Answer on Question 57030, Physics, Mechanics, Relativity

Question:

Astrology, that unlikely and vague pseudoscience, makes much of the position of the planets at the moment of one's birth. The only known force a planet exerts on Earth is gravitational.

a) Calculate the gravitational force exerted on a $3.00 kg$ baby by a $90 kg$ father $0.150 m$ away at birth (he is assisting, so he is close to the child).

b) Calculate the force on the baby due to Jupiter if it is at its closest distance to Earth, some $6.29 \cdot 10^{11} m$ away, showing it to be comparable to that of the father. The mass of the Jupiter is about $1.90 \cdot 10^{27} kg$. Other objects in the room and the hospital building also exert similar gravitational forces. (Of course, there could be an unknown force acting, but scientists first need to be convinced that there is even an effect, much less that an unknown force causes it.)

Solution:

a) By the law of universal gravitation we have:

$$F_{father} = \frac{GM_{father}m_{baby}}{r^2} = \frac{6.673 \cdot 10^{-11}\frac{Nm^2}{kg^2} \cdot 90kg \cdot 3.00kg}{(0.150m)^2} = 8.01 \cdot 10^{-7}N.$$

b) Similarly we can calculate the force on the baby due to Jupiter:

$$F_{Jupiter} = \frac{GM_{Jupiter}m_{baby}}{r^2} = \frac{6.673 \cdot 10^{-11}\frac{Nm^2}{kg^2} \cdot 1.90 \cdot 10^{27}kg \cdot 3.00kg}{(6.29 \cdot 10^{11}m)^2} =$$
$$= 0.96 \cdot 10^{-6}N.$$

Let's calculate how the force of Jupiter on the baby compare to the force of the father on the baby:

$$\frac{F_{father}}{F_{Jupiter}} = \frac{8.01 \cdot 10^{-7}N}{0.96 \cdot 10^{-6}N} = 0.834.$$

Answer:

a) $F_{father} = 8.01 \cdot 10^{-7}N.$

b) $F_{Jupiter} = 0.96 \cdot 10^{-6}N, \frac{F_{father}}{F_{Jupiter}} = 0.834.$