Gravitational Fields and Forces Homework

Name: Solutions

Date: _____

oops!

<u>Read Me</u>: Justify #2-5 with a fact. Write each fact out fully in words and also include the equation. Refer to the inside back cover of your textbook for astronomical information as needed.

1. Read "The Gravitational Field Model: Activity 3" and write today's new facts in your Physics Facts booklet.

2. Calculate the gravitational field at the surface of Mars.

The <u>gravitational field caused by an Agent at point P depends on</u> the <u>Agent's mass and the distance from the Agent's center to P.</u>

$g = G \frac{m_A}{r^2}$, where Mars is the Agent, and r is the radius of Mars

$$g = \frac{\left(6.67 \times 10^{-11} \frac{N m^2}{kg^2}\right)\left(6.42 \times 10^{23} \, kg\right)}{\left(3.37 \times 10^6 \, m\right)^2}$$

$g = \boxed{3.8 \frac{N}{kg}}$

The gravitational field at the surface of Mars is $3.8 \frac{N}{kg}$

3. If a 100 kg astronaut is standing on the surface of Mars, what gravitational force does she experience?

The <u>gravitational force exerted by an Agent on an Object is</u> the <u>product of the object's mass and the gravitational field caused by the Agent.</u> $F_{A \, on \, O} = m_o g$, where the object in this situation is the Astronaut, and g is 3.8 N/kg.

$$F_{A \, on \, O} = m_o g$$
$$= (100 \, kg)(3.8 \frac{N}{kg})$$
$$\boxed{380 N}$$

Over...

The astronaut experiences a gravitational force of 380N.

4. If the mass of the astronaut in #2 was increased, would the gravitational field strength where she is standing increase, decrease, or stay the same?

The gravitational field caused by an Agent at point P depends on the Agent's mass and the distance from the Agent's center to P, $g = \dfrac{G m_A}{r^2}$. Since G, m_A, and r would not change, the gravitational field strength stays the same.

5. Suppose it is found experimentally that when the 100 kg astronaut is in space some distance away from Mars, the force exerted by Mars on her is 250 N. Use this information to find the gravitational field strength at her location.

Point P

$F_{M \text{ on } a}$ is 250 N
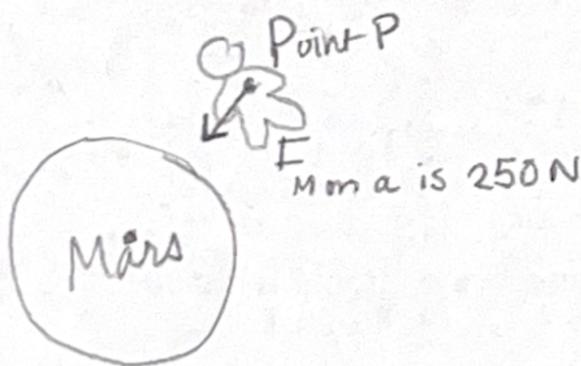
Mars

The gravitational field is the ratio of the force exerted by an Agent on an object to the mass of the object, $g = \dfrac{F_{A \text{ on } o}}{m_o}$

In this case, the agent is Mars and the object is the astronaut, so

$$g = \frac{F_{A \text{ on } o}}{m_o} = \frac{250 N}{100 kg} = \boxed{2.5 \frac{N}{kg}}$$ The gravitational field at her location is 2.5 N/kg

You could also have used the third fact from the New Facts instead of the first one that I used.

Notice that this is less than the gravitational field you found in #3 at Mars' surface.