Science KS4: Blended Learning Booklet

Stewards Academy

P4 Atomic structure

Name:

Form:

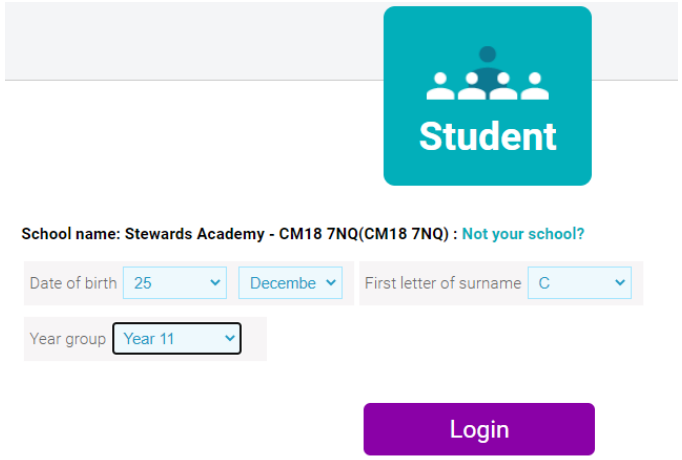
Aim to complete four lessons each week. Watch the videos and follow the four part lesson plan

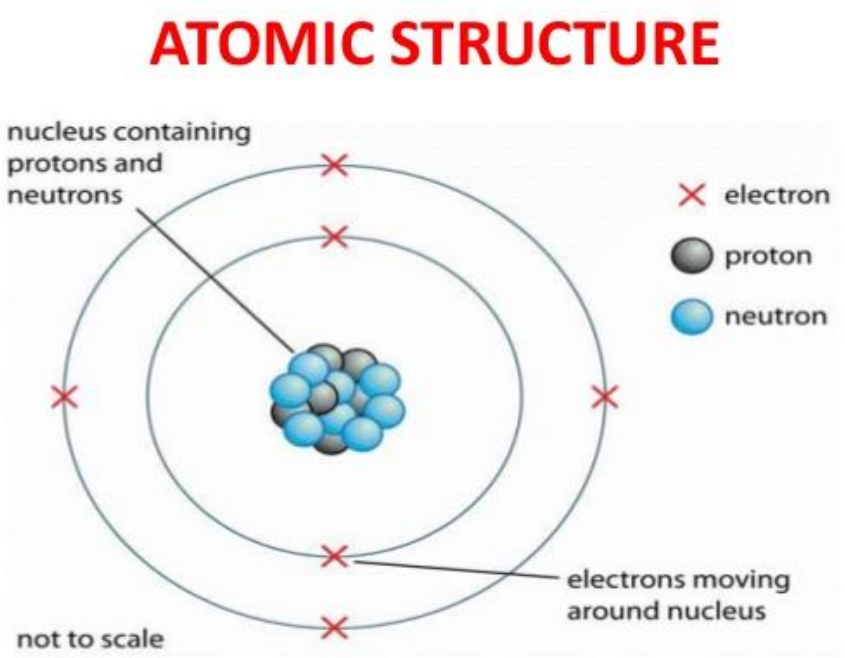
All video clips are online using the ClassCharts link. Upload all work onto ClassCharts for feedback.

The online textbook has all the key information and vocabulary to help you with this unit

To log on to the online textbook:

- https://connect.collins.co.uk/school/portal.aspx
- Type in “stewards” and select Stewards Academy
- Login using your date of birth, initial of your surname and your academic year





Contents

Contents

(T) = Triple scientists only

Big Picture – Year 10 Overview
Science

Unit Test
End of Year Exams
Nest Year

IR emission and absorption (T)
Colour, lenses, images and magnification (T)
The electro-magnetic spectrum
Sound waves and seismic waves (T)
Properties of waves
UNIT P6
Unit Test
Spectroscopy and other instrumental methods (T)
Tests for gases, *metals, hydroxides and anions (T)*
Pure substances and chroma-tography
Polymers and poly-merisation (T)

Waves

I will be able to describe characteristics of waves that can be measured. **I will** be able to measure reflection and refraction of waves and explain why they occur. **I will** be able to place visible light withing the electromagnetic spectrum. ***I will** be able to sound waves can reveal structures (T). **I will** be able to explain how lenses work (T)*

Hydrocarbons & Chemical analysis

I will be able to describe the properties of hydrocarbons. ***I will** be able to describe the properties of alkenes, alcohols, carboxylic acids and polymers (T).* **I will** be able to use techniques to produce and identify a pure substance. ***I will** be able to identify positive and negative ions and evaluate different analysis techniques (T).*

Meiosis and reproduction
Genetics and gene disorders
The work of Gregor Mendel (T)
Unit Test
UNIT C7 & C8
Crude oil, hydrocarbons and fractional distillation
Combustion and cracking of alkanes
Alkenes, alcohols and carboxylic acids (T)
DNA structure and protein production (T)

Genetics

I will be able to explain how we inherit our characteristics as a result of our genes which are made of DNA. **I will** be able to explain how the DNA is replicated and packaged in a specialised way to form the sex cells. ***I will** be able to describe the work by Gregor Mendel around plant genetics*

I will be able to explain how forces affect motion and how an understanding of these forces can make driving safer. ***I will** be able to explain the effects of forces on levers and in creating pressure (T).* I will be able to explain the effects of forces applied to springs.

Forces

DNA, genes and the human genome
UNIT B6
Unit Test
Forces and energy in springs
Moments, levers and pressure (T)
Momentum and road safety
Mass and Weight
Forces, speed and acceleration
UNIT P5

Energy Changes & Reaction Rates

I will be able to describe, explain and represent energy changes in chemical reactions and link them to bond energies and the particle theory. ***I will** be able to explain how dells produce a voltage and how fuel cells work (T).* **I will** be able to measure and calculate the rate of a reaction and describe factors that can affect rate. ***I will** be able to apply Le Chatelier's principle to reactions in equilibrium (T).*

Unit Test
Exo and endo thermic reactions
Reaction profiles
Cells, batteries and fuels cells (T)
Measuring rates of reaction
Factors affecting rates of reaction
Catalysts and collision theory
Reversible reactions and energy changes
Factors affecting equilibrium
UNIT C5 & C6

I will be able to explain how conditions in the body, processes and organ systems are coordinated and controlled. **I will** be able to describe how hormones control sexual development and human reproduction, *as well as how hormones enable plants to respond to stimuli (T)*

Homeostasis

Unit Test
Plant hormones (T)
Human reproduction and IVF
The endocrine system and the kidneys (T)
The nervous system and the eye (T)
Homeostasis
UNIT B5
Unit Test
Nuclear fission and fusion (T)
Hazards and uses of radiation

I will be able to reconise an atomic isotope and explain how one isotope can turn into another through three different forms of radioactive decay. **I will** be able to represent radioactive decay using a nuclear equation.

Atomic structure

Titration (T)
Electrolysis
Oxidation and reduction)
Unit Test
UNIT P4
Atomic structure
Radioactive decay
Nuclear equations
Neutralisation

Chemical changes

I will be able to describe why some metals are more reactive than others, **I will** be able to describe how neutralization occurs and how salts are formed. **I will** be able to explain how some metals are extracted by electrolysis rather than oxidation

I will be able to describe how lifestyle choices can affect the risk of catching a non-communicable disease. **I will** be able to explain how communicable diseases are spread and how we can control their spread. ***I will** be able to describe how plants are affected by and protected from disease causing organisms (T).*

Health

Metal reactivity
UNIT C4
Unit Test
Plant diseases & defenses (T)
Protecting the body
Malaria
Pathogens
Health and disease
UNIT B4
Year 10

ZOOM IN...

MY LEARNING JOURNEY:

Subject: Atomic structure Year: 10 Unit: P4

AIMS

Students will learn that atoms of the same element can show variation and that these variants are called isotopes. They will learn how it is possible for one element to turn into another element by means of radioactive decay which can be represented by an equation. This unit will also provide an opportunity to understand the current model of the atoms and how ideas about the structure of the atom have changed over time. They will be introduced to the three types of ionising radiation and consider hazards related to and uses of each type of radiation.

DEVELOPING COURAGE

- C Use of Nuclear Radiation as a therapeutic
- O to use models to understand something too small to see
- U Scientists working together have come up with the model of the atom we use today
- R Learning how radioactive decay produces new elements
- A Tha Scientific invention can be used both positively and negatively
- G Share our scientific knowledge
- E Using a model to demonstrate half life

UP NEXT

Forces

- Speed & accceleration
- Velocity time graphs
- Caluclate motion using Newton's Laws
- Momentum & road safety
- Moments, levers & gears
- Forces on a spring

CAREERS

- Radiographer
- Nuclear Physicist
- Materials tester
- Smoke alarm fitter

PREVIOUS LEARNING

Pupils will have some knowledge of the structure of atoms and how this is used to order elements on the periodic table. They will have heard of the law of conservation of matter, that it cannot be created or destroyed. They will understand some examples of chemical formula and that they summarise what is happening in a chemical reaction.

WHAT WE KNOW/ REMEMBER

- .....
- .....
- .....
- .....
- .....

RECOMMENDED READING

1. Strange Glow: The Story of Radiation by Timothy J. Jorgensen,
2. Cancer Party!: Explain Cancer, Chemo, and Radiation to Kids by Sara S Olsher,
3. Chemistry for Kids, The Atomic Structure: Charges and Mass by Lex Sharp

PERSONAL OBJECTIVES

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Lesson 1: P4.1 – Atomic structure

Connection

Have a look at the topic overview and the P4 zoom in.

Populate what you know and your personal objectives.

Activation

LI: Describe the structure of the atom

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

1. Make a note of the title and the LI
2. Read pages 110-111
3. Make a list of the key words and define those you don't know
4. Copy fig 4.1 and 4.2
5. Explain $^{A}_{Z}X$
6. Define radio-isotope

Demonstration

Attempt questions 1-6.
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 1: P4.1 – Atomic structure

Connection

1 NA
2 NA
3 NA

Demonstration

1 88 electrons

2 92 protons, 238 – 92 = 146 neutrons

3 The number of electrons is the same; the number of protons is the same; the number of neutrons is different.

4a 7 protons and 14 – 7 = 7 neutrons.
4b 92 protons and 235 – 92 = 143 neutrons.

5 Uranium in Fig 4.2: 92 protons, 238 – 92 = 146 neutrons
Uranium in Q4: 92 protons, 235 – 92 = 143 neutrons.
Isotopes of Uranium

6 Nuclear radiation can knock electrons off atoms. These atoms become positive ions since hey have lost negative charge.
Once the electrons have been knocked off, these can join onto other atoms. These atoms become negative ions because they have gained negative charge.

Lesson 2: P4.2 – Radioactive decay

Connection

1. Name 3 sub atomic particles
2. What letter represents the mass number and what does it show?
3. What letter represents the atomic number and what does it show?

Activation

LI: Describe the types of nuclear radiation and radioactive decay

https://www.youtube.com/watch?v=UtZw9jfIxXM

1. Make a note of the title and the LI
2. Read pages 112-113
3. Make a list of the key words and define those you don't know
4. Copy fig 4.4 and 4.5 and the bullet points below each diagram
5. Write a sentence to explain what gamma radiation is and how it affects the charge and mass of an atom

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

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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 2: P4.2 – Radioactive decay

Connection

1 Protons, Electrons, Neutrons

2 A nucleon number = protons and neutrons

3 Z proton number

Demonstration

1 150 × 20 = 3000 counts

2 They are all unstable and form radioisotopes.

3 You can't predict when a particular nucleus is going to decay.

4 The nitrogen nucleus has one more proton and one fewer neutron than the carbon nucleus.

5a The nucleus loses 2 protons and 2 neutrons.
5b One of the neutrons in the nucleus becomes a proton.

6 This is beta decay.

7 A nucleus has a lot of energy after it has undergone alpha or beta decay. This energy is enough for gamma radiation to be released.

Lesson 3: P4.3 – Background radiation

Connection

1. What unit is used to measure levels of radioactivity
2. What is an alpha particle?
3. What are beta and gamma radiation?

Activation

LI: List the sources of background radiation and describe the ionising power of the different types

https://www.youtube.com/watch?v=Z7394DMkfQs
https://www.youtube.com/watch?v=nW0S1C6wVrg

1. Make a note of the title and the LI
2. Read pages 114-115
3. Make a list of the key words and define those you don't know
4. Copy the bullet points (sources background radiation) on page 114
5. Draw and label figure 4.8
6. Explain how a smoke detector and a machine to monitor paper thickness works (write a paragraph for each)

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

Demonstration

Attempt questions 2-8
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

Answers Lesson 3: P4.3 – Background radiation

Connection

1 Becquerels

2 2 protons & 2 neutrons (Helium nucleus)

3 beta is an electron, gamma is an electromagnetic wave

Demonstration

1 Radon and thoron from soil, rocks and building materials; gamma rays from rocks and soil; radiation from living things and food; cosmic rays from outer space; medical; fallout from nuclear weapons testing and other forms such as air travel; work related; nuclear power industry.

2 All of the forms of background radiation apart from medical, work related, nuclear fallout, nuclear industry and air travel are natural. Therefore, the total percentage=37+19+17+14=87%.

3a The types of rock are different in different areas so some areas are exposed to more background radiation than others.
3b For example, nuclear fallout will vary depending on which way the wind is blowing. Cosmic background radiation increases when the Sun is particularly active.

4 Beta particles can pass through a few metres of air and paper but they are stopped by a few mm of low density metals such as aluminium. Beta particles are more ionising than gamma rays but are less ionising than alpha particles.

5 Gamma radiation

6 To function as a smoke detector the alpha radiation must not be very penetrating (stopped by the smoke). Having a reduced range also helps regarding safety as alpha particles are very ionising and therefore dangerous to the body. Having the alpha sources high up prevents people passing below the detector being exposed to them.

7 Alpha particles would be stopped by the paper and gamma would pass straight through whatever the thickness. However, the amount of beta particles passing through would depend on the thickness.

8 The alpha radiation extremely ionising cause a lot of damage - would be absorbed before it passes outside the body. Therefore it would not be detected outside the body due to poor penetration.

Lesson 4: P4.4 – Nuclear equations

Connection

1. List 3 sources of background radiation
2. What is needed to stop alpha, beta and gamma radiation?
3. Why is alpha radiation useful in a smoke detector?

Activation

LI: Write balanced nuclear equations

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

1. Make a note of the title and the LI
2. Read pages 116-117
3. Make a list of the key words and define those you don't know
4. Draw and label figure 4.9 and 4.11
5. Copy the 1st sentence in the purple section to describe beta decay

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 4: P4.4 – Nuclear equations

Connection

1 Becquerels

2 2 protons & 2 neutrons (Helium nucleus)

3 beta is an electron, gamma is an electromagnetic wave

Demonstration

1 They both have to be balanced.

2 A chemical equation only has one set of numbers that need to be balanced, a nuclear equation has two sets of numbers.

3a $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{2}_{4}He$
3b $^{219}_{86}Rn \rightarrow {}^{215}_{84}Po + {}^{2}_{4}He$

4a $^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}e$
4b $^{24}_{15}P \rightarrow {}^{32}_{16}S + {}^{0}_{-1}e$

5a $^{24}_{11}Na \rightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e$
5b The particle emitted is a beta particle (an electron).

6a An alpha particle is emitted.
6b A = 228, Z = 88

7a platinum-190 → osmium-186 + alpha particle

$^{190}_{78}Pt \rightarrow {}^{186}_{76}Os + {}^{4}_{2}He$

7b rhenium-187 → tantalum-183 + alpha particle

$^{187}_{75}Re \rightarrow {}^{183}_{73}Ta + {}^{4}_{2}He$

7c copper-66 →zinc-66 + beta particle

$^{66}_{29}Cu \rightarrow {}^{66}_{30}Zn + {}^{0}_{-1}e$

7d nickel-66 → copper-66 + beta particle

$^{66}_{28}Ni \rightarrow {}^{66}_{29}Cu + {}^{0}_{-1}e$

7e rhodium-105 → palladium-105 + beta particle

$^{105}_{45}Rh \rightarrow {}^{105}_{46}Pd + {}^{0}_{-1}e$

7f osmium-186 → tungsten-182 + alpha particle

$^{186}_{76}Os \rightarrow {}^{182}_{74}W + {}^{4}_{2}He$

Lesson 5: P4.5 – Radioactive half life

Connection

1. $^{186}_{76}Os \rightarrow ^{---}_{--} W + ^{4}_{2} He$
2. $^{190}_{78}Pt \rightarrow ^{186}_{76}Os + ?$
3. $^{105}_{45}Rh \rightarrow ^{105}_{46\ Pd} + ?$

Activation

LI: Explain and calculate radioactive half life

https://www.youtube.com/watch?v=wj9BzGFao8k

1. Make a note of the title and the LI
2. Read pages 118-119
3. Make a list of the key words and define those you don't know
4. Sketch and label figure 4.12

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

Demonstration

Attempt questions 1-9
In 20 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

Answers Lesson 5: P4.5 – Radioactive half life

Connection

1. $^{186}_{76}Os \rightarrow {}^{182}_{74}W + {}^{4}_{2}He$

2. $^{190}_{78}Pt \rightarrow {}^{186}_{76}Os + {}^{4}_{2}He$

3. $^{105}_{45}Rh \rightarrow {}^{105}_{46\,Pd} + {}^{0}_{-1}e$

Demonstration

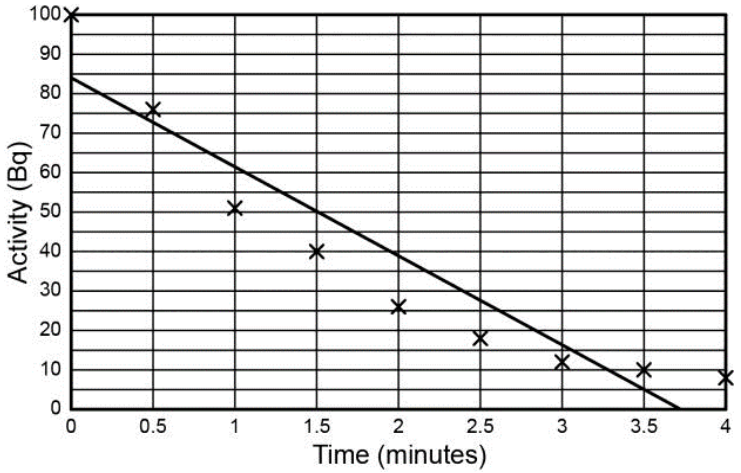
1 Because radioactive decay is random.

2 It is the time it takes for the activity of a sample to fall to half of its current amount.

3a 40 counts per minute
3b 20 counts per minute
3c 10 counts per minute
3d 5 counts per minute

4 8 minutes

5a & 5b see graph



5c Time taken to halve from 100 Bq to 50 Bq = 1 minute
Time taken to halve from 40 Bq to 20 Bq = 2.4 – 1.4 = 1 minute
Time taken to halve from 32 Bq to 16 Bq = 2.7 – 1.7 = 1 minute
So the average of these three measurements = (1 + 1 + 1) / 3 = 1 minute.

6 It takes 1 half-life to decrease from 100 Bq to 50 Bq and a further half-life to decrease from 50 Bq to 25 Bq. Therefore 4 hours is 2 half-lives which means that 1 half-life = 2 hours.

7 Number of half-lives = 24 / 6 = 4. So the amount remaining is ½ × ½ × ½ × ½ = 1/16th of the original amount.

8 80 minutes = 10 half-lives. 210 = 1024, so the fraction remaining = 1/1024.

9 Number of half-lives = 6 / 2 = 3. So the amount remaining is ½ × ½ × ½ = 1/8th of the original amount.

Lesson 6: P4.6 – Hazards and uses of radiation

Connection

1. Define half life.

2. PA radioactive isotope has a half life of 2 days and an activity of 200Bq. How active will it be after 6 days?

3. The activity of a sample took 8 hours to decrease from 400Bq to 25Bq. What is its half life?

Activation

LI: Describe radioactive contamination and explain how radioactive tracers work

https://www.youtube.com/watch?v=teGu0VAPlOo
https://www.youtube.com/watch?v=7mSR--zJGv0

1. Make a note of the title and the LI
2. Read pages 120-121
3. Make a list of the key words and define those you don't know
4. Draw figure 4.14

Demonstration

Attempt questions 1-8
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 6: P4.6 – Hazards and uses of radiation

Connection

1. The time taken for half the radioactive nuclei to decay

2. 6/2=3 half lifes
   i. 200/2 = 100
   ii. 100/2 = 50
   iii. 50/2 = 25Bq

3. 400>200>100>50>25 = 4 half lifes in 8 hours
   8hrs/4 = half life = 2hrs

Demonstration

1 When a radioactive material is somewhere where it isn't wanted.

2 Radioactive materials produce ionising radiation which is harmful to health. Ionising radiation can kill cells and can cause cancer.

3 Gamma (since it has the weakest ionising power)

4 Alpha particles are very ionising which means that they are more likely to kill cells or cause cancer. However, they are not very penetrating so if they are outside the body they can't get in and cause the damage.

5a You need to make sure that your measurements are a true measure of the activity of the tracer rather than that of the background radiation.
5b Background radiation is random and its activity can be higher at some times than at others. You need to use an accurate average.

6 The isotope with the half-life of 6 hours. 6 seconds would mean that the isotope has decayed to unmeasurable levels before the tracer can be monitored and 6 days would mean the patient would remain radioactive long after the procedure had taken place which would add unnecessary risk.

7 A gamma emitter. Gamma radiation has the weakest ionising power so it does the least harm to the body. It is also the most penetrating so it can pass from the inside of the body where the tracer is, to the outside where it can be detected.

8 Inject the tracer into the blood. Leave enough time for the tracer to be carried by the blood through the body. Examine the patient with a gamma camera. If there is a large signal at a particular place in the vessel then it is likely that there is a blockage in that place.

Lesson 7: P4.7 – Irradiation

Connection

1. Define radioactive contamination
2. Why is alpha radiation not useful as a medical tracer?
3. What form/s of radiation is useful as a medical tracer? Why?

Activation

LI: Understand the difference between contamination and irradiation

https://www.youtube.com/watch?v=4tiyPnUgQ0s

1. Make a note of the title and the LI
2. Read pages 122-123
3. Make a list of the key words and define those you don't know
4. Draw figure 4.17

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

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

Answers Lesson 7: P4.7 – Irradiation

Connection

1. The unwanted presence of materials containing radioactive atoms

2. Alpha is too ionising (causes too much damage to tissue) and is not penetrating enough to be detected outside the body.

3. Beta or gamma would be suitable as they are weakly ionising and are penetrating enough to be detected outside the body. They need to have a half life that is not too long so it does not remain in the body for a long time but is not so short it can be detected

Demonstration

1 Irradiation is when you expose an object to nuclear radiation.

2 We receive much more irradiation from the food than from the air (it's about 500 times more).

3 Accurate repair, cell death, misrepair

4 If a sperm cell or an egg cell is misrepaired then this change of genetic material could be passed onto offspring.

5 Irradiation is exposing someone to nuclear radiation. Contamination is when radioactive material is actually present on the person (which will continue to irradiate them).

6 The people doing the experiments might have made mistakes. If other people carrying out an experiment agree with the findings, then the findings are more likely to be true.

7 Once the pigeons move away from something that is irradiating them then they are no longer exposed to the radiation. However, if they are contaminated with radioactive material then they will continue to be irradiated for as long as the material in them remains radioactive. This is much more likely to cause them serious harm

Lesson 8: P4.8 – Uses of radiation in medicine (Triple)

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: Understand the difference between contamination and irradiation

https://www.youtube.com/watch?v=4tiyPnUgQ0s

1. Make a note of the title and the LI
2. Read pages 124-125
3. Make a list of the key words and define those you don't know
4. Copy bullet points page 124 and 125

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

Answer Lesson 8: P4.8 – Uses of radiation in medicine (Triple)

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 They are both types of electromagnetic waves.

2 Many manufactured radioisotopes are used in medicine. Some of these are used to destroy cancerous cells from the radiation they produce; others are used as tracers to help diagnose problems with a patient in order to treat them.

3 X-rays are only produced when needed. You can control the energy of the x-rays that you produce.

4 Brachytherapy uses the radioactive source right next to (or inside) the tumour rather than the radiation coming from outside the body.

5 You need to make sure that you can extract all of the radioactive source so you don't contaminate the patient. Placing the radioactive source near the tumour might need invasive surgery which can lead to problems with infection.

6 Alpha particles wouldn't penetrate very far into the tumour (and probably wouldn't even be able to leave the protective casing). Many gamma rays would pass through the tumour so there would be a large dose applied to tissue outside of the tumour. Beta particles would penetrate into the tumour and deposit most of their energy within the tumour. Therefore, the tumour would get the biggest dose with a beta emitter.