① what is the order of operations? Order and group.

  ① $\sim$ (negation)
  ② $\wedge, \vee$ (And /or)
  ③ $\rightarrow, \leftrightarrow$ (if-then, iff)

② Is this a valid argument? Prove

Premises.   Conclusion.

1	2	3	4	5	6	7	8	9	
a	b	c	$\sim c$	$b \vee c$	$a \wedge \sim c$	$a \rightarrow 5$	$b \rightarrow 6$	$b \rightarrow c$	
T	T	T	F	T	F	T	F	T	
T	T	F	T	T	T	T	T	F	← Invalid
T	F	T	F	T	F	(T)	(T)	(T)	*
T	F	F	T	F	T	F	T	T	
F	T	T	F	T	F	T	F	T	
F	T	F	T	T	F	T	F	F	
F	F	T	F	T	F	(T)	(T)	(T)	*
F	F	F	T	F	F	(T)	(T)	(T)	*

The argument is valid because there are forms of argument that
have true premises and a true conclusion. The rows marked
with * indicate forms of argument that are valid. Row 2
however shows us that an argument of this form can have
all true premises and a false conclusion, so this form is
invalid.

③ State 2 fallacious, well-known syllogisms.

  ① converse Error: ② Inverse Error:

       $p \rightarrow q$ $p \rightarrow q$
       q $\sim p$
    ∴ p → Invalid   ∴ $\sim q$ → Invalid
        Conclusion   Conclusion

④ State 2 well-known syllogisms.

Modus Ponens: Modus Tollens:

$$p \to q$$
$$p$$
$$\therefore q$$

$$p \to q$$
$$\sim q$$
$$\therefore \sim p$$

⑤ Prove $a \leftrightarrow b \equiv (b \to a) \wedge (a \to b)$

1	2	3	4	5	6
a	b	$a \to b$	$b \to a$	$a \leftrightarrow b$	$3 \wedge 4$
T	T	(T)	(T)	(T)	(T)
T	F	F	T	(F)	(F)
F	T	T	F	(F)	(F)
F	F	(T)	(T)	(T)	(T)

Since $3 \wedge 4$ and 5 have identical truth values, $a \leftrightarrow b \equiv (b \to a) \wedge (a \to b)$.