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1. Given the three premises

• $S \rightarrow L$
• $\neg S \rightarrow \neg J$
• $Y \rightarrow \neg L$

Use propositional logic to prove formally that

• $J \rightarrow \neg Y$
2. In the Venn diagrams below, shade in the regions (i) \((A \cap B) \cup C\) and (ii) \(A \cap (B - C)\).

(i) \((A \cap B) \cup C\)

(ii) \(A \cap (B - C)\)
3. For sets $A = \{a, b, c\}$ and $B = \{x, y\}$, write down (using correct bracketing) the following sets:

(i) $A \cap B$
(ii) $A \times B$
(iii) $\mathcal{P}(A)$
4. Let $A = \{1, \{1\}, \{2\}, 3\}$.

Decide whether each of the following statements is True (T) or False (F).

(i) $1 \in A$
(ii) $\{3\} \in A$
(iii) $\{\{1\}\} \subseteq A$
(iv) $3 \subseteq A$
(v) $\{1, 2\} \subset A$
(vi) $(1, 2) \in (A \times A)$
5. (a) Draw the *bipartite graph diagram* and the *directed graph diagram* of the relation $R$ on the set $X = \{0, 1, 2, 3\}$ defined by $(a, b) \in R$ if and only if $1 \leq a + b \leq 3$.

(b) Is $R$ one-to-one, one-to-many, many-to-one, or many-to-many? Give a brief explanation.

(c) For each of the properties *reflexivity*, *symmetry*, *transitivity* and *antisymmetry*, explain carefully whether $R$ has that property or not.
6. Suppose a binary relation $R$ is defined on the set of all integers by the following definition: $(a, b) \in R$ iff $a$ is a multiple of $b$. So for instance, $(6, 2) \in R$ and $(6, -3) \in R$ but $(4, 5) \not\in R$.

For each of the properties reflexivity, symmetry, transitivity and antisymmetry, explain carefully whether $R$ has that property or not.