CAIE Physics A-level

13 - Gravitational Fields

Flashcards

What is gravity?

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Gravity is the universal attractive force that acts between all mass-possessing matter.

What is *G*?

What is G?

The universal gravitational constant.

Approx. 6.67×10^{-11} m^3 kg^{-1} s^{-2}

What is the magnitude of the average gravitational field strength on the surface of the Earth?

What is the magnitude of the average gravitational field strength on the surface of the Earth?

$9.81 Nkg^{-1}$ or $9.81 ms^{-2}$

This means a force of attraction of 9.81N is experienced between an object and the Earth's surface for every kilogram that the object weighs. Note that, due to Newton's Second Law: a = F/m, this can also be described as an acceleration in ms^{-2}.

What can field lines tell you about a field?

What can field lines tell you about a field?

- The direction of the field.
- The strength of the field, which depends on the number of the field lines per unit area.

What is g?

What is *g*?

g is the force per unit area in a uniform gravitational field. (acceleration due to gravity)
In a radial field the magnitude of *g* is the the proportionality constant at that point between force and mass.

I.e. $g = GM/r^2$

What is Newton's law of gravitation?

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Newton's law of gravitation states that the gravitational force acting between two point masses is directly proportional to their product and inversely proportional to the square of the distance between them, such that:

$$F = GMm/r^2$$

Derive the equation for the gravitational field strength of a radial field.

Derive the equation for the gravitational field strength of a radial field.

Starting with $g = F/m$ and sub in $F=GMm/r^2$ to get $g=GMm/(r^2m)$

$$g = GM/r^2$$

What are satellites? What are they used for?

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- Satellites are bodies that orbit other, significantly more massive bodies - they include natural satellites like the moon, as well as artificial satellites that humans have sent into space.
- Uses of artificial satellites include communications, scientific research, and Global Positioning Systems (GPS).

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- Geostationary satellites have an orbital period that is exactly a day, so that they appear stationary above the Earth.
  - They orbit 36,000km above the equator.
- They are useful for communications and surveying since they can provide continuous coverage.

What is gravitational potential?

What is gravitational potential?

The potential energy per kilogram, at any point in the field.

0 potential is defined at infinity, so at a point close to a mass, the potential of another body is negative, since gravity does positive work as the bodies converge.

What is gravitational potential difference?

What is gravitational potential difference?

Gravitational potential difference is the difference in the gravitational potentials of two points in a gravitational field.

What is gravitational potential energy at a point in the field?

What is gravitational potential energy at a point in the field?

The work done per unit mass in moving an object from infinity to that point in the field.

Give an equation that describes the gravitational potential field exerted by a body?

Give an equation that describes the gravitational potential field exerted by a body?

$\phi = -GM/r$

Where ϕ is the gravitational potential, G is the universal gravitational constant, M is the mass of the body, and r is the distance of the body to the body that is subject to its field.

ϕ has the units Jkg^{-1} so the potential energy between two bodies depends on the mass of the second.

Give an equation that describes the gravitational potential energy between two point masses?

Give an equation that describes the gravitational potential energy between two point masses?

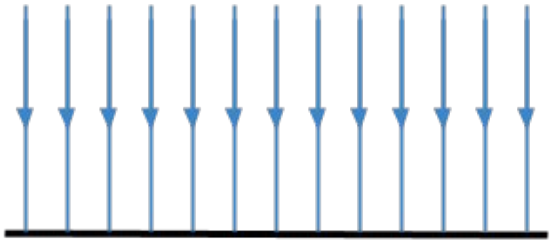
$$E_P = -GMm/r$$

Where E_P is the gravitational potential energy, G is the universal gravitational constant, M is the mass of the more massive body, m is the mass of the less massive body, and r is the distance between the centre of masses of the two bodies.

True or false? At the Earth's surface the value of g is approximately constant.

True or false? At the Earth's surface the value of g is approximately constant.

True. At the Earth's surface the field is relatively uniform so 'g' is approximately constant.



Uniform field