GCSE

3445U20-1A

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APPLIED SCIENCE (Double Award)

UNIT 2: Space, Health and Life

Pre-Release Article for use in the following examinations on TUESDAY 13 JUNE 2023 – MORNING:

GCSE Applied Science (D/A) Unit 2 Foundation Tier (3445U20-1)

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To be opened on 9 MAY 2023.

A new copy of this Article will be given out in the examination.

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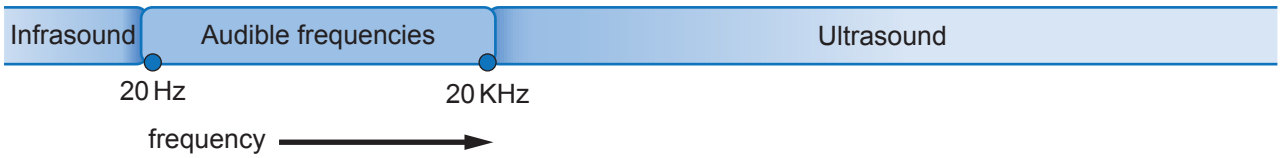
Diagnosis and treatment.

Different types of waves are used in the diagnosis and treatment of illness. One of these types is ultrasound. The position of ultrasound on the sound spectrum is shown in **Figure 1**.

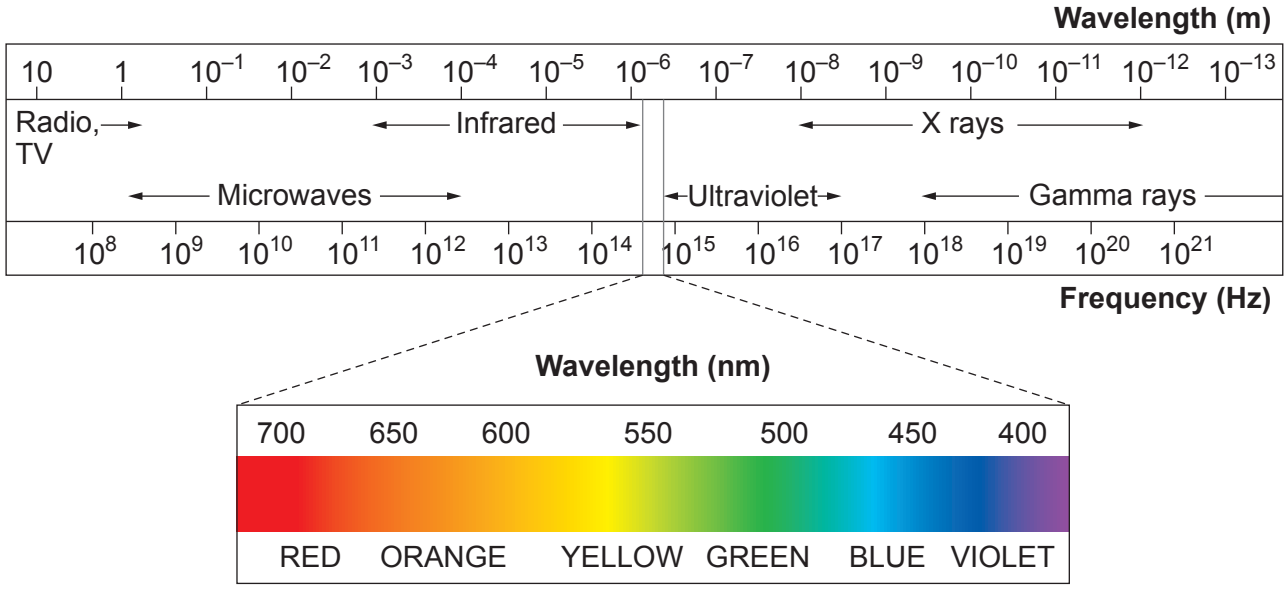
Figure 1



Medical ultrasound scans use frequencies in the range 2 MHz to 20 MHz.
(1 MHz = 1 000 000 Hz)

The electromagnetic (em) spectrum is a family of waves shown in **Figure 2**. Some em waves have medical uses.

Figure 2



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A hospital radiology department displays information about the dose a patient receives from different types of X-rays. This is shown in **Figure 3**.

Figure 3

Type of X-Ray	Received dose in units	Equivalent days of background radiation
knee	1	1.5
chest	2	3
skull	10	15
spine	100	150
hip	30	45
pelvis	100	150
abdomen	150	225

Radioisotopes

Radioisotopes are used in many medical applications, including diagnosis and therapy.

Radioactive tracer – a radioisotope inserted into the body and used to track a substance by monitoring its radioactive emissions.

Radiation therapy – use of radiation to damage the DNA of cancer cells, which kills them or keeps them from dividing. There are two types.

- **External beam radiation therapy –** radiation delivered by a machine outside the body to kill cancer cells.
- **Internal radiation therapy (brachytherapy) –** radiation from a radioactive substance introduced into the body to kill cancer cells.

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The table in **Figure 4** gives information about some radioisotopes.

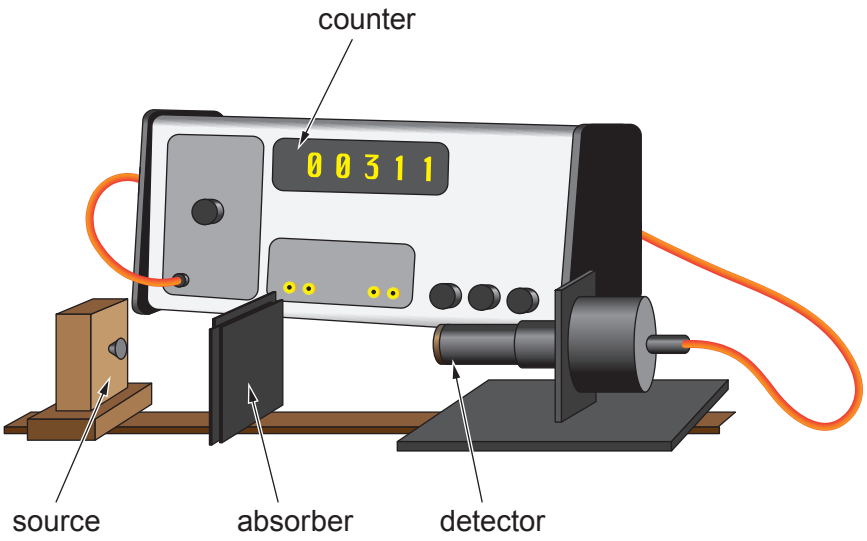
Figure 4

Radioisotope	Half-life	Decay mode
cobalt-55	17.3 hours	beta
cobalt-58	70 days	beta
cobalt-60	5.3 years	beta and gamma
francium-220	27.4 seconds	alpha
gold-198	2.7 days	beta
iodine-123	13 hours	gamma
iodine-125	59.4 days	gamma
iodine-128	25 minutes	beta
iodine-131	8.4 days	beta and gamma
lutetium-177	6.7 days	beta and gamma
radium-226	1 600 years	alpha
radon-222	3.8 days	alpha
scandium-47	3.3 days	beta
technetium-99m	6 hours	gamma
thallium-201	73 hours	gamma
yttrium-86	14.7 hours	beta
yttrium-88	107 days	beta

Identifying radioisotopes

The apparatus in **Figure 5** is used to identify the type(s) of radiation emitted by a radioisotope.

Figure 5



This apparatus was used to analyse a number of different radioisotopes, **R1** – **R6**. The results obtained from different radioisotopes are shown in the table in **Figure 6**. The data has been corrected for background.

Figure 6

Radioisotope	Corrected count rate (units)			
	no absorber	paper	aluminium	lead
R1	250	250	250	55
R2	200	120	120	40
R3	125	0	0	0
R4	175	175	80	20
R5	75	75	0	0
R6	100	75	0	0

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Modelling half-life

Students model the random nature of radioactive decay using 6-sided dice.
Each group of students is given 50 dice.
There are 12 groups in total.

Model 1
1. They throw the dice and remove any that land with the number 6 facing upwards.
2. They throw the remaining dice again.

Figure 7 shows the results for Group A and the whole class.

Figure 7

Throw	Number of dice remaining with Model 1	
	For Group A	For the class
0	50	600
1	41	505
2	34	420
3	27	350
4	23	290
5	19	240
6	17	200
7	13	170
8	9	140

Model 2
1. They throw the dice and remove any that land with the numbers 5 and 6 facing upwards.
2. They throw the remaining dice again.

Model 3
1. They throw the dice and remove any that land with the numbers 4, 5 and 6 facing upwards.
2. They throw the remaining dice again.

Figure 8 shows the results for the whole class for **Models 2** and **3**.

Figure 8

Throw	Number of dice remaining in the class	
	Model 2	Model 3
0	600	600
1	400	310
2	265	145
3	175	80
4	115	40
5	75	15
6	45	10
7	25	5
8	20	3

Each model represents a different radioisotope with a different half-life which can be calculated from the data.