Planet Holloway Physics
Notes chapter 3 – Vectors and Projectiles

Vectors

A vector is a measurement quantity that has both magnitude (size) and direction.
examples of vectors in physics – displacement, velocity, acceleration

A scalar has magnitude (size) only.
examples of scalars in physics – speed, mass, time

To represent a vector we draw an arrow . The arrows length represents the size of the vector and the direction matches or represents the direction of the quantity.

A single vector can be replaced by x and y component vectors. To find vector components of a vector, draw the original vector then create a right triangle with horizontal and vertical legs. Imagine drawing a horizontal rectangle and only using the top or bottom half of the rectangle.

To add vectors, draw the vectors such that the tip of one is on the tail of the next vector. Then draw a resultant vector from the tail of the first vector to the tip of the last vector.

Or you may add by finding the horizontal and vertical components of each vector and adding these using summation columns. The resulting components can be combined to find the resulting vector using the Pythagorean theory. You can find the direction of the resultant by using the inverse tangent of the y component over the x component.

Projectiles

An object launched into the air either straight up, but more often at an angle (this includes horizontal) is a projectile.

A projectile travels in a parabolic arc. (Except for straight up)

An projectile travels in a parabolic arc because there is an acceleration in the y direction, but no acceleration in the x direction. Since, the x and y direction have no effect on each other the object follows a parabola.

On Planet Holloway (no air resistance) the projectile has constant speed in the x direction (because there are no forces acting horizontally on the object) and constant acceleration (9.8 m/s/s down) in the y direction.

- therefore, a ball dropped and a ball thrown horizontally from the same height will both hit the ground at the same time.

A ball thrown at an angle will have only its initial horizontal velocity at the top of its arc since the vertical velocity is zero at the top. Hence, the projectiles minimum speed is always at the top of the arc. Be careful, the speed is not zero here, only the y component of the velocity is zero.

A ball thrown at $45°$ will have the greatest range (distance in the x direction) on a horizontal surface.

On planet Earth, with air present, a projectile will slow and fall short of a true parabola.

A very interesting projectile is the moon. The moon (or any object that orbits another object) is a projectile that is falling around that planet or body. Gravity still pulls the object down, but it is also moving sideways (tangent to the orbit) which would cause it to move away. If the distance it falls in a second matches how far it moves away as it moves tangentially in a second, the object will be in orbit.

When solving projectile problems, follow the following steps:
1. Break the initial velocity vector in to its x and y components.
2. Solve for time using the direction that you have the most information in (usually it is the distance it goes).
3. Use the time found in one direction to solve the missing quantity in the other direction.