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- (a) rotation (or wobble) of the axis of spin (1)
about the direction of the external magnetic field (1)
 - (b) hydrogen (1)
any two from:
abundant in the body (1)
odd number of protons (allow odd number of nucleons) (1)
possess the property of spin (1)
possess magnetic moment (act like tiny magnets) (1)
 - (c) the frequency of precession (of the targeted nuclei) (1)
found in the radio frequency part of the e/m spectrum (1)
 - (d) different types of tissue have different relaxation times (1)

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- Any 7 e.g.**
- nuclei / atoms, (with unequal nos. of neutrons and protons) spin (B1)
 - act like tiny magnets (B1)
 - align in an external magnetic field (B1)
 - they precess / wobble (B1)
 - RF radiation pulse is applied (B1)
 - resonance occurs / nuclei flip (B1)
 - RF emitted by nuclei and detected (B1)
 - the time taken for the nuclei to return to their equilibrium state (is measured) / time taken to return to equilibrium state is called the relaxation time (B1)
 - hydrogen atom is (most commonly) used (B1)
 - different tissues have different hydrogen content and so can be differentiated (B1)
- any 2 e.g.**
- it is non-ionising (B1)
 - differentiates well between tissues (of similar density) (B1)
 - higher resolution (B1)
 - allow response if corresponding disadvantages given

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- any relevant response to a maximum of 8 e.g.
- atoms with unequal numbers of protons and neutrons spin (1)
 - act as tiny magnets (1)
 - align in external magnetic field (1)
 - and precess / wobble (1)
 - rf radiation is sent in (1)
 - at resonant frequency of precession / at Larmor frequency (1)
 - r.f. radiation is emitted (1)
 - (as atoms return to the unexcited state) (1)
 - relaxation times are measured / relaxation times identify different atoms (1)
 - One detail mark for eg**
 - hydrogen is most commonly used / different relaxation times in fat and water / value for size of magnetic field > 1 T
 - / gradient in magnetic field needed (1)
 - Agreement with student's comment**
 - (no because) radio frequency radiation is sent into the patient (1)
 - (but yes because the radiation sent in is) not ionising, so is safer (1)
 - (no because) less safe if you have metal implants / pacemaker due to strong magnetic field (1)

Question	Expected Answers	Marks
5	<p>any 7 e.g. atoms with unequal nos. of neutrons and protons, spin act like tiny magnets <u>strong</u> external magnetic field applied atoms align in this magnetic field they precess / wobble when a RF radiation (pulse) is applied resonance occurs / atoms flip RF is emitted as atoms return to their equilibrium state the time taken for the atoms to return to their equilibrium state is measured</p> <p>allow one detail mark from the following (up to max 7): two relaxation times hydrogen atoms usually used magnetic field gradient across the length and width of the body</p> <p>any 2 e.g. it is non-ionising differentiates well between tissues of similar density MRI not affected by the bone of the skull allow response if corresponding disadvantages given</p>	<p>1 1 1 1 1 1 1 1</p> <p>1 1 1</p> <p>1 1 1</p> <p>Total: 9</p>