MODULE C DATA REPRESENTATION · C5

Binary addition and overflow: mark scheme

20 marks · OCR J277 spec 1.2.4

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words; **//** separates alternative answers. Words in (brackets) are not needed for the mark. In the grids, the carry row shows each carry under the column it is carried **into** (the dashed column is the overflow bit); carries written above the numbers are equally fine. Working marks are only for binary carries: converting to denary and back earns no working mark. These questions say "Show your working", so a correct answer with no carries earns the answer mark only (as in J277 mark schemes).

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.2.4	10	**1**	Accept 0 carry 1. Do not accept 2 (not binary).
1(b) J277 1.2.4	255	**1**	Correct answer only. Do not accept 256.
2(a) J277 1.2.4	1 mark per bullet: Working: carries shown correctly (into the 8, 16, 32, 64 and 128 columns) 10000011	**2**	Correct answer with no carries: 1 mark. Check: 53 + 78 = 131.
3(a) J277 1.2.4	1 mark per bullet: Working: carries shown correctly (into the 4, 8, 16, 32 and 64 columns) 11010001	**2**	As 2(a). Check: 150 + 59 = 209.

	128	64	32	16	8	4	2	1	
	0	0	1	1	0	1	0	1	
	0	1	0	0	1	1	1	0	+
	1	0	0	0	0	0	1	1	Answer
	1	1	1	1	1				Carries

	128	64	32	16	8	4	2	1	
	1	0	0	1	0	1	1	0	
	0	0	1	1	1	0	1	1	+
	1	1	0	1	0	0	0	1	Answer
		1	1	1	1	1			Carries

QUESTION	ANSWER	MARKS	GUIDANCE
3(b) J277 1.2.4	1 mark per bullet: Working: carries shown correctly, including the final carry out of the 128 column (1) 00100001	**2**	Accept 100100001 (9 bits) or 00100001 for the answer mark. The working mark needs the final carry out of the 128 column. Check: 204 + 85 = 289; 289 − 256 = 33 = 00100001.

	128	64	32	16	8	4	2	1	
	1	1	0	0	1	1	0	0	
	0	1	0	1	0	1	0	1	+
1	0	0	1	0	0	0	0	1	Answer
1	1		1	1	1				Carries

3(c) J277 1.2.4	Overflow (error)	**1**	Do not accept "carry" alone.
3(d) J277 1.2.4	1 mark per bullet to max 2: The result / 289 is larger than 255 // larger than the maximum 8 bits can hold The 128 column produces a carry // the answer needs a 9th bit The register only has 8 bits // there is no space to store the extra bit (So) the extra bit is not stored // the total stored is wrong (33)	**2**	Max 2. "The number is too big" alone is NE: it must be too big for 8 bits / 255.
4(a) J277 1.2.4	01111111 + 00000001: No overflow error 10000000 + 10000000: Overflow error 01010101 + 00101010: No overflow error 11110000 + 00010001: Overflow error	**4**	1 mark per row. 2 ticks in a row = 0 for that row. Checks: 127 + 1 = 128; 128 + 128 = 256; 85 + 42 = 127; 240 + 17 = 257.
5(a) J277 1.2.4	First number: 1 (giving 01011010) Second number: 0 (giving 10010110)	**2**	1 mark per correct bit, in the correct number. Check: 90 + 150 = 240 = 11110000; the other three choices give 232, 296 and 304, so the answer is unique.
6(a) J277 1.2.4	1 mark per bullet to max 3: 140 + 120 = 260, which is more than 255 // too large for 8 bits An overflow error occurs // the extra / 9th bit cannot be stored The stored total is wrong // it shows 4 (floors) // much less than was climbed The user sees an incorrect / misleading count // a daily goal is not recorded The program may crash / behave unexpectedly	**3**	Max 3. For 3 marks at least one point must be about the floors / the user. Check: 260 − 256 = 4.

Total: 20 marks