Problem 1. (10 points) Griffiths Problem 10.3.
Comment: The potentials in this problem are for a very basic system. Part (a) is a strange form to choose, but perfectly valid. The gauge transformation in part (b) produces the more standard choice.

Problem 2. (10 points) Read Griffiths Problem 10.6.

(i) Using the gauge freedom of the scalar and vector potentials, show that we can always choose \( \nabla \cdot \mathbf{A} = 0 \). \[\text{Note:} \] Yes, Griffiths does this for you, as he notes in the problem. Here I am forcing you to reread his proof. Now we can see how that argument fits in a larger context.]

(ii) Show that it is always possible to choose

\[
\nabla \cdot \mathbf{A} = -\mu_0 \varepsilon_0 \frac{\partial V}{\partial t},
\]

thus showing that we can satisfy the Lorenz gauge condition.

(iii) Is it always possible to choose \( V = 0 \)? Clearly explain your answer.

(iv) Is it always possible to choose \( \mathbf{A} = 0 \)? Clearly explain your answer.

Problem 3. (15 points) Read Griffiths Problem 10.11.

(i) Consider the case of an infinite wire with a linearly increasing current, \( I(t) = kt \), for \( t > 0 \). (For \( t < 0 \) the current is zero.) What do you expect for the late time behavior (\( t \to \infty \)) of the electric and magnetic fields? \[\text{Note:} \] You should always ask such questions before solving a problem. This is a somewhat peculiar case. What is \( I(t) \) at late times?]

(ii) Calculate the electric, \( \mathbf{E}(r,t) \), and magnetic, \( \mathbf{B}(r,t) \), fields for the current in the previous part.

(iii) Now consider the same wire but with only a burst of current, \( I(t) = q_0 \delta(t) \). Again describe what you expect for the late time behavior of the electric and magnetic fields.

(iv) Calculate the electric, \( \mathbf{E}(r,t) \), and magnetic, \( \mathbf{B}(r,t) \), fields for the current in the previous part.