1. Express the wave $f(t,x) = A\ \sin(\omega t - kx)$ in complex notation.

   Answer: In complex notation, $f(x) = Re\left(\tilde{f}(x)\right)$, where $\tilde{f}(x) = \tilde{A}e^{i(\omega t - kx)}, \tilde{A} = Ae^{-i\pi/2}$

2. In vacuum, EM waves are transverse with **E** and **B** perpendicular to each other. This can be shown from (a) Gauss law, (b) Ampere's law, (c)$\boldsymbol{\nabla}\cdot\mathbf{B} = 0$, (d) Faraday-Lenz law

   Answer: (b) & (d)

3. Pressure applied by EM waves incident on a surface is arises due to forces applied by the oscillating EM fields of the EM wave on electrons in the wall material. This pressure is along which force component:
   (a) $q\mathbf{E}$, (b) $\frac{q}{c}\mathbf{v}\times\mathbf{B}$, (c) $q\mathbf{E} + \frac{q}{c}\mathbf{v}\times\mathbf{B}$, (d) $\mathbf{I}\times\mathbf{B}$

   Answer: (b)

4. For an Ohmic conductor, on which timescale any injected volume charge dissipates i.e. flows out to the surface/edges:
   (a) 0, (b)$\frac{\varepsilon}{\sigma}$, (c) $\frac{\mu\epsilon}{\sigma}$, (d) $\frac{1}{\omega}$

   Answer: (b)

5. Skin Effect: As we increase ω, the EM wave incident on a conductor, penetrates :
   (a) deeper, (b) lesser, (c) about the same

   Answer: (b)

6. Cauchy dispersion formula holds for
   (a) Normal dispersion (b) Anomalous dispersion (c) General Case

   Answer: (a)

7. Which frequency is not allowed in a rectangular wave guide:
   (a)ω_{00}(b)ω_{10}(c)ω_{01} (d) ω_{11}

   Answer: (a)

8. For reflection at conducting surface, the Fresnel equations although formally identical to the dielectric, are different due to...

   Answer: For the case of conductors the equations are complex, while for dielectrics they are real (no phase factors contributing to phase difference between Eand **B).**

9. Poynting vector in a dielectric is
   (a) $\frac{1}{\mu_0}\mathbf{E}\times\mathbf{B}$ (b) $\frac{1}{c^2}\mathbf{D}\times\mathbf{B}$ (c) $\mathbf{E}\times\mathbf{H}$ (d) $\mathbf{D}\times\mathbf{H}$

   Answer: (c)

1. **Solution:**

$$f(x) = A\ \sin(\omega t - kx) = A\ \cos(\omega t - kx - \frac{\pi}{2})$$

which is the real part of,

$$\tilde{f}(x) = A\, e^{i\left(\omega t - kx - \frac{\pi}{2}\right)} = \tilde{A}e^{i(\omega t - kx)}, \tilde{A} = Ae^{-i\pi/2}.$$

2. **Solution:** Look up lecture slides.

3. **Solution:** The electric field component of the EM waves make the charged particles move around, and these moving charges experience the Lorenz magnetic force, $F = \frac{q}{c}\mathbf{v} \times \mathbf{B}$. Since $\mathbf{v}$ is lies on the wall, as well as $\mathbf{B}$ has a component parallel to the wall, the charge experiences a Lorentz magnetic force in a direction normal to the wall. The sum total of this normal Lorentz magnetic force over all charges per unit area of the wall gives rise to radiation pressure.

4. **Solution:** Look up the lecture slides.

5. **Solution:** Skin depth is, $d \sim \sqrt{\frac{2}{\mu\sigma\omega}} \propto \omega^{-1/2}$.

6. **Solution:** Look up lecture slides

7. **Solution:** Recall from lecture, for the **TE** mode ω_{00}, $m = n = 0$, which gives $B_z = constant$. This immediately implies, $B_{x,y} = E_{x,y} = 0$. Thus ω_{00} cannot be sustained in a rectangular wave guide.

8. **Solution:** Look up lecture slides

9. **Solution:** Derive this as an exercise.