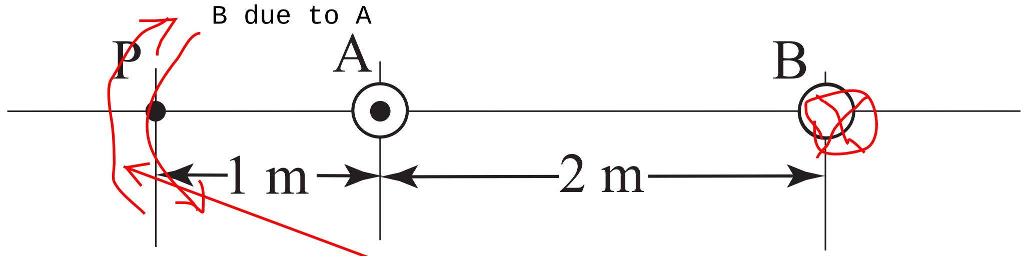
Physics 102 (F16)

Q7A

Name: ____________________ **Section:** __________ **Score:** __________/20

1. Two straight thin wires are perpendicular to the page as illustrated in the figure. Wire A carries a current I of 3 A, whose direction is as indicated. A force of magnitude f per unit length acts on wire B.



(1) The magnetic field at P happens to be zero. What is the current through wire B? Its magnitude and direction must be answered. [5]

Ampere's law, RHscrew rule
B = mu0 I/(2Pi r)

B due to B
RH screw rule tells us
current B must be into the page

```
Magnitude: B = mu0 I/(2pi r)
rA = 1 m, rB = 3 m.
Therefore, IA/rA = IB/rB is required.  ->  IB = IA(rB/rA) = 3(3/1) = 9 A.
```

(2) While keeping the currents through wires A and B as in (1), the distance between A and B is halved. What is the magnitude F of the force acting on wire A in terms of f? [5]

F = ILB sin phi

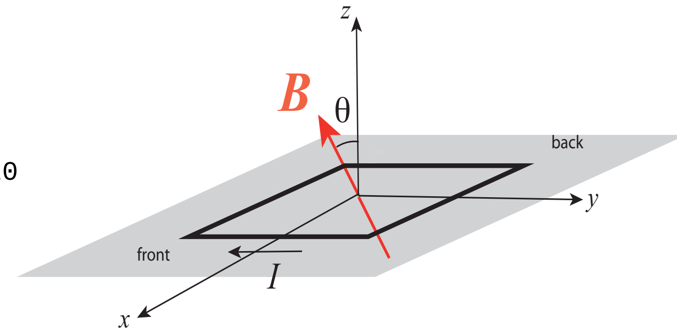
```
F is proportional to B, if I is intact.
Now, r is halved, so the B field magnitude is doubled.
Therefore,  F = 2f.
```

2. On the xy-plane is a closed square loop of wire enclosing an area $A = 2.3 \times 10^{-4}$ m^2. The wire carries a permanent current of $I = 12$ A as shown in the figure.

(1) A uniform magnetic field $\boldsymbol{B}$ makes an angle $\theta = 20°$ with the positive z-axis as illustrated twists the loop with a torque of 6×10^{-3} N·m. What is the magnitude of $|\boldsymbol{B}|$ of the magnetic field? [5]

tau = NIAB sin phi

```
B = tau/IA sin phi
  = 6x10^{-3}/12 x 2.3x10^{-4}x sin 20
  = 6x10^{-3}/9.43x10^{-4} = 6.36 T
```



(2) After turning off the magnetic field, a bar magnet parallel to the x-axis is placed on the x-axis as illustrated below while the loop with the same current as in (1) is fixed. Then, the loop is gently released so that it can freely rotate around the origin. What happens to the loop shortly after it is released? [e.g., it starts to rotate around $\cdots$ as shown by the arrow (that you draw) in the figure.] [5]