Gravitational and Electric Fields

Homework sheet

Fluency Questions

1. The equations for Force between 2 masses and 2 charges are shown below:

$$F = k\frac{q_1 q_2}{r^2} \qquad\qquad F = G\frac{m_1 m_2}{r^2}$$

Where k represents the constant $1/4\pi\varepsilon_0$

a) Describe three similarities between the two equations.

1._____

2._____

3._____

[3]

b. Define the quantity Field Strength. **Try** to write a definition that could apply to both fields without being specific, but if you need to it is acceptable to define gravitational and electric field strengths separately.

_____
_____
_____   [2]

c. Therefore derive an expression for gravitational field strength that contains G and r.

[1]

d. Derive an expression for electric field strength that contains k and r.

[1]

e. Using either your answers from parts c and d, or the original force equations, derive expressions for the work done moving:

     I) a point charge from infinity to a specific point in an electric field

                                                            [2]

     ii) a mass from infinity to a specific point in a gravitational field

                                                            [2]

f. Define the term 'Potential' as it pertains to a field. Again, try to keep it general but if you need to, you may define grav and elec separately.

_____
_____
                                                            [2]

g. State whether gravitational potential is always positive or negative, and explain why it must always have that sign.

_____
_____
_____
_____   [4]

Conceptual Questions

True or False?

1. Gravitational Fields are always attractive.

2. Both Electric and Gravitational Fields have an inverse relationship to distance.

3. Gravitational forces have an infinite range, while electrical fields have a finite range.

4. Field strength is a vector quantity.

5. Electric fields are always stronger than gravitational.

6. It is possible to shield against an electric field, but not a gravitational field.

7. The gradient of a graph with gravitational potential on the y-axis and distance on the x-axis will represent the potential energy.

[7]

Ratio Questions

1. The gravitational field strength on the surface of Planet A is g. Planet B has the same mass as that of Planet A and double its radius. What is the gravitational field strength on the surface of Planet B?

[2]

2. At a distance X from a point charge, the electric field is given by E, and the potential by V. What is the magnitude of E and V at a distance of 3X?

[2]

3. Mars has twice the mass of Mercury and is four time further away from the sun. What is the ratio of the gravitational force experienced by Mercury / gravitational force experienced by Mars?

[2]

4. The gravitational potential on the surface of Planet C is V. Planet D has twice the ratio of Planet C, and is twice as dense. What is the gravitational potential on the surface of Planet D?

[3]