Sample Diploma Question

Depends on mass

Depends on charge

1. One difference between gravitational fields and electric fields is that

   A. gravitational field strength depends on mass, but electric field strength does not

   B. gravitational fields can be either repulsive or attractive, but electric fields are only attractive

   lEl not g!

   C. the measurement for gravitational field strength is N/C and for electric field strength is N/kg

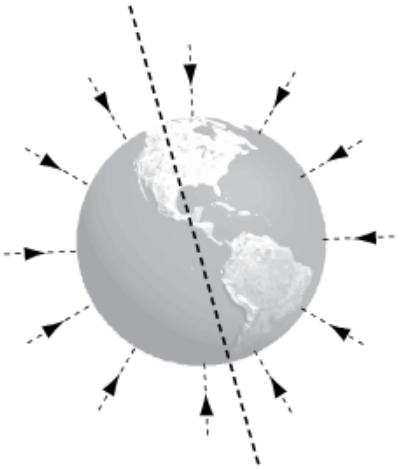
   D. gravitational field strength depends on the distance between objects, but electric field strength does not

   Both strengths rely on distance

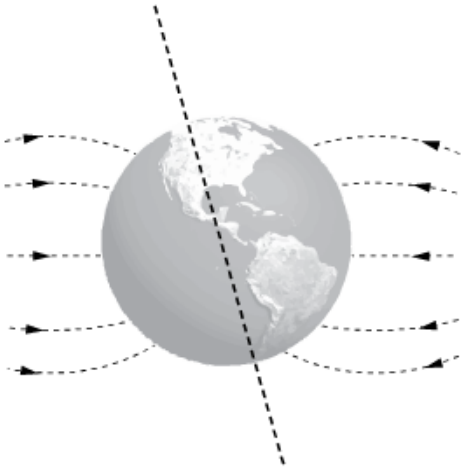
There is evidence from volcanic rocks that Earth's magnetic field has changed drastically in the past.

2. Which of the following diagrams provides an accurate representation of Earth's present-day magnetic field lines?

A.



B.



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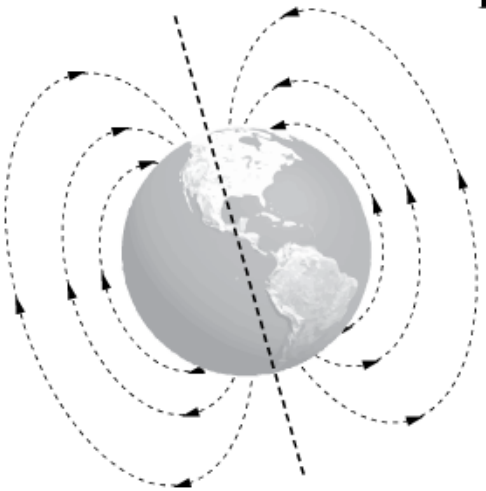
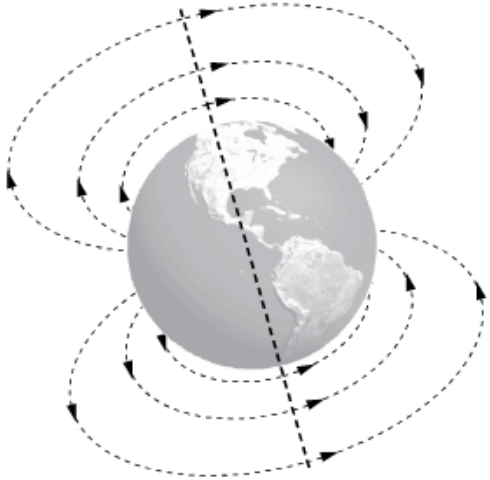


D.

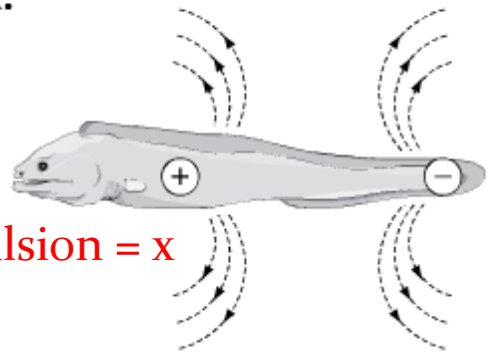


Use the following information to answer question 3 and numerical-response 1.

The South American electric eel can produce a low-voltage discharge to detect prey or a high-voltage discharge to stun prey.

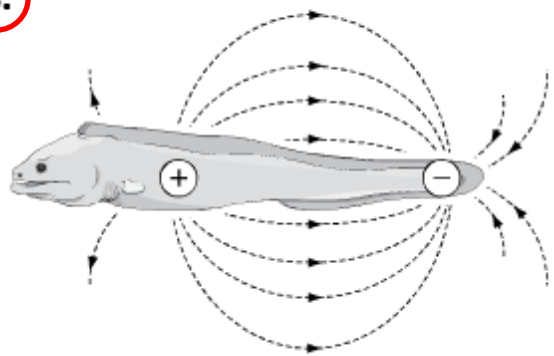
3. Which diagram below **best** shows the field lines near an electric eel?

A.

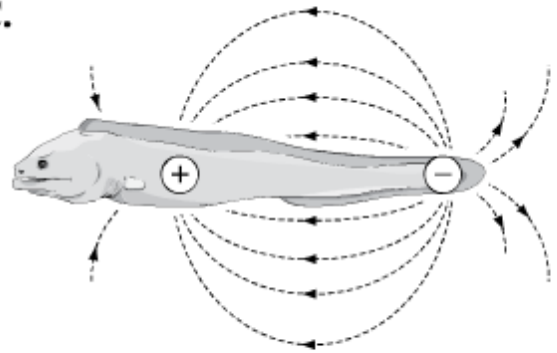


Repulsion = x

B.

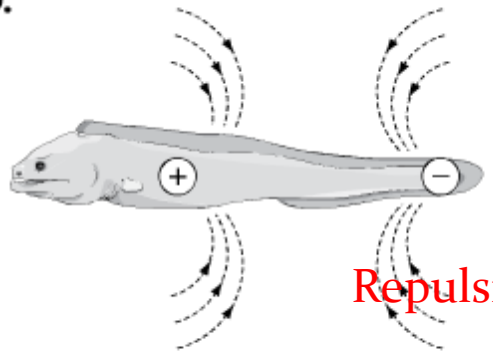


C.



-'ve to positive = x

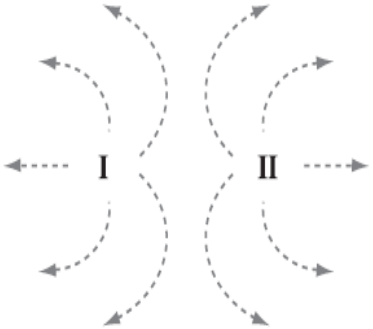
D.



Repulsion = x

Use the following information to answer question 21.

Field Lines in a Region Near Two Sources



Showing repulsion

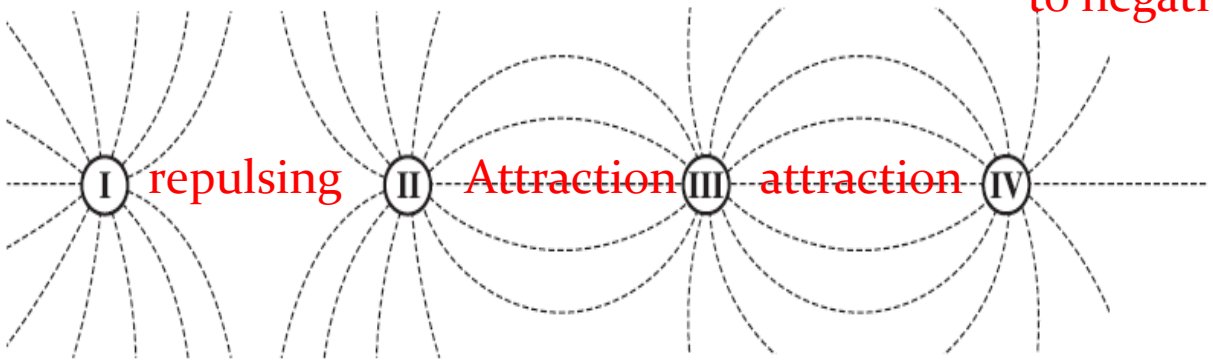
21. Which of the following rows shows the possible identifications for Source I and Source II?

Row	Source I	Source II
A.	North pole of a magnet	Positive point charge
B.	North pole of a magnet	South pole of a magnet
C.	Positive point charge	South pole of a magnet
D.	Positive point charge	Positive point charge

Use the following information to answer question 23.

Field Lines Surrounding Charged Particles

Positive goes to negative



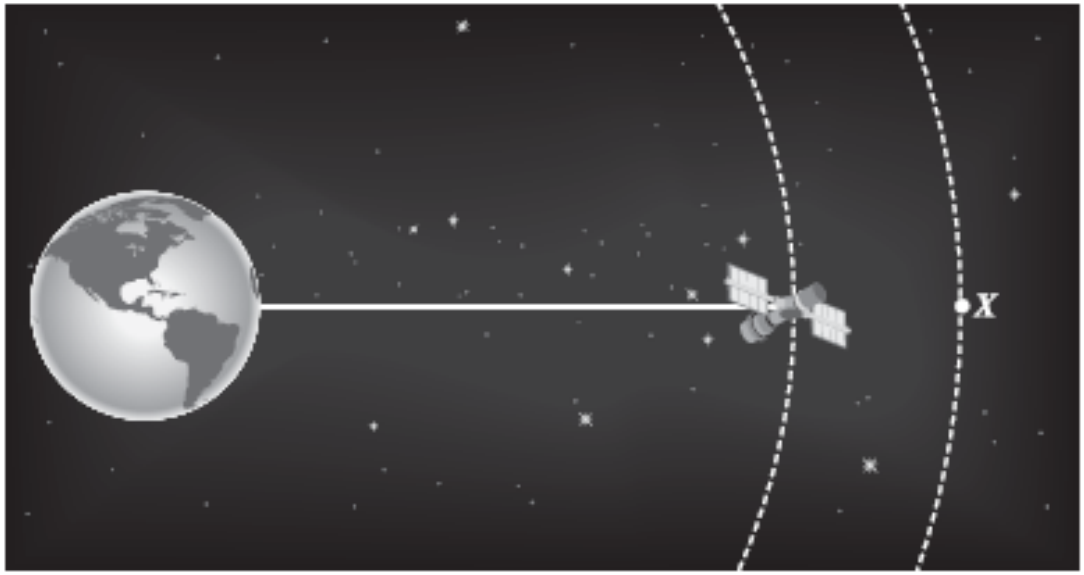
23. Which of the following rows shows the **most likely** charge of the particles in the diagram above?

Row	Charge of Particle I	Charge of Particle II	Charge of Particle III	Charge of Particle IV
A.	Negative	Positive	Negative	Positive
B.	Positive	Negative	Positive	Positive
C.	Negative	Negative	Positive	Negative
D.	Positive	Positive	Positive	Positive

Use the following information to answer question 25.

A Satellite in Orbit Around Earth

A satellite that has been orbiting Earth will soon be moved to a new orbit that goes through Point *X*, as shown below.



25. As the satellite is moved to Point *X*, Earth's gravitational field strength at the position of the satellite will

A. increase, because the mass of Earth does not change

B. increase, because the distance between Earth and the satellite will be greater

C. decrease, because the mass of Earth does not change

D. decrease, because the distance between Earth and the satellite will be greater

24. Which of the following rows depicts Earth's gravitational field and the equation used to determine the strength of the gravitational field?

Row	Earth's Gravitational Field Diagram	Equation
A.	 N & S pole	$\lvert\vec{E}\rvert = \frac{kq}{r^2}$
B.	 N & S pole	$g = \frac{Gm}{r^2}$
C.	 Gravitations field	$\lvert\vec{E}\rvert = \frac{kq}{r^2}$
D.	 Gravitations field	$g = \frac{Gm}{r^2}$

Calculating Fields

Curriculum

- describe gravitational and electric field strength at a given distance from a mass or a point charge, using the equations $|\vec{g}| = Gm/r^2$ and $|\vec{E}| = kq/r^2$
- calculate the values for g and E , using the corresponding field-strength equations

Equations for fields

- Fields can be calculated using equations when an exact value is needed.

- A field will usually be calculated using a test body (an object that is put in the field).

Gravitational Field Strength

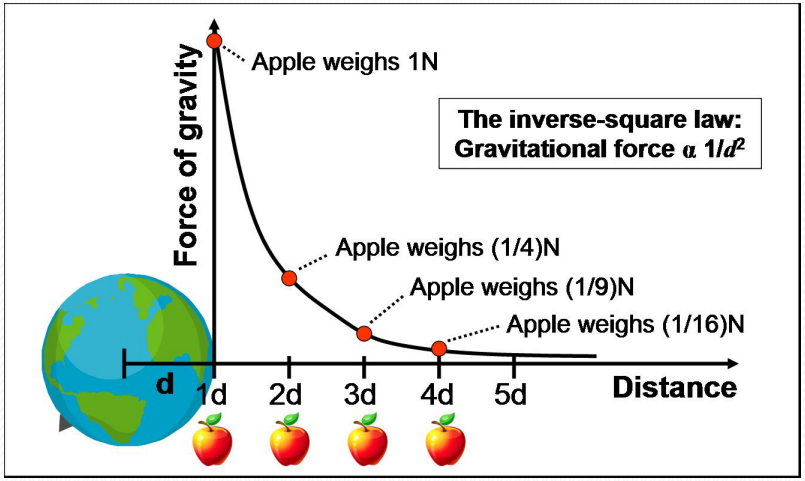
- What do you think happens to earth's ability to pull masses in as they get farther and farther away?

As distance increases the gravitational force decreases

The strength of Earth's gravity field depends on the distance from the center of the earth and on the types of rocks beneath the surface.

The larger the masses the larger the gravitation field

- Gravitational field strength has in inverse relationship to distance away



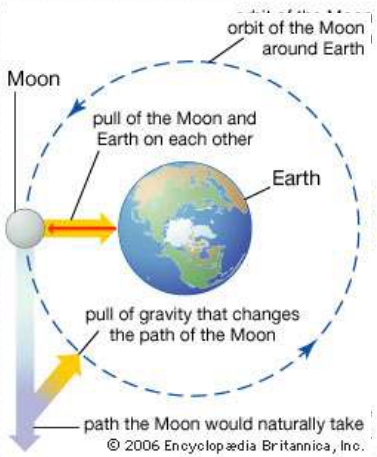
$$\frac{1}{2^2} = \frac{1}{4}$$

- Ex: if the distance is doubled, the gravitational force reduces to a quarter its original strength.

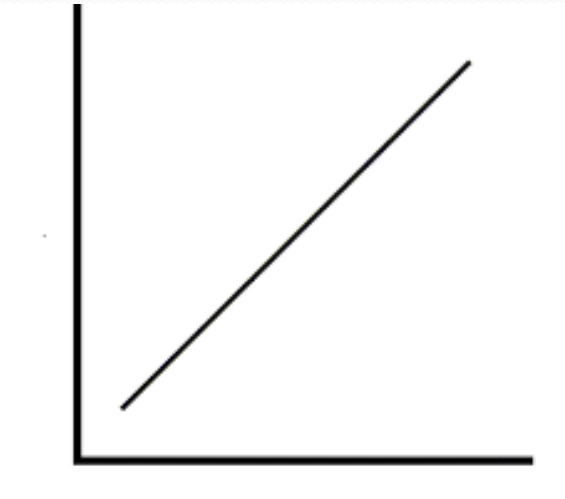
Gravitational Field Strength

- What is better at pulling things in, the earth or the moon?

The earth b/c it has more mass



- Gravitational field strength has a direct relationship to the mass creating it.

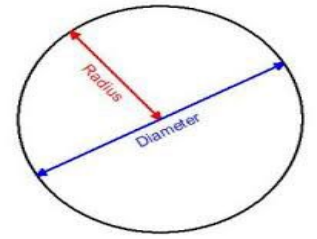


The force per unit mass that an object would experience if placed in a gravitational field.
As distance from source increases, field strength decreases.

Formula

$$g = \frac{Gm}{r^2}$$

- g = Gravitational Field Strength (N/kg or m/s²)
- G = Universal Gravitational Constant (N·m²/kg²)
- m = Mass of source (kg)
- r = distance from center of source (m)



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Gravitational and Electric Fields

$\vec{F}_g = m\vec{g}$

$g = \frac{Gm}{r^2}$

$|\vec{E}| = \frac{kq}{r^2}$

$\vec{F}_g$ = force due to gravity (N)
m = mass (kg)
G = gravitational constant = 6.67×10^{-11} N·m^2/kg^2
r = radius or centre-to-centre distance (m)
g = magnitude of gravitational field strength (N/kg)
k = Coulomb's law constant = 8.99×10^9 N·m^2/C^2
q = electrostatic charge in coulombs (C)
$|\vec{E}|$ = electric field strength (N/C)

Astronomy Data

Mass of Earth = 5.98×10^{24} kg
Radius of Earth = 6.37×10^6 m
Mass of sun = 1.99×10^{30} kg
1 light-year = 9.47×10^{15} m
1 AU (astronomical unit) = 1.50×10^{11} m

Average acceleration due to gravity on surface of Earth = 9.81 m/s^2

Average gravitational field strength on surface of Earth = 9.81 N/kg

Example

- Calculate the gravitational field experienced by someone standing on the surface of the earth

$$g = \frac{Gm}{r^2}$$

G = 6.67×10^{-11}
m= 5.98×10^{24}
r= 6.37×10^{6}

=9.82987 m/s^2

Example

- How far away far away from the sun would you be if you experience the same gravitational field as someone standing on the surface of the earth? (hint: use your 'g' value from the previous question)

Looking for r

$$g = \frac{Gm}{r^2}$$

G= 6.67 x 10^{-11}
g= 9.82987
m=1.99 x10^{30}

=3.675 x10^{9} m

Board Question

$$g = \frac{Gm}{r^2}$$

- If the moon has a mass of 7.35×10^{22} kg, and has a radius of 1.74×10^{6} m, calculate the gravitational field on the surface of the moon.

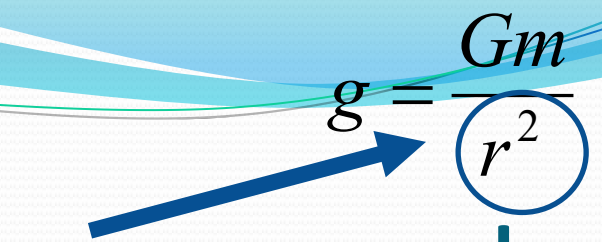
1.619252

- Is this bigger or smaller than the value on earth?

smaller

- Why is it smaller?

Less of a gravitational pull b/c the moon has **less mass**



The effect of inverse squared

- If you went double the radius away from earth, calculate the gravitational field

- If you went triple the radius away from earth, what calculate the gravitational field
- If you double the radius, the g field gets 4 times weaker
- If you triple the radius, the g field gets 9 times weaker

Gravitational Force (F_g)

- The mass on an object created by the field.
- Calculate using:

$$\mathbf{F_g = mg}$$

F_g = force of gravity (N)

m = mass of object (kg)

g = acceleration due to gravity (m/s^2).

Example

- The moon has an average radius of 1740 km and a mass of 7.35×10^{22} kg.
  - Calculate the ***gravitational field strength*** of the moon.
  - If an astronaut with a ***mass of 100kg*** was on the moon, what is the ***force of gravity*** on the astronaut?

Calculate the gravitational field experienced

- *convert km to m!

$$g = \frac{Gm}{r^2}$$

- =1.6192 N/kg

Calculating force of gravity

- $F_g = mg$

- 161.92 N

Questions

- What can create an electric field?

  A charge

- How do we tell the direction of an electric field?

  A positive test charge

- What happens to the electric field the further away we get from an object creating the field?

  Less of a pull
  Strength decreases

Electrical Field Strength (E)

Formula $\left|\vec{E}\right| = \frac{kq}{r^2}$

- |E| = electric field (N/C)
- k = coulomb's constant (8.99×10^9 N·m²/C²)
- q = charge creating the field (C)
- r = distance away from the field (m)

Example

- Determine the electric field 90.0 cm north of a -9.50μC charged object. Step 1: convert charge to C and cm to m!

Prefix	Symbol	Factor by Which Base Unit Is Multiplied	
tera	T	1 000 000 000 000	$= 10^{12}$
giga	G	1 000 000 000	$= 10^{9}$
mega	M	1 000 000	$= 10^{6}$
kilo	k	1 000	$= 10^{3}$
hecto	h	100	$= 10^{2}$
deca	da	10	$= 10^{1}$
Common Base Units*		1	$= 10^{0}$
deci	d	0.1	$= 10^{-1}$
centi	c	0.01	$= 10^{-2}$
milli	m	0.001	$= 10^{-3}$
micro	μ	0.000 001	$= 10^{-6}$
nano	n	0.000 000 001	$= 10^{-9}$
pico	p	0.000 000 000 001	$= 10^{-12}$

$$\left|\vec{E}\right| = \frac{kq}{r^2}$$

$=1.05 \times 10^6$ N/C

Example

$$\left|\vec{E}\right| = \frac{kq}{r^2}$$

- What is the charge of an object giving off a 43.0 N/C field 30 cm away from the object?

- 4.3 x 10^-10 C

Board Question

- How far away would you have to be from a 720 μC van de graaff generator to experience an electric field of 100 N/C?

- 254.41698 m