PhyzJob: Field Calculations

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1. a. Calculate the strength of the earth's gravitational field at the surface of the earth. (The earth's mass is 5.98×10^{24} kg and the earth's radius is 6.37×10^{6} m.)

$$g = \frac{F}{m} = \frac{GM}{R^2} = \frac{6.67 \times 10^{-11}\ Nm^2/C^2 \cdot 5.98 \times 10^{2}\ kg}{(6.37 \times 10^{6}\ m)^2}$$

$$g = 9.83 N/kg$$

b. What is the force acting on a 10 kg mass at this point?

$$F = mg = 10\ kg \cdot 9.83\ N/kg = 98.3\ N$$

2. a. Do you recognize the number from your answer in 1. a? What did we previously call this number?

Acceleration due to gravity

b. Are the units m/s^2 equivalent to N/kg? Which units (m/s^2 or N/kg) are better suited to describe gravitational field strength (force per unit mass)?

$\frac{N}{kg}$ $\frac{kg \cdot m/s^2}{kg}$ $\frac{m}{s^2}$ Force per mass should be measured in N/kg

3. Acceleration due to gravity at the surface of the moon is 1.6 m/s^2. What is the strength of the gravitational field at the surface of the moon?

1.6 N/kg

4. a. What is the electric field strength 0.30 m away from a Van de Graaff generator with a charge of 1.2 μC?

$$E = \frac{F}{q} = \frac{kQ}{R^2} = \frac{9.0 \times 10^9\ Nm^2/C^2 \cdot 12 \times 10^{-3}\ C}{(0.3\ m)^2}$$

$E = 120{,}000$ N/C $= 120$ kN/C

b. What is the force on a 0.1 μC test charge at this point (0.30 m from the generator)?

$F = qE = 0.1 \times 10^{-6}\ C \cdot 120{,}000\ N/C = 0.012\ N$

5. Without using your calculator, can you determine the strength of the field at 0.60 m from the same charge (from 4) ...You *should* be able to do this! (Use your calculator to check your estimate.)

Since the distance is doubled, the field is reduced to $1/2^2$ $= 1/4$ its original value: $E = 30$ kN/C

6. Two cookie sheets (flat metal plates) are given opposite charges. The left plate has a charge of +5 μC and the right plate has a charge of –5 μC. Each plate has an area of 0.90 m^2 (for a *total* of 1.8 m^2) and the plates are separated by a distance of 0.02 m. What is the electric field strength between the plates?

$$E = 4\ kQ/A = \frac{4 \cdot 9.0 \times 10^9\ Nm^2/C^2 \cdot 5 \times 10^{-6}\ C}{0.9\ m^2}$$

$E = 6.3 \times 10^6$ N/C $= 630$ kN/C

1a. 9.83 N/kg b. 98.3 N 3. 1.6 N/kg 4a. 120 kN/C b. 12 mN 5. 30 kN/C 6. 630 kN/C