i. $|\psi\rangle = \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{2}|10\rangle - \frac{1}{2}|11\rangle$

a). Probability of measuring both qubits as 0

$= \left(\frac{1}{\sqrt{2}}\right)^2$ since $|00\rangle$ is the only state with two 0 qubits.

$= \frac{1}{2}$.

b) Probability of measuring first qubit as 1

$= \left(\frac{1}{2}\right)^2 + \left(\frac{-1}{2}\right)^2$ since $|10\rangle$ and $|11\rangle$ are the only state with qubit starting with 1

$= \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$

c) Probability of measuring second qubit as 0

$= \left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{1}{2}\right)^2$ since $|00\rangle$ and $|10\rangle$ are the only state with 0 at second qubit

$= \frac{1}{2} + \frac{1}{4} = \frac{3}{4}$

d) After measuring the first qubit as 0, then we know that the only part of $|\psi\rangle$ that has the first qubit as 0 is $\frac{1}{\sqrt{2}}|00\rangle$. However, we need to renormalise the state to make sure it has a propability of one. So the new state of the system after measuring the first qubit as 0 is $|\psi'\rangle = |00\rangle$.

e) After measuring the first qubit as 1, then we know that the only parts of $|\psi\rangle$ that have the first qubit as 1 are $\frac{1}{2}(|10\rangle) - \frac{1}{2}|11\rangle$. However, we need to renormalize the state to make sure it has a probability of one. So, the new state of the system after the measurement is $|\psi'\rangle = \frac{1}{\sqrt{2}}|10\rangle - \frac{1}{\sqrt{2}}|11\rangle$.

2. For two fair coins: Let us consider 0 as heads and 1 as tails. While they are in the air, the state of the two-coin system is

$$|\psi\rangle = \frac{1}{2}|00\rangle + \frac{1}{2}|01\rangle + \frac{1}{2}|10\rangle + \frac{1}{2}|11\rangle.$$

where $\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 = 1.$

3. For two six-sided dice. Let us consider 0 as the state for (2,4,6) and 1 for the odds (1,3,5) in the dice. There exist 36 combinations. But let us represent this in a two qubit system.

$$|\psi\rangle = \underbrace{\frac{1}{2}|00\rangle}_{\text{all even}} + \underbrace{\frac{1}{2}|01\rangle}_{\text{one even one odd}} + \underbrace{\frac{1}{2}|10\rangle}_{\text{one odd one even}} + \underbrace{\frac{1}{2}|11\rangle}_{\text{all odd}}.$$

Now, we only need probability for one even and other odd.

The probability is $\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 = \frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \boxed{\frac{1}{2}}.$