1. **(2 points)** `Library/SDSU/Discrete/Logic/formallogicB21.pg`
Negate the following statement:

$$\text{If } \mathbf{a} = \mathbf{1} \text{ and } \mathbf{b} = \mathbf{2}, \text{ then } \mathbf{a} + \mathbf{b} = \mathbf{3}.$$

Choose the correct statement:

- A. $a \neq 1$ or $b \neq 2$ and $a + b \neq 3$
- B. $a = 1$ and $b = 2$ and $a + b \neq 3$
- C. $a = 1$ and $b = 2$ or $a + b \neq 3$
- D. $a \neq 1$ or $b \neq 2$ or $a + b \neq 3$

2. **(2 points)** `Library/SDSU/Discrete/Logic/formallogicB10.pg`
Convert the following statement using an "or" structure.

if a is irrational and b is rational, then $a \cdot b$ is irrational.

Choose the correct statement:

- A. a is rational, or b is irrational, or $a \cdot b$ is irrational
- B. a is rational and b is rational, or $a \cdot b$ is irrational
- C. a is irrational, or b is rational, or $a \cdot b$ is irrational
- D. a is irrational, or b is rational, and $a \cdot b$ is irrational

3. **(8 points)** `Library/MontanaState/Misc.Logic/1.5A33Logic1.pg`

Are the two sentences logically equivalent?
If John and Fred will go, Jess will go.
If John will go, Jess will go, and if Fred will go, Jess will go.

- A. Yes
- B. No

Are the two sentences logically equivalent?
If James will go, Jack and Melinda will go.
If James will go, Jack will go, and if James will go, Melinda will go.

- A. Yes
- B. No

Are the two sentences logically equivalent?
If Chris or Michael will go, Jess will go.
If Chris will go, Jess will go, and if Michael will go, Jess will go.

- A. Yes
- B. No

Are the two sentences logically equivalent?
If Sam or Bobby will go, Karen will go.
If Sam will go, Karen will go, or if Bobby will go, Karen will go.

- A. Yes
- B. No

4. **(8 points)** `Library/MontanaState/Misc.Logic/1.5B3Logic.pg`

Suppose you have four cards, each of which has an integer on one side and a letter on the other. Someone tells you that
if the letter is a vowel, the number is even.
Right now you can see the following cards: 4, B, E, 7. To check if the assertion is true, you may need to flip over some cards. Which cards?

Do you need to flip over this card?
4

- A. Yes
- B. No

Do you need to flip over this card?
B

- A. Yes
- B. No

Do you need to flip over this card?
E

- A. Yes
- B. No

Do you need to flip over this card?
7

- A. Yes
- B. No

5. **(6 points)** `Library/NAU/setFoundations/MAT320_0302.pg`

Enter T or F depending on whether the statement is true or false. (You must enter T or F – True and False will not work.)

___1. $\tilde{A} \subseteq B \implies A \subseteq \tilde{B}$
___2. $B \subseteq C \implies A \cup B \subseteq A \cup C$
___3. $A \cup B \subseteq A \implies B \subseteq A$

6. **(8 points)** `Library/MontanaState/Misc.Logic/1.6B13Logic4.pg`
Suppose this is true: All widgets are gadgets.

Which is the correct conditional form of the sentence?

- A. If it's a widget, then it's a gadget
- B. If it's a gadget, then it's a widget

What can be deduced from that and this additional fact?
It's a gadget

- A. It is not a widget
- B. It is not a gadget
- C. It's a widget
- D. It's a gadget
- E. Nothing

What can be deduced from that and this additional fact?
It's not a widget

- A. It is not a widget
- B. It is not a gadget
- C. It's a widget
- D. It's a gadget
- E. Nothing

What can be deduced from that and this additional fact?
It's not a gadget

- A. It is not a widget
- B. It's a gadget
- C. It is not a gadget
- D. It's a widget
- E. Nothing

7. **(8 points)** `Library/Rochester/setDiscrete8Reasoning/ur_dis_8_1.pg`

Which rule of inference is used in each of the following arguments? Check the correct answers.
1. If it snows today, the university will close. The university is not closed today. Therefore, it did not snow today.

- A. Hypothetical syllogism.
- B. Modus tollens.
- C. Disjunctive syllogism.
- D. Conjunction.
- E. Simplification.
- F. Addition.
- G. Modus ponens.

2. If I go swimming, then I will stay in the sun too long. If I stay in the sun too long, then I will sunburn. Therefore, if I go swimming, then I will sunburn.

- A. Modus tollens.
- B. Hypothetical syllogism.
- C. Modus ponens.
- D. Simplification.
- E. Conjunction.
- F. Addition.
- G. Disjunctive syllogism.

3. Alice is a mathematics major. Therefore, Alice is either a mathematics major or a computer science major.

- A. Simplification.
- B. Modus ponens.
- C. Addition.
- D. Conjunction.
- E. Hypothetical syllogism.
- F. Modus tollens.
- G. Disjunctive syllogism.

4. If it is rainy, then the pool will be closed. It is rainy. Therfore, the pool is closed.

- A. Simplification.
- B. Modus ponens.
- C. Conjunction.
- D. Disjunctive syllogism.
- E. Hypothetical syllogism.
- F. Addition.
- G. Modus tollens.

8. **(8 points)** `Library/SUNYSB/contradiction.pg`
For the following **proof by contradiction** provide the justifications at each step, using the following equivalences and inference rules. Use the following keys:

a	Idempotent Law
b	Double Negation
c	De Morgan's Law
d	Commutative Properties
e	Associative Properties
f	Distributive Properties
g	Equivalence of Contrapositive
h	Definition of Implication
i	Definition of Equivalence
j	Identity Laws $(p \vee F = p \wedge T = p)$
k	Tautology $(p \vee \neg p = T)$
l	Contradiction $(p \wedge \neg p = F)$
m	Negation of the goal to prove
n	Modus Ponens
o	Modus Tollens
p	Transitivity of Implication
q	Conjunctive Simplification
r	Conjunctive Addition
s	Disjunctive Addition

We want to prove d by a proof by contradiction from the following propositions.

$a \to b$
$r \to b$
$\neg b$
$\neg(d \wedge T) \to a$

$\neg d$ by ___
$\neg a$ by ___ between $a \to b$ and $\neg b$
$d \wedge T$ by ___ between $\neg(d \wedge T) \to a$ and $\neg a$ previously deduced.
d by ___ of $d \wedge T$
We have d and $\neg d$ true, therefore we have a contradiction.

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9. **(8 points)** `Library/SUNYSB/proofReasons1.pg`

For the following proof (of equivalence of 2 formulae) provide the justifications at each step, using the following equivalences. Use the following key:

a	Idempotent Law
b	Double Negation
c	De Morgan's Law
d	Commutative Properties
e	Associative Properties
f	Distributive Properties
g	Equivalence of Contrapositive
h	Definition of Implication
i	Definition of Equivalence
j	Identity Laws $(p \vee F \equiv p \wedge T \equiv p)$
k	Tautology $(p \vee \neg p \equiv T)$
l	Contradiction $(p \wedge \neg p \equiv F)$

$\neg(\neg p \wedge q) \wedge (p \vee q)$
= $(\neg(\neg p) \vee \neg q) \wedge (p \vee q)$ by ___ = $(p \vee \neg q) \wedge (p \vee q)$ by ___ = $p \vee (\neg q \wedge q)$ by ___ = $p \vee (q \wedge \neg q)$ by ___ = $p \vee F$ by ___ = p by ___