Symbolizations with complex singular terms and identity: Answers

(Exercises for Unit 5 Part 2: Sections 5.11-5.14)

Symbolize each of the following sentences using the abbreviation scheme provided

A^1: *a* is a dog.	C^1: *a* is a cat.	D^1: *a* is a doctor.
F^1: *a* is a person.	B^2: *a* belongs to *b*.	G^2: *a* works for *b*.
H^2: *a* is married to *b*.	K^2: *a* is a neighbor of *b*.	L^2: *a* likes *b*.
a: Ann	b: Bob	c: Connie
d: Dave	a^1: the aunt of *a*.	b^1: the partner of *a*.
c^1: the cousin of a	d^2: the child of *a* and *b*.	

S5.01 Dave's partner works for Bob's aunt.
G(b(d)a(b))

S5.02 Ann is Connie's aunt.

a=a(c)

S5.03 Dave is Bob's or Ann's cousin.

d=c(b) ∨ d=c(a)

S5.04 Only Ann's cousin likes Ann's cat.

∃y(Cy ∧ B(ya) ∧ ∀x(L(xy)) ↔ x=c(a)))

S5.05 If Ann is not Dave's aunt, then Connie is.

~a=a(d) → c=a(d)

S5.06 Dave works only for Bob.

∀x(G(dx) ↔ x=b)

S5.07 Only Dave works for Ann's partner.

∀x(G(xb(a)) ↔ x=d)

S5.08 Anybody married to Dave is Anne's aunt.

∀x(H(xd) ↔ x=a(a))

S5.09 If anybody works for Dave, his cousin does.

∀x(G(xd) → G(c(d)d)) OR ∃xG(xd) → G(c(d)d)

S5.10 The child of Ann and Bob is married to Connie's cousin.

H(d(ab)c(c))

S5.11 The child of Dave and Ann is married to Bob's aunt only if their child is Bob's cousin.

H(d(da)a(b)) → d(da)=c(b)

S5.12 The only cat that Ann likes belongs to one of Ann's neighbors.

∃x∀y((Cy ∧ L(ay) ↔ x=y) ∧ ∃z(K(za) ∧ B(xz)))

S5.13 Ann and Bob's cousin's child is Dave's partner.

H(ac(b))=b(d)

S5.14 Connie has exactly one cat.

$\exists x\forall y(Cy \wedge B(yc) \leftrightarrow x=y)$

S5.15 Bob has one dog and it doesn't like cats.

$\exists x\forall y((Ay \wedge B(yb) \leftrightarrow x=y) \wedge \forall z(Cz \to \sim L(xz)))$

S5.16 The only neighbor that Bob doesn't like is his cousin.

$\forall x(K(xb) \wedge \sim L(bx) \leftrightarrow x=c(b))$

S5.17 There is only one cat that likes dogs.

$\exists x\forall y(Cy \wedge \forall z(Az \to L(yz)) \leftrightarrow x=y)$
or if you think the cat likes only some dogs: $\exists x\forall y(Cy \wedge \exists z(Az \wedge L(yz)) \leftrightarrow x=y)$

S5.18 One person works for Connie's partner, and that is Ann and Bob's child.

$\exists x\forall y(Fy \wedge G(yb(c)) \leftrightarrow x=y) \wedge x=d(ab))$ or $\forall x(Fx \wedge G(xb(c)) \leftrightarrow x=d(ab))$

S5.19 The only doctor who doesn't like cats likes dogs.

$\exists x\forall y((Dy \wedge \forall z(Cz \to \sim L(yz)) \leftrightarrow x=y) \wedge \forall w(Aw \to L(xw)))$

or if you think that doctor only likes some dogs:

$\exists x\forall y((Dy \wedge \forall z(Cz \to \sim L(yz)) \leftrightarrow x=y) \wedge \exists w(Aw \wedge L(xw)))$

S5.20 Anybody who likes just one dog likes cats.

$\forall x(Fx \wedge \exists y\forall z(Az \wedge L(xz) \leftrightarrow z=y) \to \forall w(Cw \to L(xw)))$

S5.21 If only one person likes Bob, then Bob isn't married to anybody.

$\exists x\forall y(Fy \wedge L(yb) \leftrightarrow x=y) \to \sim\exists z(Fz \wedge H(bz))$

S5.22 Exactly one dog likes exactly one cat.

$\exists x\forall y(Ay \wedge \exists z\forall w(Cw \wedge L(yw) \leftrightarrow w=z) \leftrightarrow x=y)$

Symbolize each of the following sentences using the abbreviation scheme provided

A^1: *a* is a sea.	B^1: *a* is a river.	C^1: *a* is a canyon.
D^1: *a* is a time	E^1: *a* is a planet.	F^1: *a* is a person.
G^2: *a* is quieter than *b*.	H^2: *a* flows through *b*.	
K^2: *a* is deeper than *b*.	L^2: *a* leads to *b*.	O^2 *a* is on *b*.
J^3: *a* steps into *b* at *c*.	L^3: *a* leads *b* to *c*.	
a: Ann	b: Mars	c: The Cotahuasi Canyon
e: Earth	f: the sun	g: The Grand Canyon
d^1: the planet closest to *a*.		

NOTE: the Cotahuasi may not actually be the deepest canyon on earth (although it has been considered to be the deepest.) And many canyons are deeper than the Grand.

S5.23 Only Ann leads people to The Cotahuasi Canyon.

$\forall x(\exists y(Fy \wedge L(xyc)) \leftrightarrow x=a)$ OR $\exists y(Fy \wedge L(ayc)) \wedge \forall x(\exists y(Fy \wedge L(xyc)) \rightarrow x=a)$

OR $\exists x\forall y((\exists z(Fz \wedge L(yzc)) \leftrightarrow x=y) \wedge x=a)$

S5.24 Only the Cotahuasi Canyon is deeper than the Grand Canyon.

$\forall x(Cx \wedge K(xg) \leftrightarrow x=c)$ OR $Cc \wedge K(cg) \wedge \forall x(Cx \wedge K(xg) \rightarrow x=c)$

OR $\exists x\forall y((Cy \wedge K(yg) \leftrightarrow x=y) \wedge x=c)$

S5.25 Exactly one canyon is deeper than the Grand Canyon.

$\exists x\forall y((Cy \wedge K(yg) \leftrightarrow x=y)$

S5.26 There are no rivers on any planet other than Earth only if there are no seas on Mars.

$\sim\exists x\exists y(Bx \wedge Ey \wedge O(xy) \wedge y\neq e) \rightarrow \sim\exists x(Ax \wedge O(xb))$

S5.27 Different rivers lead to the same sea.

$\exists x\exists y(Bx \wedge By \wedge \sim x=y \wedge \exists z(Az \wedge L(xz) \wedge L(yz)))$

S5.28 Earth is the planet closest to Mars.

$e=d(b)$

S5.29 Earth is not the planet closest to the sun.

$\sim e=d(f)$ OR $e\neq d(f)$

S5.30 Earth is not the planet closest to the planet closest to Earth.

$\sim e=d(d(e))$ OR $e\neq d(d(e))$

S5.31 The planet closest to the Earth is the planet closest to the planet closest to the sun.

$d(e)=d(d(f))$

S5.32 The Cotahuasi and at least one other canyon are deeper than the Grand Canyon.

$K(cg) \wedge \exists x(Cx \wedge x \neq c \wedge K(xg))$

S5.33 Exactly one sea has exactly one river leading to it.

$\exists x \forall y(Ay \wedge \exists w \forall z((Bz \wedge L(zy)) \leftrightarrow w=z) \leftrightarrow x=y)$

S5.34 The Cotahuasi Canyon is the deepest canyon.

$\forall x(Cx \wedge x \neq c \rightarrow K(cx))$

S5.35 The Cotahuasi Canyon is not deeper than the deepest sea.

$\exists x(Ax \wedge \forall y(Ay \wedge x \neq y \rightarrow K(xy)) \wedge \sim K(cx))$

S5.36 If there are canyons on Mars that are deeper than those on Earth, the Cotahuasi is not the deepest canyon.

$\exists x(Cx \wedge O(xb) \wedge \forall y(Cy \wedge O(ye) \rightarrow K(xy))) \rightarrow \sim \forall x(Cx \wedge x \neq c \rightarrow K(cx))$

OR $\exists x(Cx \wedge O(xb) \wedge \forall y(Cy \wedge O(ye) \rightarrow K(xy))) \rightarrow \exists x(Cx \wedge x \neq c \wedge \sim K(cx))$

S5.37 The deepest river makes the least noise.

$\exists x(Bx \wedge \forall y(By \wedge x \neq y \rightarrow K(xy)) \wedge \forall z(Bz \wedge x \neq z \rightarrow G(xz)))$

S5.38 The river that flows through the Grand Canyon flows through other canyons.

$\exists x \forall y((By \wedge H(yg) \leftrightarrow x=y) \wedge \exists z(Cz \wedge \sim z=g \wedge H(xz)))$

S5.39 A person can only step into one river at a time. (A lot of different ways of doing this! Here are a few.)

If your answer is different, when thinking about whether it is also correct, don't forget to consider scope… are all your variables under the scope of the relevant quantifier? Is it the correct quantifier? Does the universal match a conditional, and the existential match a conjunction?

$\forall x(Fx \rightarrow \forall y(Dy \rightarrow \sim \exists z \exists w(Bz \wedge Bw \wedge \sim z=w \wedge J(xzy) \wedge J(xzw))))$

OR $\forall x(Fx \rightarrow \forall y(By \rightarrow \sim \exists z(Dz \wedge J(xyz) \wedge \exists w(Bw \wedge \sim w=y \wedge J(xwz)))))$

OR $\forall x(Fx \rightarrow \forall y(By \rightarrow \forall z(Dz \wedge J(xyz) \rightarrow \forall w(Bw \wedge \sim w=y \rightarrow \sim J(xwz)))))$

OR $\sim \exists x \exists y \exists z \exists w(Fx \wedge Dy \wedge Bz \wedge Bw \wedge z \neq w \wedge J(xzy) \wedge J(xwy))$

S5.40 Nobody steps into the same river twice. (Again… many ways to do this!)

$\sim \exists x(Fx \wedge \exists y(By \wedge \exists z(Dz \wedge \exists w(Dw \wedge z \neq w \wedge J(xyz) \wedge J(xyw)))))$

$\forall x(Fx \rightarrow \sim \exists y(By \wedge \exists z(Dz \wedge \exists w(Dw \wedge z \neq w \wedge J(xyz) \wedge J(xyw)))))$

$\forall x(Fx \rightarrow \forall y \forall z(By \wedge Dz \wedge J(xyz) \rightarrow \forall w(Dw \wedge J(xyw) \rightarrow z=w)))$

A^1: *a* is a problem. D^1: *a* is difficult. H^1: *a* is a person.

I^2: *a* is in *b*. J^2: *a* is a student of *b*. K^2: *a* is able to understand *b*.

M^2: *a* can solve *b*.

a: Amy. b: Bob c: the text. d^1: the teacher of *a*. e^1: the author of *a*. d^2: the son of *a* and *b*

S5.41 Everything is identical with something.

$\forall x \exists y\ x=y$

S5.42 Things equal to the same thing are equal to each other.

$\forall x \forall y(\exists z(x=z \wedge y=z) \rightarrow x=y)$ or $\forall x \forall y \forall z(x=z \wedge y=z \rightarrow x=y)$

S5.43 Everybody is identical to his/herself.

$\forall x(Hx \rightarrow x=x)$

S5.44 Only Bob's teacher can understand the text.

$\forall x(K(xc) \leftrightarrow x=d(b))$

S5.45 Bob is the only person who can understand Amy.

$\forall x(Hx \wedge K(xa) \leftrightarrow x=b)$

S5.46 There is exactly one difficult problem in the text.

$\exists x \forall y(Ay \wedge Dy \wedge I(yc) \leftrightarrow x=y)$

S5.47 The difficult problem in the text cannot be solved by anybody.

$\exists x \forall y((Ay \wedge Dy \wedge I(yc) \leftrightarrow x=y) \wedge {\sim}\exists z(Hz \wedge M(zx)))$

S5.48 Amy can understand only Bob.

$\forall x(K(ax) \leftrightarrow x=b)$ OR if you think it is about people: $\forall x(Hx \wedge K(ax) \leftrightarrow x=b)$

S5.49 There is exactly one problem that all of Amy's students can solve.

$\exists x \forall y(Ay \wedge \forall z(J(za) \rightarrow M(zy)) \leftrightarrow x=y)$

S5.50 The problem in the text that everybody can solve is not difficult.

$\exists x \forall y((Ay \wedge \forall z(Hz \rightarrow M(zy)) \leftrightarrow x=y) \wedge {\sim}Dx)$

S5.51 Bob's difficult student doesn't understand the text.

$\exists x \forall y((J(yb) \wedge Dy \leftrightarrow x=y) \wedge {\sim}K(xc))$

S5.52 If only one person can understand the text, then it is difficult.

$\exists x \forall y(Hy \wedge K(yc) \leftrightarrow x{=}y) \rightarrow Dc$

S5.53 Amy has only one student.

$\exists x \forall y(Hy \wedge J(ya) \leftrightarrow x{=}y)$

S5.54 If only one person can solve every difficult problem in the text, that person is Bob.

$\exists x \forall y(Hy \wedge \forall z(Az \wedge Dz \wedge I(zc) \rightarrow M(yz)) \leftrightarrow y{=}x) \rightarrow \forall z(Az \wedge Dz \wedge I(zc) \rightarrow M(bz))$

(If exactly one person can solve every difficult problem in the text, Bob can do it.)

OR $\sim\exists x(Hx \wedge \forall z(Az \wedge Dz \wedge I(zc) \rightarrow M(xz)) \vee \forall y(Hy \wedge \forall z(Az \wedge Dz \wedge I(zc) \rightarrow M(yz)) \leftrightarrow y{=}b)$

(Nobody can solve every difficult problem in the text unless Bob is the one person who can do it.)

S5.55 Only Amy and her teacher are able to understand the text.

$\forall x(Hx \wedge K(xc) \leftrightarrow x{=}a \vee x{=}d(a))$

S5.56 The person who can solve all the problems in the text is one of Amy's students.

$\exists x \forall y((Hy \wedge \forall z(Az \wedge I(zc) \rightarrow M(yz)) \leftrightarrow x{=}y) \wedge J(xa))$

S5.57 The person who can't solve any of the problems in the text cannot understand any of his teachers.

$\exists x \forall y((Hy \wedge \forall z(Az \wedge I(zc) \rightarrow \sim M(yz)) \leftrightarrow x{=}y) \wedge \forall w(J(xw) \rightarrow \sim K(xw)))$

or $\exists x \forall y((Hy \wedge \sim\exists z(Az \wedge I(zc) \wedge M(yz)) \leftrightarrow x{=}y) \wedge \forall w(J(xw) \rightarrow \sim K(xw)))$

S5.58 Just one person is able to understand Bob and Amy's son.

$\exists x \forall y(Hy \wedge K(yd(ba)) \leftrightarrow x{=}y)$

S5.59 Amy is the son of Bob and Bob's teacher.

$a{=}d(bd(b))$

S5.60 Bob's teacher is the author of the text.

$d(b){=}e(c)$

S5.61 Bob and Amy's son is not able to understand the text even though he a student of its author.

$\sim K(d(ba)c) \wedge J(d(ba)e(c))$