Q2a: Let $\{B_n\}$ be an disjoint sequence of sets in $\mathcal{A}$. We define

$$A_n = \bigcup_{i=1}^{n} B_i$$

We have that the $A_i's$ are an increasing sequence by construction. It is clear that each $A_i$ belongs to $\mathcal{A}$, since each is the union of sets in $\mathcal{A}$. It is given that $\mu$ is a finitely additive measure, so

$$\mu(\bigcup_{j=1}^{n} B_j) = \sum_{j=1}^{n} \mu(B_j)$$

By the construction of $\{A_n\}$ it is also true that

$$\mu(A_n) = \mu(\bigcup_{j=1}^{n} B_n)$$

Taking the limit we see that

$$\begin{aligned}
\lim_{n\to\infty} \sum_{j=1}^{n} \mu(B_j) &= \lim_{n\to\infty} \mu(\bigcup_{j=1}^{n} B_j) \\
&= \lim_{n\to\infty} \mu(A_n) && \text{(by construction of } A_n\text{)} \\
&= \mu(\lim_{n\to\infty} \bigcup_{j=1}^{n} A_n) && \text{(by given measure continuity)} \\
&= \mu(\lim_{n\to\infty} \bigcup_{j=1}^{n} B_n) && \text{(by definition of } B_n\text{)}
\end{aligned}$$

We get the desired equality and conclude that $\mu$ is a premeasure.

Q2b: Let $\{B_n\}$ be a sequence of disjoint sets in $\mathcal{A}$. Since $\mu$ is finite, we have that downward measure continuity holds. We define a decreasing sequence of sets $\{A_n\}$ by $A_n = \bigcup_{i=n} B_i$. Note that this sequence is contained in $\mathcal{A}$ since it is the union of elements of $\mathcal{A}$. We note that by finiteness of $\mu$ we have that

$$\sum_{i=1}^{n} \mu(B_i) = \mu(\bigcup_{i=1}^{n} B_i)$$

But also by the construction of $\{A_n\}$ we get that

$$\sum_{i=1}^{n} \mu(B_i) = \sum_{i=1}^{n} \mu(A_i) - \mu(A_{i+1}) = \mu(A_1) - \mu(A_{n+1})$$

Taking the limit as $n \to \infty$, we get that

$$\begin{aligned}
\sum_{i=1}^{\infty} \mu(B_i) &= \lim_{n\to\infty} \sum_{i=1}^{n} \mu(B_i) \\
&= \mu(A_1) - \lim_{n\to\infty} \mu(A_{n+1}) \\
&= \mu(A_1) && \text{(by assumption of measure of nested sets)} \\
&= \mu(\bigcup_{i=1}^{\infty} B_i)
\end{aligned}$$

We get the desired result and conclude that $\mu$ is a premeasure on $\mathcal{A}$