Dynamics and Space Revision

March 2017

Name: **MARK SCHEME**

Describe the difference between a scalar and vector.

A scalar quantity has a magnitude (size) and unit.
A vector quantity has a magnitude, unit and a direction.

List 4 vector quantities and 5 scalar quantities

NB You can't say Force and also weight or Friction, Force includes ALL forces

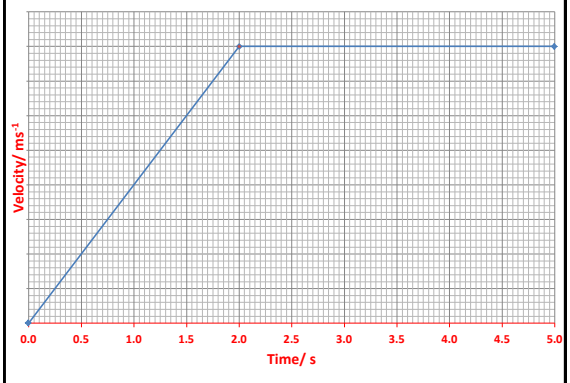
Scalar	Vector
Time	Displacement
Distance	Velocity
Speed	Acceleration
Energy	Force (Weight, Friction
Mass	Upthrust, Drag etc)
Everything else at N5 etc.	Gravitational Field strength

In the relationship $v = u + at$, state what each symbol represents and the units of each

v = final velocity (metres per second, ms^{-1})
u = initial or starting velocity (metres per second, ms^{-1})
a = acceleration(metres per second per second, ms^{-2})
t = time for the object to accelerate (second, s)

Sketch a velocity–time graph to show how the velocity of the car varies during the test run.

- During a test run, a car starts from rest on a straight, flat track.
- For the first 2 s of its motion it has a constant acceleration. It then travels at a constant velocity for a further 3 s.
- Numerical values are only required on the time axis.



- A fork –lift truck us used to load a crate of mass 200kg onto a lorry.
- It has to drive 12m to the lorry and then lift the crate up 1.5 m on to the lorry. The driving force is 500N and the energy available for the operation is 8000J. Will the fork lift truck be able to load the crate onto the lorry?

Find the E_w moving the crate 12m
E_w=?
F=500N
d=12m

E_w=F x d
E_w=500 x 12
E_w=6000J

Ep=
m =200 kg
g = 9.8 N kg^{-1}
h= 1.5 m

Ep= m x g x h
Ep= 200 x 9.8 x 1.5
Ep= 2940 J

Total work done in lifting the crate = E_w+E_p
6000 + 2940 = 8940J

The fork lift truck CANNOT carry out this operation as it is approx. 1000J too short.

State Newton's Three Laws of Motion

- **An object will remain at rest or move at steady speed in a straight line unless acted upon by an unbalanced force.**

Or Unless an unbalanced force acts on an object the object will move at constant velocity (which means constant speed in a straight line)

Or An object will remain at rest or move at constant velocity unless acted upon by an unbalanced force.

This is best learned as a formula

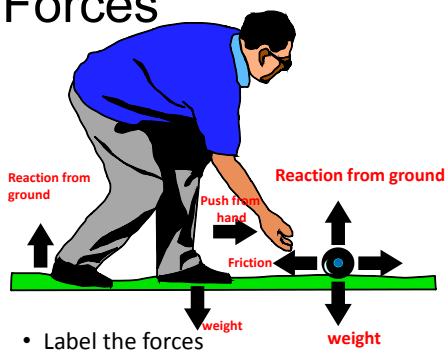
- **Force=mass × acceleration**
- **F=ma**

- **For every action there is an equal but opposite reaction**

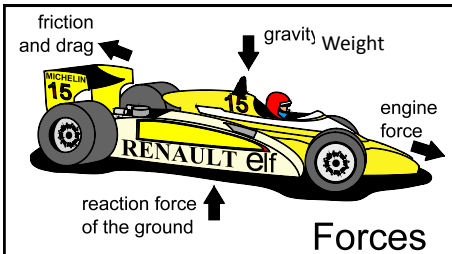
Or if A & B are objects!

- **If A exerts a force on B, B exerts and equal but opposite force on A.**

Forces



- Label the forces



Forces

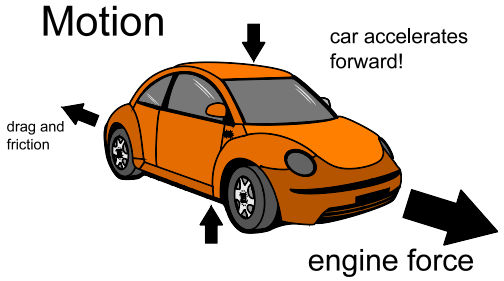
- Are these examples of balanced forces or Newton Pairs?

Weight & Reaction, are a Newton Pair (push off car on the ground push of the ground on the car

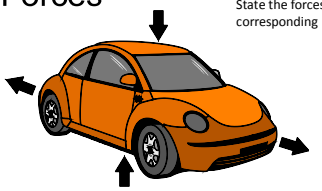
Engine Force and Friction balanced forces

What can you infer about the size of the forces in the eg below?

- **Engine Force > Drag as car accelerates**
- **Reaction and Weight balanced**



Forces



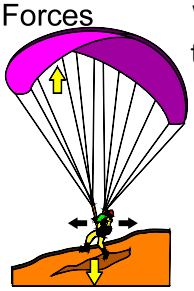
State the forces on the car and the corresponding Newton Pair.

Weight is the force of the car on the ground, reaction is the force of the ground on the car.

Engine force of the car, reaction is the force *****.**

The frictional forces are tyres on road, road on tyres and car on the air and the air on the car

Forces



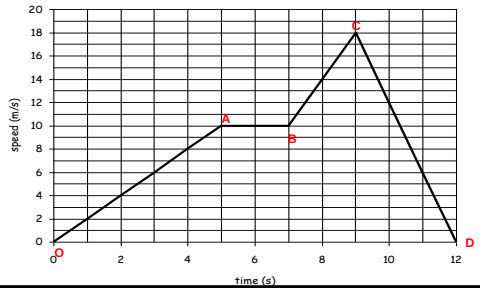
What is the name given to this type of diagram?

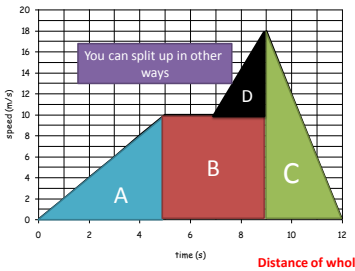
- Label the forces on the diagram.

Free body diagram

- **Weight**
- **Lift force, upthrust**
- **Wind**
- **Person's push**
- **Drag**

Calculate the accelerations and the distance travelled in the first 5s and the total distance travelled





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

0-A

$a = \frac{10-0}{5} = 2.0\ ms^{-2}$

B-C

$a = \frac{18-10}{2} = 4.0\ ms^{-2}$

C-D

$a = \frac{0-18}{3} = -6.0\ ms^{-2}$

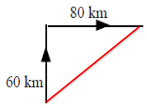
Distance first 5s- area under v-t graph
d= ½ bh = 0·5 ×5 ×10 = 25m

Distance of whole journey = areas A+B+C+D
B= b × h = 4 × 10 = 40 m
C = ½ bh = 0·5 ×3 ×18 = 27m
D = ½ bh = 0·5 ×2 ×8 = 8m

Distance for Total journey = 25 + 40 + 27 + 8 = 100 m

- A car drives 60 km north, then 80 km east, as shown in the diagram. The journey takes 2 hours. Calculate the
- a) distance travelled **60 + 80 = 140 km**
- b) displacement **(3,4 5 triangle) by scale diagram or Pythagoras = 100 km @ 53° from North**
- c) average speed **v=d/t = 140/2 = 70 kmh^{-1}**
- d) average velocity. **v=s/t = 100/2 = 50 kmh^{-1}**

@ an angle of 53° from North



$tan\theta = \frac{opp}{adj} = \frac{80}{60}$

$tan\theta = 1.33333333$

$\theta = tan^{-1}\ 1.3 = 53°$

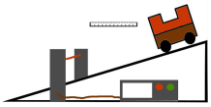
The brakes of a car exert a force of 500N to stop the car. If the braking distance is 67m how much work is done by the brakes to stop the car.

- What happens to the kinetic energy of the car?

$$E_w = Fd = 500 \times 67 = 3400J$$

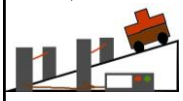
The kinetic energy is converted into heat in the brakes and the tyres

Explain how to measure the acceleration of a trolley as it rolls down a slope



You can measure acceleration in the lab with EITHER one single mas and two light gates or a double mask and one light gate.
Whichever way the experiment is conducted the measurements that need to be made are:
•Width of the mask or masks.
•Time for first light beam to be broken.
•Time for second light beam to be broken.
•Time between the breaks in the light beam to be measured.

The formula to use is:
whre;
u = starting speed
v = final speed
t = time for change in speed.
To find the speed

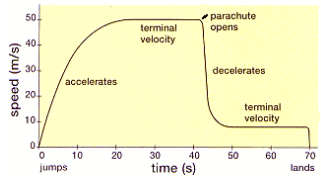


Measurements	Calculations
t_1 time to pass first light gate	$u = \frac{l}{t_1}$
t_2 time to pass second light gate	$v = \frac{l}{t_2}$
t_3 time between light gate	$a = \frac{v-u}{t_3}$
Length of mask	L

Acceleration is the "rate of change of velocity", that is how quickly you change your velocity *Or* change of velocity per second

Sketch a graph of the velocity against time for a parachutist from the moment they jump out of the plane to when they land

- Describe each part of the journey, making references to the forces involved

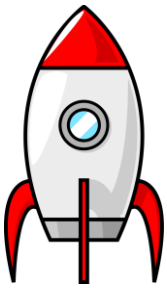


During the acceleration phases W> Drag
During deceleration phase W< either drag or ground force
During terminal velocity phases W = Drag

Explain the term terminal velocity and explain how this arises.

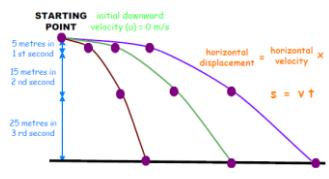
- **Terminal velocity is when the forces of weight or engine force etc, are balanced by the drag / frictional forces.**
- **Both forces are equal in size but opposite in direction and results in constant velocity called terminal velocity.**

A rocket, of mass 300kg, on a launch pad produces a thrust of 2500 N. Describe what happens to the rocket.



$$W = mg$$
W= 300 ×9.8 = 2940N

As W> Thrust the rocket remains on the launch pad.
The additional force to balance the weight will come from the reaction force from the ground.



A ball is kicked horizontally off a bench.
a) Sketch the path taken by the ball.
b) describe, in detail, the motion of the ball.

- **Horizontally the ball travels with constant horizontal speed**
- **Vertically the ball travels with constant acceleration or increasing velocity.**

Space Exploration-Give two risks and two benefits of space exploration

Some Risks of Space Travel	Benefits of space travel
• Sitting on top of a rocket at take off • Problems of re-entry • Problems of skimming atmosphere and being thrown into space • micrometeorites - danger from impact • damage to space craft or astronaut during space walk • solar flares and radiation-a brief eruption of intense high-energy radiation from the sun's surface • no atmosphere- we need air to breathe • space debris • Travelling really fast • Problems of pressure differential • Weightlessness and the reduction of bone density	• Explore our own planet from above and the rest of the solar system • Search into the distant past and find out where we came from • Satellites- we can now reach any one from almost anywhere on earth due to satellites, we can also predict the weather and monitor environmental conditions such as temperature and water content • NASA Spin offs e.g. Memory foam, Water filters, Long range communication, Scratch resistant lenses Smoke detectors, Special Baby food. Cordless tools

Explain the difference in motion between an object dropped from 2m on the Earth and one dropped from the same height on the Moon.

- **On the Earth the object will accelerate at 9.8ms^{-2}**
- **On the Moon the object will accelerate at 1.6ms^{-2}**

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

$$9.8 = \frac{v-0}{t} \qquad 1.6 = \frac{v-0}{t}$$

$$s = \frac{v+u}{2}\,t$$

$$2 = \frac{v+0}{2}\,t$$

Describe what is special about the orbit of a geostationary/ geosynchronous satellite

Geostationary satellites take 24 hours to orbit the Earth. This is the same time that Earth takes to complete one rotation and so the satellite always remains above the same point on the Earth's surface. To achieve this orbit, the satellite must be at an altitude of 36,000 km and positioned above the equator of the Earth.

State what you can infer about satellite periods from the table below

Height of orbit (km)	Period (h)
200	1.5
700	1.6
1 000	1.8
1 414	1.9
10 000	5.8
20 000	11.9
35 786	24.0

As the height above the Earth increases the period of orbit (time for one orbit) increases

A 5kg object is taken to the moon

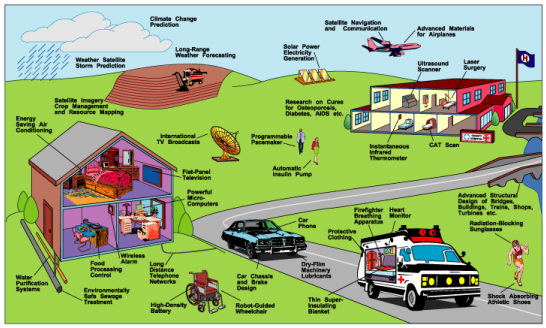
- State the value of the mass at the three points in its journey.

Position	Mass (kg)
On Earth	**5**
In space ship during the journey	**5**
On the moon	**5**

Show by calculation that a light year is 9.46×10^{15} m

- $\boldsymbol{Distance = speed \times time}$
- $\boldsymbol{d = 3 \times 10^8 \times (seconds\ in\ one\ year)}$
- $\boldsymbol{d = 3 \times 10^8 \times (60 \times 60 \times 24 \times 365)}$
- $\boldsymbol{\underline{d = 9.46 \times 10^{15}\text{m}}}$

Give **one** example of how space exploration has impacted on everyday life.



Why does re-entry to a planet's atmosphere pose a challenge to spacecraft designers and engineers?

On returning to Earth, the spacecraft will re-enter the atmosphere. While the air itself may not seem dense, travelling very fast through air creates very high frictional forces generating extremely high temperatures.
To protect astronauts from these high temperatures, the spacecraft must be able to:

- **absorb a certain amount of heat energy.**
- **radiate heat energy back into the atmosphere.**
- **Spacecraft have heatproof tiles on the underside. These protect the occupants from the high temperatures and prevent the spacecraft from being destroyed on re-entry. Re-entry temperatures can reach as high as 1,650°C.**

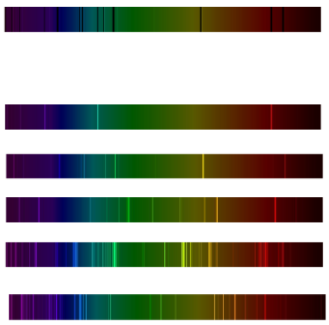
Name the different spectra

Emission Spectrum

Continuous Spectrum

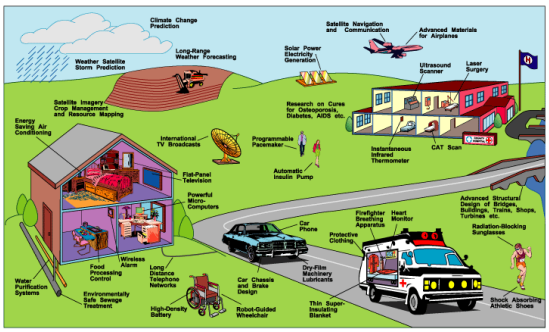
Absorption Spectrum

Identify the elements in this star spectrum



H & He

How many of these NASA spinoffs have you used recently?



Define the following terms

Term	Definition
Planet	A natural satellite of a star
Moon	A natural satellite of a planet
Star	A bright ball of burning plasma
Sun	A star with planets surrounding it
Galaxy	The basic building block of the universe containing stars, planets etc
Solar System	One or more suns surrounded by planets,
Universe	The sum total of everything that exists.
Comet	A dirty snowball of ice and rock travelling in an elliptical orbit around the sun

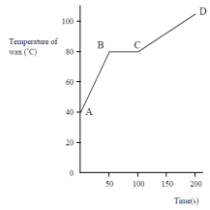
Put the following in order of size from the largest to the smallest.

- **Comet**
- **Moon**
- **Planet**
- **Star/ Sun**
- **Solar System**
- **Galaxy**
- **Universe**

Calculate the amount of heat energy required to melt 0.3 kg of ice at 0 °C.
(Specific latent heat of fusion of ice = 3.34 x 10^5 J/kg)

$$E_H = ml = 0.3 \times 3.34 \times 10^5$$
$$E_H = 1.00 \times 10^5 \text{J}$$

The graph below shows how the temperature of a 2 kg lump of solid wax varies with time when heated.
A) Explain what is happening to the wax in the regions AB, BC and CD.
B) If a 200 W heater was used to heat the wax, calculate the specific latent heat of fusion of the solid wax.



AB wax being heated
BC wax melting
CD liquid wax heating

$$Pt = E = ml$$
The time for the wax to melt is 50s
$200 \times 50 = 2l$
$10\,000/2 = l$
$l = 5\,000\ \text{Jkg}^{-1}$