Eduqas Physics – Component 2

Module 6: Electrostatic and gravitational fields of force

This topic examines the similarities and differences between electrostatic and gravitational fields. The ideas of potential and potential energy in fields of force are introduced.

You should be able to demonstrate and show your understanding of:	**Progress and understanding:**			
	1	**2**	**3**	**4**
The features of electric and gravitational fields as specified in the **table below**				
The idea that the gravitational field outside spherical bodies such as the Earth is essentially the same as if the whole mass were concentrated at the centre				
Field lines (or lines of force) giving the direction of the field at a point, thus, for a positive point charge, the field lines are radially outward				
Equipotential surfaces joining points of equal potential and are therefore spherical for a point charge				
How to calculate the net potential and resultant field strength for a number of point charges or point masses				
The equation $\Delta U_P = mg\Delta h$ for distances over which the variation of g is negligible				

ELECTRIC FIELDS	**GRAVITATIONAL FIELDS**
Electric field strength, E, is the force per unit charge on a small positive test charge placed at the point	Gravitational field strength, g, is the force per unit mass on a small test mass placed at the point
Inverse square law for the force between two electric charges in the form $F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$ (Coulomb's law)	Inverse square law for the force between two masses in the form $F = G\frac{M_1M_2}{r^2}$ (Newton's law of gravitation)
F can be attractive or repulsive	F is attractive only

$F = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ for the field strength due to a point charge in free space or air	$g = \frac{GM}{r^2}$ for the field strength due to a point mass
Potential at a point due to a point charge in terms of the work done in bringing a unit positive charge from infinity to that point	Potential at a point due to a point mass in terms of the work done in bringing a unit mass from infinity to that point
$V_E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$ and $PE = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r}$	$V_g = -\frac{GM}{r}$ $PE = -\frac{GM_1M_2}{r}$
Change in potential energy of a point charge moving in any electric field = $q\Delta V_E$	Change in potential energy of a point mass moving in any gravitational field = $m\Delta V_g$
Field strength at a point is given by E = - slope of the $V_E - r$ graph at that point	Field strength at a point is given by g = - slope of the $V_g - r$ graph at that point
Note that $\frac{1}{4\pi\varepsilon_0} \approx 9 \times 10^9 F^{-1}m$ is an acceptable approximation	