Unit 3 – Dynamics and Space

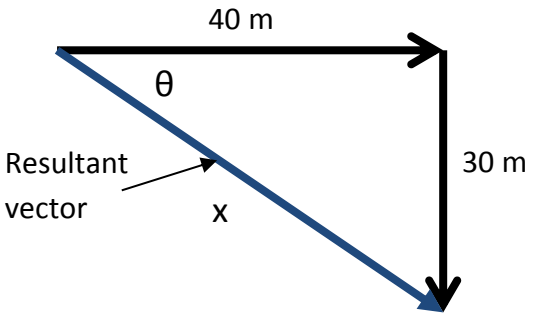
Contents

In the next few pages there will be tables with knowledge that **must** be learned before the National 5 Physics exam. In the 1st box put a ✓ or ✗ to show your understanding. You can use the 2nd box to check your understanding at a later date.

Using this sheet **will** help you become more prepared for your final exam.

Use the extra space sections to include any additional information that you find when doing past paper questions/reading your notes etc…

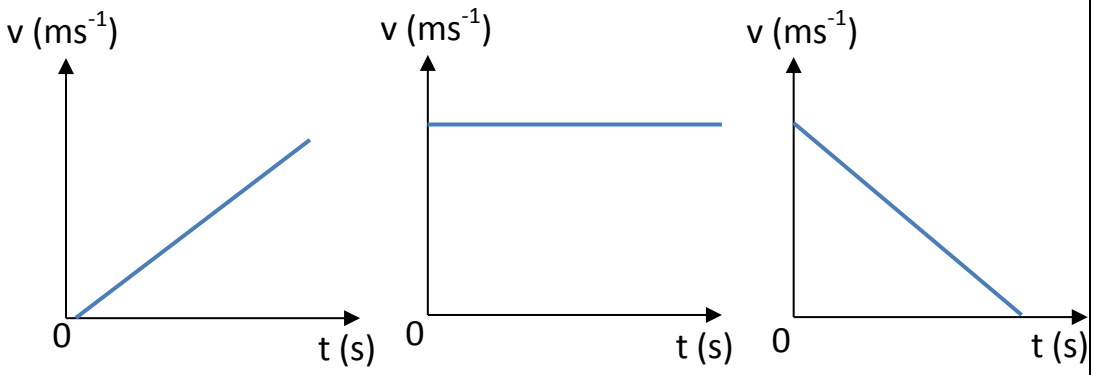
Section 1 – Velocity and Displacement – Vectors and Scalars

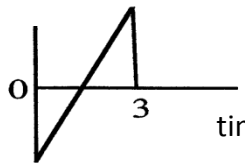
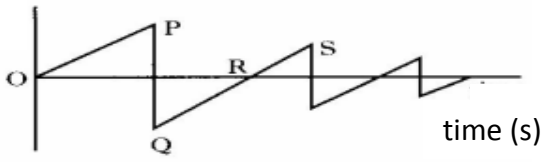
A scalar quantity has size (magnitude) only.		
A vector quantity has size (magnitude) and direction.		
Examples of scalar quantities are; speed, distance, mass, time and energy.		
Examples of vector quantities are; force, velocity, displacement, acceleration and weight.		
When calculating a vector the size **and** direction **must** be given in the answer.		
Vectors can be added in a straight line to find the resultant vector. 8 N + 6 N = 14 N		
Vectors can be subtracted in a straight line to find the resultant vector. 8 N + 6 N = 2 N		
Vectors can be added in two dimensions when they are at right angles to each other. To find the size, Pythagoras is used: $x^2 = a^2 + b^2$ To find the angle, trigonometry is used: tan θ = opposite/adjacent The angle must then be converted to a 3 figure bearing measured from the North. i.e. 25^o = 025		
When solving vectors at right angles a sketch should be made showing the resultant vector, the angle θ and size x added to the diagram. 		
distance = speed x time (d = v t) – these are scalar quantities.		
displacement = velocity x time (s = v t) – these are vector quantities. When finding velocity and displacement a direction **must** be given in the answer.		
Extra space for additional information		

Section 2 - Acceleration

Acceleration is defined as the change in velocity per unit time. The equation is; $a = \frac{v-u}{t}$ An acceleration of 3 ms^{-2} means the velocity is changing by 3 ms^{-1} per second.		
V = final velocity and U = initial velocity.		
The units of acceleration are ms^{-2}.		
When measuring acceleration the initial velocity, final velocity and time taken are required. The initial velocity is found using the length of the first part of the U-shaped card and the time the light beam on the light gate is broken with the equation; $v = \frac{\text{length of card}}{\text{time light beam broken}}$. The final velocity is found using the length of the second part of the card and the time the light beam is broken with the equation; $v = \frac{\text{length of card}}{\text{time light beam broken}}$. The time is the total length of time from start of the first part to the end of the second part. The acceleration is then found using; $a = \frac{v-u}{t}$		
A deceleration is a negative acceleration when it is calculated.		
Extra space for additional information		

Section 3 – Velocity-time graphs

Velocity-time graphs have 3 types of lines;  Graph 1 – An upward diagonal = a constant acceleration. Graph 2 – A horizontal line = a constant velocity (no acceleration). Graph 3 – A downward diagonal = a constant deceleration.		

To find the acceleration for a line on a velocity-time graph the equation; $a = \frac{v-u}{t}$ is used.		
To find the distance/displacement from a velocity-time graph the area under the graph is found by splitting it into triangles and rectangles, then adding the answers together.		
A velocity-time graph can be used to show that an object has changed direction. If upwards is positive then downwards will be negative. velocity (ms^{-1})  time (s) Ball thrown upwards and caught by thrower. velocity (ms^{-1})  time (s) Ball dropped then bounces off desk three times.		
Extra space for additional information		

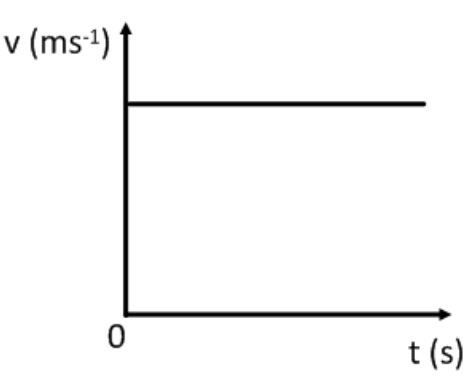
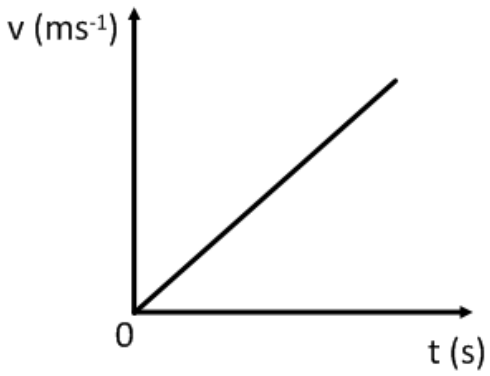
Section 4 – Newton's Laws

Newton's 1st law states that an object at rest or moving with a constant speed in a straight line will have balanced forces.		
An object at **rest** or **constant speed** has **balanced forces**.		
Balanced forces are the same as having no forces at all.		
Newton's 2nd law involves objects that **accelerate** because an **unbalanced force** is applied to it.		
Newton's 2nd law uses the equation F = ma where F is the **unbalanced force**.		
The acceleration varies **directly** with the unbalanced force.		
The acceleration varies **inversely** with the mass.		
The units of force are Newton's.		
One Newton is defined as the force required to accelerate a 1 Kg mass by 1 ms^{-2}.		

When solving vector questions using forces the vectors must be added 'tip' to 'tail'. If they are not added this way the size of the resultant vector will be correct but the direction will be incorrect.		
Seatbelts, air bags and crumple zones are safety features in cars which reduce the force of an impact by increasing the time of contact during a collision.		
Work done = force x distance. $E_w = F\ d$		
Work done is a type of energy and is measured in Joules.		
Energy is always transferred from one type to another and never created or destroyed.		
The loss in potential energy is equal to the gain in kinetic energy and vice versa. $E_p = E_k$		
Weight is a downward force caused by the Earth's gravitational pull.		
Weight is measured in Newton's.		
Mass is a measure of the amount of matter/particles that make something up.		
Mass is measured in Kilograms.		
Weight = mass x gravitational field strength. $W = m\ g$		
Gravitational field strength is defined as weight per unit mass.		
Gravitational field strength is measured in Nkg^{-1} and is 9.8 NKg^{-1} on Earth.		
Newton's 3rd law states; If object A pushes object B, object B will push object A with an equal and opposite force.		
Object A and object B are called 'Newton pairs'.		
When doing questions involving rocket launch/landing the equations; W = m g is used to calculate the weight and F = m a is used to calculate the acceleration. F is the **<u>unbalanced force</u>** and **<u>NOT</u>** the thrust. Unbalanced force = thrust - weight **or** weight – thrust.		
If the thrust is greater than the weight the rocket will accelerate upwards.		
If the weight is greater than the thrust the rocket will accelerate downwards.		
The acceleration of a rocket will increase as it leaves the Earth's surface because; • Fuel is used up so the mass will decrease • The weight will decrease so there is a greater unbalanced force • Gravitational field strength will decrease with height		
Fluids apply resistive forces (friction) to an object.		
An object will accelerate in a fluid when dropped to begin with as there is an unbalanced force downwards due to the object's weight.		

As the speed of the object increases the resistive force increases. This means there is a smaller unbalanced force so the acceleration decreases.		
When the resistive force is the same size as the weight the forces are balanced and the object reaches a constant speed. When an object is falling the constant speed is called the 'terminal velocity'.		
If the resistive force is large, the object will reach a constant speed in a shorter time.		
Extra space for additional information		

Section 5 – Projectile Motion

Projectiles follow a curved path 		
A projectile always has a; • constant HORIZONTAL velocity • constant VERTICAL acceleration		
For horizontal motion we use the equation; $s = v\,t$		
For vertical motion we use the equation; $v = u + at$ where $u = 0\ ms^{-1}$ and acceleration (always) = $9.8\ ms^{-2}$.		
The velocity-time graph for each motion looks like;  Horizontal (velocity is constant)  Vertical (constant acceleration)		

The distance (horizontal and vertical) can be found by calculating the area under the graph. To find the horizontal distance s = v t can be used. To find the vertical distance s = v t can be used but v must be the average velocity.		
Satellites orbit Earth as they have a constant horizontal velocity and constant downward acceleration. As the Earth is curved the satellite orbits the Earth and does not crash into it as long as the horizontal velocity is large enough.		
Extra space for additional information		

Section 6 – Cosmology

A planet is an object that orbits a star.		
A moon is an object that orbits a planet.		
A star is a ball of very hot gas produced by nuclear fusion.		
A solar system contains one star and numerous planets.		
An exo-planet is a planet which does not orbit our sun.		
To support life an exo-planet must; • Have liquid water • Have air with oxygen in it • Not be too hot or cold • Be rocky (not a gas giant)		
A galaxy is a system of stars, dust and gas.		
The Universe is the whole of space.		
A light year is the **<u>distance</u>** light travels in one year.		
To calculate this distance in metres the equation; d = v t is used where; v = speed of light (3×10^8 ms^{-1}) and t = the number of seconds in one year.		
Big bang theory states that the Universe began from a single point approximately 13.7 billion years ago.		
The size of the Universe is always expanding.		

Each part of the EM spectrum has a certain range of wavelengths so needs its own type of telescope to obtain information about different parts of space.		
TV and Radio waves are detected by an aerial. Microwaves are detected by an aerial. Infrared waves are detected by a photodiode. Visible light is detected by our eye and photographic film. UV waves are detected by photographic film and fluorescent materials. X-rays are detected by photographic film. Gamma rays are detected by photographic film and a Geiger Muller tube.		
Continuous spectra shows all of the visible colours of light. (ROY G BIV)		
Line spectra shows only certain colours of light. These colours have a certain wavelength that is detected.		
Line spectra is used to identify elements in a sample. This is done by comparing it with known line spectra of these elements.		
Extra space for additional information		

Section 7 – Space Exploration

Our understanding of the universe and our Earth is supported by evidence from telescopes and space exploration.		
The benefits of telescopes space exploration are; development of weather forecasting, telecommunications via satellites, analysis of our environment, national security, spin off technologies such as robotics, sat nav systems etc…		
When a spacecraft re-enters the Earth's atmosphere the main energy change is kinetic energy to heat energy.		
Heat energy is caused by friction at very high speeds. This can damage the spacecraft.		
The angle of re-entry must be carefully calculated so the spacecraft does not bounce off the atmosphere.		
Specific latent heat is defined as the energy released/absorbed by a substance while changing state for a 1 kg mass.		

A substance absorbs energy when melting and boiling.		
A substance releases energy when condensing and freezing.		
Specific latent heat equation is; $E_H = m\,l$ where l = specific latent heat		
Specific latent heat is measured in JKg^{-1}.		
Latent heat of fusion is when a substance changes state from a solid to liquid or vice versa.		
Latent heat of vaporisation is when a substance changes state from a liquid to gas or vice versa.		
A substance **DOES NOT** change temperature when changing state.		
Extra space for additional information		