--- Day 14: Space Stoichiometry ---

As you approach the rings of Saturn, your ship's **low fuel** indicator turns on. There isn't any fuel here, but the rings have plenty of raw material. Perhaps your ship's Inter-Stellar Refinery Union brand **nanofactory** can turn these raw materials into fuel.

You ask the nanofactory to produce a list of the **reactions** it can perform that are relevant to this process (your puzzle input). Every reaction turns some quantities of specific **input chemicals** into some quantity of an **output chemical**. Almost every **chemical** is produced by exactly one reaction; the only exception, `ORE`, is the raw material input to the entire process and is not produced by a reaction.

You just need to know how much `ORE` you'll need to collect before you can produce one unit of `FUEL`.

Each reaction gives specific quantities for its inputs and output; reactions cannot be partially run, so only whole integer multiples of these quantities can be used. (It's okay to have leftover chemicals when you're done, though.) For example, the reaction `1 A, 2 B, 3 C => 2 D` means that exactly 2 units of chemical `D` can be produced by consuming exactly 1 `A`, 2 `B` and 3 `C`. You can run the full reaction as many times as necessary; for example, you could produce 10 `D` by consuming 5 `A`, 10 `B`, and 15 `C`.

Suppose your nanofactory produces the following list of reactions:

```
10 ORE => 10 A
1 ORE => 1 B
7 A, 1 B => 1 C
7 A, 1 C => 1 D
7 A, 1 D => 1 E
7 A, 1 E => 1 FUEL
```

The first two reactions use only `ORE` as inputs; they indicate that you can produce as much of chemical `A` as you want (in increments of 10 units, each 10 costing 10 `ORE`) and as much of chemical `B` as you want (each costing 1 `ORE`). To produce 1 `FUEL`, a total of **31** `ORE` is required: 1 `ORE` to produce 1 `B`, then 30 more `ORE` to produce the 7 + 7 + 7 + 7 = 28 `A` (with 2 extra `A` wasted) required in the reactions to convert the `B` into `C`, `C` into `D`, `D` into `E`, and finally `E` into `FUEL`. (30 `A` is produced because its reaction requires that it is created in increments of 10.)

Or, suppose you have the following list of reactions:

```
9 ORE => 2 A
8 ORE => 3 B
7 ORE => 5 C
3 A, 4 B => 1 AB
5 B, 7 C => 1 BC
4 C, 1 A => 1 CA
2 AB, 3 BC, 4 CA => 1 FUEL
```

The above list of reactions requires **165** `ORE` to produce 1 `FUEL`:

- Consume 45 `ORE` to produce 10 `A`.
- Consume 64 `ORE` to produce 24 `B`.
- Consume 56 `ORE` to produce 40 `C`.
- Consume 6 `A`, 8 `B` to produce 2 `AB`.
- Consume 15 `B`, 21 `C` to produce 3 `BC`.
- Consume 16 `C`, 4 `A` to produce 4 `CA`.
- Consume 2 `AB`, 3 `BC`, 4 `CA` to produce 1 `FUEL`.

Here are some larger examples:

- **13312** `ORE` for 1 `FUEL`:

```
157 ORE => 5 NZVS
165 ORE => 6 DCFZ
44 XJWVT, 5 KHKGT, 1 QDVJ, 29 NZVS, 9 GPVTF, 48 HKGWZ => 1 FUEL
12 HKGWZ, 1 GPVTF, 8 PSHF => 9 QDVJ
179 ORE => 7 PSHF
177 ORE => 5 HKGWZ
7 DCFZ, 7 PSHF => 2 XJWVT
165 ORE => 2 GPVTF
3 DCFZ, 7 NZVS, 5 HKGWZ, 10 PSHF => 8 KHKGT
```

- `180697` `ORE` for 1 `FUEL`:

```
2 VPVL, 7 FWMGM, 2 CXFTF, 11 MNCFX => 1 STKFG
17 NVRVD, 3 JNWZP => 8 VPVL
53 STKFG, 6 MNCFX, 46 VJHF, 81 HVMC, 68 CXFTF, 25 GNMV => 1 FUEL
22 VJHF, 37 MNCFX => 5 FWMGM
139 ORE => 4 NVRVD
144 ORE => 7 JNWZP
5 MNCFX, 7 RFSQX, 2 FWMGM, 2 VPVL, 19 CXFTF => 3 HVMC
5 VJHF, 7 MNCFX, 9 VPVL, 37 CXFTF => 6 GNMV
145 ORE => 6 MNCFX
1 NVRVD => 8 CXFTF
1 VJHF, 6 MNCFX => 4 RFSQX
176 ORE => 6 VJHF
```

- `2210736` `ORE` for 1 `FUEL`:

```
171 ORE => 8 CNZTR
7 ZLQW, 3 BMBT, 9 XCVML, 26 XMNCP, 1 WPTQ, 2 MZWV, 1 RJRHP => 4 PLWSL
114 ORE => 4 BHXH
14 VRPVC => 6 BMBT
6 BHXH, 18 KTJDG, 12 WPTQ, 7 PLWSL, 31 FHTLT, 37 ZDVW => 1 FUEL
6 WPTQ, 2 BMBT, 8 ZLQW, 18 KTJDG, 1 XMNCP, 6 MZWV, 1 RJRHP => 6 FHTLT
15 XDBXC, 2 LTCX, 1 VRPVC => 6 ZLQW
13 WPTQ, 10 LTCX, 3 RJRHP, 14 XMNCP, 2 MZWV, 1 ZLQW => 1 ZDVW
5 BMBT => 4 WPTQ
189 ORE => 9 KTJDG
1 MZWV, 17 XDBXC, 3 XCVML => 2 XMNCP
12 VRPVC, 27 CNZTR => 2 XDBXC
15 KTJDG, 12 BHXH => 5 XCVML
3 BHXH, 2 VRPVC => 7 MZWV
121 ORE => 7 VRPVC
7 XCVML => 6 RJRHP
5 BHXH, 4 VRPVC => 5 LTCX
```

Given the list of reactions in your puzzle input, what is the minimum amount of `ORE` required to produce exactly 1 `FUEL`?

To begin, get your puzzle input.

Answer: [Submit]

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