1. It is required to select a random sample of 30 pupils from a school with 853 pupils. A student suggests the following method.
"Give each pupil sequentially a three-digit number from 001 to 853. Use a calculator to generate random three-digit numbers from 0.000 to 0.999 inclusive, multiply the answer by 853, add 1 and round off to the nearest whole number. Select the corresponding pupil, and repeat as necessary."

   i. Determine which pupil would be picked for each of the following calculator outputs:

   $$0.103, \quad 0.104, \quad 0.105, \quad 0.106, \quad 0.107.$$

   [2]

   ii. Use your answers to part (i) to show that this method is biased, and suggest an improvement.

   [2]

2. A club secretary wishes to survey a sample of members of his club. He uses all members present at a
particular meeting as his sample.

   (a) Explain why this sample is likely to be biased. [1]

   Later the secretary decides to choose a random sample of members. The club has 253 members and the secretary numbers the members from 1 to 253. He then generates random 3-digit numbers on his calculator. The first six random numbers generated are 156, 965, 248, 156, 073 and 181. The secretary uses each number, where possible, as the number of a member in the sample.

   (b) Find possible numbers for the first four members in the sample. [2]

3. The governors of a school wish to investigate the opinions of the parents and guardians of the pupils.
The secretary of the governors distributes a questionnaire to all parents and guardians who are present at a particular Parents' Evening.

   (i) Explain why this method of sampling may not give reliable results. [1]

   (ii) Suggest a better method of sampling, using random numbers. [2]

4. Jo is investigating the popularity of a certain band amongst students at her school. She decides to survey a sample of 100 students.

(a) State an advantage of using a stratified sample rather than a simple random sample. [1]

(b) Explain whether it would be reasonable for Jo to use her results to draw conclusions about all students in the UK. [1]

END OF QUESTION paper

Mark scheme

Question			Answer/Indicative content	Marks	Part marks and guidance	
1		i	89, 90, 91, 91, 92	B2	All correct; B2; one error (e.g. all – 1), B1	Allow 088, etc **Examiner's Comments** Most got this right, though some failed to add 1 to the numbers (answering "88, 89, 90, 90, 91") and some rushed to the conclusion that the numbers always went up by 1.
		i				
		ii	Not all equally likely (91 more than 90 etc)	B1	Imply different likelihood / probability	*Not* "same pupil *is* selected twice" **Examiner's Comments** Quite a few candidates showed that they had misunderstood the words "which candidates *would be picked*", by answering that the same pupils *had been picked* twice and that repeats should be ignored. All that was needed was the comment that not all pupils were equally likely to be selected, and that the random numbers should be multiplied by 1000, rejecting numbers greater than 853.
		ii	Multiply by 1000 and ignore if > 853	B1	Or equivalent method. Not "ignore repeats". Ignore extras.	
			Total	**4**		
2		a	E.g. Members who attend may be of a particular type E.g. Absent members cannot be included	**B1 (AO2.5)** **[1]**	Any correct explanation Sample is not random **B0**	
		b	156, 248 73, 181	**B1 (AO1.1)** **B1 (AO1.1)** **[2]**	Allow 073	965 must be discarded In *this* context do not accept a repeat of 156

			Total	3		
3		i	Biased against those not at the parents' evening	B1 1	Reason for being biased or unrepresentative, needs more than "not all will be at the meeting", e.g. "not all will return the questionnaire" or "those at the meeting may have different opinions" "Biased" can be implied by the reason Not *just* "not random" or "not representative", but allow "self-selecting". Ignore irrelevancies (e.g. "small sample", but withhold if definitely wrong comment seen **Examiner's Comments** The question asked for an explanation of why a method was unsuitable. The following common answers are inadequate for the reasons stated: • "The method is not random": some non-random methods (for instance, a systematic sample with non-random choice of the starting point) can be perfectly adequate. • "The sample is not representative": simple random samples selected without bias may not be representative purely by chance. • "Not everyone would be able to reply": *any* sampling method involves not getting replies from all the population. Some sort of reason for bias was required, such as "those attending the meeting may have stronger opinions". In fact the main problem with any method that asks respondents to return a questionnaire is always that of the "self-selecting sample" (those with stronger opinions are more likely to reply), but few candidates focussed on this problem.	
		ii	Obtain list of parents / pupils & number it 1 to *n*	B1 B1 2	Number (a list of) parents (sequentially) (statements in brackets can be implied) SC: Allocate *random* numbers: max B1 unless *sorted*	

			Select using random numbers, ignoring repeats / numbers outside range		Mention use of RNs, as *only* method, *and* either "ignore repeats" or "ignore outside range" (allow "use RNs in range") *Not* "select numbers randomly" *Not* hat / lottery machine [RNs required by question] Allow systematic provided random start **Examiner's Comments** Candidates were required to explain a method involving random numbers, so those who suggested putting names into a hat did not gain full marks. Some candidates said "number the parents randomly", which is not an appropriate method unless they are then *sorted* by those random numbers. Some demonstrated a lack of understanding of random numbers by saying "put the numbers into a random number generator". As in previous years, candidates had to refer to "ignoring repeats" or "ignoring numbers outside the range" in order to score full marks.	
			Total	3		
4		a	**Any mention of diff categories or types, eg** Includes students in all years (or classes) More representative of diff ages Prevents obtaining too many in one year gp	E1 (AO2.4) [1]	**or any mention of proportions, eg** Uses the right proportions of students Ignore all else NOT eg: Wider variety results More representative of pop **Examiner's Comments** Many incorrect answers were seen, such as "It is more accurate" or "Not biased" or "It's easier" or "With stratified, she could ask people who were interested". Many inadequate answers were also seen, such as "It is more representative" or "More reliable". It is important to refer to the context and not simply provide a generic statement.	
		b	**Must include reason why not rep've, eg**		except allow Small sample or	

			Her school may be biased Students' friends may be in local band Opinions at one school not indep of one another Ignore all else	E1 (AO2.3) [1]	Only 100 students in sample Student opinion elsewhere may differ Diff conditions, or diff types of school, in diff areas, Diff bands liked in diff areas NOT: Not representative of UK "No" may be implied Examiner's Comments Here many inadequate answers were seen, such as "Her school might not be representative of schools in the UK". Some hint of a reason why the school might not be representative was required for the mark.	
			Total	2		