

NMR

Mark Scheme

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Magnetic Fields
Sub Topic	NMR
Paper Type	Theory
Booklet	Mark Scheme

Time Allowed: 51 minutes

Score: /42

Percentage: /100

CHEMISTRY ONLINE

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a) (i) to align nuclei/protons
to cause Larmor/precessional frequency to be in r.f. region B1
B1 [2]
- (ii) Larmor/precessional frequency depends on (applied magnetic) field strength B1
knowing field strength enables (region of precessing) nuclei to be located M1
by knowing the frequency A1 [3]
- (b) $E = 2.82 \times 10^{-26} \times B$
 $6.63 \times 10^{-34} \times 42 \times 10^6 = 2.82 \times 10^{-26} \times B$ C1
 $B = 0.99 \text{ T}$ A1 [2]
- 2 (a) nuclei spin/precess B1
spin/precess about direction of magnetic field B1
either frequency of precession depends on magnetic field strength
or large field means frequency in radio frequency range B1 [3]
- (b) non-uniform field means frequency of precession different in different regions of subject B1
enables location of precessing nuclei to be determined B1
enables thickness of slice to be varied / location of slice to be changed B1 [3]
- 3 (a) strong uniform (magnetic) field M1
either aligns nuclei
or gives rise to Larmor/resonant frequency in r.f. region A1
non-uniform (magnetic) field M1
either enables nuclei to be located
or changes the Larmor/resonant frequency A1 [4]
- (b) (i) difference in flux density = $2.0 \times 10^{-2} \times 3.0 \times 10^{-3} = 6.0 \times 10^{-5} \text{ T}$ A1 [1]
- (ii) $\Delta f = 2 \times c \times \Delta B$ C1
 $= 2 \times 1.34 \times 10^8 \times 6.0 \times 10^{-5}$
 $= 1.6 \times 10^4 \text{ Hz}$ A1 [2]

- 4 strong / large (uniform) magnetic field B1
 nuclei precess / rotate about field direction (1)
 radio frequency pulse B1
 at Larmor frequency (1)
 causes resonance / nuclei absorb energy B1
 on relaxation / de-excitation, nuclei emit r.f. pulse B1
 pulse detected and processed (1)
 non-uniform field superposed on uniform field B1
 allows position of resonating nuclei to be determined B1
 allows for location of detection to be changed (1)
(six points, 1 each plus any two extra – max 8) [8]

- 5 large / 1 T magnetic field applied along body (*allow 'across'*) (1)
r.f. pulse applied (1)
 causes hydrogen nuclei / protons (1)
 to resonate (1)
 (nuclei) return to equilibrium state / after relaxation time (1)
 r.f. (pulse) emitted (1)
 pulses detected, processed and displayed (1)
 resonant frequency depends on magnetic field strength (1)
 calibrated non-uniform field enables nuclei to be located (1)
 any six points, one mark each B6 [6]

[Total: 6]

- 6 large / strong (constant) magnetic field B1
 nuclei rotate about direction of field / precess (1)
 radio frequency / r.f. pulse B1
 causes resonance in nuclei , nuclei absorb energy (1)
 (pulse) is at the Larmor frequency (1)
 on relaxation / nuclei de-excite emit (pulse of) r.f. B1
 detected and processed B1
 non-uniform field (superimposed) B1
 allows for position of nuclei to be determined B1
 and for location of detection to be changed (1)
(B6 plus any two extra details, 1 each, max 2) B2 [8]