SOLUTIONS TO SELECTED EXERCISES

Section 5.6

A

1. Cb
2. Cb & Sf
3. Lr ∨ La
4. Da & ~(Df ∨ Db)
5. Pm & Pr
6. Pr → Lr
7. ∃xCx
8. ∃x~Cx
9. ∀xPx
10. ∀x(Sx → Dx)
11. ∀x(Lx → Cx)
12. ∃x(Lx & ~Dx)
13. ∃x(~Dx & ~Lx)
14. ∃xDx & ~(Df ∨ Db)
15. ∀xPx
16. ∃xDx & ~Dm
17. ~∀xPx
18. ~∀x(Sx → Lx)
19. ∃x[~Dx & ~(Sx ∨ Cx)]
20. ∀x(Cx → ~Sx)
21. ∀x(Px → Sx)
22. ∀x(~Cx → ~Px) & ∀xCx

B

23. ~Fk & Sk
24. ~Fj & ~Fs
25. ~Fs & As
26. ∀x(Ex → Fx)
27. Bf & Vk
28. ∀x(Gx → Ex)
29. ∀x(Ex → Gx)
30. ∃xCx → Cs
31. ∀x(Fx → Ax)
32. ∃xCx → (Cf & Cj)
33. ∃xAx → Aj
34. ∀x[(Fx & Gx) → (Cx &Ax)]

35. $(Ep \,\&\, {\sim}Fp) \,\&\, Vp$
36. $(Ek \,\&\, Ef) \,\&\, \forall x(Fx \to Ex)$
37. $\forall x[(Fx \,\&\, Bx) \to {\sim}(Ex \lor Ax)]$
38. ${\sim}Ef \to \forall x{\sim}Ex$
39. $(Vp \lor Vs) \to (Ep \lor Es)$

C

40.	$\exists xWx$	*D*: {x | x is a person}
	$\forall x(Wx \to Sx)$	Wx: x is wise
	$\therefore\ \exists xSx$	Sx: x likes sports
41.	$\forall x(Sx \to {\sim}Fx)$	*D*: {x | x is a person}
	$\forall x(Fx \to Vx)$	Sx: x likes sports
	$\therefore\ \forall x(Vx \to {\sim}Sx)$	Fx: x is a friend of the family
		Vx: x likes to drink Vernor’s soda
42.	$Mc \,\&\, \forall x(Cx \to Mx)$	*D*: {x | x is a person}
	$\therefore\ \exists xCx \to Cc$	Mx: x is a mountain climber
		Cx: x enjoys the cold
		c: Charlene
43.	$Rj \to \forall x(Kx \to Hx)$	Rx: x gets a raise
	$Rj \to \exists x(Kx \,\&\, {\sim}Hx)$	Kx: x knows Jack
	$\therefore\ {\sim}Rj$	Hx: x is happy
		j: Jack
44.	$\forall x[Ex \to (Px \lor Nx)]$	Ex: x is an electrode
	$\forall x[(Ex \,\&\, Nx) \to Rx]$	Px: x is positive
	$\forall x[(Ex \,\&\, Px) \to Lx]$	Nx: x is negative
	${\sim}Rg \,\&\, {\sim}Lg$	Rx: x emits protons
	$\therefore\ {\sim}Eg$	Lx: x emits electrons
		g: Gary
45.	$\forall x(Cx \to Ux)$	Cx: x calculates the consequences of her actions
	$\forall x(Kx \to Rx)$	Ux: x is a utilitarian
	Cj	Kx: x is a Kantian
	$\therefore\ Uj \,\&\, {\sim}Kj$	Rx: x bases her ethics of reason alone
		j: John Stuart Mill
46.	${\sim}\forall x(Cx \to Ux)$	Cx: x calculates the consequences of her actions
	$\forall x(Wx \to Ux)$	Ux: x is a utilitarian
	$\therefore\ Ca \,\&\, {\sim}Wa$	Wx: x considers the welfare of all humans equally
	$\therefore\ {\sim}Ua$	a: Ayn Rand

47. $\forall x(Ex \rightarrow Dx)$ — Ex: x expresses a proposition
$\forall x((Sx \& \sim Ex) \rightarrow Mx)$ — Dx: x is a declarative sentence
$\forall x(Fx \rightarrow \sim Dx)$ — Mx: x is meaningless
$\therefore \forall x[Fx \rightarrow (\sim Ex \& Mx)]$ — Fx: x is an expression of feeling
Sx: x is a sentence

48. *D*: {$Rh \rightarrow (Ow \& R_1w)$, $Re \rightarrow Fw$, $(\sim Ow \& \sim R_1w) \& \sim Fw$, $Rh \vee Re$, Hegel, Heraclitus, world}
Rx: x is right
Ox: x is a place of order
R_1x: x is a place of reason
Fx: x is a place of flux
e: Heraclitus
h: Hegel
w: world
Tx: x is true
Sx: x is a square
Cx: x is a circle
S_1x: x is a statement

$\forall x(S_1x \rightarrow Tx) \rightarrow \exists x(Sx \& Cx)$
$\therefore \exists x(S_1x \& \sim Tx)$

D

49. $\exists x(Fx \& Sx)$ — Fx: x is a fake diamond
Sx: x is sold in New York

50. $\exists x[(Ex \& Dx) \& Mx]$ — Ex: x is expensive
Dx: x is a diamond
Mx: x is sold in Manhattan

51. $\forall x[(Ax \& Wx) \rightarrow Tx]$ — Ax: x is an actor
Wx: x is well-known
Tx: x is a television star

52. $\forall x(Fx \rightarrow \sim Nx)$ — *D*: {x | x is a mathematician}
Fx: x is famous
Nx: x is nervous

53. $\forall x(Nx \rightarrow Px)$ — Nx: x will be notified
Px: x is a potential winner

54. $\exists x[(Bx \& Cx) \& \sim Fx]$ — Bx: x is black
Cx: x is a cat

Fx: x is a fast eater

Section 5.7

A

1. ~Od & Oc
2. Gcb & Lcd
3. Sabc
4. Pbbd
5. Sabc & Dbaa
6. ∃x(Gxb & Lxc)
7. ∀x[(Ex & Px) → ~Gxb]
8. ∀x∀y[(Ex & Ey) → ∃z(Sxyz & Ez)]
9. ∀x∀y[(Ox & Oy) → ∃z(Sxyz & Ez)]
10. ∀x∀y[(Ex & Oy) → ∃z(Sxyz & Oz)]
11. ∃x(Pxxd & Sxxd)
12. ∀x(Px → ~Lxb)
13. ∀x∀y∀z[Sxyz → (Gzx & Gzy)]
14. ∀x∀y∃z[Pxyz → ∃w~(Sxyw & Lzw)]
15. ∀x(~Gxx & ~Lxx)
16. ∀x[(Px & Gxb) → Ox]
17. ∀x[(Ox & (Px & (Gxb & Lxd))) → Ox]
18. ∀x∃yGyx
19. (~Lcb & ~Gbc) & Lcd
20. ∀x[Px → ∃y(Py & Gyx)]
21. ∀x∀y[(Ox & Oy) → ∃z(Dxyz & Ez)]
22. ∀x∀y∃z[Dxyz → ((Ox & Oy) → Ez)]

B

23. Set & Htm
24. Dj & Klj
25. Llj & Lle
26. Kse & (~Bs & De)
27. [∃x(Wxt & Jex)] & (Gh & ∃yWyh)
28. Set & (Htm & ~Ste)
29. (Hjl & Slh) & ~Jjh
30. (Be & De) & (Kel → ~Ge)
31. ∃xKxl → Kel
32. ∀x(∃yHxy → Bx)
33. ∀x∃y(Lxy → ~Sxy)
34. ∃x∃y(Lxy & Sxy)
35. ∀x(∃yHxy → ∀z~Wxz) & ∀x(∃yWxy → ∀z~Hxz)
36. ∀x∀y[Kxy → (~Jxy & ~Jyx)]

37. $\exists x[\exists y(Hxy \vee Wxy) \,\&\, \sim(Bx \,\&\, Gx)]$
38. $\forall x(\exists y\, Lxy \rightarrow \exists z Szx)$
39. $\forall x \exists y(Lxy \rightarrow Jxy)$
40. $\forall x \exists y(Sxy \rightarrow \sim Lxy)$
41. $\forall x \forall y[Kxy \rightarrow (Jxy \,\&\, Lxy)]$
42. $\forall x[\exists y[Sxy \,\&\, \exists z((Wzy \vee Hzy) \,\&\, Jxz)] \rightarrow \sim Gx]$
43. $Lle \rightarrow \exists y(Kly \,\&\, Sey)$