

2 Introduction

1. Question 2 page 1: does the SM really give a 'compelling explanation of the existing experimental data'? What about dark matter, the matter-antimatter asymmetry and to a lesser degree the lightness of the Higgs?
- ✓ 2. Page 4 Table 1: I don't think the uncertainties on the t and b quark masses of around 40 MeV are correct? *Its correct. Reference PDG.*
- ✓ 3. Page 5: Here and elsewhere care should be taken to integrate equations correctly into the text around them. Here, there should not be a full stop before Eq. 1.1 and there should be a full stop rather than a colon after Eq. 1.2.
4. Question 3 page 5: Why do gauge bosons have to be massless to preserve gauge invariance?
5. Question 4 page 6: Why do we need three matrices to generate $SU(2)$?
- ✓ 6. Page 8: It is not clear how we get from W_i , $i = 1, 2, 3$ fields to W^\pm , Z and γ fields. I think a few lines should be added to describe this. Also, is your list of quartic couplings complete? I think one is missing. *Text updated.*
- ✓ 7. Page 9: 'left-handed spins relative to their motion' describes helicity not the chiral structure of the SM. Please define lefthanded accurately. *Defined in footnote*
8. Question 5 page 11: in the footnote you say the gauge transformation removes unphysical degrees of freedom. What is the manifestation of these unphysical degrees of freedom? Have they really been completely removed?
- ✓ 9. Page 12: as noted before this description of electroweak unification should be earlier.
- ✓ 10. Page 13: the 2nd and 3rd diagrams in Fig. 1.1 are identical. There is a undefined reference at the end of the page.
11. Question 6 page 20: Are there any existing constraints on the GM model, Fig 4.21 has some theoretical disallowed region for example?

3 The LHC and CMS detector

1. Question 7 page 24: Why is it the Large Hadron Collider if it just accelerates protons as stated? Some mention of the heavy-ion programme should be made.
2. Question 8 page 25: Why can the LHC not accelerate protons to several TeV in one go? What is the limitation? Hardware restrictions is vague.

3. Question 9 page 26: A hope the candidate could explain why the protons are in bunches? This is somewhat taken for granted in the discussion.
- ✓ 4. Page 28: As the quadrupole focusing is discussed, it is surprising that the dipoles are not. One could argue that these are the single most important item in the whole of the LHC. *Text & figure add & having details of dipole*
- ✓ 5. Page 31: Table 2.1 gives a half-crossing angle for the beams. I think Eq. 2.2 and 2.4 should reflect this. Also, γ is not defined in these expressions? *Done*
6. Question 10 page 32: There are seven official experiments at the LHC. As you are discussing TOTEM and LHCf, what about MOEDAL?
7. Question 11 page 33: Can you explain why the momentum resolution is related to B and L in this way?
- ✓ 8. Page 36: The kaons are not written correctly in the text i.e k^\pm ? *K^\pm*
- ✓ 9. Page 44: physicswhile typo in first line

4 Gas Electron Multiplier

1. Question 12 page 52: What is (are) the highly-ionising particle(s) that can lead to destructive discharge? What is the physical reason for GEMs improved radiation hardness? The statement is purely qualitative in the text.
- ✓ 2. Page 53. *→ added in caption & updated figure.* The field lines (red) and equipotentials (green) should be clearly labeled in Fig 3.1. Eq. 3.1 equates a vector to the ratio of two scalars please correct *→ corrected.*
- ✓ 3. Page 54 *et seq.*: Are Figs. 3.2 and 3.4 drawn by the candidate? If not they should be attributed.
- ✓ 4. Page 54: In Fig 3.3 it is not clear if these are the same data series for the gain and discharge probability given the difference in ΔV_{GEM} points. Are they same configuration? If not some more details should be given.
5. Question 13 page 58: Is there a stereo angle between the strips in a superchamber? If not what is the ghost hit rate as a result?
6. Question 14 page 58: What is the shielding made of and what is it protecting the chamber from?
- ✓ 7. Page 59: The pre-bending of the with respect to "bar bowing" seems to be garbled and I could not divine the meaning. *sentence updated.*

→ Yes the detectors have some configuration. The details are given in the referenced paper number 77 from where I grabbed this plot.

8. Question 15 page 60: Why was the gas mix changed from H₂ to H₄ test beams? There is a missing reference to the appendix. Also, "certain quality checks" is a very vague statement: can what was checked and how be stated?
- ✓ 9. Page 64: Fig. 3.13 is illegible and the difference between the red, green and blue data series can not be worked out? *Fig. 2 caption updated.*
- ✓ 10. Page 68: the beam is said to have a Gaussian spread but the left plot in Fig. 3.19 is far from Gaussian. Can this be explained? *updated sentence.*
- ✓ 11. Page 73: perhaps some comment can be made about the inefficiency for $q > 80$ mm seen in Fig. 3.23? *Added details & a fig. explaining this.*
- ✓ 12. Page 74 *et seq.*: the precision of the central values and uncertainties of the fit parameters are messed up i.e. $[0] = -0.013 \pm 0.042$ would be just fine. Where do the 0.989 and 687.3 come from in the expression for $F1$?
13. Question 16 page 78: There are seven parameters fit to seven points so the fit is under constrained. Why is this fit not meaningless?
14. Question 17 page 78: What is meant by golden runs?
- ✓ 15. Page 80: These Poisson fits have very poor χ^2/ndf , should the results really be shown?
16. Question 18 page 81: It is not clear how the bending affects the transparency of the bottom third of the GEM. Can this be explained?
17. Question 19 page 85: Fig 3.32 can the real and effective gain be defined? I did not find it earlier in the chapter?
18. Question 20 page 86: Why does the back have less defects than the front?
19. Page 88: The vertical scales of the two plots should be the same to a comparison between the leakage current of the two foil types. *Not implemented.*
- ✓ 20. Page 89: Some sort of conclusion and outlook should be given about the GEM studies, otherwise the chapter ends very abruptly.

5 Anomalous Quartic Gauge Coupling Measurement

- ✓ 1. Page 92: What is the meaning of the Ref CEJ? *Latex citation issue. Fixed.*
2. Question 21 page 93: In table 4.1 what is the meaning of the version numbers?

→ As the plots are clear and can be compared by eye easily
 so didn't make them with same scale.
 → Also this plots are published so its not good to change now.

3. Question 22 page 93: How much data is lost due to the golden JSON requirement?
4. Question 23 page 94: Why the sample names identical in Tables 4.2 and 4.3?
5. Question 24 page 94: Why is the interference effect larger at larger masses?
6. Question 25 page 95: Why is there an excess at low mass in Fig. 4.3?
✓ Page 95: H_T^2 needs to be defined
8. Question 26 page 97: What are the logarithmic weights and the leakage variable? More detail required.
- ✓ Page 100: "delta-beta" is jargon? *Explained this in footnote*
- ✓ Page 101: The fine-tuned values of the CSV discriminator would seem to require a reference at least to motivate them?
11. Question 27 page 102: Was any optimization done of the selection criteria such as the Zeppenfeld variable?
- ✓ Page 104: Could the data-MC agreement of the CSV variable be shown for the b -jets? *Added plots in Fig. 4.5*
- ✓ Page 110: More problems with too many significant figures in Table 4.10?
14. Question 28 page 123: What happens if you don't float the parameters one at a time? Are many of them correlated? How do the limits worsen?
15. Question 29 page 124: What happens if you cannot use the narrow width approximation for the Higgs? Some more detail of how Fig. 4.4 becomes Fig. 4.21 would be a welcome addition?

Here superscript 2 was representing the footnote, where H_T was defined. Since it seems confusing so updated the sentence