Homework Test Assignment

Deadline for handing in: 2022/12/19
Scoring: 10 points per each problem (50 in total)

1. A point particle moves along a straight line in one dimension. Its law of motion (position vs. time) is given by

$$x(t) = b + ct^2 + ft^4,$$

where $b = 5.00\,\text{m}$, $c = 3.15\,\text{m/s}^2$, and $f = -0.150\,\text{m/s}^4$. Find (a) the position and (b) acceleration of the particle at the time instants when its velocity is equal to 0. What is (c) the average velocity of the particle between these instants?

2. A force $\vec{F} = (3.50\,\text{N})\hat{i} - (5.10\,\text{N})\hat{j} + (9.10\,\text{N})\hat{k}$ is applied to an object, which moves in space from the initial position $\vec{r}_i = (1.40\,\text{m})\hat{i} + (2.70\,\text{m})\hat{j}$ to the final position $\vec{r}_f = (5.70\,\text{m})\hat{i} + (7.30\,\text{m})\hat{k}$. The mass of the object is 2.50 kg and the duration of motion is 3.10 s. Find (a) the acceleration of the object, (b) the work done by the force, and (c) the average power due to the force.

3. Figure 1 shows two uniformly and equally charged rings of radii $r = 1.00\,\text{cm}$ and $R = 4.00\,\text{cm}$, respectively. The centers of both rings are located on the same axis and their planes are parallel to each other. The charge of each ring is $q = 9.00\,\text{nC}$ and the separation distance between their centers is $d = 7.00\,\text{cm}$. Find (a) the electric field, and (b) the electric potential at the point of observation P, which is located on the axis at $z = 5.00\,\text{cm}$ above the bottom ring.

4. Figure 2 shows the electric circuit consisting of emf, three resistors, and the ampermeter (device, which measures the electric current). Find the reading of the ampermeter, if $\mathcal{E} = 12.0\,\text{V}$, $R_1 = 25.0\,\Omega$, $R_2 = 15.0\,\Omega$, and $R_3 = 18.0\,\Omega$. The internal resistance of emf is $r = 2.00\,\Omega$.

5. A charged particle enters the laboratory chamber, which is put into the uniform magnetic field $\vec{B} = (2.70\,\text{T})\hat{i}$. Find the force (both magnitude and direction) exerted on this particle by the magnetic field, if its charge $q = -3.15 \times 10^{-8}\,\text{C}$ and the instantaneous velocity $\vec{v} = (2.60 \times 10^4\,\text{m/s})\hat{j} - (4.20 \times 10^4\,\text{m/s})\hat{k}$.

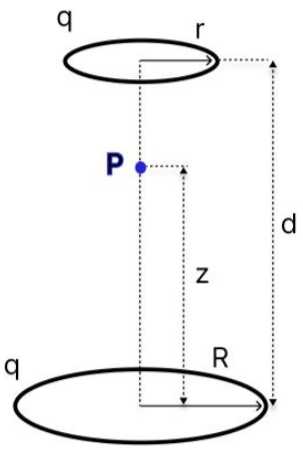

Figure 1

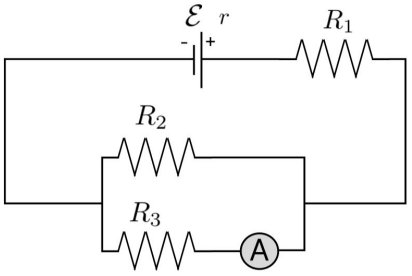

Figure 2

Hint: the unit basis vectors of the Cartesian coordinates satisfy the following relations:

$$\hat{i}^2 = \hat{j}^2 = \hat{k}^2 = 1, \quad \hat{i}\cdot\hat{j} = 0 = \hat{i}\cdot\hat{k} = \hat{j}\cdot\hat{k},$$
$$\hat{i}\times\hat{j} = \hat{k}, \quad \hat{i}\times\hat{k} = -\hat{j}, \quad \hat{j}\times\hat{k} = \hat{i}.$$