21 Gravitational Fields

21.1 Gravitational Field Strength

Any two masses exerts a gravitational pull on each other, but usually the force is too weak to be noticed unless at least one of the masses is very large.

The force field around a mass is called a **gravitational field strength**.

1. The mass of an object **creates a force field** around itself.
2. Any other mass placed in the field is **attracted towards the object**.
3. The second mass also has a force field around itself that **pulls on the first object** with an equal force in the opposite direction.

The **magnetic field strength** g is the force per unit mass on a small test mass placed in the field. The path which the smaller mass would follow is called a **field line** or **line of force**.

$$g = \frac{F}{m}$$

The unit of gravitational field strength is the **newton per kilogram**.

The test mass needs to be small, otherwise it might pull so much on the other object that it changes its position and alters the field.

Free Fall

The weight of an object is the force of gravity on it, $F = mg$ for an object of mass m in a gravitational field.

$$a = \frac{F}{m} = \frac{mg}{m} = g$$

Therefore g is the acceleration of a freely falling object.

The object is described as **unsupported** because it is acted on by the force of gravity alone.

Field Patterns

- A **radial field** is where the field lines are **always directed to the centre**, since the force of gravity on a small mass near a much bigger spherical mass is always directed to the centre of the larger mass, regardless of position.

  The magnitude of g in a radial field decreases with increasing distance from the massive body.

- A **uniform field** is where the gravitational field strength is the **same in magnitude and direction throughout the field**.

  The field lines are therefore **parallel** to one another and **equally spaced**.

The gravitational field strength of the Earth is radial because it falls with increasing distance. But **over small distances** compared to the Earth's radius, the change in gravitational field strength is insignificant so the field can be **considered uniform**.