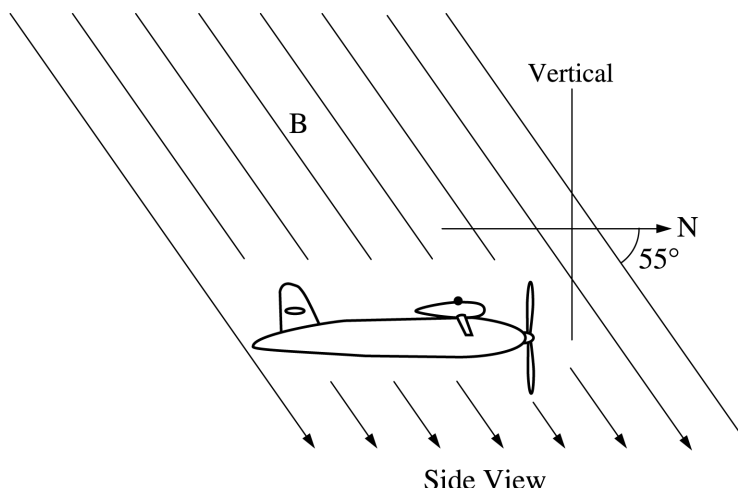
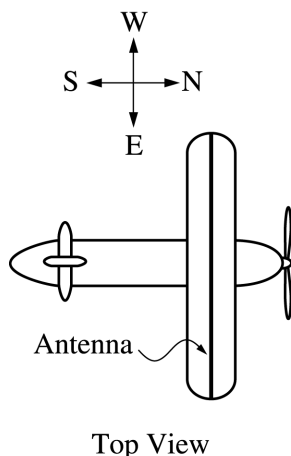


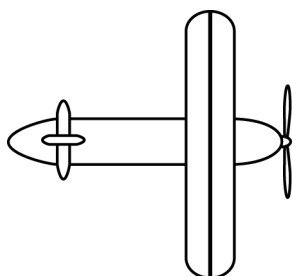
**2003 AP[®] PHYSICS C: ELECTRICITY AND MAGNETISM
FREE-RESPONSE QUESTIONS**



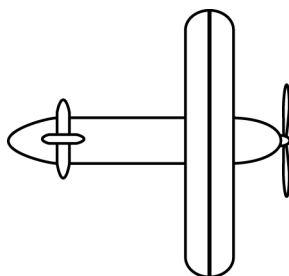
E&M. 3.

An airplane has an aluminum antenna attached to its wing that extends 15 m from wingtip to wingtip. The plane is traveling north at 75 m/s in a region where Earth's magnetic field has both a vertical component and a northward component, as shown above. The net magnetic field is at an angle of 55 degrees from horizontal and has a magnitude of 6.0×10^{-5} T.

- (a) On the figure below, indicate the direction of the magnetic force on electrons in the antenna. Justify your answer.

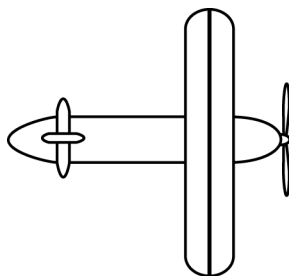


- (b) Determine the magnitude of the electric field generated in the antenna.
 (c) Determine the potential difference between the ends of the antenna.
 (d) On the figure below, indicate which end of the antenna is at higher potential.



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- (e) The ends of the antenna are now connected by a conducting wire so that a closed circuit is formed.
- i. Describe the condition(s) that would be necessary for a current to be induced in the circuit. Give a specific example of how the condition(s) could be created.
 - ii. For the example you gave in i. above, indicate the direction of the current in the antenna on the figure below.



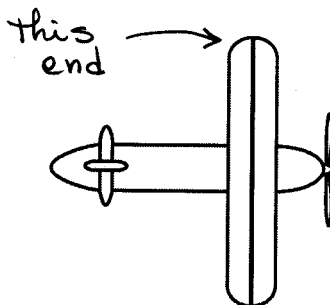
END OF SECTION II, ELECTRICITY AND MAGNETISM

**AP[®] PHYSICS C: ELECTRICITY AND MAGNETISM
2003 SCORING GUIDELINES**

Question 3 (cont'd.)

**Distribution
of points**

(d) 1 point



For indicating that the top of the wing is at the higher potential

1 point

Note: To earn credit, this answer must be consistent with the student's answer to part (a).

(e) 5 points

i. (3 points)

For indicating that there must be a change in the magnetic flux through the closed loop

2 points

For specifying a correct change in the plane's orientation or the connected wire that could result in a change in flux through the closed loop.

1 point

ii. (2 points)

For any indication of the position of the connected wire in the closed loop

1 point

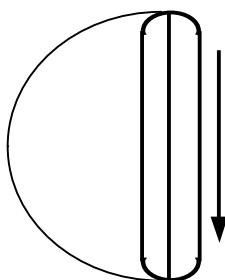
For showing the correct direction of the resulting induced current on the diagram, based upon the conditions indicated in part (e) i.

1 point

Examples

Ex. 1: The connecting wire trails behind the antenna, over the body of the plane.

The plane goes into a forward dive, increasing its angle with respect to horizontal.



The forward dive would decrease magnetic flux downward through the loop, so a current will be induced to create an increased downward flux.