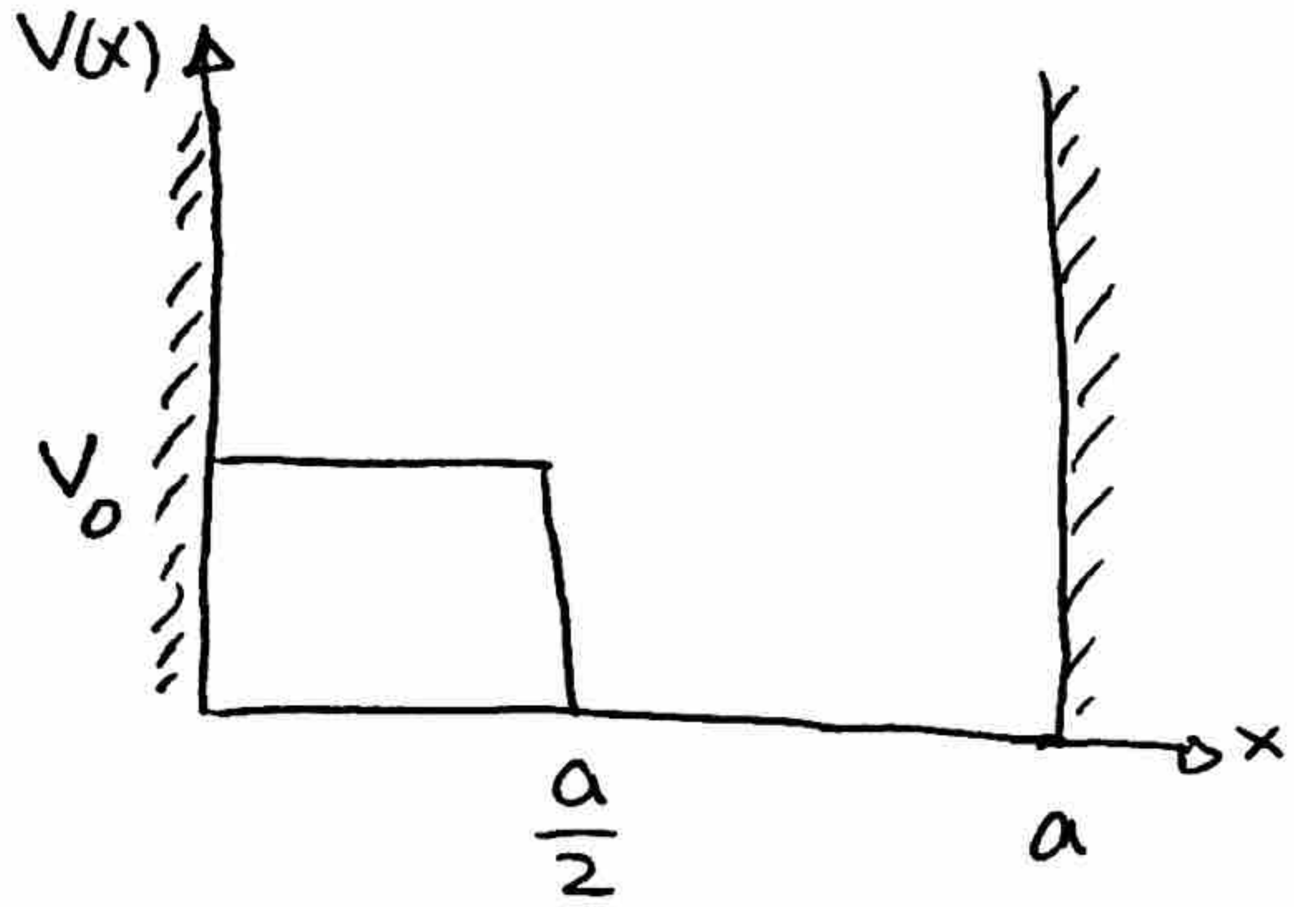
1- Use the WKB approximation to find the allowed energies E_n of an infinite square well with a "shelf" of height V_0, extending half-way across:

$$V(x) = \begin{cases} V_0 & 0 < x < a/2 \\ 0 & a/2 < x < a \\ \infty & \text{otherwise} \end{cases}$$



Express your answer in terms of V_0 and $E_n^0 \equiv \frac{(n\pi\hbar)^2}{2ma^2}$ (n^{th} allowed energy with no shelf). Assume $E_1^0 > V_0$, but do not assume that $E_n \gg V_0$. Compare your results with first-order perturbation theory. Note that they should be in agreement if either V_0 is very small (perturbation regime) or n is very large (WKB regime).

2- In a semiconductor, an electric field (if it's large enough) can produce transitions between energy bands, a phenomenon known as Zener tunneling. A uniform electric field $E = -E_0\hat{i}$ for which $H' = -eE_0x$ makes the energy bands position dependent as shown. It is then possible for an electron to tunnel from the valence (lower) band to the conduction (upper) band. Treating the gap as a potential barrier through which the electron may tunnel, find the tunneling probability in terms of E_g and E_0 (as well as $m, \hbar, e$)