Exercise 3.1.1a
Explain why the rule &E for MPL is a sound rule.

In MPL, if (φ&ψ) is true under some interpretation then φ and ψ are true under that interpretation too. Thus, if (φ&ψ) is entailed by some formula or formulas, then φ and ψ are both entailed by those formulas too. So if in a derivation (φ&ψ) is entailed by its dependencies, and you write down φ or ψ with those dependencies, then the formula you write down will be entailed by its dependencies. Hence &E for MPL is a sound rule.

Exercise 3.1.2a
Explain why for any interpretation under which "Sa" is true, "∃xSx" is true too.

Consider all interpretations under which "Sa" is true. For all such interpretations, the predicate S applies to the element a. That means for all such interpretations, there exists some element in the domain to which the predicate S applies. So for all interpretations under which "Sa" is true, "∃xSx" is true too.

Exercise 3.1.2b
Show (Fa & Ga) ⊢ (∃xFx & Ga)

1	1. (Fa & Ga)	A
1	2. Fa	1 &E
1	3. ∃xFx	2 ∃I
1	4. Ga	1 &E
1	5. (∃xFx & Ga)	3, 4 &I

Exercise 3.1.2c
Explain why "∃x(∃xSx & Rx)" is not a well-formed formula of MPL.

"∃x(∃xSx & Rx)" is not a WFF because it cannot be formed by applying the MPL formation rules as stated in [MPL03.1]. Rule 4 there stipulates that only a variable that has not occurred before can be used to generate a quantified WFF. Hence from the expression "(∃xSx & Ra)", "∃y(∃xSx & Ry)" can be formed but not "∃x(∃xSx & Rx)" because "x" already occurs in "(∃xSx & Ra)".

Exercise 3.1.2d
State Rule ∃I without the shorthand symbolism.

If you have derived φ, and φ contains at least one occurrence of some constant c, then for any variable v which does not occur in φ, you can write down "∃", followed by v, followed by an expression formed by replacing one or more occurrences of c within φ by v, depending on everything φ depends on.

Exercise 3.1.3a
Explain why Rule ∀E is a sound rule.

In MPL, if ∀vφ is true under some interpretation, then φv/c is true under that interpretation too. Thus if ∀vφ is entailed by some formula or formulas, then φv/c is entailed by those formulas too. So if, in a derivation, ∀vφ is entailed by its dependencies, and you write down φv/c with those dependencies, then φv/c will be entailed by its dependencies. Hence ∀E is a sound rule.