NAME: ______________________________ ID: ____________________

Exam 3

PHY 204: Elementary Physics II

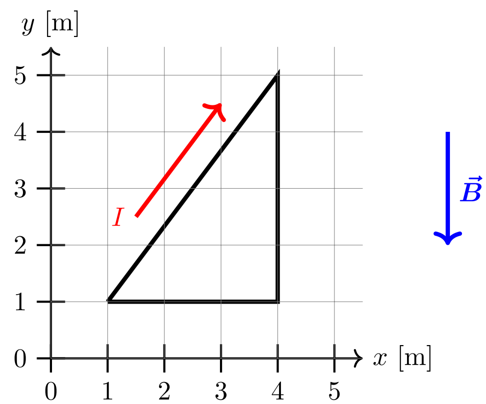
You have 50 minutes to complete this exam. Explain your reasoning, include sketches where appropriate, and clearly indicate your final answer. All vectors must have clearly identified magnitude and direction (or be written in unit-vector notation) for full credit. All final answers must have units for full credit.

1. The conducting loop shown in the figure to the right has $N = 3$ turns and carries a clockwise current $I = 1\,\mathrm{A}$. A constant magnetic field $\vec{\boldsymbol{B}} = -2\,\mathrm{T}\,\hat{\boldsymbol{j}}$ is present throughout the region, as shown. Calculate the magnitude and direction of each of the following:

   (a) The magnetic dipole moment $\vec{\boldsymbol{\mu}}$ of the loop.

   (b) The net force $\vec{\boldsymbol{F}}$ on the loop.

   (c) The net torque $\vec{\boldsymbol{\tau}}$ on the loop.



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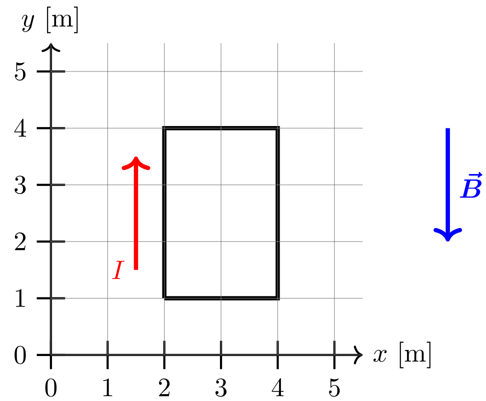
1. The rectangular conducting loop shown in the figure to the right has $N = 3$ turns and carries a clockwise current $I = 1\,\mathrm{A}$. A constant magnetic field $\vec{\boldsymbol{B}} = -\frac{1}{2}\,\mathrm{T}\,\hat{\boldsymbol{\jmath}}$ is present throughout the region, as shown. Calculate the magnitude and direction of each of the following:

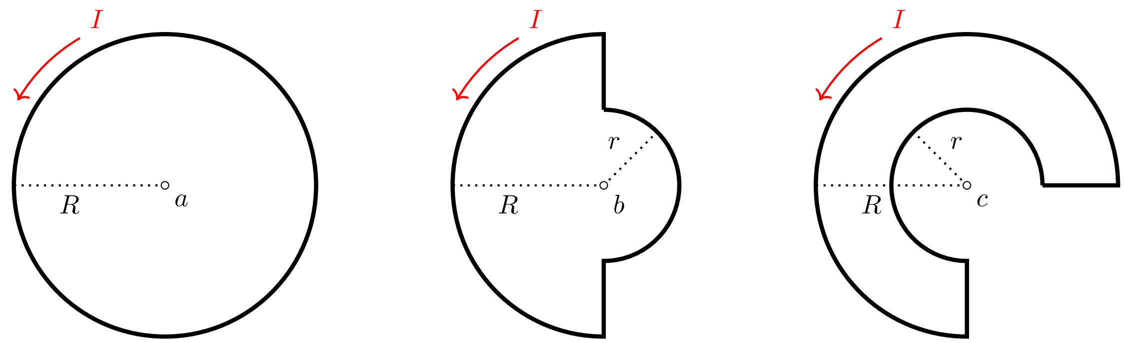
   (a) The magnitude and direction of the magnetic dipole moment $\vec{\boldsymbol{\mu}}$ of the loop.

   (b) The magnitude and direction of the net torque $\vec{\boldsymbol{\tau}}$ on the loop.

   (c) The magnitude and direction of the force $\vec{\boldsymbol{F}}$ on each of the four sides of the loop (top, bottom, left, right), as well as the net force $\vec{\boldsymbol{F}}_{\text{net}}$ on the loop.



2. A single loop of wire is bent into semi-circular segments connected by straight segments of wire in three different configurations, as shown in the figures below. There is a current $I = 4\,\mathrm{A}$ flowing through each loop in the direction shown. The smaller radius is $r = 1\,\mathrm{m}$ and the larger radius is $R = 2\,\mathrm{m}$. The center of each loop is indicated by the point a, b, and c in each figure. Use the approximation $\pi \approx 3$ such that $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A} \approx 12 \times 10^{-7}\,\mathrm{Tm/A}$.



(a) What is the magnitude and direction ($\odot$, $\otimes$) of the magnetic field $\vec{\boldsymbol{B}}_a$ at point a?

(b) What is the magnitude and direction ($\odot$, $\otimes$) of the magnetic field $\vec{\boldsymbol{B}}_b$ at point b?

(c) What is the magnitude and direction ($\odot$, $\otimes$) of the magnetic field $\vec{\boldsymbol{B}}_c$ at point c?

2. Two semi-infinite straight wires are connected to a curved wire in the form of either a half-circle or three-quarters of a circle with radius $R = 1\,\mathrm{m}$ in three different configurations (except for configuration a, where instead there are simply two infinite straight wires). A current $I = 2\,\mathrm{A}$ flows in the directions indicated by the arrows. Find magnitudes B_a, B_b, B_c and direction ($\odot$, $\otimes$) of the magnetic field thus generated at points a, b, c. Recall that $\mu_0 = 4\pi \times 10^{-7}\,\mathrm{Tm/A}$, and use the approximation $\pi \approx 3$.