

Calculating Field Strength

IB PHYSICS | FORCE FIELDS

Warm Up

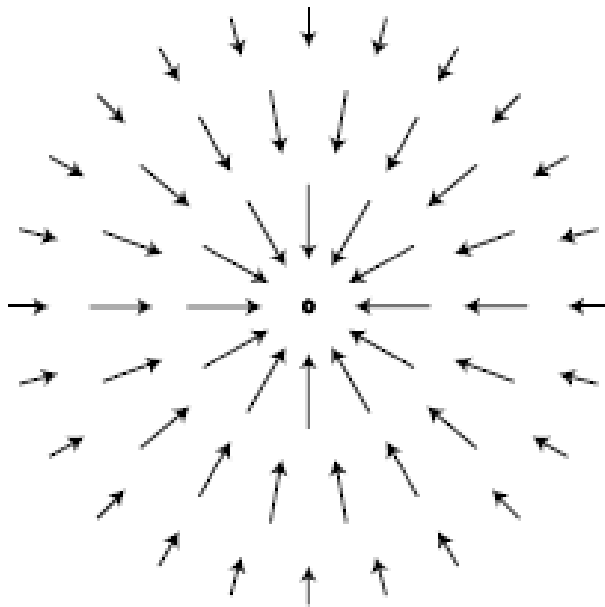
Calculate F_g for a 75-kg student on the surface of the earth

$$F_g = mg$$

$$F_g = G \frac{m_1 m_2}{r^2}$$

Force Fields

Vector field that describes the force that would act on a particle at various positions



	Electric Field	Gravitational Field
Symbol		
Unit		

IB Physics Data Booklet

D. Fields

Standard level and higher level	
D.1 Gravitational fields	$F = G \frac{m_1 m_2}{r^2}$ $g = \frac{F}{m} = G \frac{M}{r^2}$
D.2 Electric and magnetic fields	$F = k \frac{q_1 q_2}{r^2} \text{ where } k = \frac{1}{4\pi\epsilon_0}$ $E = \frac{F}{q}$ $E = \frac{V}{d}$
D.3 Motion in electromagnetic fields	$F = qvB \sin \theta$ $F = BIL \sin \theta$ $\frac{F}{L} = \mu_0 \frac{I_1 I_2}{2\pi r}$

Remember g?

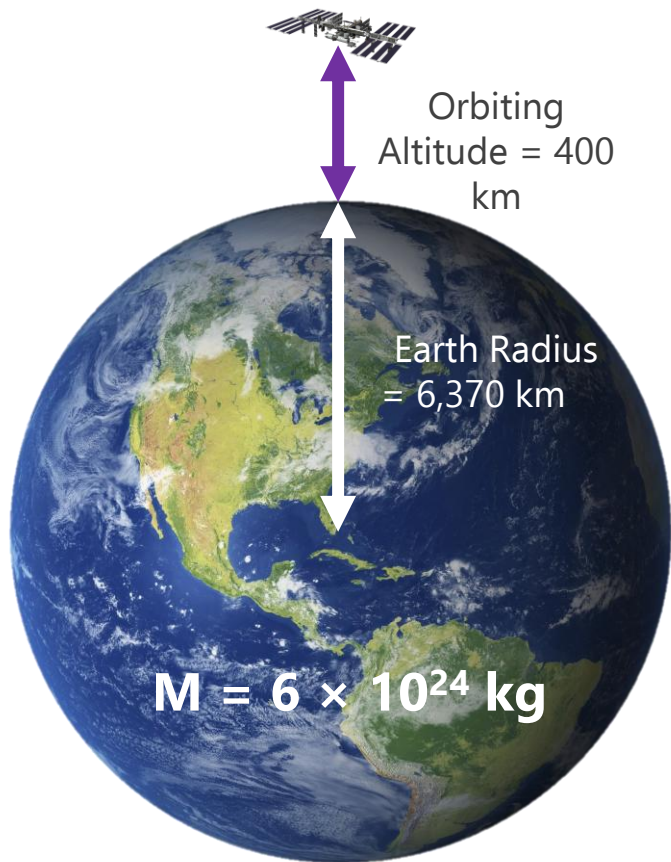
$$g = 9.8 \text{ m s}^{-2}$$

g representing acceleration is not the whole story...

g → Gravitational Field Strength

Wait, does that mean g changes?

$$400 \text{ km} + 6370 \text{ km} = 6770 \text{ km}$$



$$g = G \frac{M}{r^2}$$

Using g

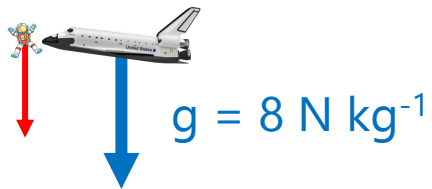


= 2,000,000 kg



= 75 kg

What is the force of gravity for each position?



Try This

What is the electric field strength if a particle with a charge of $+6.3 \mu\text{C}$ experiences a force of 0.0025 N ?

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$$E = \frac{F}{q}$$

Try This

$$E = \frac{V}{d}$$

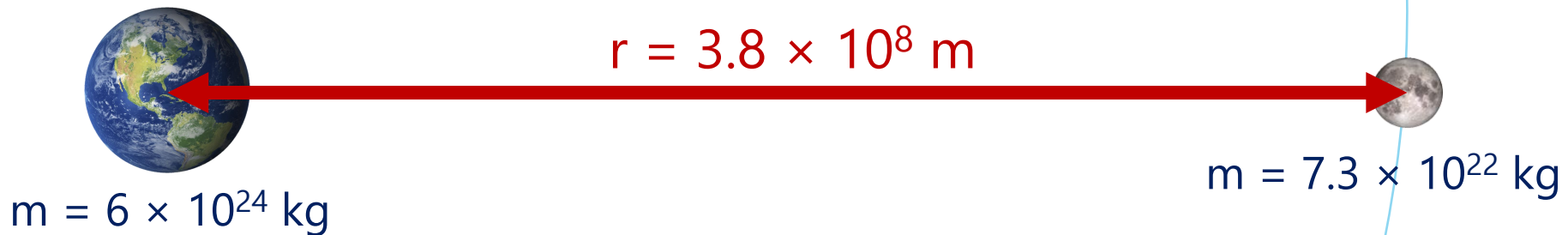
D.2

A pair of parallel plates with a potential difference of 700 V are separated by 160 mm. What is the electric field strength between the plates?

What is the electric force acting on an alpha particle (2 protons and 2 neutrons) placed between these charged plates?

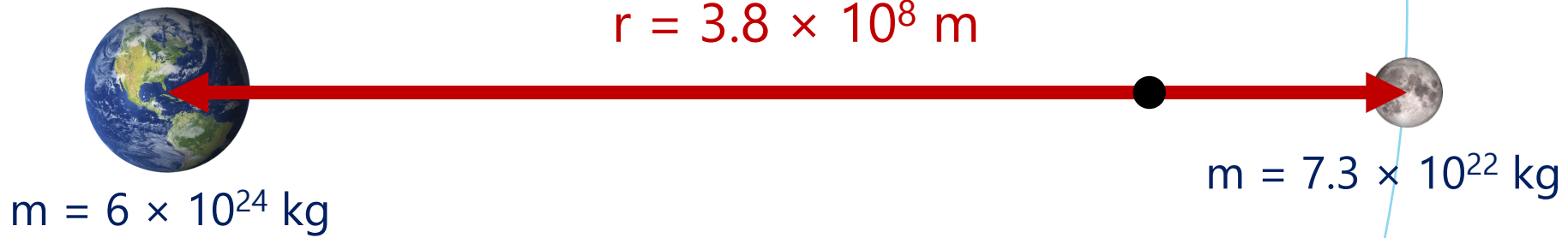
Try this

What is the gravitational field strength halfway between the centers of the earth and the moon?



Try this | Hard Mode

Where would an object experience a gravitational field of 0 N kg^{-1}



Try this | Hard Mode

Where would an object experience a gravitational field of 0 N kg^{-1} →

$$G \frac{M_e}{r_e^2} = G \frac{M_m}{r_m^2}$$



$m = 6 \times 10^{24} \text{ kg}$

$r = 3.8 \times 10^8 \text{ m}$

$r_m = 3.8 \times 10^8 - r_e$



$m = 7.3 \times 10^{22} \text{ kg}$

cancel out G and square root everything

$$\sqrt{G \frac{M_e}{r_e^2}} = \sqrt{G \frac{M_m}{r_m^2}}$$

$$\frac{\sqrt{M_e}}{r_e} = \frac{\sqrt{M_m}}{r_m}$$

$$\frac{\sqrt{6 \times 10^{24}}}{r_e} = \frac{\sqrt{7.3 \times 10^{22}}}{(3.8 \times 10^8 - r_e)}$$

$$(9.31 \times 10^{20}) - (2.45 \times 10^{12})r_e = (2.70 \times 10^{11})r_e$$

$$(9.31 \times 10^{20}) = (2.72 \times 10^{12})r_e$$

$$g = G \frac{M}{r^2}$$

$$G = 6.67 \times 10^{-11} \frac{\text{N} \times \text{m}^2}{\text{kg}^2}$$

$$r_e = 3.42 \times 10^8 \text{ m}$$

Lesson Takeaways

- I can use the universal law of gravitation and circular motion to describe the motion of an orbiting body
- I can describe and calculate electric and gravitational field strength
- I can calculate resultant field strength from multiple sources