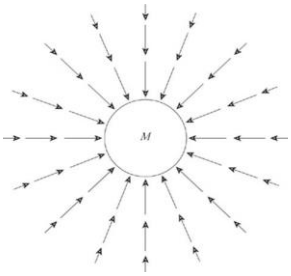
10.1 Describing fields.

Gravitational fields

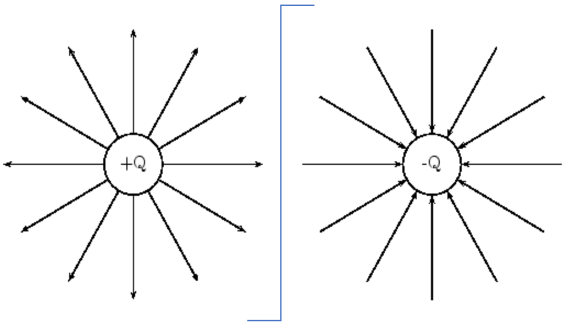
A gravitational field is a region of space where a test mass experiences a force due to another mass.



Gravitational fields are radial only and attractive. A test mass placed in the field will experience a force in the direction of the field lines.

Electrostatic fields

An electrostatic field is the region of space where a small positive test charge experiences a force per unit charge.



Electric field lines are drawn to show the direction of the force on a positive charge.

The field surrounding a point charge is radial, as shown above.

Electric potential and gravitational potential

Electric potential

Electric potential is the work done per unit charge which can be written like this:

$$V = \frac{W}{Q}$$

This equation is used to define the potential difference as the energy given to each unit charge. From what we have just defined we can now update our definition of potential difference. *Potential difference is the difference in electric potential between two points in an electric field.*

The work done to move a charge from potential V_1 to potential V_2 is given by:
$\Delta W = Q(V_2 - V_1)$ which can be written as…. $\Delta W = Q\Delta V$

See section 10.2 (potential difference) for further explanation.

Gravitational Potential

The gravitational potential at a point r from a planet or mass is defined as:
The work done per unit mass against the field to move a point mass from infinity to that point.

The gravitational potential at a distance r from a mass M is given by: $V = -\frac{GM}{r}$

The value is always negative because the potential at infinity is zero and as we move to the mass we lose potential or energy.
The gravitational field is attractive so work is done **by** the field in moving the mass, meaning energy is given out.

Gravitational Potential is measured in Joules per kilogram, J kg^{-1}

Gravitational potential is a scalar quantity. To calculate the gravitational potential due to multiple masses, simply add up the gravitational potential due to the individual masses.

Equipotential surfaces

Points with the same gravitational potential can be joined together to form an equipotential surface. Equipotential lines are perpendicular to field lines.

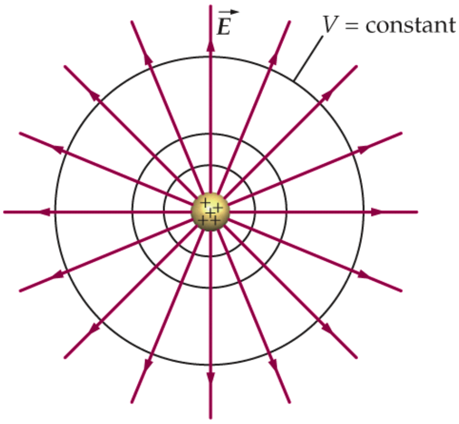


Figure 1. Equipotential lines surrounding a point charge (shown as black concentric circles)

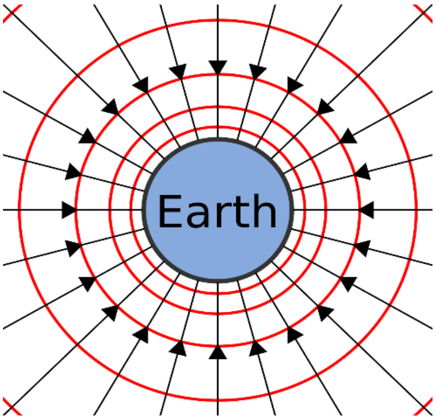


Figure 2. Equipotential lines surrounding a mass (shown as red concentric circles)

The density of field lines is proportional to the field strength.

Far from the earth, the field line separation changes as the gravitational field strength changes. However, near the surface of the earth, the value of the gravitational field strength is relatively constant with height, as long as the change of height is not too great.