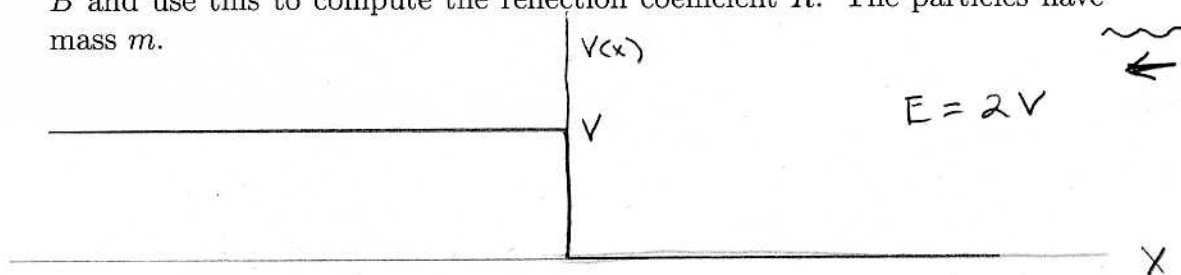


Name: _____

1) (a) Compute $\langle \hat{X}\hat{P} \rangle$ and $\langle \hat{P}\hat{X} \rangle$ for a particle in harmonic oscillator state $|\phi_n \rangle$. Define any constants you use in terms of m and K , where, $\hat{H} = \frac{\hat{P}^2}{2m} + \frac{K}{2}\hat{X}^2$.

(b) Compute $\langle \hat{X}\hat{P} \rangle$ for a state that is $|\psi(t=0) \rangle = \frac{1}{\sqrt{2}}|\phi_0 \rangle + \frac{1}{\sqrt{2}}|\phi_1 \rangle$ at time $t = 0$. This is a function of time. The algebraic method is the easiest way to do this calculation.

2) Particles are shot at the step potential shown below from the right, so that the wavefunction for $x > 0$ is $e^{-ikx} + Be^{ikx}$. Assume $E = 2V$, compute B and use this to compute the reflection coefficient R . The particles have mass m .



3) The finite square well potential shown below has only one bound state. Derive the boundary conditions for the ground state at $x = a$. If I adjust V and a separately, how deep can I make this bound state? Prove your answer.

