**Physics Forces 4 Acceleration (P4.5.6.1.5)**

* The acceleration of an object tells you how quickly its velocity is changing.
* The units of acceleration are m/s2.
* If the acceleration is positive this means that the velocity is increasing.
* If the acceleration is negative the velocity is decreasing .
* Acceleration is shown by a diagonal line on a velocity/time graph.
* The gradient of the line on a velocity time graph is the acceleration.
* The area under a velocity time graph is the distance travelled.
* The acceleration of an object falling freely near the earth is 9.8m/s2
* Air resistance increases as an object accelerates.
* An object falling through a fluid initially accelerates due to the force of gravity. Eventually the resultant force will be zero so the object will move at it’s terminal velocity . This the greatest velocity it can reach.

**Complete the following:**

* 1. Revise distance / time graphs by watching <https://www.youtube.com/watch?v=DkCw2C-DkT0>
  2. Make careful notes on acceleration from this clip <https://www.youtube.com/watch?v=r5iXzDCRMsE>  
     Your notes should include:  
     (i) the definition of acceleration and the difference between acceleration and deceleration  
     (ii) the equation used to calculate acceleration and the units of acceleration  
     (iii) an example of an acceleration calculation  
     (iv)What acceleration looks like on a distance / time graph  
     (v) what acceleration looks like on a velocity /time graph  
     (vi) how to calculate acceleration from a velocity time graph.  
     (vii) how to calculate the distance travelled from the area under the graph (higher paper only)
  3. Higher level students, watch and make notes on <https://www.youtube.com/watch?v=okMA18ppu98>
  4. Complete the following: (remember to show all working out and units)  
     a. Calculate the speed of a car which travels 100m in a time of 4 seconds  
     b. Calculate the time taken for this car to travel 5 km.  
     c. Calculate the distance this car travels in a time of 20 minutes  
     d. Estimate the average speed of a world class 100m sprinter (show your working)  
     e. Calculate the acceleration of a lorry whose speed increases from 0 m/s to 15m/s in 3 seconds  
     f. Calculate the final speed of a car which travelling at 5m/s then accelerates at 2m/s2 for 5s .   
     g. A runner accelerates at 1.5m/s2. Calculate how long will it take them to change their speed from 1.0m/s to 8.0m/s?  
     Useful information: Speed = distance/time Acceleration = (v – u)/t W = mg (g = 9.8 N/kg )
  5. The graph show the movement of a gnome pushing a wheel barrow.  
     a. Calculate the total distance moved by the gnome  
     b. Calculate the maximum speed reached by the gnome  
     c. Calculate the average speed for the whole journey.
  6. The graph shows the motion of a 2.0 kg radio controlled herring.
  7. Describe the motion of the herring from t=0s to t=20s
  8. Calculate the total time that the herring was stationary
  9. Calculate the acceleration of the herring at (i) t = 4 seconds, (ii) t = 12 seconds
  10. Calculate the deceleration of the herring at t = 19s
  11. Calculate the distance travelled by the herring between t-6s and t=10s.
  12. Calculate the total distance travelled by the herring from t=0s to t=20s (Higher only)
  13. Watch and make careful notes on the clip. <https://www.youtube.com/watch?v=aVy_gNVaCGg>
  14. Complete the following worksheet:

Air Resistance & Terminal Velocity



When a skydiver jumps out of a plane and falls through the air, there are two forces acting on him:

**1.**

**2.**

*Draw and label these two forces on the diagram.*

*Fill in the gaps using the forces you have just written down.*

His ............................... is constant.

The ..................................................... increases as he gets faster.

The resultant force = .................................... .......................................................

*Read the following statements carefully. Then copy them out into a logical order, using the numbered lines below.*

1. His weight pulls him downwards.
2. He continues to fall at a steady speed.
3. The *resultant force* decreases.
4. Just as he begins to jump, his speed is zero, so no air resistance.
5. The resultant force is now zero, so the skydiver is in equilibrium.
6. He accelerates.
7. He has reached his ***terminal velocity***.
8. Because he is getting faster, the air resistance increases.
9. He continues to accelerate, and the air resistance increases until it is *equal* to his weight.

# Hint. Your first statements should be d followed by a. Make sure you write out the whole statement!

# Terminal Velocity

The ***terminal velocity*** is the fastest velocity which an object can reach as it falls through the air. It depends on the ............................... and ............................... of the object.

eg: a .................................................... has a slow terminal velocity.

a .................................................... has a fast terminal velocity.

# Velocity-Time Graph

Alison jumps out of an aeroplane.

She accelerates quickly at first, then the acceleration decreases smoothly.

After 100 seconds she reaches her terminal velocity of 50m/s. Her acceleration is zero.

She falls for a further 300 seconds, then opens her parachute.

Her terminal velocity drops sharply to 8m/s, and she continues to fall at this velocity.

*On the axes below, sketch a velocity-time graph for Alison.*



*Copy the following labels onto the graph at the relevant places:*

Jumps out of the plane. Reaches terminal velocity. Opens parachute.

* 1. Watch the following clip and then explain carefully why this machine can travel so fast compared to an ordinary bicycle. In your answer, make references to the forces acing on the machines.   
     <https://www.youtube.com/watch?v=qYeuTXj1FY8>
  2. Research and make notes on Newton’s 1st Law of motion. (lots of Youtube clips to choose from)
  3. Carry out an investigation to see the relationship between the force on a mass and it’s acceleration

You will have received an email from {your tutor group} @ englishmartyrs.org. This contains a link to the Focus software package. Open the link and go to Physics Required Practicals

Select AQA from the menu bar on the left hand side

Select Force and Acceleration practical

Click and read the Introduction, and Experiment tabs. Draw a results table (see Results tab. )  
Carry out the experiment - change the force pulling the trolley in steps of 0..5N and record the acceleration. Repeat each measurement 3 times and calculate the mean acceleration.

Plot a graph of Force against mean acceleration and write a conclusion. NOTE: DO NOT use the word ‘correlation’ in your answer!!

* 1. What is the independent variable in this experiment?
  2. What is the dependent variable in this experiment?
  3. Name one control variable in this experiment.
  4. What is the resolution of your force measurements?
  5. From this experiment, we get the equation Force = Mass x acceleration. This is Newtons 2nd Law
  6. Calculate the force needed to give a 2000kg car an acceleration of 3.5m/s2.
  7. *Extension: Calculate the force from the rocket engine needed to give a Saturn 5 rocket an acceleration upwards of 11.7m/s2. The mass of the rocket is 2.8x106 kg. (g = 9.8N/kg)   
     (Hint: Draw a free body diagram - you will need to think about the resultant force on the rocket)*