Questions

Q1.

A section from the periodic table is shown.

Element symbol	Zr	Nb	Mo	Tc	Ru	Rh	Pd
Atomic number	40	41	42	43	44	45	46

Technetium (Tc) is produced when a deuterium ion collides with a nucleus of one of the other elements shown in the table. In this process a number of neutrons are also released.

Deuterium is an isotope of hydrogen with 1 proton and 1 neutron.

Complete the nuclear equation to determine the element and the number of neutrons released.

$$^{96}_{\ldots\ldots}\ldots\ldots\ldots + {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{H} \rightarrow {}^{95}_{43}\mathrm{Tc} + \ldots\ldots\ldots\ {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{n}$$

(Total for question = 3 marks)

Q2.

In 1908 Rutherford, Geiger and Marsden investigated the interaction of alpha particles with matter. In one set of experiments they directed alpha particles towards a thin gold foil.

(a) State why the alpha source and gold foil were contained in a vacuum.

(1)

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(b) At that time, one model for the structure of atoms was the plum pudding model proposed by J J Thompson. In this model, the positive charge and mass were spread evenly throughout the atom. Negatively charged electrons were distributed within the atom.

Discuss the extent to which the results of the alpha particle scattering experiments justified replacing the plum pudding model with a nuclear model of the atom.

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(Total for question = 7 marks)

Q3.

In an electron deflection tube, electrons are released by passing a current through a metal filament.

What is the name of the process that releases the electrons?

☒ **A** electron diffraction

☒ **B** ionisation

☒ **C** photoelectric effect

☒ **D** thermionic emission

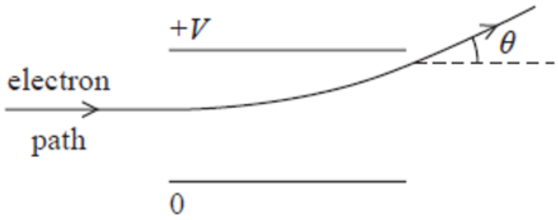
(Total for question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows two metal plates with a potential difference *V* across them.

The path of an electron travelling between the plates is shown.



The electron is deviated through an angle θ.

Which row of the table shows changes that will cause θ to decrease?

		V	Distance between plates
☐	**A**	doubled	halved
☐	**B**	doubled	unchanged
☐	**C**	halved	doubled
☐	**D**	unchanged	halved

(Total for question = 1 mark)

Q5.

There is an electric field around a helium nucleus.

(a) Calculate the electric potential at a distance 26.6×10^{-12} m from a helium ${}^{4}_{2}He$ nucleus.

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Electric potential = ...

(b) State one assumption made for this calculation.

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(Total for question = 4 marks)

Q6.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In the early 20th century, scattering experiments were carried out by directing high speed alpha particles at thin metal foils.

Which of the following could **not** be concluded from these experiments?

☐ **A** Most of the atom is empty space.

☐ **B** The nucleus of the atom is positively charged.

☐ **C** There is a concentration of charge in the atom.

☐ **D** There is a concentration of mass in the atom.

(Total for question = 1 mark)

Q7.

In 2016 the element oganesson was added to the periodic table.

One isotope of oganesson has the symbol $^{294}_{118}\mathrm{Og}$.

Which row of the table shows the number of protons and the number of neutrons in a nucleus of this isotope of oganesson?

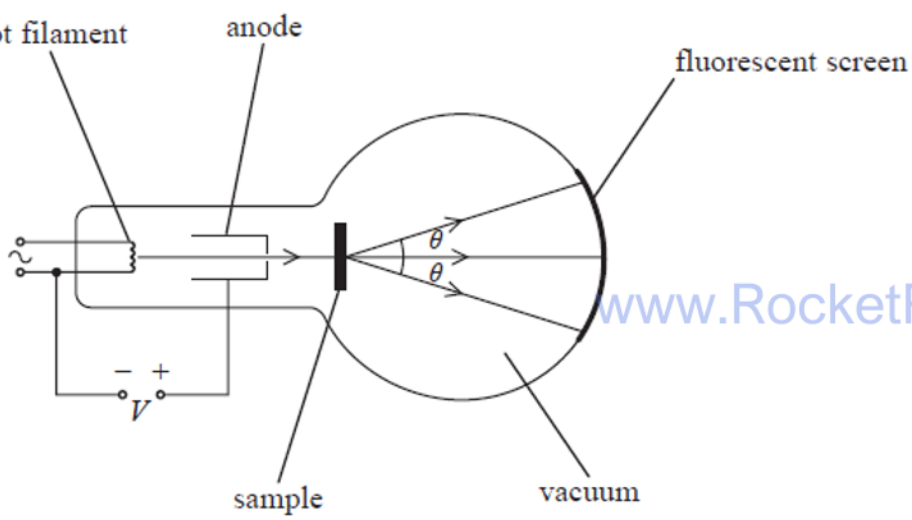
		Number of protons	Number of neutrons
☒	**A**	118	176
☒	**B**	118	294
☒	**C**	176	294
☒	**D**	294	118

(Total for question = 1 mark)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram represents an arrangement to demonstrate electron diffraction.



A beam of electrons is directed at a sample of crystalline material.

Which of the following single changes would decrease the angle of diffraction θ?

☒ **A** decrease the distance between the sample and the screen

☒

B increase the anode potential *V*

☒ **C** increase the current in the filament

☒ **D** use a sample with a smaller atomic spacing

(Total for question = 1 mark)

Q9.

The alpha particle scattering experiments using gold foil were first carried out by a team of scientists led by Rutherford.

*(a) Following these experiments Rutherford said, "It was almost as incredible as if you fired a 15-inch shell (large missile) at a piece of tissue paper and it came back and hit you."

Explain why Rutherford was surprised at the results of the experiment and how this led to the nuclear model for the atom.

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(b) Explain why the thickness of the gold foil had to be very small.

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(Total for question = 8 marks)

Q10.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In the early 20th century experiments were carried out to measure the scattering of alpha particles after striking thin gold foil.

Which of the following could **not** be concluded from the results of these experiments?

☐ **A** The nucleus is charged.

☐ **B** The nucleus contains most of the mass of the atom.

☐ **C** The nucleus contains neutrons and protons.

☐ **D** The nucleus is very small compared to the atom.

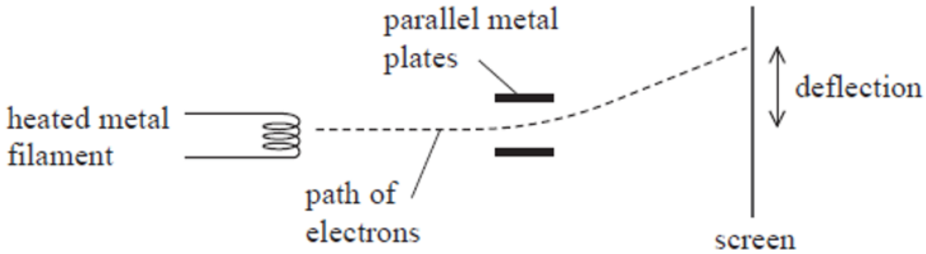
(Total for question = 1 mark)

Q11.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question refers to a cathode ray tube.

The diagram shows some of the components in a cathode ray tube.



Electrons are released from the heated metal filament.

Which of the following is the name of this process?

☒ **A** ionisation

☒ **B** photoelectric emission

☒ **C** relativistic effect

☒ **D** thermionic emission

(Total for question = 1 mark)

Q12.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

$^{17}_{8}O$ is an isotope of oxygen.

Which row of the table gives the number of nucleons and the number of neutrons in an atom of $^{17}_{8}O$?

	Number of nucleons	Number of neutrons
☒ **A**	8	8
☒ **B**	8	9
☒ **C**	17	8
☒ **D**	17	9

(Total for question = 1 mark)

Q13.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following describes why electrons are released from the metal filament during thermionic emission?

☐ **A** The metal filament is heated by an electric current.

☐ **B** The metal filament is contained within a vacuum.

☐ **C** The metal filament is bombarded by high-energy electrons.

☐ **D** The metal filament is maintained at a high potential.

(Total for question = 1 mark)

Q14.

Alpha particles were chosen by Rutherford for large-angle scattering experiments.

(a) Explain why alpha particles are more suitable for these experiments compared to beta particles or gamma rays.

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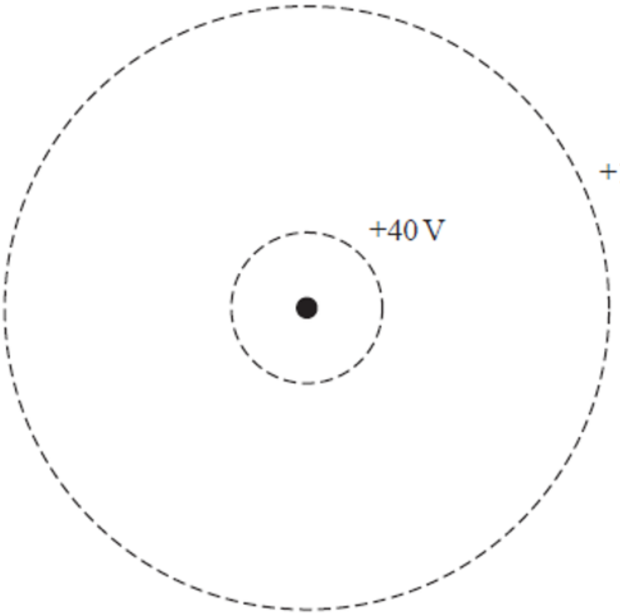
(b) The scaled diagram shows two equipotential lines in the electric field around a gold nucleus.



(i) Sketch lines to show the electric field between these two lines of equipotential.

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(ii) The 40 V line is drawn to scale correctly.

Deduce whether the 10 V equipotential line is in the correct scaled position.

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(iii) An alpha particle moves from the +10 V potential to the +40 V potential.

Calculate the increase in the potential energy of the alpha particle in eV.

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Increase in potential energy = ... eV

(Total for question = 12 marks)

Q15.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following is a valid conclusion from alpha particle scattering experiments?

☒ **A** Atoms contain positive and negative charge distributed evenly.

☒ **B** The nucleus of an atom contains protons and neutrons.

☒ **C** The nucleus of an atom is very small compared to the size of the atom.

☒ **D** Atoms contain very little empty space.

(Total for question = 1 mark)

Q16.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In an electron gun, electrons are released from a heated filament.

Which of the following is the name of this process?

☒ **A** annihilation

☒ **B** ionisation

☒ **C** photoelectric effect

☒ **D** thermionic emission

(Total for question = 1 mark)

Q17.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A nucleus of ${}^{38}_{19}\mathrm{K}$ emits a β^+ particle.

Which row of the table shows the proton number and nucleon number of the nucleus that is produced?

		Proton number	Nucleon number
☒	**A**	18	39
☒	**B**	18	38
☒	**C**	20	38
☒	**D**	20	37

(Total for question = 1 mark)

Q18.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In the early 20th century, scientists carried out alpha particle scattering experiments.

Which of the following is **not** a conclusion from the scientists' observations during these experiments?

☒ **A** Most of the atom is empty space.

☒ **B** The nucleus contains most of the mass of the atom.

☒ **C** The nucleus is made up of protons and neutrons.

☒ **D** There is a concentration of charge in the atom.

(Total for question = 1 mark)

Q19.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The nucleus of an isotope of osmium (Os) contains 76 protons and 190 neutrons.

Which of the following can be used to represent this isotope?

☒ **A** $^{266}_{76}Os$

☒ **B** $^{190}_{76}Os$

☒ **C** $^{76}_{190}Os$

☒ **D** $^{76}_{266}Os$

(Total for question = 1 mark)

Q20.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following is **not** a valid conclusion from Rutherford's alpha particle scattering experiments?

☒ **A** The nucleus contains most of the mass of the atom.

☒ **B** The nucleus contains protons and neutrons.

☒ **C** The nucleus is charged.

☒ **D** The nucleus is very small compared with the atom.

(Total for question = 1 mark)

Q21.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A nucleus of element X emits an alpha particle to produce the nucleus $^{233}_{91}\mathrm{Y}$.

Which of the following is the correct nucleon structure of element X?

☒ **A** 95 protons and 235 neutrons

☒ **B** 93 protons and 144 neutrons

☒ **C** 93 protons and 237 neutrons

☒ **D** 89 protons and 138 neutrons

(Total for question = 1 mark)

Q22.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following statements is **not** a valid conclusion from alpha particle scattering experiments?

☒ **A** Most of the atom is empty space.

☒ **B** Most of the mass of the atom is concentrated in the nucleus.

☒ **C** The nucleus contains all of the charge of the atom.

☒ **D** The radius of the nucleus is very small compared to the radius of the atom.

(Total for question = 1 mark)