Advanced Higher Applied Mathematics (Mechanics)

Unit 2

Outcome 2.1 Motion In A Horizontal Circle	**NS**	**OT**	**VG**
I know the meaning of *angular velocity and angular acceleration*.			
I know that for motion in a circle where $\theta = \omega t$ then: $\mathbf{r} = r\cos(\omega t)\mathbf{i} + r\sin(\omega t)\mathbf{j}$ $\mathbf{v} = -r\omega \sin(\omega t)\mathbf{i} + r\omega \cos(\omega t)\mathbf{j}$ $\mathbf{a} = -r\omega^2 \cos(\omega t)\mathbf{i} - r\omega^2 \sin(\omega t)\mathbf{j}$.			
I know that, from the above,: $v = r\omega$, $a = \omega^2 r = v^2/r$ and $\mathbf{a} = -\omega\mathbf{r}$.			
I can apply the above equations to motion in a horizontal circle with uniform angular velocity including skidding, banking, conical pendulum and other applications.			
I know Newton's inverse square law of gravitation, namely $F \alpha {}^1/r^2$			
I can apply Newton's inverse square law of gravitation to simplified examples of motion of satellites and moons for circular orbits only.			
I can find the time for one orbit and the height above the surface etc.			

Outcome 2.2 Relative Position and Velocity	**NS**	**OT**	**VG**
I know the meaning of the terms *relative position, relative velocity and relative acceleration, air speed, ground speed* and *nearest approach*.			
I am familiar with notation for relative position, velocity and acceleration vectors of 2 objects.			
I can resolve vectors into components.			
I can differentiate and integrate vector functions in time.			
I can use position, velocity and acceleration vectors to solve practical problems.			
I can solve problems involving collision courses and nearest approach.			

Outcome 1.3 Motion of Projectiles in a Vertical Plane	**NS**	**OT**	**VG**
I know the meaning of the terms *projectile, velocity, angle of projection, trajectory, time of flight, range* and *constant gravity*.			
I can solve the vector equation $\ddot{r} = -gj$ to obtain **r** in terms of			

its horizontal and vertical components.			
I can obtain and solve the equations of motion $\ddot{x} = 0, \ddot{y} = -g$, obtaining expressions for $\dot{x}, \dot{y}, x$ and y in any particular case.			
I can find the time of flight, greatest height reached and the range of a projectile.			
I can find the maximum range of a projectile on a horizontal plane and the angle of projection to achieve this.			
I can find, and use, the equation of the trajectory of a projectile.			
I can solve problems in two-dimensional motion involving projectiles under a constant gravitational force and neglecting air resistance.			

Outcome 1.4 Forces and Newton's Laws of Motion	**NS**	**OT**	**VG**
I can understand the terms *mass, force, weight, momentum, balanced and unbalanced forces, resultant force, equilibrium* and *resistive forces.*			
I know Newton's first and third laws of motion.			
I can resolve forces in two dimensions to find their components.			
I can combine forces to find a resultant force.			
I can understand the concept of static and dynamic friction and limiting friction.			
I understand the terms frictional force, normal reaction, coefficient of friction μ, angle of friction λ, and know the equations $F = \mu R$ and $\mu = \tan\theta$.			
I can solve problems involving a particle or body in equilibrium under the action of certain forces.			
I know Newton's second law of motion, that force is the rate of change of momentum, and derive the equation $F = ma$.			
I can use this equation to form equations of motion to model practical problems on motion in a straight line.			
I can solve such equations modelling motion in one dimension, including cases where the acceleration is dependent on time.			
I can solve problems involving friction and problems on both rough and smooth inclined planes.			