Advanced Higher Physics Key areas

Rotational Motion and Astrophysics

Kinematic Relationships

1. I can derive the equations of motion using calculus methods.
2. I can calculate displacement, velocity and acceleration for straight line motion with a constant or varying acceleration using differentiation and integration. a = $\frac{dv}{dt} = \frac{d^2s}{dt^2}$
3. I can use the equations of motion to carry out calculations involving displacement, velocity and acceleration and time for straight line motion with constant or varying acceleration.
4. I know that an expression for acceleration or velocity which does not have the quantity time in it would be a constant acceleration or velocity. If the expression contains the quantity time then it would be a varying acceleration or velocity.
5. I can interpret graphs of motion for objects moving in a straight line.
6. I can calculate displacement, velocity or acceleration from graphs.

Angular Motion

1. I know that radians are used as a measure of angular displacement.
2. I can convert between radians and degrees and vice versa.
3. I can carry out calculations involving the angular equations of motion.
4. I can carry out calculations involving angular and tangential motion. $s = r\theta$ $v = r\omega$ $a_t = r\alpha$
5. I can carry out calculations involving angular velocity, period and frequency. $\omega = 2\pi f$ $\omega = \frac{2\pi}{T}$
6. I know a centripetal force acts on an object to maintain a circular motion, which means that the object has a centripetal acceleration.
7. I know that an object with circular motion will move off at a tangent in a straight line if the centripetal force is no longer acting on the object.
8. I know that an object which is attached to a piece of string that has circular motion uses the tension in the string as its centripetal force.
9. I know that the tension in the string in a conical pendulum has both a horizontal and vertical component.
10. I know that when an object has circular motion that it is accelerating even though it has a constant speed because it is constantly changing direction and therefore its velocity is changing.
11. I can derive the centripetal accelerations; $a_r = \frac{v^2}{r}$ and $a_r = \omega^2 r$ a_r = radial (centripetal) acceleration.
12. I can carry out calculations involving centripetal force and centripetal acceleration.

Rotational Dynamics

1. I know that torque is the turning effect of a force on a rotating object and has units Nm. $T = Fr$
2. I know that an unbalanced torque causes a change in the angular motion of an object (produces an angular acceleration). $T = I\alpha$
3. I know the moment of inertia of an object is a measure of its resistance to angular acceleration about a given axis and has units kgm^2.
4. I can carry out calculations involving moment of inertia of point masses, rods, discs and spheres about a given axis.
5. I know the angular momentum of a rotating object is conserved provided there is no external torques acting on the object. Angular momentum has units kgm^2s^{-1}.
6. I know that I can predict what will happen the angular velocity of a rotating object when its moment of inertia is changed, using the conservation of angular momentum. $L = I\omega$.
7. I know that when an object is rotating it has both translational (normal) kinetic energy and rotational kinetic energy. $EK_r = \frac{1}{2}I\omega^2$
8. I can carry out calculations involving the loss in potential energy which is equal to the translational kinetic energy and rotational kinetic energy added together, provided there are no energy loses.

Gravitation

1. I know that gravitational field strength is defined as the gravitational force acting on a unit mass.
2. I know how to derive an equation to carry out calculations involving gravitational field strength using the starting point that the gravitational force = weight.
3. I can sketch field lines around a planet and field line patterns around a planet - moon system.
4. I can carry out calculations involving gravitational force, masses and their separation. $F = \frac{GMm}{r^2}$
5. I know how to derive an equation to carry out calculations involving satellite motion using the starting point that the gravitational force = the centripetal force.
6. I know that gravitational potential is defined as the work done in moving a unit mass from infinity to that point.
7. I know that a gravitational field is a 'conservative field' which means that the energy required to move mass between two points in space is independent of the path taken.
8. I can carry out calculations involving gravitational potential and gravitational potential energy and know that their values are always negative. $V = -\frac{GM}{r}$ and $E_p = -\frac{Gmm}{r}$
9. I know that the escape velocity is defined as the minimum velocity required to allow a mass to escape a gravitational field or as the minimum velocity required to achieve zero kinetic energy and zero potential energy.
10. I know how to derive an equation to carry out calculations involving escape velocity using the starting point that $E_k + E_p = 0$

General Relativity

1. I know that special relativity deals with motion in inertial (non-accelerating) frames of reference and that general relativity deals with motion in non-inertial (accelerating) frames of reference.
2. I know that the equivalence principle states that it is not possible to distinguish between the effects on an observer of a uniform gravitational field and of a constant acceleration.
3. I know that the equivalence principle shows that if something happens in a constant acceleration then it will also happen in a uniform gravitational field. Consequences of this are gravitational lensing/bending of light and clocks in altitude/accelerating spacecraft.
4. I know that general relativity shows that mass curves spacetime and gravity arises from the curvature of spacetime.
5. I know that spacetime diagrams are a representation of four-dimensional space.
6. I know that light or a free moving object follows a geodesic which is the shortest distance between two points in spacetime.
7. I can interpret the world lines for objects which are stationary, moving with a constant velocity and accelerating and also say whether events could possibly be linked to one another.
8. I know about the three main parts of a black hole (singularity, Schwarzchild radius and event horizon) and know that time appears to be frozen at the event horizon of a black hole.
9. I can carry out calculations relating to the Schwarzchild radius of a black hole. $r = \frac{2MG}{c^2}$

Stellar Physics

1. I know that I can make the assumption that stars behave as black bodies do when emitting radiation.
2. I can carry out calculations involving luminosity, apparent brightness and power per unit area.
   $b = \frac{L}{4\pi r^2}$ $L = 4\pi r^2 \sigma T^4$ and power per unit area $= \sigma T^4$
3. I know the stages in the proton-proton chain in stellar fusion reactions which convert hydrogen into helium and can state which particles are released in this process.
4. I know the stages in stellar evolution and can explain why these stages are happening.
5. I know where a star may lie in the Hertzsprung-Russell diagram by looking at which stage it is at in its life cycle.
6. I know what class a star is based on their position in the Hertzsprung-Russell diagram and based on their position I can predict the size of the stars surface area and colour.