1. At a particular time, the magnetic field of an EM wave is in the -z direction, and the direction of propagation of the wave is in x, in what direction does the electric field point? Explain. (You can draw a diagram to help you visualize the wave and explain your answer. Include in your answer the sign of the direction.) [2 pts]

   The electric field points in the –y direction. The electric field has to be perpendicular to both the magnetic field and the direction of propagation according to the right hand rule. With the thumb pointing to the x direction, the only way the fingers can move towards the –z direction is if they start at the –y direction.

2. List two possibilities for what happens to the portion of the electric field of the EM wave that is not transmitted through a polarizer. [2 pts]

   - It can be absorbed by the polarizer.
   - It can be reflected off the polarizer.

3. A transmitter oriented horizontally emits EM waves with electric field $E_0$, which goes through a polarizer and then to a receiver, as shown in the figure.
Physics 108  Experiment 6: EM waves – Group Problems  Spring 2013

Name __________________________  Section __________________________

a) Suppose that initially there is no polarizer. What is the electric field measured by the receiver? Explain. [1 pt]

Zero. Transmitter and receiver are perpendicular to each other, so none of the electric field emitted can be measured by the receiver.

b) After the polarizer is placed in the position shown in the figure, what is the electric field coming out of the polarizer? (Express your answer in terms of $E_o$ and $\theta$. Show all work.) [2 pts]

$$E_{pol} = E_o \sin(\theta)$$

c) With the polarizer still in place, for what angle(s) $\theta$ (between 0 and 360 degrees) do you predict the amplitude of the electric field measured by the receiver will be a minimum? Maximum? (Note: You will have more than one for each). [2 pts]

Minimum: 0, 90, 180, 270 and 360 degrees.

Maximum: 45, 135, 225 and 315 degrees.
d) For any angle, what is the electric field measured in the receiver? (Express your answer in terms of $E_o$ and $\theta$. Show all work.) [2 pts]

$$E_{measured} = E_p \cos(\theta)$$

$$\Rightarrow E_{measured} = E_o \sin(\theta) \cos(\theta)$$

e) What curves will best describe the electric fields found in b) and d)? Explain why you chose a particular plot for the field found in d). [2 pts]

![Graphs](image)

**d)**

Plot for d) has to be zero at $\theta = 0$ degrees, so it can only be the first or the third option. The third option cannot be as the plot also has to be 0 at $\theta = 90$ degrees. The first plot follows both conditions.

**f)** The polarizer is replaced by a plane conductor. What is the electric field measured now by the receiver? Explain. [2 pts]

**Zero. No electric field will pass through the plane conductor. Thus, the receiver measures nothing.**
4. *(extra credit)* Assume now that the transmitter also has a receiving antenna aligned vertically that is not sensitive to the wave produced by the transmitter. Assume also that any component of the EM wave is either reflected off or passes through the polarizer. What is the amplitude of the electric field received by the new antenna? (Express your answer in terms of $E_o$ and $\theta$. Show all work.) [2 pts]

\[
E_{\text{reflected}} = E_o \cos(\theta)
\]

\[
E_{\text{antenna}} = E_{\text{reflected}} \sin(\theta)
\]

\[
E_{\text{antenna}} = E_o \cos(\theta)\sin(\theta)
\]