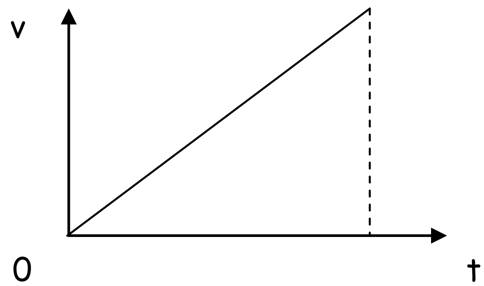


Velocity Time Graphs

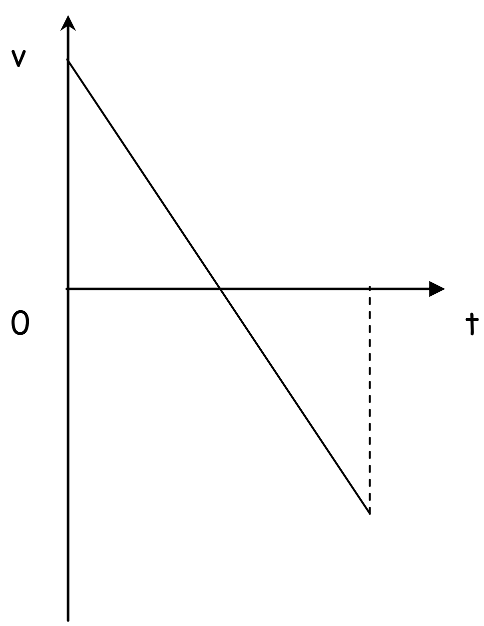


Displacement from Velocity Time Graphs

Example 20

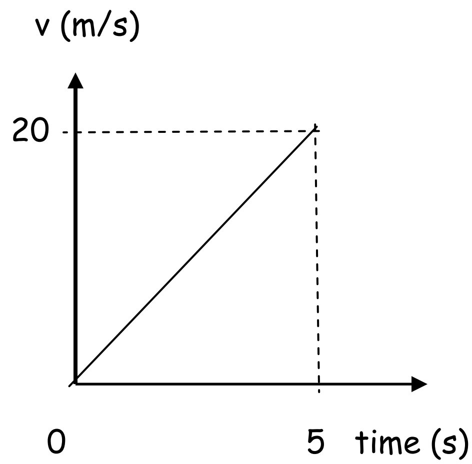


Example 21

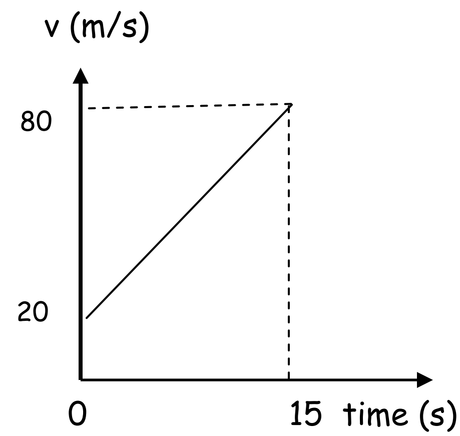


Acceleration

Example 22

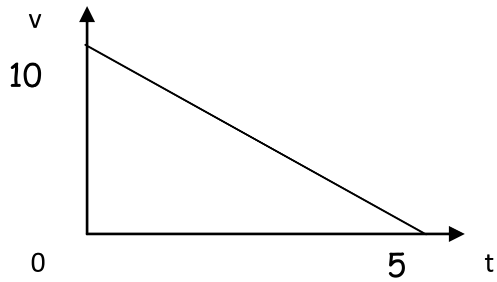


Example 23



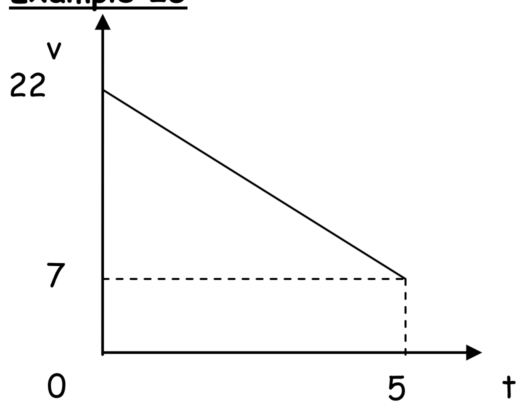
Negative Acceleration

.Example 24

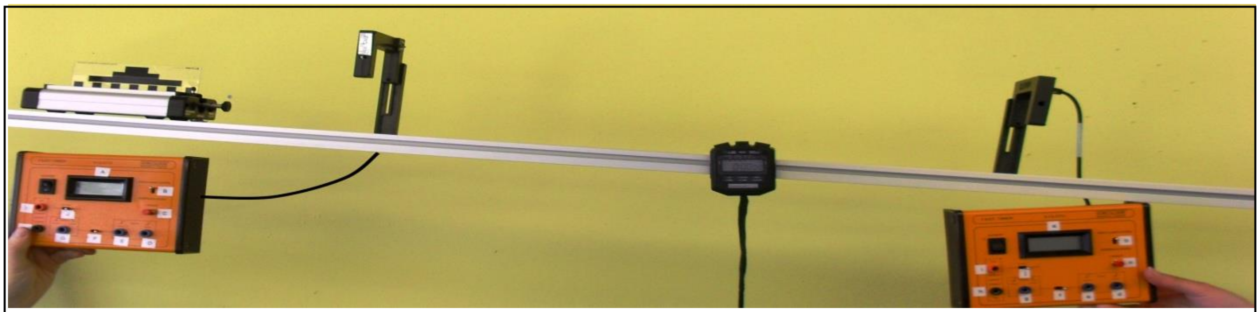


The **acceleration** is

Example 25



Acceleration



v = final speed

u = initial speed

a = acceleration

t = time

Example 26

A car accelerates from 20m/s to 80m/s in 12 seconds. Calculate the acceleration.

Example 27

An object travelling at 80m/s suddenly comes to a stop in 2 seconds

Calculate the deceleration.

Acceleration

Example 28

A trolley starts at rest and speeds up at $4 m/s^2$ for 6 seconds.

Calculate the final speed.

Example 29

A car travelling at 5m/s accelerates at $3 m/s^2$ for 4s. What is its final speed?

Acceleration due to Gravity

Example 30

A stone is dropped off the edge of a cliff. It takes 6 seconds to hit the ground. What speed does it hit the ground at?

Forces

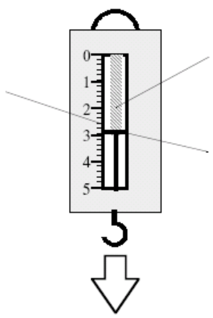
Forces can do three things to an object.
Change the –

1.

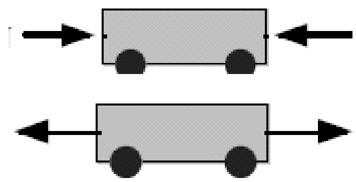
2.

3.

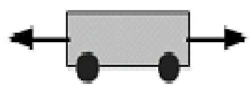
Measuring Force

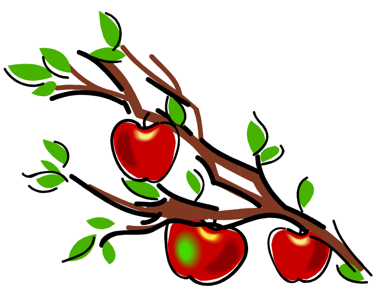


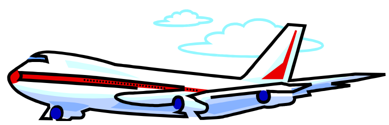
Balanced Forces

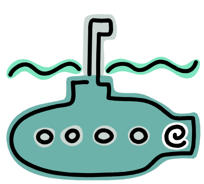


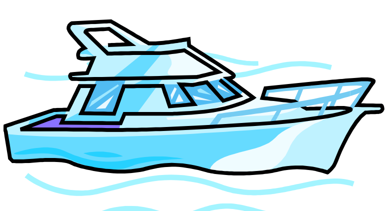
Balanced Forces on the Move











Newton's First Law

Seatbelts

Friction

Definition –

INCREASING FRICTION	DECREASING FRICTION

Newton's Second Law

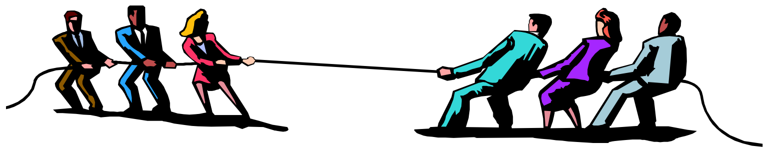
Example 31
Calculate the unbalanced force needed to accelerate a bike of mass 60kg at a rate of $4m/s^2$.

Example 32
Calculate the acceleration caused by a force of 300N acting on a 25kg mass.

Example 33
An object accelerates at $15m/s^2$ when a force of 900N is applied. What was its mass?

Example 34
A boy pushes his sister downhill on her sledge with a force of 150N. The combined mass of the girl and sledge is 40kg. What is her acceleration?

Resultant Forces



In a tug-o-war the two sides each exert a force.

<u>Example 35</u>

A dog out for a walk sees a cat and tries to chase after it. It exerts a force of 75N forwards on the lead. If the child holding the lead can exert a force of 65N backwards – what will happen?

Resultant Forces

Example 36

A motorbike of mass 800kg has an engine force of 12,000N.
The frictional force is 2000N.
What is the acceleration of the bike?

Example 37

A car has an engine force of 5000N.
Each of the four tyres has a frictional force of 50N with the road.
If the mass of the car is 1200kg, what is the acceleration?

Example 38

A boat engine is able to apply a force of 6000N. The boat has a mass of 500kg and accelerates at a rate of $10m/s^2$.

(a) Calculate the size of the frictional force acting on the boat.

(b) What will happen to this force if the barnacles grow on the hull over the summer

Resultant Forces

Example 39

A boat tows a barge with a force of 800N South. The tide exerts a force of 600N East. What is the effect of these forces on the barge?

Weight

Example 40
What is the weight of a person with a mass of 65kg (on Earth)

Example 41
What is the mass of an object which has a weight of 7200N on Earth.

Planet/Moon	'g' (N/kg)
Mercury	4
Venus	9
Earth	10
Mars	4
Jupiter	25
Saturn	10
Uranus	10
Neptune	12
Moon	1.6

Example 42
Find the weight and mass of a 75kg spaceman on

a) Moon
b) Mars

Work Done

Example 43

A cyclist exerts a force of 200N when riding a bike a distance of 60m. How much work has she done?

Example 44

A battery powered model car has a motor which exerts a force of 1.5N over a distance of 25m.

How much work does the motor do?

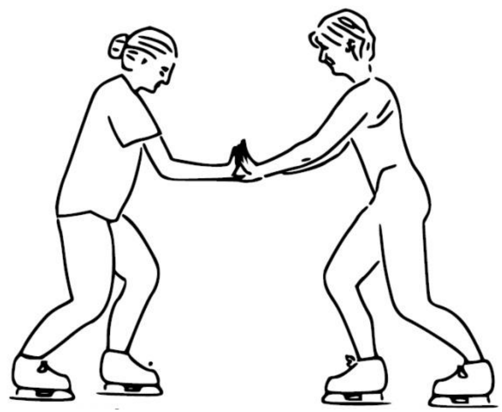
Example 45

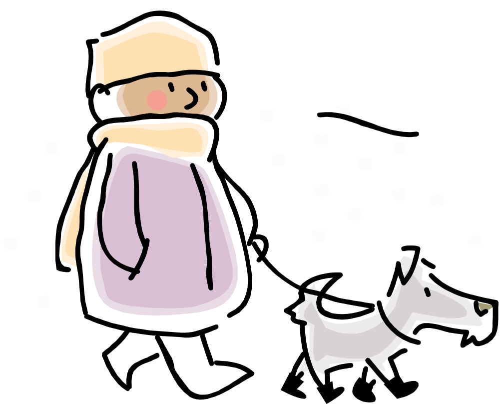
A winch uses 750J of energy pulling a car 6m out of a ditch. What force is exerted on the car?

Example 46

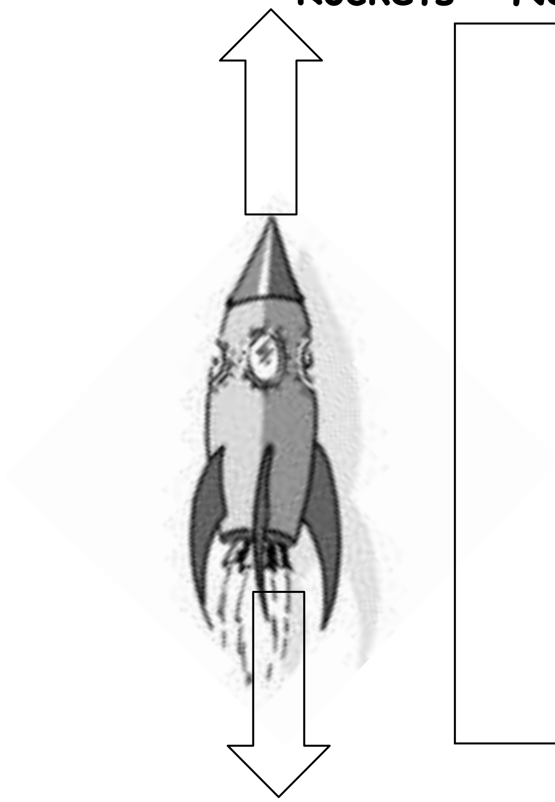
How far can a football team tow a truck using a force of 1500N if their available energy is 22,500J ?

Newton's Third Law





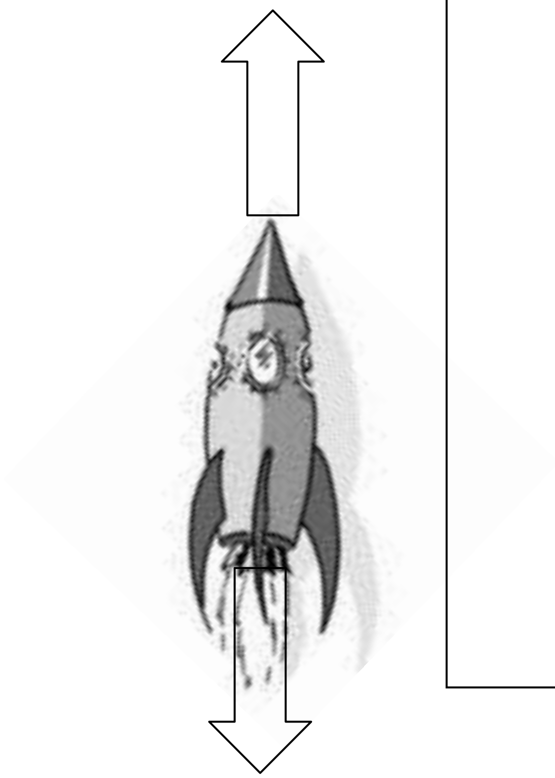
Rockets – Newton's Second Law



Example 47

After lift off a spacecraft of mass 6000kg applies its thruster rockets with a combined thrust of 480000N. What is the acceleration of the rocket?

Rockets – Newton's Third Law



Example 48

Planets and Moons

Stars – what are they?

Our Solar System

Definition of a light year

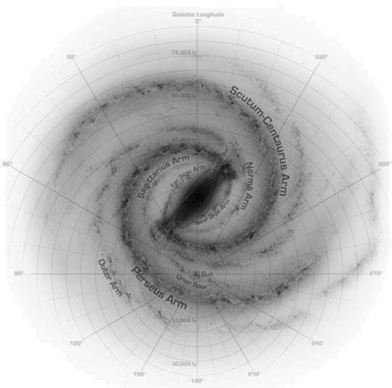
Light year Equivalent in Metres

Calculate the distance in metres, that light travels in one year.

The speed of light in vacuum is 300 000 000m/s.

Distances in Space

Our Milky Way and other Galaxies



Exoplanets and Life Beyond Our Solar System

The Age of the Universe

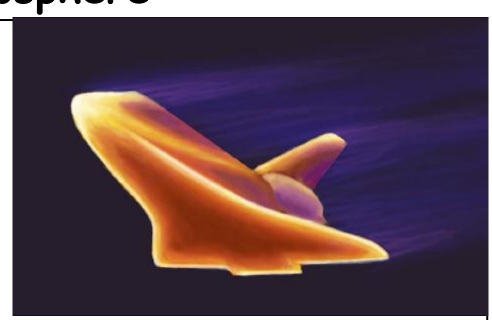
Cosmologists estimate the age of the universe to be around 14 billion years, since the "Big Bang".

The Observable Universe

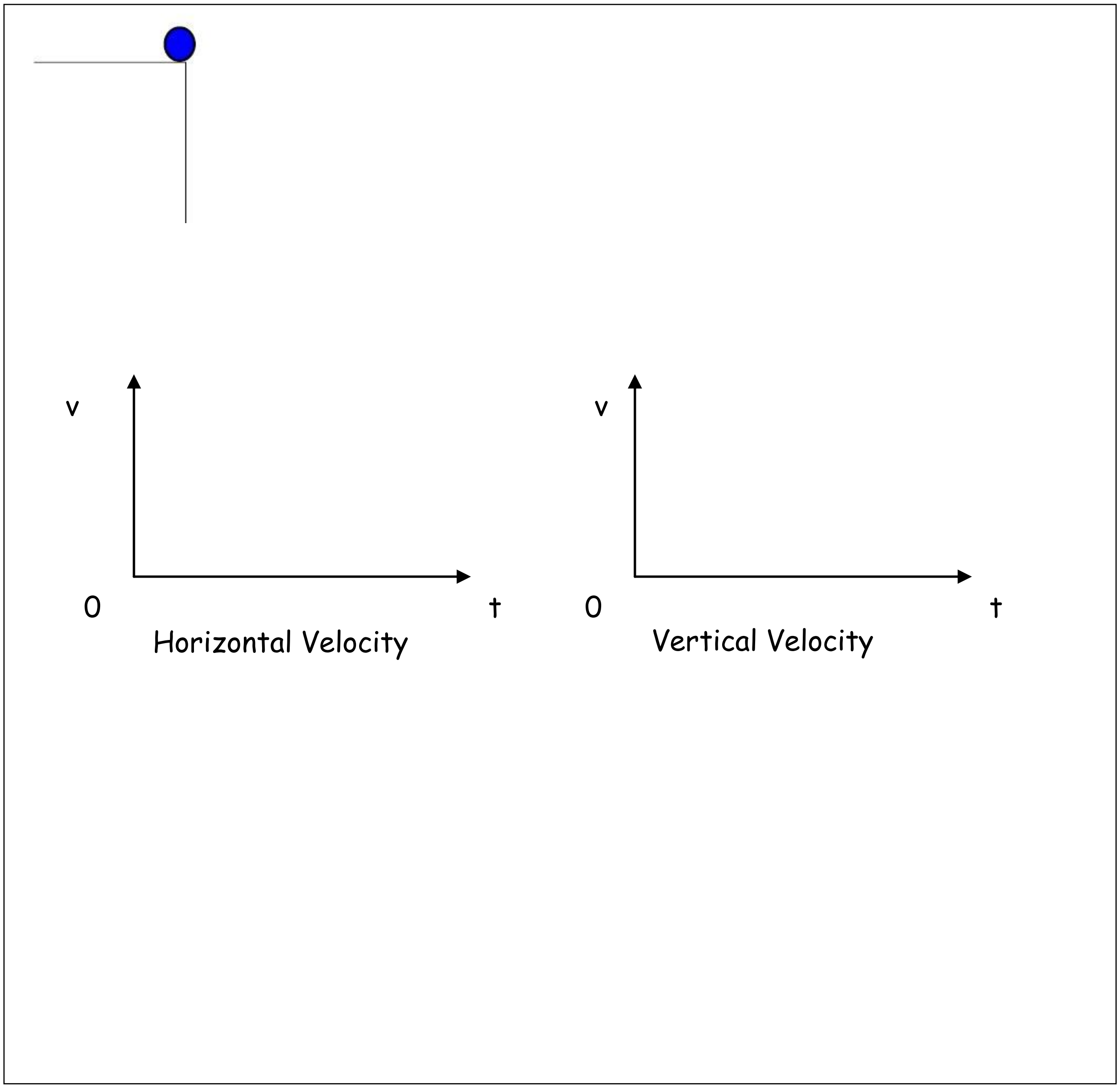
How do we Explore Space?

There are 3 main ways to explore space:

Re-entry to atmosphere

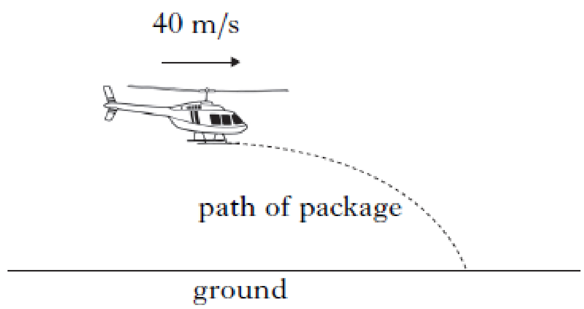


Projectile Motion



Projectile Motion

Example 49

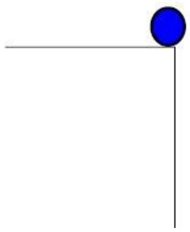


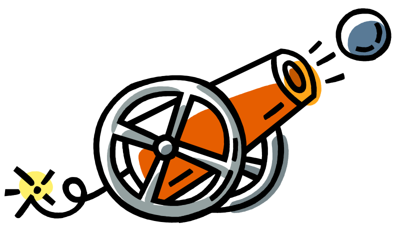
A helicopter flying at 40m/s releases an aid package. It takes 3s to hit the ground.

Calculate:

a) The horizontal speed when the package hits the ground
b) The horizontal distance travelled
c) The initial vertical speed
d) The final vertical speed when it hits the ground.

Newton's Thought Experiment





Newton's Thought Experiment

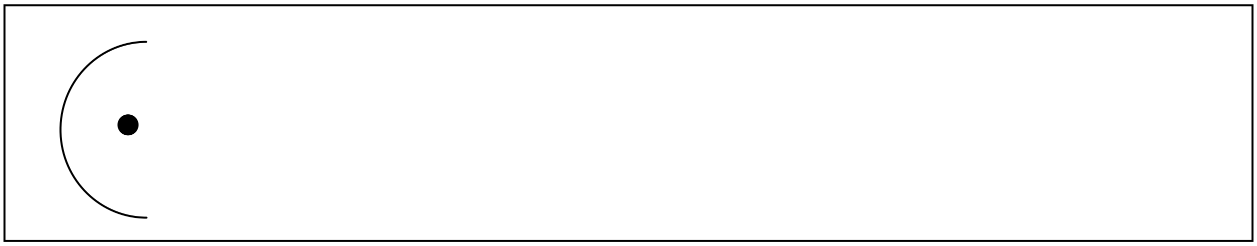
Satellites

Uses of Satellites

Period of a Satellite

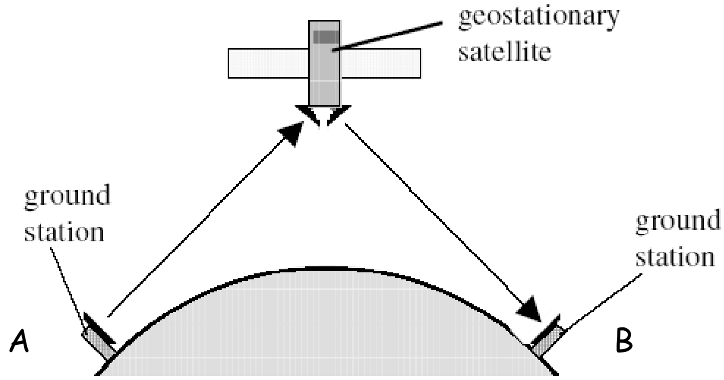
Geostationary Satellite

Satellite Transmitter

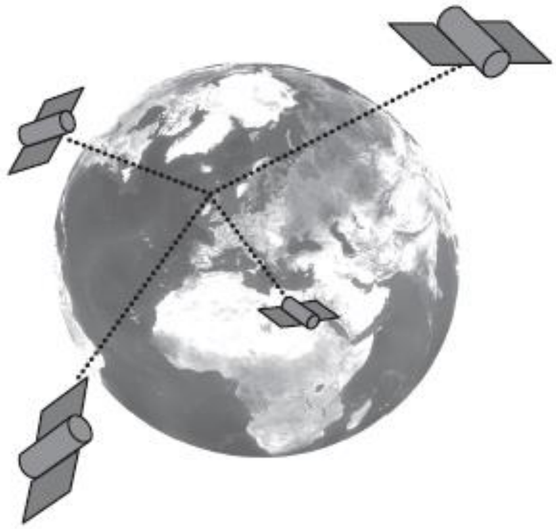


Satellite Receiver

Intercontinental Communication using Satellites



Satellites



Navigation System (GPS)

Example 50

In addition to the speed of the signals, what other quantity must be known to calculate distance?

Example 51

A satellite is at a height of 150km. If the signal travels at 300,000,000m/s, how long will it take for the signal to travel from one ground station to the other?

Freefall and Weightlessness

Example 52

On Earth an astronaut has a weight of 550N. What is her weight in the Space Station?

Example 53

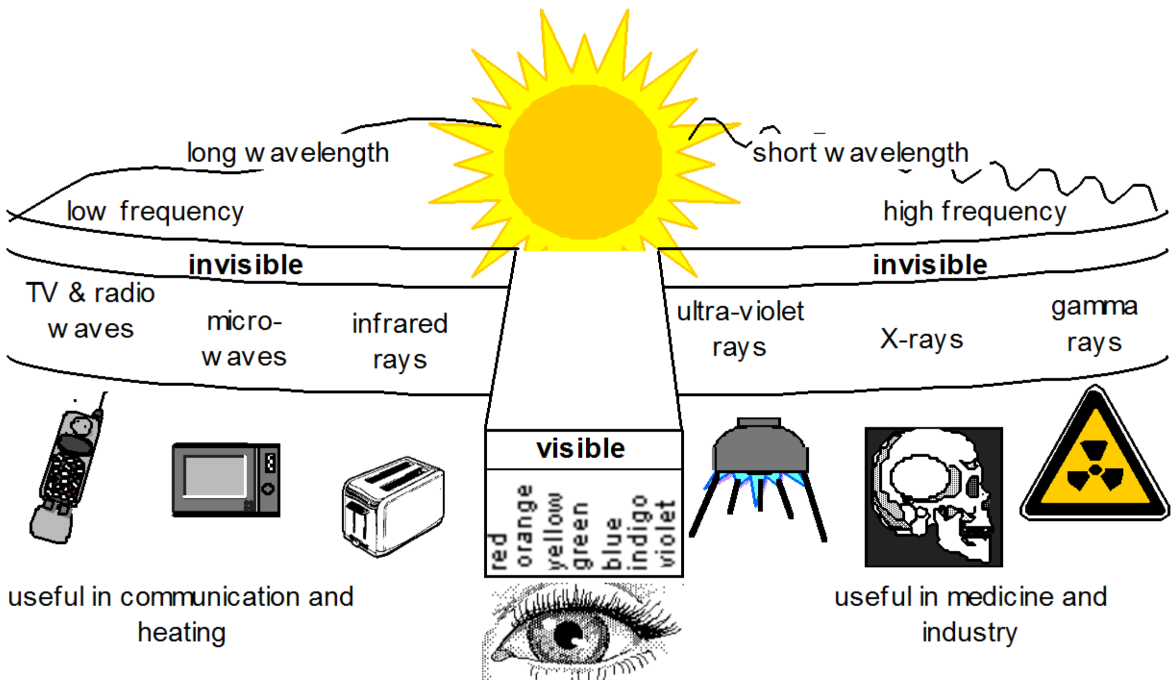
On Earth an astronaut has a weight of 550N. What is her mass in the Space Station?

Risks and Benefits of Space Exploration

Re-entry to atmosphere

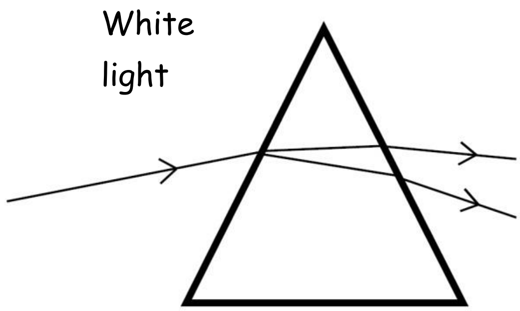
Terminal Velocity

The Electromagnetic Spectrum in Astronomy



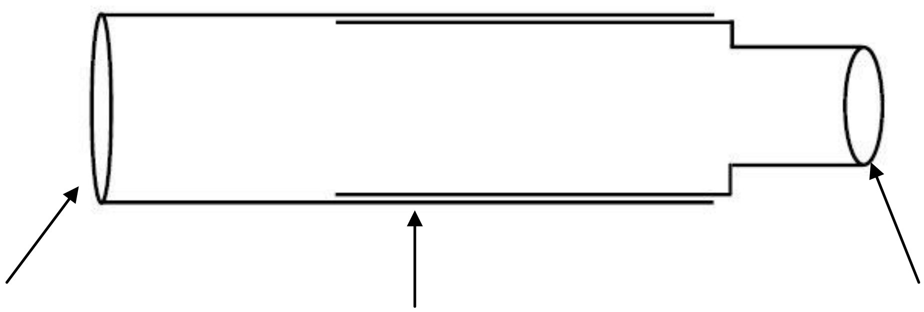
White light

When white light is passed through a prism it forms a spectral pattern



R –
O -
Y -
G -
B –
I -
V -

Telescopes

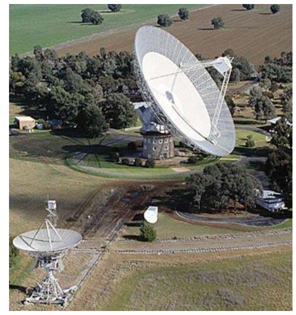


Objective Lens -

Eyepiece Lens –

Light tight tube –

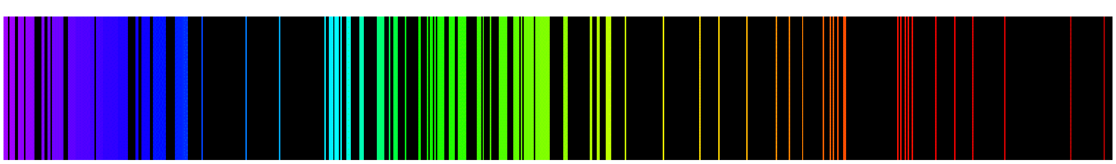
Radio Telescopes



Parkes Observatory, NSW, Australia

Very Large Array, New Mexico, USA

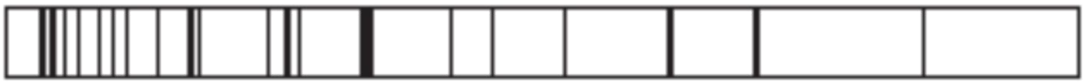
Radiations from Space



Radiation from Space

Example 54

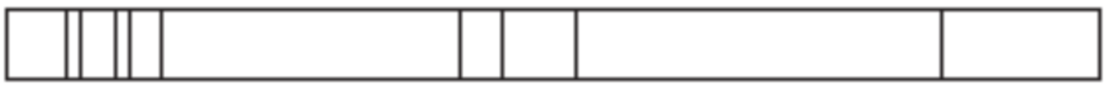
Some spectral lines of radiation from a distant star are shown below.



Spectral lines of radiation from distant star

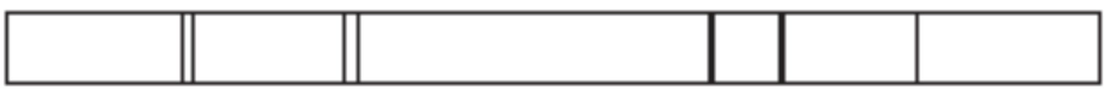
The spectral lines of a number of elements are also shown.

Cadmium

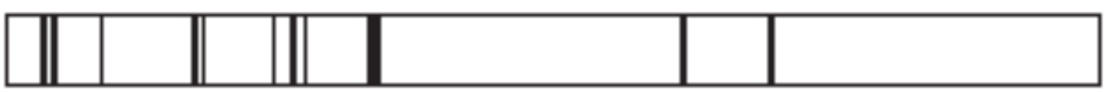


Calcium

Krypton



Mercury



Use the spectral lines of the elements shown to identify which of these elements are present in the distant star.

Types of Radiation from Space