Lesson9: P4.9 – Using nuclear radiation (Triple)

Connection

1. 3 key features of radioisotopes used in medicine are?
2. Why might x rays be preferred over gamma rays?
3. How is Brachytherapy used to treat cancer?

Activation

LI: Explain the risks and benefits of using nuclear radiation

https://www.youtube.com/watch?v=YejvYYRjSUk

Make a note of the title and the LI

1. Read pages 126-127
2. Make a list of the key words and define those you don't know
3. Copy bullet points page 126 (side effects of radiotherapy)

Demonstration

Attempt questions 1-7
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P4 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers Lesson 9: P4.9 – Using nuclear radiation (Triple)

Connection

1. Mainly be gamma emitters with a short half life and be non-toxic

2. X rays produced only when needed, can be controlled and can have their energy levels changed

3. A radioactive source is placed within the tumour for prostate cervical and uterine cancer.

Activation

1 The patients have cancer and are therefore likely to suffer much more if they are left untreated. The benefits of the cancer treatment outweigh the risks of side effects from the treatment.

2 Compare the amount of radiation produced from the radioactive iodine with an image produced by a normal thyroid gland. If the patient is suffering from hypothyroidism then the image will show less radiation since the gland would not have as absorbed as much iodine.

3 Radiotherapy has a risk of harm to the patient. Although surgery is also dangerous, it is the safer option once the tumour has been reduced in size.

4 Not all of the cancer cells would have been removed from the tumour and these could go on to cause further cancer. The radiotherapy is used to kill all of the remaining cancer cells.

5a Activity is the number of decays per second.
5b Dose is a measure of harm that a particular procedure does to the patient.

6 It is more important to consider the dose as this is a measure of the direct harmful effect that the procedure has on the patient. A high activity of one source might actually be less harmful than a low activity of another source.

7a The heart scan.
7b Over this time interval you would receive the same amount of radiation from background radiation as you would from the scan.
7c The patient might have had a radiation dose previously and this scan might make them

Lesson 10: P4.10 – Nuclear Fission (Triple)

Connection

1. Why is radiation used as a treatment for cancer when radiation can cause cancer?
2. How is radioactive iodine used to investigate the thyroid?
3. Why is it better to remove a tumour using surgery prior to treating the area with radiation?

Activation

LI: Describe nuclear fission and how it is used

https://www.youtube.com/watch?v=onkW8BF5I3Q

Make a note of the title and the LI

1. Read pages 128-127
2. Make a list of the key words and define those you don't know
3. Copy figure 4.24
4. Copy figure 4.25

Demonstration

Attempt questions 1-7
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P4 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers Lesson 10: P4.10 – Nuclear Fission (Triple)

Connection

1. Need to assess the risk. The likelihood of getting new tumours is less than the certainty of dying from the tumour you have.

2. Take a tablet of radioactive iodine, this is absorbed by the tyroid and the gamma reays emitted are detected using a gamma camera and over activity is detected by bright spots and underactive less bright compared to normal.

3. Removing the bulk of the tumour by surgery means that a shorted dose of radiotherapy is needed = less risk

Demonstration

1 Nuclear fission is the splitting up of a large nucleus into two smaller daughter nuclei and a few neutrons.

2 Fission is made to happen when a neutron is absorbed whereas radioactive decay happens spontaneously. The nucleus splits into two approximately equally sized parts in fission whereas only a small part of the nucleus is ejected (if any) in radioactive decay.

3 Fission can be induced by absorbing a neutron. Fission also releases a few neutrons which can then go on to cause further nuclei to fission. Thus a chain reaction can build up.

4 The similarities are that they both heat up water to produce steam, which turns a turbine and a generator. The steam turns back into water using cooling towers. A nuclear power station differs from a coal-fired one in that it uses uranium as a fuel rather than coal. Also you only have to replace the uranium every few years whereas you have to continually feed a coal fired power station with coal. The amount of fuel you need in a coal fired power station is much more than you need in a nuclear power station.

5 A coolant (e.g. a gas) is made to flow through the nuclear reactor. This heats up the gas. The hot gas then passes by some cold water and energy is transferred to the water by conduction. This turns the water into steam.

6 The moderator slows down the neutrons. Slower moving neutrons are more likely to cause fission.

7 Raising the control rods increases the temperature and lowering them decreases the temperature. When the rods are raised, more neutrons per fission go on to cause further fissions so the number of fissions happening at a particular time increases and energy is released more quickly. When the control rods are lowered then fewer neutrons go on to cause further fission so the number of fission reactions at any given time decreases. When, on average, one neutron in a fission reaction goes on to cause a further fission then the temperature remains constant.

Lesson 11: P4.11 – Nuclear Fusion (Triple)

Connection

1. What is nuclear fission?
2. What is a chain reaction?
3. How are a coal powered and a nuclear powered power station similar?

Activation

LI: Describe nuclear fusion

https://www.youtube.com/watch?v=xrk7Mt2fx6Y

Make a note of the title and the LI

1. Read pages 130-131
2. Make a list of the key words and define those you don't know
3. Copy figure 4.27
4. Copy figure 4.28
5. Add examples of nuclear equations (blue section)

Demonstration

Attempt questions 1-6
In 10 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P4 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers Lesson 11: P4.11 – Nuclear Fusion (Triple)

Connection

1. When a large unstable atom splits to release energy. Usually initiated by a stray neutron.

2. Each time fission occurs 3 neutrons are released which means that more nuclei are triggered to spilt. This is uncontrollable unless the extra neutrons can be absorbed.

3. The energy produced from both a nuclear and a coal powered power station is used to heat water which produces steam that turns a turbine that turns a generator to produce electricity.

Demonstration

1 They both release energy from changes in the structure of a nucleus. However, fission involves a large nucleus splitting into smaller ones whereas fusion is the joining of two small nuclei to form a larger one.

2 High temperatures and high pressures. The nuclei need to get very close together before fusion can take place. A large force is needed to do this because the nuclei repel each other (since they are both positively charged). Both high pressure and high temperature provide the conditions for the nuclei to get close enough to fuse.

3 There is plenty of available fuel and the waste products do not harm the environment.

4 The work is shared so that the work can be checked to see if everyone agrees with the results. Also other people can continue the work and use it in further developments in science.

5 You don't need to generate electricity from a hydrogen bomb. Therefore, you don't need to control the rate that energy is released from a hydrogen bomb. You can create the conditions needed for nuclear fusion using a fission bomb within a hydrogen bomb – it would not be possible to do this safely in a domestic fusion reactor.

6 There is plenty of fuel for fusion and the waste products are clean so this would solve many of the future problems that we are currently facing in energy production. Also the fuel is available everywhere so this limits potential for wars over gaining resources in the future. However, fusion is very difficult to achieve and we might spend lots of money trying to develop fusion power with no success. This money could be spent on developing energy resources that we know will work. Also fusion power will turn buildings radioactive so there will be hazards associated with fusion power.

Lesson 12: P4.12 – Key concept – Developing ideas for the structure of the atom

Triple Connection

1. What is nuclear fusion?

2. 2 conditions needed for fission?

3. If fusion were possible why would it be better than fission?

Answers Lesson 12: P4.12 – Key concept – Developing ideas for the structure of the atom

Triple

Connection

1. When small nuclei are joined together to create larger ones – source of energy for stars

2. High pressure and large amounts of thermal energy

3. Useful as there is a lot of hydrogen around in water to be used as a reactant in fusion and the product helium is not radioactive.

Lesson 12: P4.12 – Key concept – Developing ideas for the structure of the atom

Connection

1. Define irradiation
2. Why is radiation dangerous to cells?
3. What are the 3 possible effects on a cell as a result of irradiation?

Activation

LI: Describe nuclear fusion

https://www.youtube.com/watch?v=sNQsdrqsD_s

Make a note of the title and the LI

1. Read pages 132-133
2. Make a list of the key words and define those you don't know
3. Copy figure 4.31
4. Copy figure 4.32
5. Copy 4.33 and 4.34

Demonstration

Attempt questions 1-6
In 10 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P4 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers Lesson 12: P4.12 – Key concept – Developing ideas for the structure of the atom

Connection

1. An object is exposed to nuclear radiation

2. DNA is damaged

3. i. Cell death
   ii. Cell DNA is repaired
   iii. An unrepaired cell develops into a cancer

Demonstration

1 No it only includes the electrons. The rest of the atom was a positively charged sphere.

2 Yes – although it is unclear how they are balanced.

3 The results were very surprising and other scientists needed to peer review the work to check that they had not made any mistakes. The work is useful for other scientists to develop in order to produce further scientific theories.

4 The experimental results could not be explained by the current model of the atom.

5 Rutherford's model explained why most of the alpha particles went through the gold foil and only a few bounced back. It also went on to explain what was happening in radioactive decay.

6 More people do experiments to test whether the results agree with the predictions of the scientific theory. If the theory correctly predicts the results of many experiments over a long period of time it becomes gradually accepted. However just one experiment's results can force a theory to be changed as shown by Geiger and Marsden's experiment.

P4 - Revision

Connection

Q1. Describe Thompsons plum pudding model

Q2. What did Geiger & Marsden's gold foil experiment show?

Q3. how was Rutherford's model refined by Bohr?

Activation

LI: Create a topic summary sheet

1. Fold an A3 sheet so it is divided into 8 sections
2. Look back over you lesson and group them into 8 main headings
3. Summarise the key points into each section, use keywords and diagrams and symbols rather than sentences

Demonstration

Test yourself by working with the person sitting next to you by talking though each box on your summary sheet and seeing how many key facts you can remember

Consolidation

Look though the relevant past paper questions for this topic - From the B1 DIP file – see if you can complete any additional questions

Extension

Make a list of anything that you would like to ask your teacher to go over again

Answers Lesson – P4 revision

Connection

1. A positive sphere with negative electrons scattered throughout

2. Atoms are mainly empty space (alpha particles pass straight through) Atoms have a centre of positive charge/nucleus (positive alpha particles reflected or deflected)

3. Rutherford had electrons orbiting the nucleus of the atom in individual orbits which would not have been stable. Bohr proposed that electrons could only exist in certain orbits.

P4: Radiotherapy DART activity

Tumours in the brain and skull are the ninth most common type of cancer. The chances of two people who live within minutes of each other being diagnosed with the disease are slim - even more unlikely is that their small town would raise money for both to pay for life-saving treatment.

Christel Callow had been having headaches for some time when she booked what she assumed would be a routine eye test in July. Within days, she had surgery to remove a brain tumour the size of a tennis ball called an anaplastic astrocytoma.

"It was a shock, when you realise it is cancer, you obviously think the worst," said the 26-year-old, who lives in Shifnal in Shropshire.

Although she had the majority of the mass removed, she was told she would need radiotherapy to treat what remained - a procedure that risked damaging parts of her brain affecting speech and movement.

Her family began to research alternatives and discovered proton beam therapy, which could target the cancer with less impact on the surrounding parts of her brain. But they were told it was not be available to Christel on the NHS because she was over the age of 24.

Instead, they were left looking at a £60,000 bill to have the treatment done privately.

Meanwhile, Nick Haves was looking at the same price tag. The 46-year-old had been diagnosed with a meningioma and had been told he also he did not qualify for proton beam treatment on the NHS.

Nick, who lives in the village of Sherrifhales - three miles outside Shifnal - appealed against the decision but said he was also told "point blank" it was not available to him because of his age. His only option was to start fundraising, which he was "adamant" he didn't want.

"I had said I'll just take the conventional therapy," said the father-of-two, who had radiotherapy for acute lymphoblastic leukaemia 23 years ago.

"Just because of that feeling of going cap in hand to people and because I am quite a private person."

For Christel, fundraising was her only hope and they needed to raise the cash within a month.

"My dad said 'don't get your hopes up' because it was a lot of money to find," she said.

What is proton beam therapy?

Proton beam therapy is a specialist form of radiotherapy which uses a high energy beam of protons rather than high-energy X-rays. It was first used in 1990

It targets certain cancers very precisely, increasing success rates and reducing side-effects and does less damage to surrounding healthy tissue

It is particularly appropriate for highly complex brain, head and neck cancers and sarcomas, and for certain cancers in children who are at risk of lasting damage to organs that are still growing

Cancer Research UK estimates only 1% of people with cancer are suitable for proton beam therapy. The Brains Trust says there isn't enough evidence to say it is more effective than conventional radiotherapy

Patients can get proton beam therapy on the NHS at The Christie in Manchester and for eye tumours at the Clatterbridge Cancer Centre in Merseyside. A second NHS centre is being built at University College London Hospitals

The NHS funds treatment in the USA and Germany for patients who qualify in line with strict criteria. It said the eligibility and suitability of patients is determined by a national panel of specialist doctors on a case-by-case basis but said it might not be the best treatment option for some patients

It added: "There is no age limit for proton beam therapy - eligibility is determined on a clinical basis and the type of rare tumours that patients have."

Both Christel and Nick had treatment at the Rutherford Cancer Centre in South Wales, a private facility which sees patients with a range of cancers beyond those funded by the NHS if they are privately insured or self-funded.

Since its launch in Spring 2018, its three sites have treated 63 patients with proton beam therapy.
Christel started her six-week treatment at the end of September, returning home in early November. She has now started 12 months of chemotherapy, with an MRI scan scheduled for February to give an indication of how it has worked so far.
"Shifnal is a small place and it is just dead lovely to know everybody is genuine and kind," she said.
"I do think, if I didn't live here, what could have happened, what would have happened? I am lucky with where I live."

Nick finished his treatment on 11 December. He also expects to have an MRI scan around February to assess how the therapy has affected his tumour. He said it won't be a cure, as it is inoperable, but will hopefully stop it from growing and causing further damage.
"I'm doing really well. It is nice [to be] coming home when I can have some quality time with the kids. [The help] has been absolutely amazing - as I said, it restores your faith in humanity, all you hear is bad news, everything is bad.

"It shows how amazing this place is, but I have always known that, being Shifnal born and bred."

Article from BBC News, 29/12/19

DART P4 – Radiotherapy

1.
a. What is proton beam therapy a form of?
b. What conditions is proton beam therapy particularly appropriate for treating?
c. When was proton beam therapy first used?

2.
a. Explain how proton beam therapy works.
b. What are some of the advantages of proton beam therapy over other versions of radiotherapy?
c. Describe the process and criteria by which a patient is selected for proton beam therapy under the NHS.

3.
a. Do you think a person's age should impact their eligibility for proton beam therapy?
b. Based on the information above, do you think it was fair the patients in the story had to raise the funds for their treatment themselves?
c. Why might someone who is ineligible for proton beam therapy on the NHS choose to opt for an alternative therapy, rather than turn to private healthcare?

P4 DART Radiotherapy - Answers

1.

a. Radiotherapy.
b. Highly complex brain, head and neck cancers and sarcomas, and for certain cancers in children who are at risk of lasting damage to organs that are still growing.
c. 1990

1.

a. It uses a high energy beam of protons to target certain cancers very precisely, increasing success rates and reducing side-effects.
b. The increased level of precision means increased success rates, reduced side-effects and less damage to surrounding healthy tissue.
c. Eligibility of patients is determined by a national panel of specialist doctors on a case-by-case basis. There is no age limit for proton beam therapy - eligibility is determined on a clinical basis and the type of rare tumours that patients have.

1.

a. Subjective question. May say yes, as everyone deserves a chance at treatment for their illness and NHS state there is no age limit for the therapy. May say no, as places are limited. Younger people may have better chance of success and more of their life ahead of them.
b. Subjective question. May say no, as everyone deserves treatment and the NHS is a national service. May say yes, as the therapy is expensive, and places are limited. The NHS has a panel of specialists who decided who is most suitable to receive this therapy and decided not to offer it to the individuals in the article. Alternative therapies are also available.
c. They might not have the finances available for private healthcare. They may be proud/private and not want to ask for donations. They may decide alternative therapies are a better option.

Attainment Band :	P4 Atomic structure(AQA) Knowledge and Understanding
Yellow Plus/ Yellow	Use nuclear notation to show subatomic particles in an isotope. Calculate the half-life of a radioisotope. Explain the properties of each type of radiation. Write balanced nuclear equations for different types of nuclear reaction. Compare and contrast irradiation and contamination.
Blue	Understand that atoms of an element all have the same number of protons but can have different numbers of neutrons, giving different isotopes. Explain how the radioactive decay of a radioisotope can be described using a quantity called the half-life. Describe the structure of each type of ionising radiation. Write nuclear equations involving alpha and beta decay. List the hazards of radioactive contamination.
Green	State that the number of protons in an element is the atomic number and the total number of protons and neutrons is the mass number. Recognise that some isotopes called radioisotopes are unstable and decay in a random way. List the three types of ionising radiation resulting from nuclear activity. Recognise the symbols used in a nuclear equation. Define radioactive contamination and irradiation.
White	Some elements of the above have been achieved