Exam note

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1 Function

1.1 Definitions

Law of Universal Gravitation The law of universal gravitation states the force of gravity between two point masses is directly proportional to each mass and inversely proportional to the distance between them. This is also true for masses outside of spherically symmetric mass distributions.[**?**]

$$F_g = \frac{mMG}{r^2}$$

Hookean Forces Inside a uniformly dense sphere of mass the force is Hookean, with an attractive force proportional to the displacement from equilibrium. The effective spring constant is $K = \frac{mMG}{R^3}$.

$$F_g = \frac{mMG}{R^3} r$$

Gravitational Constant The universal gravitation constant G determines the strength of the gravity force from a given mass. It may also be considered as the force that 1 kg exerts on another 1 kg mass separated by 1 meter.

$$G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$$

Escape Velocity Escape velocity is the initial velocity required to escape gravitational attraction. An object launched at the escape velocity will never come back (escape).

$$v_{escape} = \sqrt{\frac{2MG}{r}}$$

Kinetic Energy Kinetic energy is the energy associated with motion.

$$KE = \frac{mv^2}{2}$$

Potential Energy The potential associated with the universal gravitation force is written as follows.

$$PE = -\frac{mMG}{r}$$

Circular Orbit A circular orbit is an orbit with a constant radius r.

Elliptic Orbit An elliptic orbit is a closed orbit with changing radius r.

Theory The change in the internal energy of an object or substance is equal to the product of the mass and the specific heat capacity and the change in temperature.

$$\Delta U = mC_p\Delta T$$

When water and the metal samples are in thermal equilibrium the change in heat of the water is equal in magnitude to the change in heat of the metal.

$$\Delta U_{metal} = \Delta U_{water}$$

From this relationship we may derive a formula for the specific heat capacity of the metal sample given the mass of metal, mass of water, change in temperature of the water, change in temperature of the metal and the specific heat capacity of water.

$$m_{metal}C_{metal}\Delta T_{metal} = m_{water}C_{water}\Delta T_{water}$$

$$C_{metal} = \frac{m_{water}}{m_{metal}}\frac{\Delta T_{water}}{\Delta T_{metal}}C_{water}$$

Mass analyzers separate the ions according to their mass-to-charge ratio. The following two laws govern the dynamics of charged particles in electric and magnetic fields in vacuum:

$$\mathbf{F} = Q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

Particle across the accelerating electric field:

$$\frac{1}{2}mv^2 = qV$$

Particle across the velocity-selector, because it's uniform motion, we know:

$$v = \frac{E}{B}$$

Because Newton second rule. We have function:

$$qB = m\Delta\frac{v}{r}$$

Ohms law

$$V = RI$$

Electric power

$$P = VI = I^2R = \frac{V^2}{R}$$

The electric fields

$$F = K\frac{Qq}{r^2}$$

electric fileds change

$$V = \frac{W}{q}$$

$$E = \frac{F}{q}$$

$$I = nAvq$$

2 Important question

The objective of this experiment is to measure the specific heat capacity of three different samples of metal and to compare those with the accepted values. The samples consist of aluminum, zinc and copper.

This is the calculation for the specific heat capacity of copper.

$$C_{metal} = \frac{m_{water}}{m_{metal}}\frac{\Delta T_{water}}{\Delta T_{metal}}C_{water}$$

$$\Delta T_{water} = 24.5 - 20.5 = 4.0 Celcius$$

$$\Delta T_{metal} = 100 - 24.5 = 75.5 Celcius$$

$$C_{metal} = \frac{0.350kg}{0.0906kg}\frac{4.0Celcius}{75.5Celcius}4180\ Jkg \cdot {}^\circ C = 855\ Jkg \cdot {}^\circ C$$

The percent error is calculated as follows.

$$Error = \frac{900 - 855}{900} = 5\%$$

2. **3**) Consider a capacitor. Two very large parallel conducting plates are connected to the leads of a 9 Volt battery.

a. Determine the separation between the plates to generate a 30.0 $\frac{N}{C}$ electric field.

$$-\Delta x = \frac{\Delta v}{E}$$

$$-\Delta x = \frac{-9}{0.3}$$

$$\Delta x = 30$$

b. Determine the force of this electric field on a 0.012 Coulomb charge.

$$F = Eq$$

$$F = 30 \times 0.012$$

$$F = 0.36$$

c. Determine the change in potential energy for the 0.012 C charge moving from the 9V plate to the 0V plate.

$$PE = Vq$$

$$PE = 9 \times 0.012$$

$$PE = 0.108$$

$$PE = 0 - 0.108 = -0.108$$

d. Draw the parallel plates and the electric field between them.