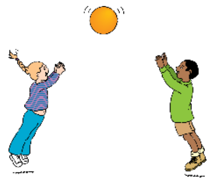
Projectile Motion: Oblique Projection **Name : ______________________**



Aim: To analyse the motion of a projectile.

A **projectile** is any object that moves, without propulsion, in free flight. If air resistance is ignored then the only force acting on a projectile during its flight is gravity. This force is constant and always directed vertically downwards. It causes a projectile to follow a parabolic path.

Equipment: Digital Camera, Metre ruler, Computer software, golf ball.

Method:

A. Film a golf ball being projected upwards at an angle of about 45 degrees. Include the ruler.
B. Using QuickTime software (or similar), mark the position of the ball **every third frame** on a clear piece of plastic (eg. a sheet protector). Measure the length of the ruler on the screen and calculate the ratio between the real-life distance and the distances on the screen. Fill in the table.

Conversion Factor = Length of metre ruler on screen: ________________ mm. Since this value is the length of 1m in real life, simply divide any on-screen measurements (in mm) by this number. You don't have to adjust for m, cm or mm, because this conversion factor automatically accounts for this.

So, displacement in real life = displacement on screen / conversion factor

Analysis:

Horizontal Motion

Golf Ball Thrown Upwards at an Angle (use the first frame after the ball has left the thrower's hand)						
1	**2**	**3**	**4**	**5**	**6**	**7**
Frame Number	Time (s)	Horizontal Displacement on screen **from original position** (mm).	Horizontal Displacement in real life **from original position** (metres). $\frac{Column\ 3}{conversion\ factor}$	Horizontal Displacement (m) during each 3-frame time period. **(from Col 4) Row 2 – Row 1, Row 3 – Row 2 etc.**	Mid-point times (s)	Average Horizontal Velocity During Each Time Period (m/s) $\frac{Column\ 5}{0.1s}$
0	0.0	0.0	0	- - - - - - - - -	- - - - - -	- - - - - - -
3	0.1				0.05	
6	0.2				0.15	
9	0.3				0.25	
12	0.4				0.35	
15	0.5				0.45	
18	0.6				0.55	
21	0.7				0.65	
24	0.8				0.75	
27	0.9				0.85	
30	1.0				0.95	
33	1.1				1.05	
36	1.2				1.15	
39	1.3				1.25	
42	1.4				1.35	
45	1.5				1.45	
48	1.6				1.55	
51	1.7				1.65	
54	1.8				1.75	
57	1.9				1.85	
60	2.0				1.95	

Draw (a) a horizontal displacement vs time graph (Column 4 vs Column 2) and (b) a horizontal velocity vs time graph (Column 7 vs Column 6).

Question: What is the gradient of the horizontal velocity vs time graph? ____________________

Vertical Motion

The velocity and the displacement in the third column will start off as positive, but, after the ball reaches the top, it will become negative.

Golf Ball Thrown Upwards at an Angle (use the first frame after the ball has left the thrower's hand)						
1	**2**	**3**	**4**	**5**	**6**	**7**
Frame Number	Time (s)	Vertical Displacement on screen **from original position** (mm).	Vertical Displacement in real life **from original position** (metres). $\frac{Column\ 3}{conversion\ factor}$	Vertical Displacement (m) during each 3-frame time period. **(from Col 4) Row 2 – Row 1, Row 3 – Row 2 etc.**	Mid-point times (s)	Average Vertical Velocity During Each Time Period (m/s) $\frac{Column\ 5}{0.1s}$
0	0.0	0.0	0	- - - - - - - - -	- - - - - - -	- - - - - - -
3	0.1				0.05	
6	0.2				0.15	
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45	1.5				1.45	
48	1.6				1.55	
51	1.7				1.65	
54	1.8				1.75	
57	1.9				1.85	
60	2.0				1.95	

Draw (a) a vertical displacement vs time graph (Column 4 vs Column 2) and (b) a vertical velocity vs time graph (Column 7 vs Column 6).

Question: What is the gradient of the vertical velocity vs time graph? ______________________

Comment on the shapes of all the graphs.