Mark schemes

1 C **[1]**

2 B **[1]**

3 **C** **[1]**

4 D **[1]**

5 D **[1]**

6 D **[1]**

7 C **[1]**

8 D **[1]**

9 D **[1]**

10 C **[1]**

11 B **[1]**

12 B **[1]**

13 A **[1]**

14 D **[1]**

15 C **[1]**

16 A **[1]**

17 A **[1]**

18 C **[1]**

19 A **[1]**

20 C **[1]**

21 C **[1]**

Examiner reports

3 A straightforward calculation of the emf induced in a moving straight conductor (using $\varepsilon = B\, l\, v$) was all that was needed. 68% of the students did this correctly. One in five of them selected distractor B, which could follow from an incorrect formula or substitution ($\varepsilon = B\, v / l$).

4 This question required students to show an understanding of the meaning of the term *electromagnetic induction*. 69% were able to do so. Careful reading of the question was needed again here, because students had to choose an application where electromagnetic induction does not take place. 13% of the students considered that electromagnetic induction does *not* take place in power station generators (distractor A) – probably because they had mis-read the question.

5 This question, which involved the direct application of $\varepsilon = \Delta N\Phi / \Delta t$, probably required less thought before committing a response. The facility of the question was 74%, an improvement of 10% over the last occasion when it appeared in an examination. Thinking that the induced emf is equal to the rate of change of *flux*, instead of *flux linkage*, probably caused 16% of the candidates to select distractor B.

6 The majority of the students knew that a faster moving magnet would induce a greater emf, and would pass through a vertical coil more rapidly, in this question. The facility of this question was 65%. One fifth of the answers selected distractor C, where the emf was greater but the time unchanged.

7 This question tested the candidates' understanding of the peak voltage and frequency terms in the equation $\varepsilon = \varepsilon_0 \sin(2\pi f\, t)$ for a coil rotating at constant speed in a uniform magnetic field. This equation was not understood as well as might have been expected, because the facility was less than 60%. Common misapprehensions seem to have been that ε_0 represents the peak-to-peak voltage (because distractors A and B each attracted more than 10% of the responses) and that $2f$ represents the frequency (because distractor D attracted 17% of responses).

8 This question on the emf generated by a moving magnet and the consequences of Lenz's law, had been used in a previous examination. The facility of 67% this time was slightly better than when it was last used. Curiously, the most common incorrect response was distractor A (chosen by 18%), where the order in which the magnet would emerge is the exact opposite of the correct order.

9 This question was a graphical test of the relationship between an induced emf and the rate of change of magnetic flux causing it. 59% of the students saw that the increasing gradient of the original graph had to imply that the emf would increase, and that therefore only graph D *could* be correct. 24% of the responses were for distractor B, where the emf is shown to decrease at an increasing rate.

10 This question which were each correctly answered by just over three-quarters of the students, respectively tested the rotating coil and energy losses in a transformer.

11 In this question a large proportion of candidates did not realise that the flux linkage increases to a constant value once the magnet is at rest inside the coil, and therefore selected the incorrect distractor A. 43% gave the correct response.

12 Electromagnetic induction continued to cause difficulty in this question, which had a facility of 40%. Candidates should have noticed that, although the speed of rotation of the coil was doubled, the flux density was halved. This has the net effect of leaving the peak emf unchanged whilst the frequency is doubled. 30% of the candidates realised that the frequency would be doubled but thought the peak emf would also double (distractor D).

13 This question had been used in a previous examination. Its facility in 2011 was 82%, an improvement on the previous result of over 10%. Evidently, the candidates this time readily recognised that the falling magnet would lose energy to the conducting ring only when the ring was complete, enabling the emf induced in it to cause a current.

14 This question was easy, with a facility of 73%. It was a direct test of $\varepsilon = N (\Delta\Phi/\Delta t)$ in a graphical context. The most common incorrect answer was distractor A.

15 A coil which was rotating in a magnetic field was the subject being tested in this question. This was successfully answered by 57% of the candidates. Incorrect answers were almost equally divided between distractors A and B, with very few for distractor D.

16 This question moved on to electromagnetic induction and tested $E = N\,\Delta\Phi\,/\Delta t$ for a uniform rate of change of magnetic flux. 72% of the responses were correct. Like questions 22 and 23, this question was a very good discriminator.

17 The uniform rate of change of flux experienced by an aircraft wing in steady horizontal flight, leading to an emf across the wing tips, was considered in this question. This had a facility of 71%. No doubt arithmetical errors were the cause of 13% of the candidates choosing distractor B, and 11% choosing distractor C.

18 This question was answered correctly by 60% of the candidates. Electromagnetic induction involves three-dimensional thinking, and it is likely that the 24% who chose distractor D experienced difficulty in visualising the meaning of the words in the statement for this distractor.