

Question 1

RN20.1 - python

Question 2

RN21.8 - python

Question 3

a True

b True

c True

d True

f Not True: Assignments [True = A, B, D False = C, E]

Question 4

a $\phi = [(X \implies Y) \vee (Z \implies Y)] \implies [(X \wedge Z) \vee Y]$

X	Y	Z	$X \implies Y$	$Z \implies Y$
T	T	T	T	T
T	T	F	T	T
T	F	T	F	F
T	F	F	F	T
F	T	T	T	T
F	T	F	T	T
F	F	T	T	F
F	F	F	T	F

$X \wedge Z$	$ $	$X \implies Y \vee Z \implies Y$
T		T
F		T
T		F
F		T
F		T
F		T
F		T
F		T

$X \wedge Z \implies Y$	$ $	ϕ
T		T
F		F
F		F
F		F
F		F
F		F
F		F
F		F

b Conversion to CNF

left-hand $[(X \implies Y) \vee (Z \implies Y)]$

elim. iff $[(X \implies Y) \vee (Z \implies Y)]$

elim. $\implies [(X \implies Y) \vee (Z \implies Y)] == [(\neg X \vee Y) \vee (\neg Z \vee Y)]$

move \neg $[(\neg X \vee Y) \vee (\neg Z \vee Y)]$

distribute \vee over \wedge $[(\neg X \vee Y) \vee (\neg Z \vee Y)]$

right-hand $[(\neg X \vee Y) \vee (\neg Z \vee Y)] \implies [(X \wedge Z) \vee Y]$

elim. iff $[(\neg X \vee Y) \vee (\neg Z \vee Y)] \implies [(X \wedge Z) \vee Y]$

elim. $\implies [(\neg X \vee Y) \vee (\neg Z \vee Y)] \implies [(X \wedge Z) \vee Y] == \neg [(\neg X \vee Y) \vee (\neg Z \vee Y)] \vee [(X \wedge Z) \vee Y]$

move $\neg \neg [(\neg X \vee Y) \vee (\neg Z \vee Y)] \vee [(X \wedge Z) \vee Y] ==$
 $\neg(\neg X \vee Y) \wedge \neg(\neg Z \vee Y) \vee [(X \wedge Z) \vee Y] ==$
 $(X \wedge \neg Y) \wedge (Z \wedge \neg Y) \vee [(X \wedge Z) \vee Y] ==$

distribute \vee over \wedge $(X \wedge \neg Y) \wedge (Z \wedge \neg Y) \vee [(X \wedge Z) \vee Y] ==$
 $(X \wedge \neg Y) \wedge (Z \wedge \neg Y) \vee [Y \vee (X \wedge Z)] ==$
 $(X \wedge \neg Y) \wedge (Z \wedge \neg Y) \vee [(Y \vee X) \wedge (Y \vee Z)] ==$

Final form $(X \wedge \neg Y) \wedge (Z \wedge \neg Y) \vee [(Y \vee X) \wedge (Y \vee Z)] ==$
 $(X \wedge \neg Y) \wedge [(Z \wedge \neg Y) \vee (Y \vee X)] \wedge [(Z \wedge \neg Y) \vee (Y \vee Z)] ==$

c

Question 5

- a let x = adult, b = basketball, s = spring 2019, $P(x, b, s)$ = played. $\exists x : (P(x, b, s) \wedge \forall y : (P(y, b, s) \implies x = y))$
- b let x = adult, f = football, s = spring 2019, $P(x, f, s)$ = played. $\exists x : (P(x, f, s))$
- c let x = person, i = ice cream, $B(x, i)$ = bought. $\neg \exists x : B(x, i)$
- d let w = woman, i = ice cream, x = person, $S(w, x, i)$ = w Sells i to x , $H(x, i)$ = x has i $\exists x : \neg H(x, i) \wedge \forall y : \neg H(y, i) \implies S(w, y, i)$
- e let x = person, f = football, $P(x, f)$ = Played, $H(x, f)$ = Hates. $\forall x : P(x, f) \implies H(x, f)$
- f let b = basketball score, f = football score, $H(x)$ = highest, $HH(x, y)$ = x higher than y . $\forall b, f : HH(H(b), H(f))$