Feynman supermeta: solution

The solution for this puzzle goes through the following stages (details below):

1) Figure out the rules for the diagram based on the supplied examples.
2) Applying the rules, use the answers from the input puzzles that are placed into the diagram to solve for all other areas of the diagram.
3) Discover that the solved diagram contains the final answer in the letters transferred by the W bosons.

1) <u>Figure out the rules for the diagram based on the supplied examples.</u>

The examples allow derivation of the following rules:

- All quarks and antiquarks are represented by smooth lines with arrows and are dictionary words. An interaction with a boson (i.e. a gluon, W boson, or Z boson) causes the quark to change to a different word (with an exception for gluon interactions, below).
- Quarks and antiquarks have one of three colors (red/blue/green). (In physics antiquarks are anti-red, anti-blue, and anti-green, typically represented by cyan, yellow, and magenta, but we are simplifying the representation here.) The color indicates the word is represented in either Morse, Braille, or 5-bit binary, respectively.
- At a vertex where a quark interacts with a gluon (represented by a spiral line), it changes color. This means that the word remains the same, but the representation system changes.
- At a vertex where a quark interacts with a W boson (represented by a wavy line with a W), that quark either gains or loses an entire letter ("unit of charge"), then optionally anagrams ("scatters"), to form a new word. (The letter may be lost from any place in the word.) The wavy line may connect to another vertex; the quark entering that vertex should lose or gain the same letter, accordingly. W bosons don't care what color a quark is; it will gain or lose a letter in whatever representation system it's in.
- At a vertex where a quark interacts with a Z boson (represented by a wavy line with a Z), that quark either gains or loses a "dot" (depending on the direction of the Z boson), then optionally anagrams, to form a new word:
    - If the quark was a red quark or anti-red antiquark (Morse), an incoming Z boson changes one dash to a dot in the first letter. An outgoing Z boson changes one dot to a dash in the last letter. After this the letters may be anagrammed.
    - If the quark was a blue quark or anti-blue antiquark (Braille), an incoming Z boson changes one white pip to a black pip in the first letter. An outgoing Z boson changes one black pip to a white pip in the last letter. After this the letters may be anagrammed.

- If the quark was a green quark or anti-green antiquark (binary), an incoming Z boson changes one 1 to a 0 on the first letter. An outgoing Z boson changes one 0 to a 1 in the last letter. After this the letters may be anagrammed.
- The gain or loss of a dot described above results in a new dictionary word that is one letter off, and anagrammed, from the old word. The potentially wide solution space here is constrained because instead of being able to substitute any letter, only certain letters are possible and substitution can only happen in the first or last letter.
- The wavy line may connect to another vertex; the quark entering that vertex should also lose or gain a dot, accordingly.

- Antiquarks and quarks are related by "invert charge plus reverse chirality" as follows.
  - If the quark is a red quark (Morse), each letter is inverted (dots for dashes), then individually rotated 180 degrees.
  - If the quark is a blue quark (Braille), each letter is inverted (black pips for white pips), then individually rotated 180 degrees.
  - If the quark is a green quark (binary), each letter is inverted (0 for 1), then individually rotated 180 degrees.
  - Note that antiquarks are *not* then anagrammed ("When this happens there is no scattering").
  - The resulting antiquark is also a dictionary word.

- In physics, a quark and its antiquark can annihilate to form a gluon (or be produced in gluon decay). Also in physics, a quark and an antiquark[1] can annihilate to form a W boson (or be produced in W boson decay). In the W boson case, this results in a unit of charge being "left over", and the W boson carries this charge. In the puzzle, this works exactly the same way: if a quark and antiquark are connected to a gluon, they are just the quark and its antiquark. If they are connected to a W boson, the quark will have an extra letter that must be removed to get a new dictionary word before making the antiquark (the extra letter is always placed in in the quark for this puzzle).

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[1] This actually only happens between a quark of one flavor and an antiquark of another flavor, but we've simplified for this puzzle by omitting flavors altogether.

The chart below lists the letter translations used for antiquarks and for Z interactions.

Initial letter	Antiquark (all letters change)			After Z interaction (dot gain) (only one letter changes)			After Z interaction (dot loss) (only one letter changes)		
	Letter in blue antiquark (Braille)	Letter in red antiquark (Morse)	Letter in green antiquark (binary)	Letter in blue quark (Braille) ○→●	Letter in red quark (Morse) —→•	Letter in green quark (binary) 1→0	Letter in blue quark (Braille) ●→○	Letter in red quark (Morse) •→—	Letter in green quark (binary) 0→1
A	Q	A	O	B, C, E, K	I	---	---	M	C, I, E, Q
B	P	---	W	F, H, L	H	---	A	C, X, Z	C, F, J, R
C	G	C	G	D, F, M	B, F	A, B	A	Y	G, K, S
D	D	G	---	G, N	S	----	C, E	G, K	E, F, L, T
E	N	T	K	D, H, O	---	A, D	A	T	G, M, U
F	F	Y	S	G, P	H	B, D	B, C, I	C, P	G, N, V
G	C	D	C	Q	D, R	C, E, F	D, F, H, J	O	O, W
H	M	---	---	G, R	---	---	B, E	B, F, L, V	I, J, L, X
I	---	M	M	F, J, S	---	A, H	---	A, N	K, M, Y
J	---	V	U	G, T, W	P	B, H	I	---	K, N, Z
K	R	R	E	L, M, O, U	D, U	C, I, J	A	O	O
L	L	Q	Y	P, R, V	H	D, H	B, K	P, Z	M, N
M	H	I	I	P, N, X	A, N	E, I, L	C, K	---	O
N	E	N	Q	Q, Y	I	F, J, L	D, M, O	M	O
O	O	S	A	N, R, Z	G, K, W	G, K, M, N	E, K	---	---
P	B	X	---	Q	F, L	---	F, L, M, S	J	Q, R, T, X
Q	A	L	N	---	X, Z	A, P	G, N, P, R, T	---	S, U, Y
R	K	K	V	Q	S	B, P	H, L, O	G, W	S, V, Z
S	---	O	F	P, T	---	C, Q, R	I	D, R, U	W
T	---	E	Z	Q	E	D, P	J, S	---	U, V
U	---	W	J	X, V, Z	S	E, Q, T	K	K, W	W
V	---	J	R	---	H	F, R, T	L, U	X	W
W	---	U	B	---	R, U	G, S, U, V	J	O	---
X	---	P	---	Y	B, V	H, P	M, U	Q, Y	Y, Z
Y	---	F	L	---	C, X	I, Q, X	N, X, Z	---	---
Z	---	Z	T	Y	B, L	J, R, X	O, U	Q	---

2) **Applying the rules, use the answers from the input puzzles that are placed into the diagram to solve for all other areas of the diagram.**

Each input answer from a puzzle in the round is placed on the diagram as soon as solvers confirm the answer for that input puzzle. One way the logic chain might work is as follows.

(In this walkthrough, W bosons and Z bosons are numbered individually left to right and top to bottom. The dictionary used for the walkthrough is YAWL, although the puzzle was constructed using only Scrabble-legal words and can be solved with a much smaller dictionary. In general we are starting from edges/ends and working towards the middle until it gets unwieldy, then moving to another edge.)

We will get the directions of the W bosons sorted out first.

2 is POLIO (given) (blue). Therefore 1 must be the antiparticle of this, plus or minus a letter. The antiparticle of POLIO is BOLxO, where I has no partner. Thus W1 must be I transferred up and 1 is BOLO.

Similarly, 4 is YANKS (given) (red). 3 must be FANRO plus or minus a letter. There is no letter that can be added to this without anagramming, so W2 is up. Also, 3 dropping a letter can only be FARO or FANO, so W2 must be N or K (TBD below). Solvers who realize that the corresponding YAKS/YANS must also be a valid word can shortcut the process, but this is not required.

6 is COCOA (given) (green). 5 must be GAGAO plus or minus a letter. There is no letter that can be added to this without anagramming, so W3 is up. Also, 5 dropping a letter can only be GAGA, so W3 must be A.

9 is LANCED (given) and 18:CELLOS (given). Between these two the W bosons are W4, W5, W2, and W3. We have just determined that W2 and W3 are up (letter outgoing). Therefore W4 and W5 must also be up (letter incoming) so that there will still be 6 letters at the end of the row.

On the second full row, between 19:GIBLETS (given) and 30:STARCHES (given) are five W's: W4, W6, W5, W7, W8. As previously determined, W4 and W5 are up (outgoing letter). STARCHES has 8 letters and GIBLETS 7, so W6, W7, and W8 must all be up (incoming letter).

On the fourth row, between 45:TRIHEDRA (given) and 50:ARREST (given) are two Ws: W9 and W10. Therefore they must both be outgoing, or up.

On the fifth row, left side, 56:GRANTER (given) and 60:AVENGERS (given) have only one W between them (W13). Therefore W13 must be incoming, or up.

Jumping to the bottom antiparticles, 94:MOTOR (given) (blue). The antiparticle of this is HOxOK, so 95:HOOK and W18 is T up. 96:GRAMS (given) (green). The antiparticle of this is CVOIF, and 97 must be this phrase plus or minus a letter. CVOIF cannot take a letter without anagramming, and can only lose V. Therefore 97:COIF and W19 is R up.

Moving up a row to the bottom row, 81:CHART (given) (red). The antiparticle of this is CxAKE so 82:CAKE and W15 is H up. 83:IGNORES has 7 letters, and 93:RAPTORS has 7 letters. In between are W16, W18 (known up / letter incoming), W19 (known up / letter incoming), and W17. Thus W16 and W17 both transfer a letter up (outgoing).

Moving up to the sixth row, 70:GRAPHS (given) and 79:PRAMS (given). In between are three W's: W13 (known up / letter outgoing), W16 (known up / letter incoming), and W14 (which must also be up / letter outgoing).

On the right side of the fifth row, 63:MANTICORES (given) and 68:DRAGLINES (given) have three W's between them: W11, W12, and W14 (known up / incoming letter). Thus W11 and 12 are also both up (outgoing letters).

Now all the Ws are known to go up, and W1 = I, W2 = N or K, W3 = A, W15 = H, W18 = T, and W19 = R.

Starting from the left side of the bottom row, 83:IGNORES (green) encounters Z18. If Z18 is up (incoming), 84:GORHENS or ONAGERS/ORANGES. If Z18 is down (outgoing), there are no possibilities for 84. So Z18 is up. Next is Z16 (direction unknown). If Z16 is up (outgoing), possible chains are 84:ONAGERS/ORANGES,85:WAGONER. If Z16 is down (incoming), possible chains are 84:GORHENS,85:RESHONE; 84:ONAGERS/ORANGES,85:ENGRAMS/GERMANS/MANGERS; 84:ONAGERS/ORANGES,85:GANGERS/GRANGES/NAGGERS. Next is Z19 (direction unknown), and after Z19 is 86:RENAMES (given). From this we can determine that 84:ONAGERS/ORANGES, Z16 is down, 85:GERMANS, Z19 is up, 86:RENAMES.

Looking right, before reaching 93:RAPTORS at the end of the row, we have W16 (outgoing, letter unknown), W18 (incoming T), gluon, Z20 (direction unknown), Z17 (direction unknown), W19 (incoming R), and W17 (outgoing, letter unknown). This represents only four opportunities to change a letter (one each for the Z's, and one for each pair of W's). There are four letters in RENAMES that are not in RAPTORS. Therefore the Z and W bosons on this row must change E, N, M, and E into P, T, O, and R in some combination: each Z or outgoing W must act on one of the first set, and incoming Ws must be / Zs must result in letters in the second set. We know that W18 is T and W19 is R, so the Zs must change letters into P and O in some combination. Both of the Z's are blue, so the only Z interactions that fit this pattern are: incoming Z acting on E to make O; outgoing Z acting on N to make O; incoming Z acting on M to make P. Thus we know that W16 and W17 cannot carry away an M (as that has to be done by a Z boson), and that they must be either 2 Es or an E and an N.

Working right from 86:RENAMES, we can lose an E at W16 to make 87:ENARMS/NAMERS/RAMENS/REMANS or an N to make 87:AMEERS/MEARES/RAMEES/REAMES/SEAMER. Gaining a T at W18 leaves the following possible chains: 87:ENARMS/NAMERS/RAMENS/REMANS,88:ARTSMEN/MARTENS/SARMENT/SMARTEN, or 87:AMEERS/MEARES/RAMEES/REAMES/SEAMER,88:REMATES/RETEAMS/STEAMER/TEAMERS. 89 = 88. Next is Z20, which we know must act on an E, N, or M. None of REMATES/RETEAMS/STEAMER/TEAMERS begin or end in these letters, so we can rule out that branch. We have now proven that W16 must be E up (outgoing), 87:ENARMS/NAMERS/RAMENS/REMANS W18=T up (incoming).

At this point there are two branches: either 88/89:ARTSMEN/SMARTEN with Z20 down/outgoing and 90:AMORETS/MAESTRO/OMERTAS, or 88/89:MARTENS with Z20 up/incoming and 90:ARPENTS/ENTRAPS/PANTERS/PARENTS/PASTERN/PERSANT/TREPANS. The next interaction is Z17, which must either turn an M into a P (in the first case) or an E or N into an O (in the second case). Thus our two branches are now three: 88/89:ARTSMEN/SMARTEN,Z20 down/outgoing,90:MAESTRO,Z17 down/incoming, 91:ESPARTO/PETROSA/PROTEAS/SEAPORT; 88/89:MARTENS,Z20 up/incoming,90:ENTRAPS,Z17 down/incoming,91:PARTONS/PATRONS/TARPONS; 88/89:MARTENS,Z20 up/incoming,90:PASTERN,Z17 up/outgoing,91:ESPARTO/PETROSA/PROTEAS/SEAPORT. Next is W19 (incoming R); 91:PARTONS/PATRONS/TARPONS cannot take an R at all, so that branch is eliminated. Thus 91:ESPARTO/PETROSA/PROTEAS/SEAPORT, W19 adds an R to make 92:PRAETORS/PRORATES and W17 removes the E to get 93:RAPTORS. However there is still an ambiguity with Z20 and Z17; they both go the same direction, but that direction must be determined with information from the next row.

On the row above, we know 70:GRAPHS (given) (blue). Just before is W15 (H incoming), so 69:GRASP/SPRAG. After 70 is W13 (unknown letter outgoing); it can be G (70:HARPS/SHARP), H (70:GRASP/SPRAG), or S (70:GRAPH). Next is Z16 (down, outgoing). Possible chains are then 70:SHARP,71:HARLS; 70:SHARP,71:HARMS/MARSH; 70:GRASP,71:FRAGS; 70:GRASP,71:GRAMS/MARGS; 70:GRASP,71:GRASS; 70:SPRAG,71:DRAPS/PARDS/PRADS/SPARD/SPRAD; 70:SPRAG,71:FRAPS; 70:SPRAG,71:HARPS/SHARP; 70:GRAPH,71:GAPER/GRAPE/PAGER/PARGE. Next is Z13 (direction unknown). Looking to the right, we know W16

adds an E to 73 to get 74:SERAPH (given); thus 73:HARPS/SHARP. This means two things: a) 71 must contain exactly 4 out of 5 letters in HARPS/SHARP, and b) if HARPS/SHARP appears earlier in the row we will need to apply the "no two quarks are exactly alike" rule. Checking for letter overlap, the only valid remaining options for 71 are HARLS; HARMS/MARSH; DRAPS/PARDS/PRADS/SPARD/SPRAD; FRAPS. However, in order for Z13 to change the different letter into one of SHARP, it must be at the beginning or end of the word. Remaining options for 71 are then only MARSH; DRAPS/SPARD/SPRAD; FRAPS. Z13 outgoing (up) cannot change a blue D into an H; Z13 incoming (down) cannot change a blue D into an H nor a blue F into an H. Thus we have resolved the first part of this row: it must be W13 G, 70:SHARP, Z16 down, 71:MARSH, Z13 down, 73:HARPS.

Moving right from 74:SERAPH, we have Z14 (direction unknown). If Z14 is up (outgoing), 75/76:PEARES/PREASE/SERAPE. If Z14 is down (incoming), 75/76:TEPHRA/TERAPH/THREAP. Looking right, we have Z15 (direction unknown), Z17 (down, outgoing), and W14 (unknown letter outgoing) before arriving at 79:PRAMS (given). So if 75/76:TEPHRA/TERAPH/THREAP then these bosons must act (one each) on the three letters in 75/76 that do not appear in PRAMS: T, E, and H. Pursuing this assumption, Z15 would have to be incoming acting on T or outgoing acting on H. However, T can only turn into D or P, H can only turn into I, J, L, or X, and we need to create an M and S. Thus Z14 is up and 75/76: PEARES/PREASE/SERAPE. Since here there are only two letters that need to change to get PRAMS (E,E) and three bosons, the situation is more complicated: either two of the bosons must act on one E in turn, or one Z boson changes an existing P,R,A,S into an M and the other changes an E into the now-missing letter. If Z15 is down (incoming), there are no such possibilities; Z15 must be up (outgoing), and the only possibilities are 75/76:PREASE/SERAPE,77:GAPERS/GASPER/GRAPES/PAGERS/PARGES/SPARGE; 75/76:PREASE/SERAPE,77:PAREUS/PAUSER; 75/76:PREASE/SERAPE,77:REMAPS.

Next is Z17 (direction unknown), which must act on a non-PRAMS letter. If it is up (incoming), 77 could be only GAPERS/GASPER/GRAPES; if it is down (outgoing), 77 could be only SPARGE. However, Z17 must create a letter that is in PRAMS. An incoming Z action on a green G can only create a C, E, or F (none of which are in PRAMS); Z17 must be down / outgoing, and 78:GRAMPS, which means that W14 carries a G away. This also fixes the row below; Z17 is down so Z20 is down, and 88/89:ARTSMEN/SMARTEN,90:MAESTRO. At the end of the current row, we know 79:PRAMS receives an E at W17; thus 80:REMAPS.

Moving up another row, 56:GRANTER (given) (green). Immediately following is Z10 (direction unknown). Looking at the beginning of row 5 just above, we have 45:TRIHEDRA (given) (green). If Z10 up (incoming to 44), 44:EARTHIER. If Z10 is down (outgoing), there are no possibilities for 44. Therefore Z10 must be up and 44:EARTHIER. This means 57 can only be 57:ARGENTS/GARNETS/STRANGE. W13 then adds another G to make 58:GANGSTER. Next is Z11 (direction unknown). If Z11 is up (outgoing), there are no possibilities for 59. Thus Z11 is down and 59 can be 59:ESTRANGE/GRANTEES/GREATENS/NEGATERS/REAGENTS/SEGREANT/SERGEANT/STERNAGE or 59:ENGRAFTS. However, next is Z13 (down, outgoing) which must turn 59 into 60:AVENGERS. Thus 59 can only be 59:SEGREANT/SERGEANT. 61:AVENGERS, and Z14 (up,incoming) then makes 62:REVENGES/SEVERING/VEERINGS.

Beginning at 63:MANTICORES (given) (green), and looking to the right, we see 68:DRAGLINES (given). Between 63 and 68 are only three possibilities to change/add a letter (Z15, W14, and Z12). MANTICORES only contains six of the nine letters in DRAGLINES, so we know it can't lose any of the shared letters (A,E,I,N,R,S) because it needs to keep them all for the rest of the row. Therefore W11 (outgoing) could only be C (64:MATRONISE), M (64:ACTIONERS/ANORETICS/CREATIONS/NARCOTISE/REACTIONS), O (64:MISCREANT), or T (64:CORAMINES). Next is Z15 (up/incoming, green), which must change a C/M/O/T into a D/L (since we already know the G is supplied by W14). In green space, C and O cannot change into D/L on gaining a dot, and there are no possibilities for 64 starting with T. Thus possible chains to this point are then: W11 = C,64:MATRONISE,65:

ORIENTALS/RELATIONS/SEROTINAL/TAILERONS/TENSORIAL; or W11=O,64:MISCREANT,65:CISTERNAL/CLARINETS/LARCENIST, both of which involve turning M into L. Next is W12, which must lose one of O/T or C/T (depending on which path we have followed). However, Z12 (green, direction unknown) must change the remaining C/O/T into a D. Only T can change into D at Z12 (incoming). This means W12 must be C or O (and the opposite of W11), and Z12 is down. Possible chains are then 65:ORIENTALS/etc,W12=O,66: ENTRAILS/LATRINES/RATLINES/RETINALS/TRENAILS; 65:CISTERNAL/etc,W12=C,66:ENTRAILS/LATRINES/RATLINES/RETINALS/TRENAILS. Since these have the same possibilities for 66, that must be the identity of 66. We can see that the identity of W11 and W12 must be locked down by the row above; we will return to these in a moment. From 66 and moving right, W14 incoming is G, so 67:GNARLIEST/INTEGRALS/RESLATING/TRIANGLES – except that the word must start with T for Z12 to act on it, so 67:TRIANGLES is the only option.

Looking now at the row above (4th row from top), 45:TRIHEDRA loses a letter at W9. This could only be H (46:TARDIER/TARRIED), R (46:AIRTHED), or T (46:HARDIER/HARRIED). Next is Z11 (down / outgoing) (green). Possible chains are 46:TARDIER,47:ARIDEST/ASTERID/ASTRIDE/DIASTER/DISRATE/STAIDER/STAIRED/TARDIES/TIRADES; 46:TARDIER,47:TARDIVE; 46:TARRIED,47:TEARIER; 46:TARRIED,47:RETIRAL/RETRIAL/TRAILER; 46:TARRIED,47:RATTIER/RETRAIT/TARTIER; 46:AIRTHED,47:LATHIER; 46:HARDIER,47:AIRSHED/DASHIER/HARDIES/SHADIER. Looking down the row, there is a letter loss at W10, a gluon to color change to blue, and a Z boson (unknown direction) at Z8 to result in 50:ARREST (given). Therefore 46 must share at least five of the letters in ARREST and we can rule out all chains at Z11 except 46:TARDIER,47:ARIDEST/ASTERID/ASTRIDE/DIASTER/DISRATE/STAIDER/STAIRED/TARDIES/TIRADES; 46:TARRIED,47:TEARIER; 46:TARRIED,47:RETIRAL/RETRIAL/TRAILER; 46:TARRIED,47:RATTIER/RETRAIT/TARTIER. This means that W9 must be H up. Further, since each of the remaining options for 46 share exactly 5 letters with 50:ARREST, the letter lost at W10 must be one of the mismatched letters, and the remaining mismatched letter must be in the first or last position so it can be changed by Z8 to the sixth letter of ARREST. The 47:ARIDEST group must lose I to make 48/49:DATERS/DERATS or STARED/STEARD, as losing D yields no words starting or ending with I. 47:TEARIER must lose I to make 48/49:TERRAE, or lose E to make 48:IRATER. 47:RETIRAL/RETRIAL/TRAILER must lose I to make 48/49:RETRAL or L to make 48/49:IRATER. 47: RATTIER/RETRAIT/TARTIER must lose I to make 48/49:TARTER or T to make 48/49:IRATER. Looking at our options for 48/49, the only one that could become ARREST at Z8 is 48/49:IRATER (with Z8 down, or incoming). Therefore 46:TARRIED, Z8 must be down, and W10 must be one of E, L, or T. We will determine this later. After 50:ARREST we have an incoming C or O at W11; ARREST could take either letter so we can't determine this just yet.

On the second half of the 4th row, we have 54:VARIABLES (given) (red). We already know Z12 is down (outgoing), so 55:ADVERBIAL. Just before VARIABLES is Z9 (direction unknown). However, we know that 53 has received either a C or an O from W12, and neither letter is present in 54. Therefore Z9 must change a C or an O into one of the letters in VARIABLES. C could turn into B if Z9 is incoming, but O could not produce a letter in VARIABLES regardless of the Z direction. Therefore Z9 is down, 53:CAVALIERS/CALVARIES/CAVALRIES, W12 transfers a C, 52:REAVAILS, W11 transfers an O, 51:ROASTER; 64:MISCREANT; 65:CISTERNAL/CLARINETS/LARCENIST.

Moving up to the third row, we have 31:SCAMP (given) (blue). Next is Z6 (direction unknown). If Z6 is up (outgoing), 32:CALMS/CLAMS or 32:SCAMS. If Z6 is down (incoming), there is no value possibility for 32. Therefore Z6 is up. We know W9 is H up (letter incoming), but 32:CALMS/CLAMS cannot take an H to make a valid word, so 32:SCAMS and 33:CHASMS. Next is a gluon, so 34:CHASMS. Then W10 (up, letter incoming), and we know it is one of E/L/T. CHASMS can only take an E, so W10 = E, 35:SACHEMS/SAMECHS/SCHEMAS, and 47:TEARIER. Next is W6 up (letter outgoing). SCHEMAS can only lose S, C, M; if it loses E it must be CHASMS which would make 36 identical to 34 (impossible). Determination of W6 and 36 must wait until the next row.

Next we have 38:STANCHION (given) (red). Immediately prior to this is Z8, which we know to be down (outgoing). Therefore 37 could only be SNATCHING/STANCHING. On the right, following 38:STANCHION is Z7 (direction unknown). Z7 down does not result in any valid words at 39, so Z7 must be up (outgoing) and 39/40:MACINTOSH/MONACHIST. Between here and 42:ANTISMOG (given) (green) there is an outgoing letter at W7 and a changed letter at Z9 (down, outgoing). Thus W7 must be either C or H, and Z9 must act on the remaining letter to change it to a G. There is no way to change a green H into a G, so W7 must be H and 41:MONASTIC. On the right, W8 transfers a letter up. 42:ANTISMOG can lose A, I, S, M, O, G – but the determination of this, and 43, will have to wait until the next row.

On the second row, we have 19:GIBLETS (given) (red). The first encounter is Z6 (up, incoming). Thus 20:BILSTED or BLISTER/BRISTLE/RIBLETS. The next is Z4 (direction unknown). Possibilities for Z4 up (outgoing) are 20:BILSTED,21/22:GIBLETS; 20:BLISTER,21/22:BLEWITS/GIBLETS; 20:RIBLETS,21/22:DRIBLET; 20:RIBLETS,21/22:REBUILT. Possibilities for Z4 down (incoming) are 20:BLISTER/BRISTLE,21/22:SLITHER; 20:RIBLETS,21/22:BITLESS. 21/22:GIBLETS is not possible, as it would be identical to 19, so our possibilities for 21/22 are BLEWITS, DRIBLET, REBUILT, SLITHER, and BITLESS. At this point we look down the row. Between 22 and 26:CHEATS are two outgoing letters (W4 and W5), one incoming letter (W6), and one Z boson (Z7, direction unknown). Thus 21/22 must share at least four letters with 26:CHEATS. Therefore the only valid entry for 21/22 is SLITHER, Z4 is down, and 20:BLISTER/BRISTLE. W4 and W5 must then remove non-shared letters (I,L,R), W6 must be one of C or A, and Z7 must change the remaining I, L, or R to the other of C or A. From before we know W6 cannot be A (only S, C, or M), so W6 must be C, 36:MASHES/SHAMES, and Z7 must change a green I, L, or R to an A. This is only possible if Z7 is incoming (up) – which we already knew, but it's nice that we can solve for it another way – and 25 starts with I, so W4 and W5 must be L and R in some order. 25 must be ITCHES, but determination of W4 and W5 (as well as 23 and 24) must wait for the next row, since either option leaves possibilities for 23 and 24.

Moving to the right side of the second row, 27:CHEATS because 26:CHEATS. Next, W7 brings in an H to make 28:CHETAHS/HATCHES. After this there is one Z (Z5, direction unknown, blue) and one incoming W (W8) before 30:STARCHES. This means that Z5 must change one H into an S or R, and then W8 will transfer the last letter. Thus we can see that Z5 must be incoming (down) acting on 28:HATCHES to make 29:ARCHEST/CHARETS/CHASTER/RACHETS/RATCHES, and then W8 is S and 43:MOATING.

Finally, the top row. 9 is LANCED (given) (blue). Z4 (down, outgoing) is immediately preceding, so possibilities for 8 are 8:DANCER; 8:LANDED. Before 8 is W1, which is I up, and 7 could only be 7: CAIRNED/CARNIED/DANCIER, so 8:DANCER.

On the right side of 9 is Z1 (direction unknown). If Z1 is down (incoming), possibilities for 10 are 10:CEDARN/CRANED/NACRED/NARCED/RANCED (DANCER is excluded because 8:DANCER). If Z1 is up (outgoing), 10:CANCEL or 10:ELANCE/ENLACE. Next is W4, which we know adds either L or R. If W4 is L, the only valid chains to this point are 10: CEDARN/CRANED/NACRED/NARCED/RANCED,11:CANDLER; 10:ELANCE/ENLACE,11:NACELLE. If W4 is R, the only valid chain to this point is 10:ELANCE/ENLACE,11:CLEANER/RECLEAN. At this point we look to the right. 13:COLANDER (given). Between 11 and 13 are Z2 (direction unknown) and W5 (adding either L or R). Thus 11 must share at least six letters with COLANDER. NACELLE does not, so we can rule out that chain. If 11:CANDLER, then W5 is R, and Z2 must then change an R to an O. This is possible if Z2 is up (outgoing). If 11:CLEANER/RECLEAN, then W5 is R – but Z2 cannot change both an E and an R to an O and a D. Thus we know Z1 is down (incoming), 10:CEDARN/CRANED/NACRED/NARCED/RANCED, W4 is L, 11:CANDLER, Z2 is up (outgoing), 12:CELADON, and W5 is R. Also, 23:THEIRS and 24:CITHERS/ESTRICH/RICHEST.

On the right side of 13:COLANDER, we now know W2 must be N (not K, since there is no K in COLANDER), 3:FARO, and 14/15:CAROLED/ORACLED. W3 removes an A, so 16:COLDER (green), and Z5 is down (outgoing), so

17:CLOSED/DOLCES. Next is Z3 (direction unknown) and 18:CELLOS, so Z3 must change the D into an L. This is only possible if 17:CLOSED and Z3 is up (outgoing).

3) **Discover that the solved diagram contains the final answer in the letters transferred by the W bosons.**

When the diagram is completely filled out, the letters transferred by the W bosons spell out (reading bottom to top and left to right, as indicated by the "Time" arrow) the answer:
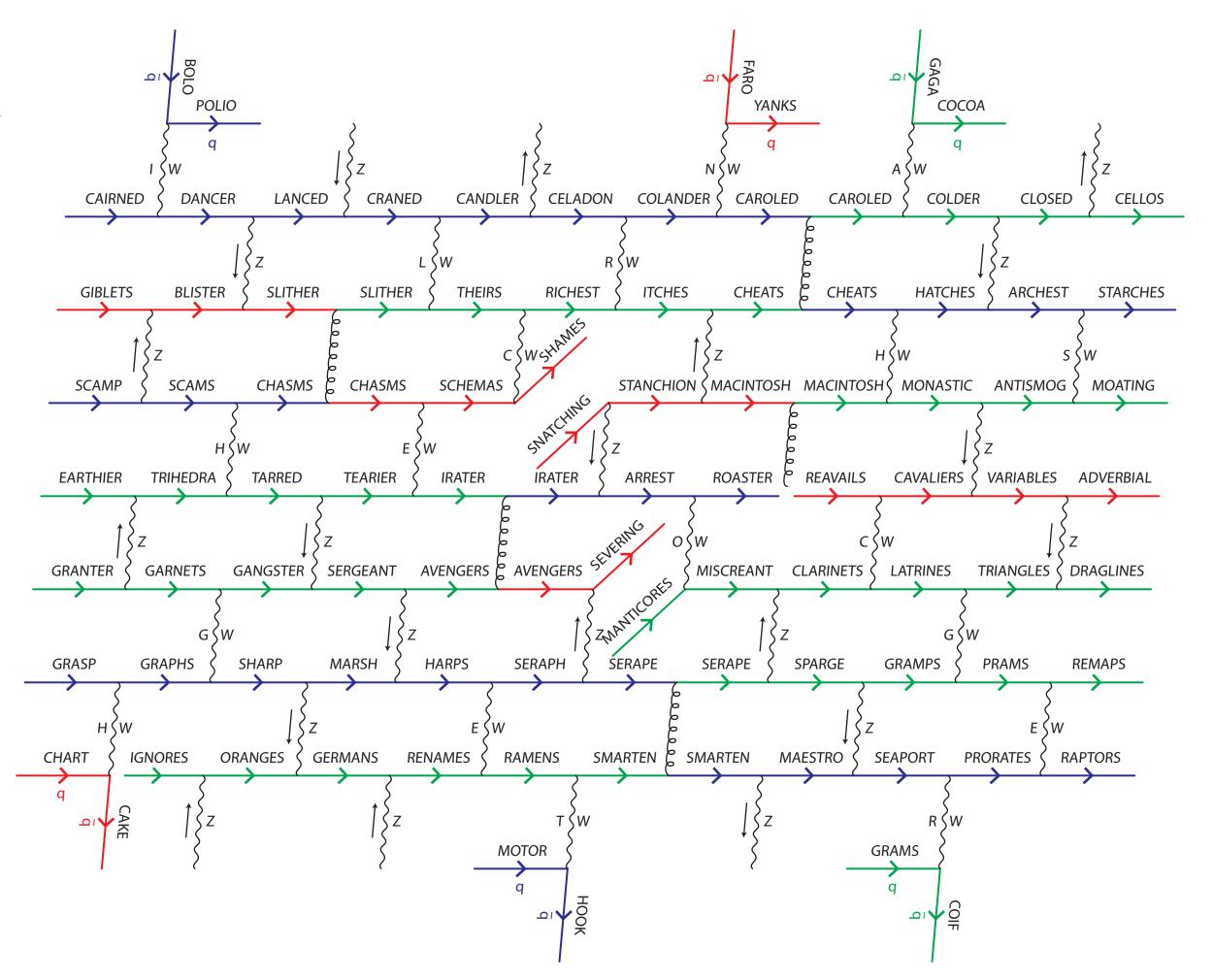
HIGH ELECTRON CHARGES

TAKE-HOME FINAL:

Complete the diagram.

Note 1: Some quarks in the diagram will appear to be scattering in more than one direction at once. This is normal and does not represent a threat to the space-time continuum.

Note 2: No two quarks are completely identical.

TIME

BOLO · POLIO · q · b

FARO · YANKS · q · b

GAGA · COCOA · q · b

I W · CAIRNED · DANCER · LANCED · Z · CRANED · CANDLER · Z · CELADON · COLANDER · CAROLED · N W · CAROLED · A W · COLDER · CLOSED · Z · CELLOS

Z · GIBLETS · BLISTER · SLITHER · SLITHER · L W · THEIRS · RICHEST · R W · ITCHES · CHEATS · CHEATS · HATCHES · Z · ARCHEST · STARCHES

SCAMP · Z · SCAMS · CHASMS · CHASMS · SCHEMAS · C W · SHAMES · STANCHION · Z · MACINTOSH · MACINTOSH · H W · MONASTIC · ANTISMOG · S W · MOATING

SNATCHING

EARTHIER · TRIHEDRA · H W · TARRED · TEARIER · E W · IRATER · IRATER · ARREST · ROASTER · REAVAILS · CAVALIERS · VARIABLES · ADVERBIAL

SEVERING

GRANTER · Z · GARNETS · GANGSTER · SERGEANT · Z · AVENGERS · AVENGERS · O W · MISCREANT · CLARINETS · LATRINES · C W · TRIANGLES · Z · DRAGLINES

MANTICORES

GRASP · GRAPHS · G W · SHARP · MARSH · Z · HARPS · SERAPH · SERAPE · SERAPE · Z · SPARGE · GRAMPS · PRAMS · G W · REMAPS

CHART · H W · IGNORES · ORANGES · GERMANS · Z · RENAMES · RAMENS · E W · SMARTEN · SMARTEN · MAESTRO · Z · SEAPORT · PRORATES · RAPTORS

q · b · CAKE

Z

Z

T W · MOTOR · q · b · HOOK

R W · GRAMS · q · b · COIF