Higher Gravitation Questions

Data required : Mass of Earth = 6.0×10^{24}kg

Radius of Earth = 6.4×10^{6}m

1. State '**Newton's Law of Gravitation'** and **list** the **quantities** and **units** involved.

2. The force of gravity is one of the **four fundamental forces** of nature.

a) **State the names** of the **other three** fundamental forces of nature.

b) List the **four** fundamental forces of nature **in order** from the **greatest to the smallest magnitude of force**.

3. **Calculate the gravitational force of attraction** between two pupils of mass 60kg and 80kg sitting 2m apart in their Higher Physics class.

4. The Universal constant of gravitation is listed as 6.67×10^{-11}.

a) From the equation use **dimensional analysis** to show that the units are $\mathbf{Nm^2kg^{-2}}$.

b) In the data sheet the units are listed as $\mathbf{m^3kg^{-1}s^{-2}}$.

Show how this **unit equates** with the **unit** found by dimensional analysis in **a)**.

5. **Calculate the gravitational force of attraction** between the **Earth** and the **Sun** using the data below:

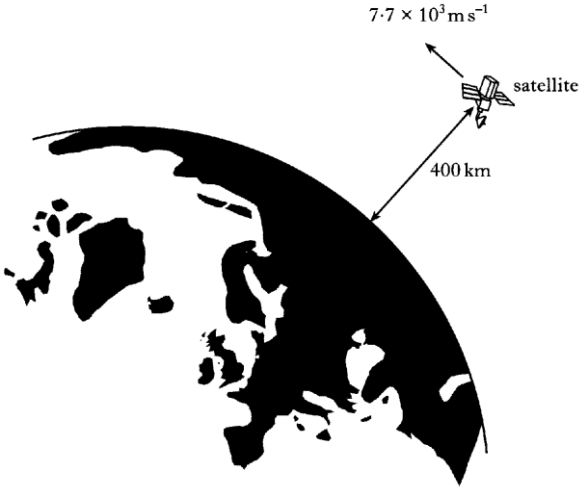
Mass of Sun = $\mathbf{2.00 \times 10^{30}kg}$

Distance from Earth to the Sun (centre to centre) = $\mathbf{1.50 \times 10^{6}km}$.

6. **Calculate** the gravitational force of attraction between the Earth and a geostationary satellite of **mass 5000kg,** if we assume that it orbits at a **height of 35,800km** above the Earth's surface.

7. a) Show that **$g = GM/r^2$** for an **object** of **mass m** on the Earth's surface.

b) A satellite of mass 900kg orbits 400km above the Earth's surface as shown below.



i) **Calculate the gravitational field strength** that the satellite experiences **at this point**.

ii) **Calculate the time** that the satellite takes to make **one complete orbit (T)** of the Earth with **$v = 2\pi r/T$**.

8. a) State what is meant by the **'gravitational field strength'**.

b) The gravitational field strength on the surface of **Jupiter** = $26.4 Nkg^{-1}$.

The radius of **Jupiter** = 70,000km

The mass of **Jupiter** = 1.94×10^{27}kg

i) **Use Newton's Universal Law of Gravitation** to show that **$G = \underline{gr^2}$**

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ii) **Show that the data given** for Jupiter **agrees with this law**.

9. The gravitational field strength at a distance of **6.0×10^5 m** from the centre of a planet is **$8.8 Nkg^{-1}$**.

a) **Calculate the distance** from the centre of the planet that will give a gravitational field strength of **$4.4 Nkg^{-1}$**.

b) **Calculate the gravitational field strength** at a distance of **4.2×10^5m** from the centre of the planet.

10. Astronomical observations tells us that **Neptune** has a gravitational field strength of **$11.8 Nkg^{-1}$** at its surface and has a **radius of 2.48×10^7m**.

Calculate the mass of Neptune.