

Name:

Section:.....

Physics 208 Quiz 3

February 06, 2008 (due: February 20, 2008)

Problem 1 (40 points)

Check for each of the following forces, whether they are conservative! If so, determine the corresponding potentials! In the following A is considered a constant.

- (a) $\vec{F}(\vec{r}) = A\vec{r}$.
- (b) $\vec{F}(\vec{r}) = Axz\vec{i}_x$. (Here, \vec{i}_x is the unit vector of a Cartesian coordinate system $\{\vec{i}_x, \vec{i}_y, \vec{i}_z\}$ as usual!)
- (c) $\vec{F}(\vec{r}) = A\vec{r}/|\vec{r}|^4$.
- (d) $\vec{F}(\vec{r}) = A(x\vec{i}_x + y\vec{i}_y)/(x^2 + y^2)$.

Problem 2 (60 points)

A particle with positive charge, q , moves in an electric field with a potential

$$V(\vec{r}) = \frac{A}{2}r^2.$$

You can assume that the particle is fixed in the xy plane, i.e., $\vec{r} = x\vec{i}_x + y\vec{i}_y$, where $A = \text{const}$ and $A > 0$.

- (a) What is the electric field, given by the electric potential, V ?
- (b) What is the force exerted on the particle?
- (c) Write down the equations of motion for the particle.
- (d) Solve the equations of motion!

Hint: Show that for the right $\omega = \text{const}$ (which is it?)

$$\vec{r}(t) = \vec{c}_1 \cos(\omega t) + \vec{c}_2 \sin(\omega t) \tag{1}$$

is a solution for arbitrary constant vectors, \vec{c}_1 and \vec{c}_2 . Then check, whether you can find always \vec{c}_1, \vec{c}_2 such that Eq. (1) is a solution for an arbitrarily given initial condition

$$\vec{r}(0) = \vec{r}_0, \quad \vec{v}(0) = \dot{\vec{r}}(0) = \vec{v}_0.$$

- (e) Determine the trajectory of a particle whose initial condition is given as follows:

$$\vec{r}_0 = x_0\vec{i}_x, \quad \vec{v}_0 = v_0\vec{i}_y. \tag{2}$$

Hint: Even if you cannot solve problem (d), you can use Eq. (1) to solve problem (e)!

- (f) What is the energy of the particle, given the initial conditions (2)? Is this energy conserved?