AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.2.1 PARTICLES

SCORE	PERCENTAGE
/163	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

(a) Describe the interaction that is responsible for keeping protons and neutrons together in a stable nucleus.
You should include details of the properties of the interaction in your answer.

(3)

(b) Nuclei can decay by alpha decay and by beta decay.

In alpha decay only one particle is emitted but in beta decay there are two emitted particles.

Explain how baryon number is conserved in alpha and beta decay.

(3)

(c) Kaons are mesons that can be produced by the strong interaction between pions and protons.

The equation shows a reaction in which a kaon and a lambda particle are produced.

$$\pi^- + p \rightarrow K^0 + \Lambda^0$$

Deduce the quark structure of the Λ^0

STEMUP.CO.UK

quark structure = _____

(2)

(d) The kaon decays by the weak interaction.

The equation shows an example of kaon decay.

$$K^0 \rightarrow \pi^+ + \pi^-$$

State **one** feature of this decay that shows it is an example of the weak interaction.

_____

_____

(1)

(e) There have been considerable advances in our understanding of particle physics over the past 100 years.

Explain why it is necessary for many teams of scientists and engineers to collaborate in order for these advances to be made.

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

Q2.

A radioactive source emits alpha particles each with 8.1×10^{-13} J of kinetic energy.

(a) Show that the velocity of an alpha particle with kinetic energy 8.1×10^{-13} J is approximately 2×10^7 m s^{-1}

specific charge of an alpha particle = 4.81×10^7 C kg^{-1}

_____

_____

_____

_____

(2)

(b) The alpha particles travel through air in straight lines with a range of 3.5 cm

Calculate the average force exerted on an alpha particle as it is stopped by the air.

STEMUP.CO.UK

average force = _____ N

(2)

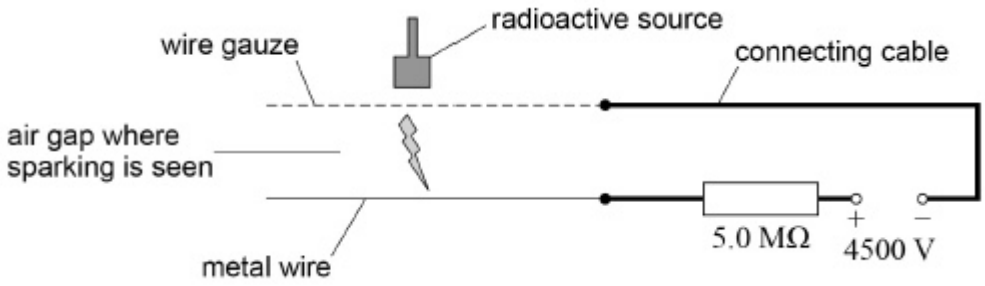
(c) An alpha particle transfers all its kinetic energy to air molecules and produces 5.1×10^4 ions per centimetre over its range of 3.5 cm

Calculate the average ionisation energy, in eV, of a molecule of air.

ionisation energy = _____ eV

(3)

(d) A spark counter consists of a wire gauze separated from a metal wire by a small air gap. A power supply with an output of 4500 V is connected in series with a 5.0 MΩ resistor and the spark counter as shown in the diagram. When the radioactive source is moved close to the wire gauze, sparking is seen in the air gap.



Sparks are produced when alpha particles produce ionisation in the air gap.

One ionisation event produces a current of 0.85 mA for a time of 1.2 ns

Calculate the number of charge carriers that pass a point in the connecting cable during this ionisation event.

number of charge carriers = _____

(2)

(e) The radioactive source was positioned 10 cm above the wire gauze before being moved slowly towards the wire gauze leading to the ionisation event in part **(d)**.

Discuss how the potential difference across the air gap varied as the radioactive source was moved over this distance.

STEMUP.CO.UK

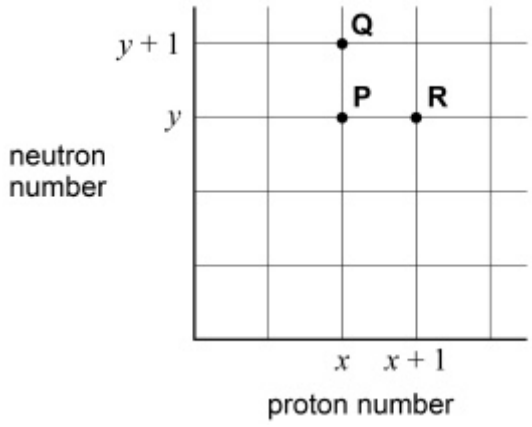
Assume the power supply has negligible internal resistance.

(3)

(Total 12 marks)

Q3.

The graph of neutron number against proton number shows three nuclei **P**, **Q** and **R**.



Which row identifies an isotope of **P** and the nucleon number of this isotope of **P**?

	Isotope of P	Nucleon number of isotope of P	
A	**Q**	$y + 1$	⬭
B	**Q**	$x + y + 1$	⬭
C	**R**	$x + y + 1$	⬭

STEMUP.CO.UK

D	**R**	$x + 1$	⬭

(Total 1 mark)

Q4.

$^{236}_{92}U$ undergoes a series of decays to produce $^{204}_{82}Pb$.

How many alpha decays are involved in this decay series?

A 5 ⬭

B 6 ⬭

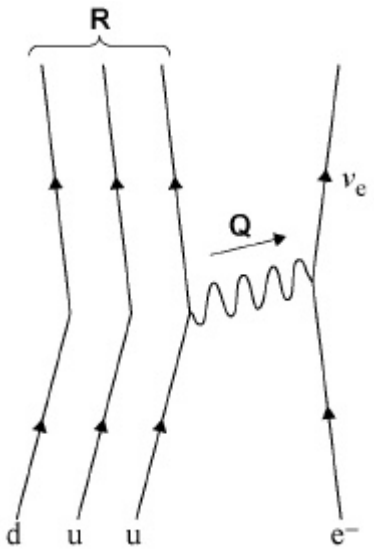
C 8 ⬭

D 10 ⬭

(Total 1 mark)

Q5.

The partially completed diagram represents electron capture.



Which row identifies the exchange particle **Q** and the quark structure of particle **R**?

	Particle Q	Quark structure of particle R	
A	W^-	uuu	⬭
B	W^+	dud	⬭
C	W^+	uuu	⬭
D	W^-	dud	⬭

STEMUP.CO.UK

(Total 1 mark)

Q6.

The decay of a neutral kaon K^0 is given by the equation

$$K^0 \rightarrow X + Y + \overline{\nu}_e$$

What are X and Y?

	X and Y	
A	e^+ and e^-	⬭
B	μ^+ and e^-	⬭
C	π^+ and e^-	⬭
D	π^- and e^+	⬭

(Total 1 mark)

Q7.

Fluoride ions are produced by the addition of a single electron to an atom of fluorine $^{19}_{9}F$.

What is the magnitude of specific charge of the fluoride ion?

A 3.2×10^{-26} C kg^{-1} ⬭

B 8.4×10^{-21} C kg^{-1} ⬭

C 5.0×10^{6} C kg^{-1} ⬭

D 4.5×10^{7} C kg^{-1} ⬭

(Total 1 mark)

Q8.

Two gamma photons are produced when a muon and an antimuon annihilate each other.

What is the minimum frequency of the gamma radiation that could be produced?

A 2.55×10^{16} Hz ⬭

B 5.10×10^{16} Hz ⬭

C 2.55×10^{22} Hz ⬭

D 5.10×10^{22} Hz ⬭

(Total 1 mark)

STEMUP.CO.UK

Q9.

The $\sum^0$ baryon, composed of the quark combination uds, is produced through the strong interaction between a π^+ meson and a neutron.

$$\pi^+ + n \rightarrow \sum^0 + X$$

What is the quark composition of X?

A $u\bar{s}$ ⬭

B ud ⬭

C $u\bar{d}$ ⬭

D $ud\bar{s}$ ⬭

(Total 1 mark)

Q10.

An iodine nucleus decays into a nucleus of Xe−131, a beta-minus particle and particle Y.

$$^{131}_{53}\mathrm{I} \rightarrow ^{131}_{54}\mathrm{Xe} + {}^{0}_{-1}\mathrm{e} + \mathrm{Y}$$

Which is a property of particle Y?

A It has a lepton number of +1 ⬭

B It is an antiparticle ⬭

C It is negatively charged ⬭

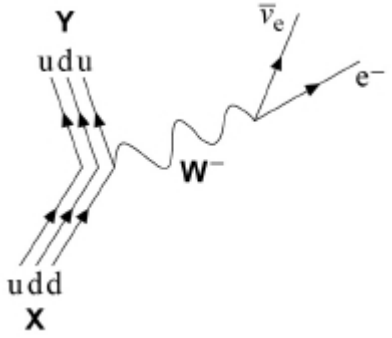
D It experiences the strong interaction ⬭

(Total 1 mark)

Q11.

The diagram below represents the decay of a particle **X** into a particle **Y** and two other particles.

The quark structure of particles **X** and **Y** are shown in the diagram.



STEMUP.CO.UK

(a) Deduce the name of particle **X**.

_____

(1)

(b) State the type of interaction that occurs in this decay.

_____

(1)

(c) State the class of particles to which the $\mathbf{W^-}$ belongs.

_____

(1)

(d) Show clearly how charge and baryon number are conserved in this interaction.

You should include reference to all the particles, including the quarks, in your answer.

_____

_____

_____

_____

_____

(2)

(e) Name the only stable baryon.

_____

(1)

(f) A muon is an unstable particle.

State the names of the particles that are produced when a muon decays.

_____

(1)

(Total 7 marks)

Q12.

Which row shows the correct interactions experienced by a hadron or a lepton?

	Particle	Strong interaction	Weak interaction	
A	Hadron	Yes	Yes	⬭
B	Lepton	Yes	Yes	⬭
C	Hadron	Yes	No	⬭

STEMUP.CO.UK

D	Lepton	Yes	No	⬭

(Total 1 mark)

Q13.

When a nucleus of the radioactive isotope $^{65}_{28}Ni$ decays, a β^- particle and an electron antineutrino are emitted.

How many protons and neutrons are there in the resulting daughter nucleus?

	Number of protons	**Number of neutons**	
A	28	65	⬭
B	29	65	⬭
C	29	36	⬭
D	30	35	⬭

(Total 1 mark)

Q14.

What interactions are involved in the production of a strange particle and its decay into non-strange particles?

	Production	**Decay**	
A	strong	weak	⬭
B	strong	strong	⬭
C	weak	strong	⬭
D	weak	weak	⬭

(Total 1 mark)

Q15.

An isotope of potassium $^{40}_{19}K$ is used to date rocks. The isotope decays into an isotope of argon (Ar) mainly by electron capture.

(a) The decay is represented by this equation:

$$^{40}_{19}K + {}^{0}_{-1}e \rightarrow {}^{\quad}_{\quad}Ar + ____$$

Complete the equation to show the decay by filling in the gaps.

(2)

STEMUP.CO.UK

(b) Explain which fundamental interaction is responsible for the decay in question (a).

_____

_____

_____

_____

(2)

(c) One decay mechanism for the decay of $^{40}_{19}K$ results in the argon nucleus having an excess energy of 1.46 MeV. It loses this energy by emitting a single gamma photon.

Calculate the wavelength of the photon released by the argon nucleus.

wavelength = _____ m

(3)

(d) The potassium isotope can also decay by a second decay process to form a calcium-40 nuclide ($^{40}_{20}Ca$).

Suggest how the emissions from a nucleus of decaying potassium can be used to confirm which decay process is occurring.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q16.

An atom of $^{16}_{7}N$ gains 3 electrons.

What is the specific charge of the ion?

A 1.80×10^{7} C kg^{-1} ⬭

STEMUP.CO.UK

B -1.80×10^7 C kg^{-1} ⬭

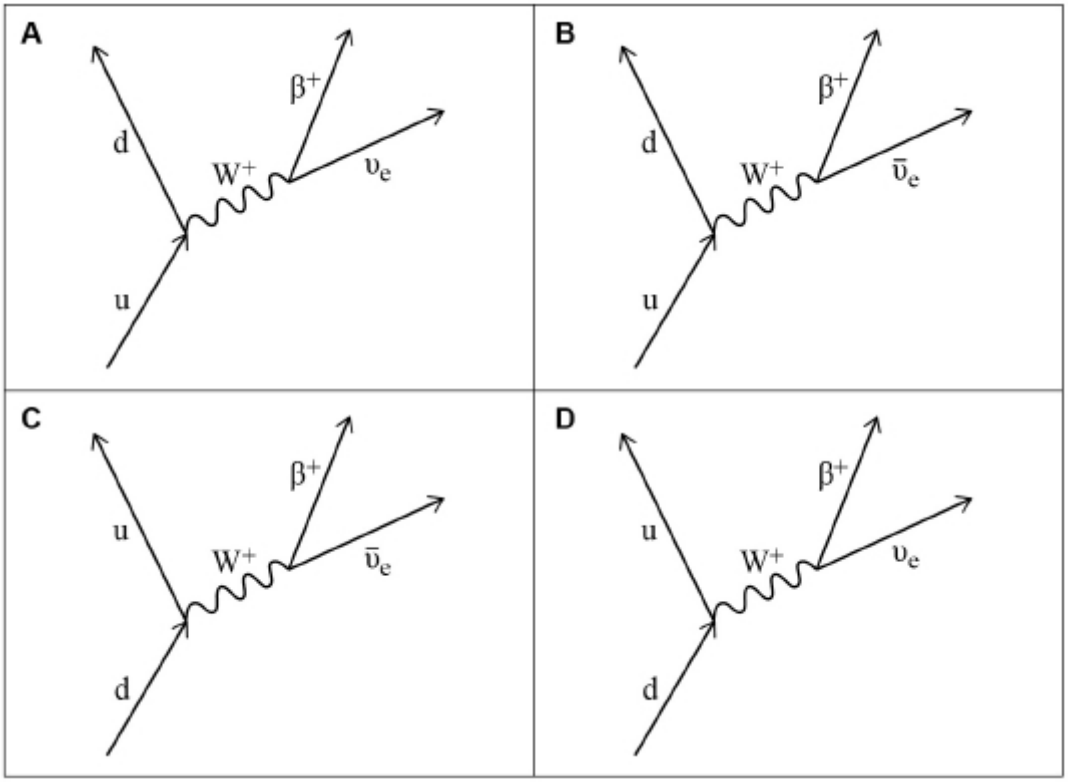
C 4.19×10^7 C kg^{-1} ⬭

D -4.19×10^7 C kg^{-1} ⬭

(Total 1 mark)

Q17.

Which diagram represents the process of beta-plus decay?



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

Q18.

A beam of light of wavelength λ is incident on a clean metal surface and photoelectrons are emitted. The wavelength of the light is halved but energy incident per second is kept the same.

Which row in the table is correct?

	Maximum kinetic	**Number of**	

STEMUP.CO.UK

	energy of the emitted photoelectrons	photoelectrons emitted per second	
A	Increases	Unchanged	⬭
B	Decreases	Increases	⬭
C	Increases	Decreases	⬭
D	Decreases	Unchanged	⬭

(Total 1 mark)

Q19.

Electrons moving in a beam have the same de Broglie wavelength as protons in a separate beam moving at a speed of 2.8×10^4 m s^{-1}.

What is the speed of the electrons?

A 1.5×10^1 m s^{-1} ⬭

B 2.8×10^4 m s^{-1} ⬭

C 1.2×10^6 m s^{-1} ⬭

D 5.1×10^7 m s^{-1} ⬭

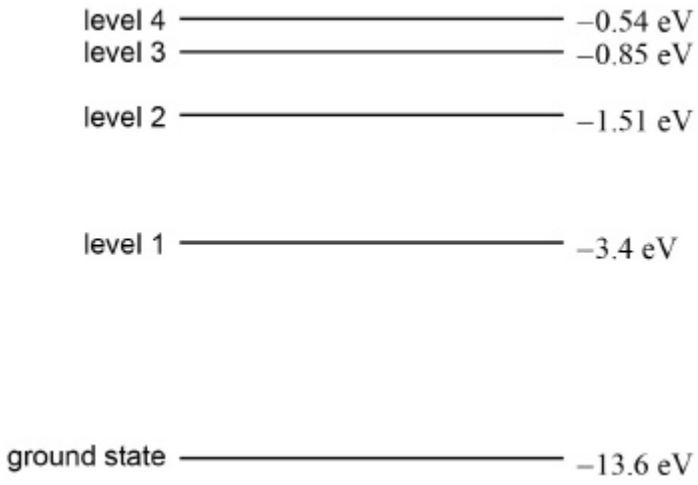
(Total 1 mark)

Q20.

The diagram shows an energy level diagram for a hydrogen atom.

Electrons with energy 13.0 eV collide with atoms of hydrogen in their ground state.

What is the number of different wavelengths of electromagnetic radiation that could be emitted when the atoms de-excite?



STEMUP.CO.UK

A 0 ⬭

B 3 ⬭

C 6 ⬭

D 7 ⬭

(Total 1 mark)

Q21.

The Rutherford scattering experiment led to

A the discovery of the electron. ⬭

B the quark model of hadrons. ⬭

C the discovery of the nucleus. ⬭

D evidence for wave-particle duality. ⬭

(Total 1 mark)

Q22.

A Geiger counter is placed near a radioactive source and different materials are placed between the source and the Geiger counter.

The results of the tests are shown in the table.

Material	Count rate of Geiger counter / s^{-1}
None	1000
Paper	1000
Aluminium foil	250
Thick steel	50

What is the radiation emitted by the source?

A α only ⬭

B α and γ ⬭

C α and β ⬭

D β and γ ⬭

(Total 1 mark)

Q23.

STEMUP.CO.UK

Nobelium-259 has a half-life of 3500 s.

What is the decay constant of nobelium-259?

A $8.7 \times 10^{-5}\ s^{-1}$ ⬭

B $2.0 \times 10^{-4}\ s^{-1}$ ⬭

C $1.7 \times 10^{-2}\ s^{-1}$ ⬭

D $1.2 \times 10^{-2}\ s^{-1}$ ⬭

(Total 1 mark)

Q24.

Cosmic rays are high-energy particles coming from Space. They collide with the air molecules in the Earth's atmosphere to produce pions and kaons.

(a) Pions and kaons are mesons. Identify the quark–antiquark composition for a meson.

Tick (✓) the correct answer in the right-hand column.

	✓ if correct
qqq	
$q\bar{q}\bar{q}$	
$q\bar{q}$	
qq	

(1)

(b) A positron with a kinetic energy of 2.0 keV collides with an electron at rest, creating two photons that have equal energy.

Show that the energy of each photon is 8.2×10^{-14} J.

(3)

(c) Calculate the wavelength of a photon of energy 8.2×10^{-14} J.

STEMUP.CO.UK

wavelength = _____ m

(2)

(d) Show that the speed of the positron before the collision was about 2.7×10^7 m s^{-1}.

(3)

(e) Calculate the de Broglie wavelength of the positron travelling at a speed of 2.7×10^7 m s^{-1}.

wavelength = _____ m

(2)

(f) The separation between the carbon atoms in graphite is about 0.15 nm.

Discuss whether electrons travelling at 2.7×10^7 m s^{-1} can be can be used to demonstrate diffraction as they pass through a sample of graphite.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 15 marks)

Q25.

Which of the following nuclei has the smallest specific charge?

STEMUP.CO.UK

A $^{1}_{1}H$ ⊙

B $^{12}_{6}C$ ⊙

C $^{14}_{6}C$ ⊙

D $^{235}_{92}U$ ⊙

(Total 1 mark)

Q26.

$^{232}_{90}Th$ is an unstable nuclide in a radioactive decay series. It decays by emitting an α particle. The next two nuclides in the series emit β^- particles.

What nuclide is formed after these three decays have taken place?

A $^{230}_{90}Th$ ⊙

B $^{228}_{92}U$ ⊙

C $^{228}_{88}Ra$ ⊙

D $^{228}_{90}Th$ ⊙

(Total 1 mark)

Q27.

Which line does **not** give the correct exchange particle for the process?

	Process	Exchange particle	
A	gravitational attraction	W boson	⊙
B	electrostatic repulsion of electrons	virtual photon	⊙
C	strong interaction	pion	⊙
D	β^- decay	W boson	⊙

(Total 1 mark)

Q28.

Which line correctly classifies the particle shown?

	Particle	Category	Quark combination	
A	neutron	baryon	$\bar{u}d$	⊙

STEMUP.CO.UK

B	neutron	meson	udd	⬭
C	proton	baryon	uud	⬭
D	positive pion	meson	ūd	⬭

(Total 1 mark)

Q29.

Which of the following statements about muons is **incorrect**?

A A muon is a lepton. ⬭

B A muon has a greater mass than an electron. ⬭

C If a muon and an electron each have the same de Broglie wavelength then they each have the same momentum. ⬭

D A muon with the same momentum as an electron has a larger kinetic energy than the electron. ⬭

(Total 1 mark)

Q30.

What is the best estimate for the order of magnitude for the diameter of an atom?

A 10^{-14} m ⬭

B 10^{-12} m ⬭

C 10^{-11} m ⬭

D 10^{-8} m ⬭

(Total 1 mark)

Q31.

More than 200 subatomic particles have been discovered so far. However, most are not fundamental and are composed of other particles including quarks.

It has been shown that a proton can be made to change into a neutron and that protons and neutrons are made of quarks.

(a) Name **one** process in which a proton changes to a neutron.

_____

_____

(1)

(b) Name the particle interaction involved in this process.

STEMUP.CO.UK

_____

_____

(1)

(c) Write down an equation for the process you stated in part **(a)** and show that the baryon number and lepton number are conserved in this process.

baryon number _____

_____

_____

lepton number _____

_____

_____

(2)

(d) The strange quark was used to explain the existence of particles whose tracks had been seen in experiments in the early 1950s. These were unexplained at that time and were referred to as 'strange particles'. One of these particles was later named the K^+ kaon.

State the quark composition of a K^+ kaon.

_____

_____

(1)

(e) A K^+ kaon decays into a π^+ particle and a π° particle.

Explain **one** property which is conserved and **one** property which is not conserved in this decay.

conserved _____

_____

not conserved _____

(2)

(Total 7 marks)

Q32.

Which nucleus has a smaller value of specific charge than the nucleus $^{18}_{8}O$?

A $^{7}_{3}Li$ ⬭

B $^{11}_{5}B$ ⬭

STEMUP.CO.UK

C $^{13}_{6}C$ ⬭

D $^{37}_{17}Cl$ ⬭

(Total 1 mark)

Q33.

When bombarded with an α particle the nuclide $^{25}_{12}Mg$ changes into another nuclide with the emission of a neutron and γ radiation.

What are the correct values for the nucleon number and proton number of the nuclide which is formed?

	Nucleon number	Proton number	
A	29	14	⬭
B	29	12	⬭
C	28	14	⬭
D	27	12	⬭

(Total 1 mark)

Q34.

Which sequence of radioactive emissions results in the formation of an isotope of the original element?

A one α particle and one β^- particle ⬭

B one α particle and two β^- particles ⬭

C two α particles and one β^- particle ⬭

D two α particles and two β^- particles ⬭

(Total 1 mark)

Q35.

Which statement concerning the forces between particles is **incorrect**?

A Leptons experience the weak interaction. ⬭

B Leptons experience the strong interaction. ⬭

C Hadrons experience the weak interaction. ⬭

D Hadrons experience the strong ⬭

STEMUP.CO.UK

interaction.

(Total 1 mark)

Q36.

What of the following is a hadron of zero charge?

A neutrino ⬭

B photon ⬭

C proton ⬭

D neutron ⬭

(Total 1 mark)

Q37.

Two coherent sources generate sound waves of wavelength 0.40 m. The waves leave the sources in phase. A detector some distance from the sources receives the sound waves. The path difference between the detector and the sources is 0.90 m.

What is the phase difference between the waves arriving at the detector?

A zero ⬭

B 45° ⬭

C 90° ⬭

D 180° ⬭

(Total 1 mark)

Q48.

A nucleus of a particular element decays, emitting a series of α and β^- particles.

Which of the following series of emissions would result in an isotope of the original element?

A 1 α and 1 β^- ⬭

B 1 α and 2 β^- ⬭

C 2 α and 1 β^- ⬭

D 2 α and 2 β^- ⬭

(Total 1 mark)

Q49.

Which equation shows the process of annihilation?

STEMUP.CO.UK

A $\pi^- + \pi \longrightarrow \gamma$ ⬭

B $p + \bar{p} \rightarrow \gamma + \gamma$ ⬭

C $\beta^- + p \longrightarrow \gamma$ ⬭

D $\gamma + \gamma \longrightarrow \beta^+ + \beta^-$ ⬭

(Total 1 mark)

Q50.

Which of the following is **not** made of quarks?

A kaon ⬭

B muon ⬭

C neutron ⬭

D pion ⬭

(Total 1 mark)

Q51.

What is the quark structure for antiprotons?

A $\bar{u}\bar{d}$ ⬭

B $\bar{d}\bar{d}\bar{s}$ ⬭

C $\bar{d}\bar{d}\bar{u}$ ⬭

D $\bar{u}\bar{u}\bar{d}$ ⬭

(Total 1 mark)

Q52.

The element uranium has an isotope $^{237}_{92}U$.

(a) Explain what is meant by an isotope.

_____

_____

_____

_____

(2)

STEMUP.CO.UK

(b) Determine the charge in coulomb of the $^{237}_{92}U$ nucleus.

charge = _____ C

(2)

(c) A positive ion of $^{237}_{92}U$ has a charge of $+4.80 \times 10^{-19}$ C.

Determine the number of electrons in the ion.

number of electrons = _____

(2)

(d) $^{237}_{92}U$ decays by β^- emission to form an isotope of neptunium (Np).

Complete the equation for this decay.

$$^{237}_{92}U \rightarrow \text{.....}Np + \text{.....} \beta^- + \text{.....}$$

(3)

(Total 9 marks)

Q53.

The positive kaon (K^+) has a strangeness of +1.

(a) Which of the following is the quark composition of the positive kaon?
Tick (✓) the correct answer.

	✓ if correct
$\bar{u}s$	
$uu\bar{s}$	
$u\bar{s}$	
$\bar{d}\bar{d}s$	

(1)

(b) The equation shows a possible decay of the positive kaon.

$$K^+ \longrightarrow \mu^+ + \nu_\mu$$

STEMUP.CO.UK

(i) Show that lepton number is conserved in this decay.

(1)

(ii) State a quantity that is not conserved in this decay.

_____

(1)

(iii) Complete the following table using ticks to indicate correct classifications for each particle. The first column has been completed for you.

	Charged	**Hadron**	**Meson**	**Baryon**	**Lepton**
K^+	✓				
μ^+	✓				
ν_μ					

(3)

(c) The positive kaon can also decay to form a π^+ and one other particle X. Deduce the identity of X.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q54.

Under certain conditions a photon may be converted into an electron and a positron.

(a) State the name of this process.

_____

(1)

(b) For the conversion to take place the photon has to have an energy equal to or

STEMUP.CO.UK

greater than a certain minimum energy.

(i) Explain why there is a minimum energy.

_____

_____

(2)

(ii) Show that this minimum energy is about 1 MeV.

(1)

(iii) Explain what happens to the excess energy when the photon energy is greater than the minimum energy.

_____

_____

(1)

(iv) A photon has an energy of 1.0 MeV.

Calculate the frequency associated with this photon energy.
State an appropriate unit in your answer.

frequency = _____ unit = _____

(4)

(Total 9 marks)

Q55.

(a) Name the only stable baryon.

_____

(1)

(b) (i) When aluminium-25($^{25}_{13}$Al) decays to magnesium-25 (Mg-25) an electron neutrino (ν_e) and another particle are also emitted.

Complete the equation to show the changes that occur.

$$^{25}_{13}\mathrm{Al} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{Mg} + {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + \nu_e$$

(2)

(ii) Name the exchange particle responsible for the decay.

STEMUP.CO.UK

_____

(1)

(Total 4 marks)

Q56.

The table below contains five statements that refer to isotopes and some radium isotopes.

	$^{223}_{88}Ra$	$^{224}_{88}Ra$	$^{225}_{88}Ra$	$^{226}_{88}Ra$
Isotope with the smallest mass number	✓			
Isotope with most neutrons in nucleus				
Isotope with nucleus which has the largest specific charge				
Isotope decays by β^- decay to form $^{225}_{89}Ac$				
Isotope decays by alpha decay to form $^{220}_{86}Rn$				

(a) Complete the table by ticking **one** box in each row to identify the appropriate isotope. The first row has been completed for you.

(4)

(b) (i) An atom of one of the radium isotopes in the table is ionised so that it has a charge of $+3.2 \times 10^{-19}$ C.

State what happens in the process of ionising this radium atom.

_____

_____

(1)

(ii) The specific charge of the ion formed is 8.57×10^{5} C kg^{-1}.

Deduce which isotope in the table has been ionised. Assume that both the mass of a proton and the mass of a neutron in the nucleus is 1.66×10^{-27} kg.

isotope = _____

(3)

(Total 8 marks)

STEMUP.CO.UK

Q57.

The equation shows an interaction between a proton and a negative kaon that results in the formation of particle, X.

$$K^- + p \rightarrow K^+ + K^0 + X$$

(a) (i) State and explain whether X is a charged particle.

_____

_____

(2)

(ii) State and explain whether X is a lepton, baryon or meson.

_____

_____

(2)

(iii) State the quark structure of the K^-, K^+ and the K^0.

K^- _____

K^+ _____

K^0 _____

(3)

(iv) Strangeness is conserved in the interaction.

Determine, explaining your answer, the quark structure of X.

_____

_____

_____

_____

(3)

(Total 10 marks)

Q58.

(a) Baryons, mesons and leptons are affected by particle interactions.

Write an account of these interactions. Your account should:

- include the names of the interactions
- identify the groups of particles that are affected by the interaction
- identify the exchange particles involved in the interaction
- give examples of **two** of the interactions you mention.

STEMUP.CO.UK

The quality of your written communication will be assessed in your answer.

(6)

(b) Draw a labelled diagram that represents a particle interaction.

(3)
(Total 9 marks)

Q59.

(a) Complete the following equation for beta minus (β^-) decay of strontium-90 ($^{90}_{38}\mathrm{Sr}$) into an isotope of yttrium (Y).

$$^{90}_{38}\mathrm{Sr} \longrightarrow \ ^{\cdots\cdots}_{\cdots\cdots}\mathrm{Y} + \ ^{\cdots\cdots}_{\cdots\cdots}\beta^- + \ ^{0}_{0}\cdots\cdots$$

(3)

(b) During β^- decay of a nucleus both the nucleon composition and the quark composition change.
State the change in quark composition.

(1)

STEMUP.CO.UK

(c) A positive kaon consists of an up quark and an antistrange quark $(u\,\bar{s})$. This kaon decays by strong and weak interactions into three pions. Two of the pions have quark compositions of $(u\,\bar{d})$. The third pion has a different quark composition.

(i) Name the unique family of particles to which the kaon and pions belong.

_____

(1)

(ii) Tick the box corresponding to the charge of the third pion.

positive ☐ negative ☐ neutral ☐

(1)

(iii) Positive kaons have unusually long lifetimes.
Give a reason why you would expect this to be the case.

_____

_____

(1)

(iv) Name the exchange particles which are involved in the strong and weak interactions of the kaon.

strong interaction _____

weak interaction _____

(1)

(Total 8 marks)

STEMUP.CO.UK