Felix

1. Gravitational Potential Energy

The 0.50 kg sphere to the right is immersed in a gravitational field created by a planet with a mass of 2.0×10^{20} kg and a radius of 3.0×10^{4} m.

a. What is the strength of the field at the surface of the planet?

$$g = GM/R^2 = \frac{6.67 \times 10^{-11}\ Nm^2/kg^2 \cdot 2 \times 10^{20}\ kg}{(3 \times 10^4\ m)^2}$$

$$g = 14.8\ N/kg$$

b. How much force must be exerted to lift the mass (i.e. what is the weight of the mass)?

$$F = mg = 0.5\ kg \cdot 14.8\ N/kg = 7.4\ N$$

c. How much work must be done to raise the mass 3.0 m above the surface?

$$W = F \cdot d = 7.4\ N \cdot 3\ m = 22.2\ J$$

d. How much gravitational potential energy does the sphere have when it's 3.0 m above the surface?

$$PE = W = 22.2\ J$$

e. If the sphere were dropped, how much kinetic energy would it have right before it hit the surface?

$$KE_{bottom} = PE_{top} = 22.2\ J$$

f. How fast would it be moving right before it hit?

$$KE = {}^1/_2 mv^2 \therefore v = (2KE/m)$$

$$v = (2 \cdot 22.2\ J / 0.5\ kg)$$

$$v = 9.4\ m/s$$

2. Electric Potential Energy

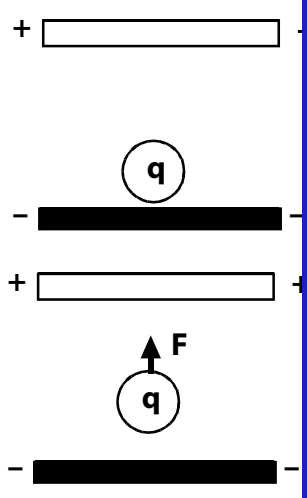
The sphere to the right has a charge of 50 nC and is immersed in an electric field created by two charged circular plates. The charge on each plate is 20 μC (top +, bottom –) and each plate's radius is 15 cm.

a. What is the strength of the field between the plates?

$E = 4\ kQ/A = 4\ kQ/\ r^2 = 4kQ/r^2$

$= 4 \cdot 9 \times 10^9\ Nm^2/kg^2 \cdot 20 \times 10^{-6}\ C$

$= 3.2 \times 10^7\ N/C = 32\ MN/C$



b. How much force must be exerted to lift the charge?

$F = qE = 50 \times 10^{-9}\ C \cdot 32 \times 10^6\ N/C$

$F = 1.6\ N$

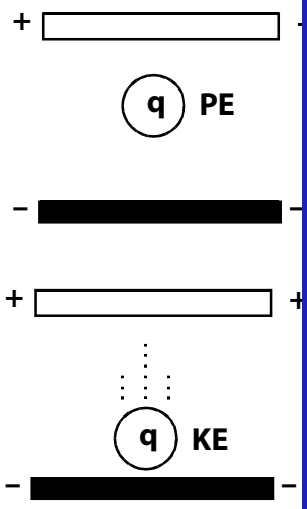
c. How much work must be done to raise the charge 2 cm away from the negative plate?

$W = F \cdot d = 1.6\ N \cdot 0.02\ m$

$W = 0.032\ J = 32\ mJ$

d. How much electric potential energy does the sphere have when it's 2 cm away from the negative plate?

$PE = W = 0.032\ J$



e. If the charge were released, how much kinetic energy would it have right before it hit the negative plate?

$KE_{neg} = PE_{pos} = 0.032\ J$

f. If the sphere had a mass of 1.0 g, how fast would it be moving right before it hit? (Neglect gravity.)

$KE = {}^1/_2 mv^2 \therefore v = \sqrt{(2KE/m)}$

$v = \sqrt{(2 \cdot 0.032\ J\ /\ 0.001\ kg)}$

$v = 8.0\ m/s$

1a. 14.8N/kg b. 7.4N c. 22.2J d. 22.2J e. 22.2J f. 9.4m/s 2a. 32MN/C b. 1.6N c. 32mJ d. 32mJ e. 32mJ f. 8.0m/s