NMR

Question paper

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

Time Allowed: **51 minutes**

Score: **/42**

Percentage: **/100**

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

1 During magnetic resonance imaging to obtain information about internal body structures, a large constant magnetic field is used with a calibrated non-uniform magnetic field superimposed on it.

(a) State and explain the purpose of

(i) the large constant magnetic field,

.....

.....

..... [2]

(ii) the non-uniform magnetic field.

.....

.....

.....

..... [3]

(b) The de-excitation energy E (measured in joule) of a proton in magnetic resonance imaging is given by the expression

$$E = 2.82 \times 10^{-26} B$$

where B is the magnetic flux density measured in tesla.
The energy E is emitted as a photon of electromagnetic radiation in the radio-frequency range.

Calculate the magnetic flux density required for the radio frequency to be 42 MHz.

magnetic flux density = ... T [2]

2 Magnetic resonance imaging (MRI) requires the use of a non-uniform magnetic field superimposed on a large uniform magnetic field.

State and explain the purpose of

(a) the large uniform magnetic field,

.....

.....

.....

.....

.....[3]

(b) the non-uniform magnetic field.

.....

.....

.....

.....

.....[3]

3 A person is to be investigated using a magnetic resonance (MR) scanner.

(a) This technique involves the use of two superimposed magnetic fields.
Describe the functions of these two magnetic fields.

.....

.....

.....

.....

.....

..... [4]

(b) The frequency f of the electromagnetic waves emitted by protons on relaxation in an MR scanner is given by the equation

$$f = 2cB$$

where B is the total magnetic flux density and c is a constant equal to $1.34 \times 10^{8}\,s^{-1}T^{-1}$.
The magnetic flux density changes by 2.0×10^{-4} T for each 1.0 cm thickness of tissue in a section.
The scanner is adjusted so that the thickness of each section is 3.0 mm.

Calculate, for corresponding points in neighbouring sections,

(i) the difference in magnetic flux density,

difference in flux density = ... T [1]

(ii) the change in emitted frequency.

frequency change = ... Hz [2]

4 Explain briefly the main principles of the use of magnetic resonance to obtain diagnostic information about internal body structures.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [8]

5 Outline briefly the main principles of the use of magnetic resonance to obtain diagnostic information about internal body structures.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

6 Outline briefly the main principles of the use of magnetic resonance to obtain information about internal body structures.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[8]