Topical Practice

IGCSE

PHYSICS

Paper 4

Chapters 13 – 14

EDITION • Volum • STUDENT

CONTENTS

Chapter 13: Electronics and Electric Circuits

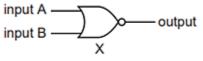1 A student is designing a digital electronics circuit and needs to use the logic gate X shown in Fig. 10.1.
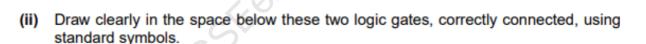

Fig. 10.1

(a) Name the logic gate X. .... [1]

(b) Write down the values of the output when the inputs are
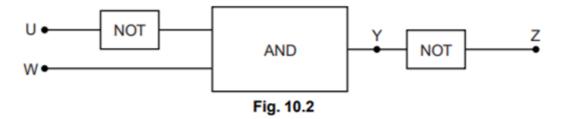
   (i)   input A low (logic 0), input B low (logic 0),   output ....

   (ii) input A low (logic 0), input B high (logic 1),   output ....

   (iii) input A high (logic 1), input B low (logic 0),   output ....

   (iv) input A high (logic 1), input B high (logic 1).   output ....
   [2]

(c) When the student starts to build the circuit, he finds that the store room has run out of this type of logic gate. There is a supply of AND, OR and NOT gates. The student's teacher explains that a combination of two of these gates may be used instead of logic gate X.

   (i)   State the two gates he should use to replace logic gate X.

   .... and ....

   (ii) Draw clearly in the space below these two logic gates, correctly connected, using standard symbols.

   [3]

(d) Fig. 10.2 shows a block diagram, not using standard symbols, of a combination of gates.

Fig. 10.2

State the logic levels of points Y and Z when the logic levels of points U and W are both 1.

   logic level at point Y ....

   logic level at point Z ....
   [2]

[Total: 8]

3

2 Fig. 11.1 shows part of a circuit designed to switch on a security lamp when it gets dark.
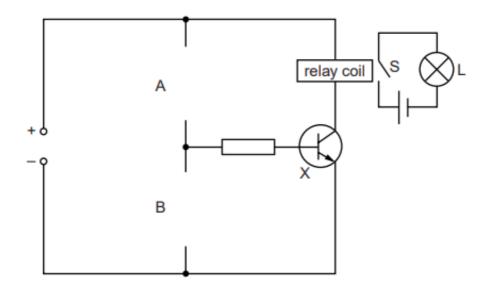
Fig. 11.1

When there is a current in the relay coil, switch S closes and the lamp L comes on.

(a) Write down the name of the component X.   .... [1]

(b) The circuit has gaps at A and at B.

State the components that need to be connected into these gaps for the circuit to perform its required function.

gap A ....

gap B ....
[3]

(c) The circuit in Fig. 11.1 is modified. The function of lamp L is now to give a warning when the temperature becomes too high.

State any necessary changes of components in the circuit.

....

....

.... [2]

[Total: 6]

3 A warning bell is fitted in a photographic dark room. In the dark, the bell is silent but in bright light, it rings. Two circuits linked by a relay R control the bell B. Fig. 10.1 is the circuit diagram for the arrangement.

Fig. 10.1

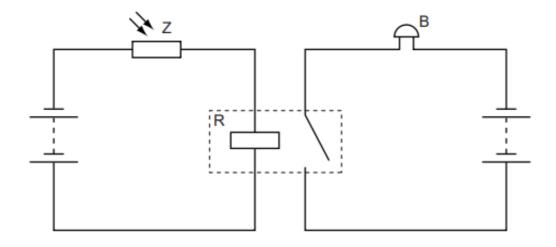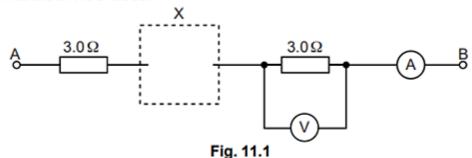(a) (i) State the name of component Z.

.... [1]

(ii) Explain why B rings in bright light.

....

....

....

....

....

....

.... [4]

(b) A change is made to one of the circuits so that B starts to ring when the temperature in the room rises.

State the change made.

....

.... [1]

[Total: 6]

4 A student carries out an experiment with the circuit shown in Fig. 11.1. The component in the dashed box labelled X is a diode.

Fig. 11.1

(a) On Fig. 11.1, draw the correct symbol for a diode, connected either way round, in the dashed box labelled X. [1]

(b) (i) +6.0V is applied to point A, 0V to point B.

State what the student observes on the ammeter.

....

(ii) −6.0V is applied to point A, 0V to point B.

State what the student observes on the ammeter.

....
[2]

(c) The voltage shown in Fig. 11.2 is applied to the point A of the circuit in Fig. 11.1. Point B is kept at 0V.

On Fig. 11.2, draw a graph of the readings indicated by the voltmeter.

Fig. 11.2

[2]

6
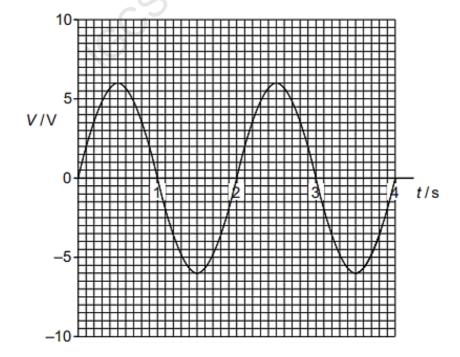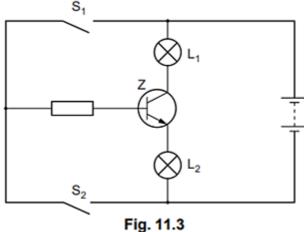
(d) The circuit shown in Fig. 11.3 contains two switches S_1 and S_2 and two indicator lamps L_1 and L_2.

Fig. 11.3
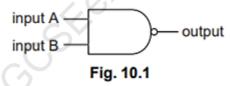
(i) Name component Z. .... [1]

(ii) Complete the table to state whether the lamps are on or off with the switches in the positions stated.

switch S_1	switch S_2	lamp L_1	lamp L_2
open	closed		
closed	open		

[2]

[Total: 8]

5 Fig. 10.1 is the symbol for a NAND gate with inputs A and B.

Fig. 10.1

(a) Input A and input B can be set to 1 (high) or to 0 (low).

Complete the table below to give the outputs for this NAND gate.

input A	input B	output
0	0	
0	1	
1	0	
1	1	

[1]

(b) The two inputs of the NAND gate are joined together and connected to an input C, as shown in Fig. 10.2.
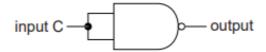
Fig. 10.2
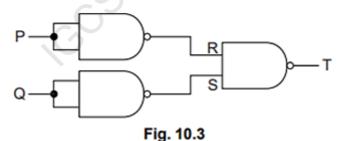
(i) Determine the output of this NAND gate when

    1.   input C is set to 0,

                                                     output = ...

    2.   input C is set to 1.

                                                     output = ...

                                                                      [1]

(ii) State the name of the logic gate that behaves in the same way as the NAND gate in Fig. 10.2.

.... **[1]**

(c) A circuit combines three NAND gates.

The inputs to the circuit are P and Q, as shown in Fig. 10.3.

Fig. 10.3

Points R, S and T in the circuit are also labelled.

Input P is set to 0 and input Q is set to 1.

Determine the logic states (0 or 1) of points R, S and T.

                                                  point R = ...

                                                  point S = ...

                                                  point T = ...

                                                               [2]

                                                                [Total: 5]

6 Fig. 11.1 shows the main components of a cathode-ray oscilloscope.
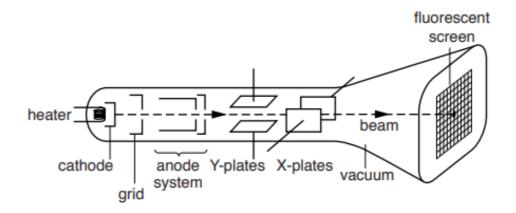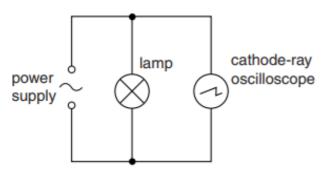
Fig. 11.1

(a) (i) Name the particles that are in the beam.

....[1]

(ii) Explain the purpose of the heater.

....[1]

(iii) Explain why there is a vacuum in the tube.

....

....[1]

(b) When no potential difference (p.d.) is applied across either the X-plates or the Y-plates, a spot is seen in the centre of the fluorescent screen.

Describe the p.d.s applied to the X-plates and to the Y-plates when the spot moves up and down in the centre of the screen.

X-plates ....

Y-plates ....

[2]

[Total: 5]

7   An a.c. power supply is connected in series with a metal-filament lamp. A cathode-ray oscilloscope (c.r.o.) is in parallel with the lamp, as shown in Fig. 8.1.

Fig. 8.2 is the trace seen on the c.r.o. screen.
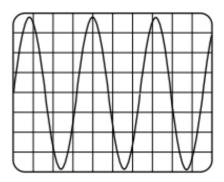
Fig. 8.1

Fig. 8.2

A diode is inserted in the circuit, as shown in Fig. 8.3.
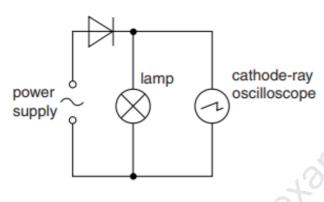
Fig. 8.3

Fig. 8.4

(a) (i)   On Fig. 8.4, draw the shape of the trace now seen on the screen.   [2]

   (ii)   Suggest a device that uses a diode in this way.

   .... [1]

(b) State and explain the effect on the lamp of inserting the diode into the circuit.

   ....

   ....

   .... [2]

[Total: 5]

8 (a) (i) Fig. 10.1 shows the symbol for a logic gate.

Fig. 10.1

Name this logic gate.

....

(ii) Draw the symbol for a NOR gate.

[2]

(b) (i) The two inputs of a NAND gate are both low (logic level 0).

Write down the output state.

....

(ii) One input of a NAND gate is low (logic level 0) and the other input is high (logic level 1).

Write down the output state.

....[2]

(c) A logic gate contains a number of components.

Circle **one** of the following that is contained in a logic gate.

thermistor   transformer   transistor   transmitter   [1]

[Total: 5]

9 (a) Fig. 10.1 shows an electron beam travelling, in a vacuum, towards the space between a pair of oppositely-charged parallel plates.
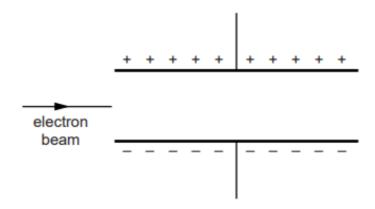
Fig. 10.1

On Fig. 10.1, draw carefully the path of the beam between the plates **and** in the space to the right of the plates.   [2]

(b) The screen of a cathode-ray oscilloscope (c.r.o.) has a grid of 1 cm squares. Fig. 10.2 shows the trace of an alternating voltage on this screen.
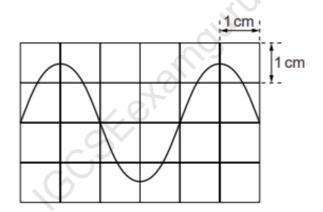
Fig. 10.2

(i) A potential difference of 5.0 V across the Y-plates of the oscilloscope moves the spot on the screen a vertical distance of 1.0 cm.

Use Fig. 10.2 to determine the maximum p.d. across the Y-plates.

maximum p.d. = ... [1]

(ii) The spot on the screen takes 1.0 ms to move 1.0 cm horizontally.

From Fig. 10.2, determine the time for 1 cycle of the waveform on the screen, and use this time to find the frequency of the alternating voltage.

frequency = ... [3]

[Total: 6]

10 (a) Describe the action of

    (i) a NOT gate,

    .... [1]

    (ii) a thermistor.

    .... [1]

(b) Fig. 11.1 shows a circuit that switches on a warning lamp when the temperature in an oven falls below a set value.
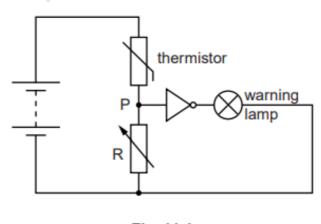
Fig. 11.1

Explain, with reference to the components in the circuit and point P,

(i) why the warning lamp is on when the temperature in the oven is below the set value,

....

....

....

....

....

....

.... [4]

(ii) the effect of changing the resistance of R.

....

.... [1]

[Total: 7]

11 A battery charger includes a transformer and a rectifier.

Fig. 11.1 represents the transformer, consisting of an iron core with two coils P and Q wound on to the core.

coil P, 40 000 turns   coil Q, 2000 turns

iron core   **Fig. 11.1**

(b) The output of Q is connected to the rectifier circuit.

State

(i) the name of the circuit component that is used in a rectifier circuit to rectify the a.c. (alternating current),

.... [1]

(ii) the property of this component that is used to rectify the current.

.... [1]

[Total: 7]

14

12 (a) Fig. 10.1 shows a digital logic circuit, not using the recognised symbols.
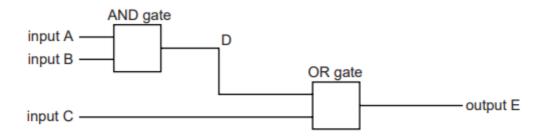
Fig. 10.1

Complete the table below to indicate the logic levels of points D and E in the circuit, when points A, B and C are at the logic levels indicated.
0 represents low or off. 1 represents high or on.

A	B	C	D	E
0	0	0		
0	0	1		
1	1	1		

[3]

(b) Draw the recognised symbol for an AND gate.

[1]

(c) A NAND gate can be replaced by an AND gate and a NOT gate.

Draw a diagram to show how the AND gate and the NOT gate should be connected. Label clearly the logic gates and any input or output.

[2]

[Total: 6]

13 A charger for a cellphone (mobile phone) is marked:

input: a.c. 240V, 50Hz, 80mA.
output: d.c. 5.3V, 500mA.

(a) State

(i) the component in the charger that converts a.c. to d.c.,

....

(ii) the quantity that has the value 50Hz.

....
[2]

14 Fig. 11.1 shows the main components of a cathode-ray oscilloscope.

Fig. 11.1
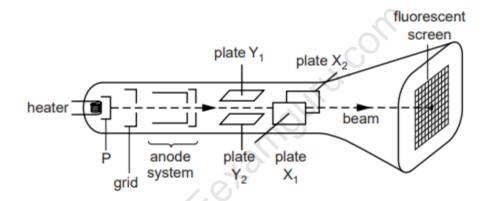
(a) **(i)** State the function of component P.

....

....[1]

(ii) Tick **one** box to complete the sentence correctly.

A cathode-ray oscilloscope contains

☐ air at about five times normal atmospheric pressure.

☐ air at about normal atmospheric pressure.

☐ air at about one fifth of normal atmospheric pressure.

☐ a vacuum.

☐ neon gas.

[1]

(b) Fig. 11.2 shows the front view of the screen of the cathode-ray oscilloscope.
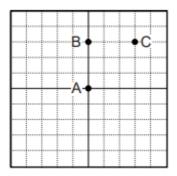
Fig. 11.2

With no voltage applied between the X-plates or between the Y-plates, the spot is at A.

(i) Place **two** ticks in **each** of the blank columns of the table to describe the voltages across the plates when the spot is at points B and C. The column for the spot at A has been completed as an example.

	spot at A	spot at B	spot at C
plate X_1 at higher voltage than plate X_2			
plate X_1 at lower voltage than plate X_2			
no voltage between X-plates	✓		
plate Y_1 at higher voltage than plate Y_2			
plate Y_1 at lower voltage than plate Y_2			
no voltage between Y-plates	✓		

[3]

(ii) Explain your answers for the spot at point B.

....

....

....

....[1]

[Total: 6]

15 (a) Place **one** tick in each row of the table to indicate one use of a thermistor and one use of a transistor.

	heat detector	light detector	magnetic field detector	rectifier	switch
thermistor					
transistor					

[2]

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(b) In Fig. 9.1, lamp A is not glowing brightly.
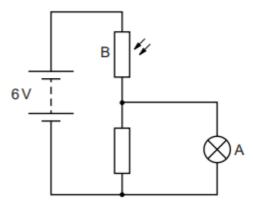
Fig. 9.1

Suggest and explain what could be done to component B to make lamp A glow brightly.

....

....

....

....

....

....**[4]**

[Total: 6]

16 (a) Fig. 9.1 shows the symbol for a logic gate.

Fig. 9.1

    (i) State the name of this gate.

    ....
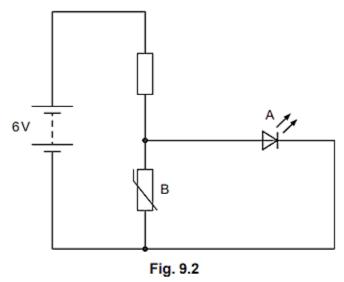
    (ii) On Fig. 9.1, clearly label an input and an output.

        [2]

(b) In the space below, draw the symbol for a fuse.

[1]

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(c) Fig. 9.2 shows a circuit.

Fig. 9.2

Component A is not emitting light. It only emits light when the p.d. across it is greater than 1V.

(i) A change to the environment around component B causes component A to emit light.

State the environmental change.

....[1]

(ii) Explain your answer to **(i)**.

....

....

....

....[3]

17 (a) Fig. 10.1 shows the symbol for a logic gate.

Fig. 10.1

(i) State the name of this gate. .... [1]

(ii) On Fig. 10.1, label an input and an output. [1]

(iii) In the space below, draw the symbol for a NAND gate.

[1]

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(b) A very low frequency alternating voltage is applied between A and B in the circuit shown in Fig. 10.2.
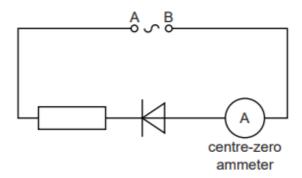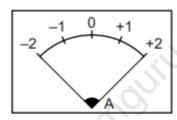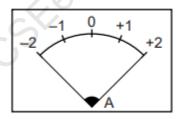
Fig. 10.2

On each diagram, draw a possible position of the indicator needle of the ammeter at the time in the cycle when
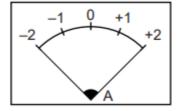
(i) A is positive and B is negative,

(ii) there is no p.d. between A and B,

(iii) A is negative and B is positive.
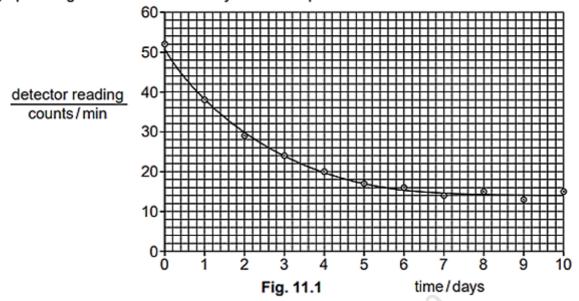
[3]

[Total: 6]

Chapter 14: Atomic Physics

1 In a research laboratory, a radioactive sample is placed close to a radiation detector. The graph in Fig. 11.1 shows the decay of the sample.

Fig. 11.1

(a) After 6 days the count rate hardly decreases and, in fact, increases a little at times. Explain these observations.

....

....

....

.... [2]

(b) Use the graph to determine the half-life of the sample. Explain your working carefully.

half-life = ... [4]

(c) Another radioactive sample is a strong emitter of α-particles and γ-rays. A junior researcher suggests that a sufficient safety precaution, when working with this sample, would be to hold the sample with long forceps. Explain why this suggestion, although helpful, may be insufficient.

....

....

....

.... [2]

[Total: 8]

21

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2 (a) Fig. 10.1 shows a wire PQ placed between the poles of a magnet. There is a current in wire PQ.
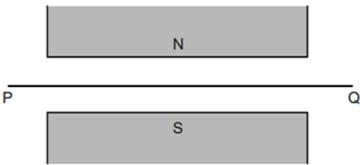
Fig. 10.1

(b) The wire PQ in Fig. 10.1 is replaced by a narrow beam of β-particles travelling from left to right.

(i) Suggest a suitable detector for the β-particles.

.... [1]

(ii) State the direction of the force on the β-particles.

.... [1]

(iii) Describe the path of the β-particles in the space between the poles of the magnet.

....

.... [1]

(iv) State what happens to the air molecules along the path of the β-particles.

.... [1]

[Total: 6]

3 The isotope thorium-234 is radioactive. It emits β-particles as it decays.

(a) The incomplete nuclide equation represents the decay of thorium-234 to an isotope of protactinium (Pa).

Complete the equation.

$$^{234}_{90}\text{Th} \rightarrow \ ^{......}_{......}\text{Pa} + \ ^{......}_{......}\beta$$

[3]

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(b) Fig. 11.1 shows a beam of β-particles from a sample of thorium-234 passing into the electric field between two charged plates in a vacuum.

+ + + + + + + + + +
_____

beam of β-particles ➔

_____
– – – – – – – – –
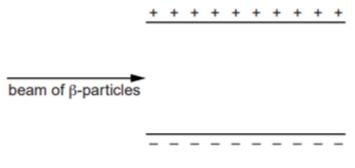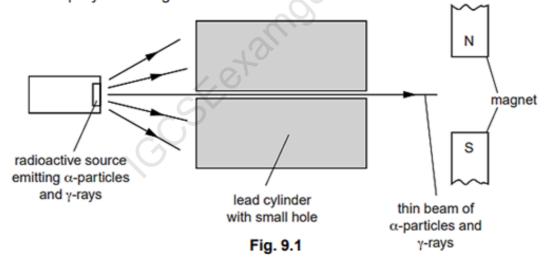
Fig. 11.1

(i) By drawing on Fig. 11.1, show how the β-particles move as they pass between the plates. [1]

(ii) Explain why the β-particles move in this way.

....

.... [1]

[Total: 5]

4 Fig. 9.1 shows an experiment carried out **in a vacuum** to investigate the deflection of α-particles and γ-rays in a magnetic field.

radioactive source
emitting α-particles
and γ-rays

lead cylinder
with small hole

thin beam of
α-particles and
γ-rays

magnet

N

S

Fig. 9.1

(a) Complete the table to describe the deflection, if any, of the α-particles and the γ-rays in the magnetic field shown. Place **one** tick in **each** column.

possible deflection	α-particles	γ-rays
no deflection		
towards N pole of magnet		
towards S pole of magnet		
out of paper		
into paper		

[3]

(b) The experiment of Fig. 9.1 was carried out in a vacuum.

State the effect of carrying out the experiment in air.

....

....

.... [2]

(c) State and explain the purpose of the lead cylinder.

....

....

.... [2]

[Total: 7]

5 (a) A radioactive source emits α-, β- and γ-radiation.

Which of these radiations

(i) has the shortest range in air, ...

(ii) has a negative charge, ...

(iii) is not deflected in a magnetic field? ....

[2]

(b) In a famous experiment, carried out in a vacuum, a very thin sheet of gold was placed in the path of alpha particles.

It was found that a large number of the alpha particles passed through the sheet with little or no deflection from their original path. A very small number of the alpha particles were reflected back towards the source.

(i) Explain, in terms of the force acting, why the direction of motion of an alpha particle changes when it comes close to the nucleus of a gold atom.

....

....

.... [2]

(ii) State **two** conclusions, about the nuclei of atoms, that were made from the results of this experiment.

1. ....

....

2. ....

....

[2]

[Total: 6]

6 In a laboratory experiment, the isotope uranium-238 is used as a source of α-particles.

(a) State

(i) one feature of uranium-238 nuclei that is the same for the nuclei of other uranium isotopes,

.... [1]

(ii) one feature of uranium-238 nuclei that is different for the nuclei of other uranium isotopes.

.... [1]

(b) Fig. 9.1 shows the α-particles from the uranium source being directed at a very thin gold foil, in a vacuum.

thin gold foil

moveable
α-particle
detector

uranium source

vacuum

α-particles

Fig. 9.1
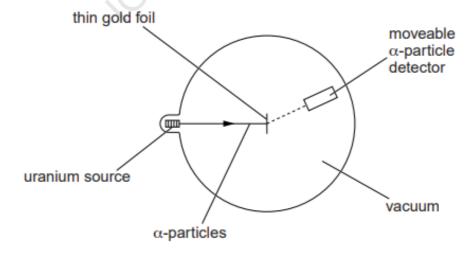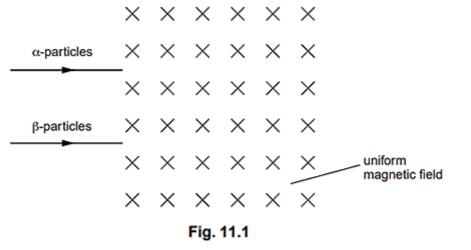
To investigate the scattering of α-particles, a detector is moved to different positions around the very thin gold foil and measurements are recorded.

Describe the results from this scattering experiment and explain what they show about the structure of atoms.

....

....

....

....

....

....

.... [4]

[Total: 6]

7   There are two stable, naturally occurring isotopes of hydrogen.

Common hydrogen (hydrogen-1) has a proton number of 1 and a nucleon number of 1.

Hydrogen-2 (deuterium) has a nucleon number of 2.

There is also a radioactive isotope of hydrogen called tritium (hydrogen-3), with a nucleon number of 3.

(a) Complete the table for neutral atoms of these isotopes.

	hydrogen-1	hydrogen-2 (deuterium)	hydrogen-3 (tritium)
number of protons			
number of neutrons			
number of electrons			

[3]

(b) Two samples of tritium are stored in aluminium containers of different thickness.

Sample 1 is in a container of thickness 0.5 mm and radiation can be detected coming through the container.

Sample 2 is in a container of thickness 5 mm and no radiation comes through.

(i)   State the type of radiation coming through the container of Sample 1.

....[1]

(ii) Explain your answer to **(b)(i)**.

....

....

....

....[2]

(c) Under conditions of extremely high temperature and pressure, as in the interior of the Sun, hydrogen nuclei can join together.

(i) Name this process.

....[1]

(ii) State whether energy is released, absorbed or neither released nor absorbed during this reaction.

....[1]

(d) When a nucleus of a certain isotope of uranium is bombarded by a suitable neutron, it splits into two smaller nuclei and energy is released.

Name this process.

....[1]

[Total: 9]

8 (a) Complete the following statements.

(i) An α-particle consists of ....

(ii) A β-particle consists of ....

[3]

(b) As α-particles and β-particles pass through a gas, molecules of the gas become ionised.

Explain what is meant by the *ionisation* of a gas molecule.

....

....[1]

(c) Fig. 11.1 shows a beam of α-particles and a beam of β-particles in a vacuum. The beams are about to enter a region in which a very strong magnetic field is acting. The direction of the magnetic field is into the page.

Fig. 11.1
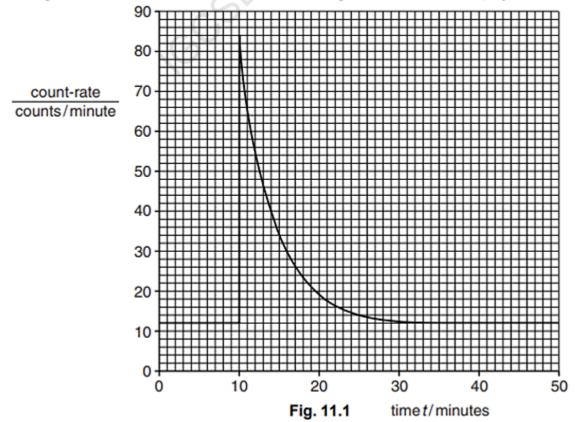
(i) Suggest why the paths of the particles in the magnetic field are curved.

....[1]

(ii) Sketch the paths of both types of particle in the magnetic field. [3]

[Total: 8]

9 In a laboratory at a nuclear power station, a radiation detector is connected to a computer. The readings recorded are displayed on the computer screen.

The detector is switched on. Ten minutes later, at time t = 10 minutes, a small sample of radioactive material is removed from a nuclear reactor and placed near to the detector. Readings are recorded for a further 40 minutes. Fig. 11.1 shows the display.

Fig. 11.1   time t / minutes

28

(a) Use Fig. 11.1 to determine the background count-rate in the laboratory.

background count-rate = ... [1]

(b) Use Fig. 11.1 to determine the count-rate due to the radioactive sample

    (i) at t = 10 minutes,

count-rate due to sample = ...

    (ii) at t = 19 minutes.

count-rate due to sample = ...

[2]

(c) Use the values obtained in **(b)** to estimate the half-life of the radioactive sample.

half-life = ... [2]

[Total: 5]

10 Strontium-90 is a radioactive isotope that emits β-particles as it decays. The nuclear equation below shows this decay.

$$^{90}_{38}\text{Sr} \longrightarrow {}^{a}_{b}\text{X} + {}^{0}_{-1}\text{e}$$

(a) Calculate

    (i) the value of a,

a = ...

    (ii) the value of b.

b = ...

[2]

(b) (i) Tick the element from the list below that is produced by this decay.

element	proton number	place **one** tick in this column
selenium	34	
bromine	35	
krypton	36	
rubidium	37	
strontium	38	
yttrium	39	
zirconium	40	
niobium	41	
molybdenum	42	

[1]

(ii) The isotope $_b^a X$ is also radioactive and undergoes β-decay.

State the name of the element that is produced by this decay.

....[1]

(c) Three nuclei are represented as

$$_{42}^{83}X \qquad _{83}^{209}Y \qquad _{42}^{84}Z$$

State and explain which nuclei are isotopes of the same element.

....

....

....

....[2]

[Total: 6]

11 Fig. 11.1 shows a beam of radiation that contains α-particles, β-particles and γ-rays. The beam enters a very strong electric field between charged plates in a vacuum.

plate at positive voltage

beam of radiation ▶

plate at negative voltage

Fig. 11.1

(a) Indicate the deflection, if any, of the α-particles, β-particles and γ-rays, by placing **one** tick in **each** column of the table.

possible deflection	α-particles	β-particles	γ-rays
no deflection			
towards positive plate			
towards negative plate			
out of the paper			
into the paper			

[3]

(b) The radiation is said to be *ionising*. Explain what this means.

....

....[1]

(c) α-particles are more strongly ionising and have a shorter range in air than γ-rays.

Use your knowledge of the nature of these radiations to explain these differences.

....

....

....

.... [3]

[Total: 7]

12 (a) Complete the table below for the three types of radiation.

radiation	nature	charge	stopped by
γ	electromagnetic radiation		
β		negative	
α			thick paper

[3]

(b) An isotope of strontium is represented in nuclide notation as $^{90}_{38}\text{Sr}$.

For a neutral atom of this isotope, state

(i) the proton number, ...

(ii) the nucleon number, ...

(iii) the number of neutrons, ...

(iv) the number of electrons. ....

[3]

(c) A sample of a radioactive material is placed near a radiation detector. A count-rate of 4800 counts/s is detected from the sample. After 36 hours the count-rate has fallen to 600 counts/s.

Calculate how many more hours must pass for the count-rate to become 150 counts/s.

number of hours = ... [3]

[Total: 9]

13 A technician sets up a radiation detector in a university laboratory, for use in some experiments. Even before the radioactive source for the experiment is brought into the laboratory, the detector registers a low count rate.

(a) Suggest what causes this count rate.

....[1]
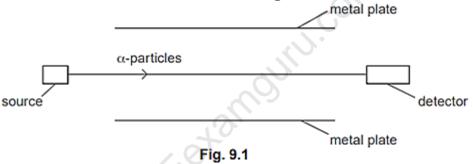
(b) A radioactive source that emits α-particles is placed on the laboratory bench and the source is gradually moved closer to the detector.

At first, the detector continues to register a low count rate sometimes slightly less than the count rate registered without the source. The count rate suddenly increases to a very high value when the source is very close to the detector.

Explain these changes in the count rate.

....

....

....

....

....[3]

(c) In a second experiment, α-particles pass between two parallel, horizontal metal plates in a vacuum.
They then continue to the detector as shown in Fig. 9.1.

Fig. 9.1

A positive charge is established on the upper plate and a negative charge on the lower plate.

(i) On Fig. 9.1, sketch the new path of the α-particles. [2]

(ii) State what happens to the count rate registered by the detector.

....

....[1]

[Total: 7]

14 (a) An underground water pipe has cracked and water is leaking into the surrounding ground.

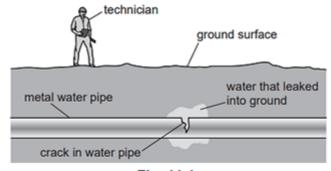Fig. 11.1 shows a technician locating the position of the leak.

Fig. 11.1

A radioactive isotope is introduced into the water supply and the water that leaks from the crack is radioactive.

The technician tries to locate an area above the pipe where the radioactive count rate is higher than in the surrounding area.

(i) State and explain the type of radiation that must be emitted by the isotope for the leak to be detected.

....

....

....[2]

(ii) The half-life of the isotope used is 6.0 hours.

Explain why an isotope with this half-life is suitable.

....

....

....

....[2]

(b) Caesium-133 is a stable isotope of the element caesium, but caesium-135 is radioactive.

A nucleus of caesium-133 contains 78 neutrons and a nucleus of caesium-135 contains 80 neutrons.

Put **one** tick in each row of the table to indicate how the number of particles in a neutral atom of caesium-133 compares with the number of particles in a neutral atom of caesium-135.

The first row has been completed already.

	particles in caesium-133				
	2 more than caesium-135	1 more than caesium-135	equal to caesium-135	1 fewer than caesium-135	2 fewer than caesium-135
number of neutrons					✓
number of protons					
number of nucleons					
number of electrons					

[2]

[Total: 6]

15 (a) State the nature of an α-particle.

....

....[1]

(b) Describe how an electric field between two charged plates could be used to determine whether a beam of particles consists of α- or β-particles.

....

....

....[2]

(c) Describe the path of γ-rays in a magnetic field.

....

....[1]

(d) State what is meant by the term *isotopes*. Use the terms proton number and nucleon number in your explanation.

....

....

....

....

....[3]

[Total: 7]

16 (a) State the nature of γ-rays.

....

.... [1]

(b) A beam of α-particles and β-particles passes, in a vacuum, between the poles of a strong magnet.

Compare the deflections of the paths of the two types of particle.

....

....

.... [2]

(c) A beam of β-particles passes, in a vacuum, through the electric field between a pair of oppositely charged metal plates.

Describe the path of the particles.

....

....

.... [2]

(d) The nuclear equation shows the decay of an isotope of polonium.

$$^{A}_{Z}Po \rightarrow \ ^{206}_{82}Pb + \ ^{4}_{2}X$$

(i) State the nature of X.

....

.... [1]

(ii) Calculate the values of A and Z.

A = ... Z = ... [1]

[Total: 7]

17 Uranium-238 and uranium-234 are radioactive isotopes of the element uranium.

A uranium-238 nucleus is different from a uranium-234 nucleus but both decay by the emission of an α-particle.

(a) (i) In terms of the particles in each, state how a nucleus of uranium-238 differs from a nucleus of uranium-234.

....

....[2]

(ii) Although the two nuclei are different, they are both nuclei of uranium.

State a property that makes these isotopes the same element.

....

....[1]

(b) When α-particles pass through air, they are more strongly ionising than β-particles.

Suggest two reasons why this is so.

....

....[2]

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(c) In an experiment, α-particles are allowed to strike a thin gold foil in a vacuum.

Almost all the α-particles pass straight through the gold undeflected. Only a very small number of α-particles are deflected from their original path.

This result reveals certain features of the atoms of the gold.

State what is shown about atoms by the fact that

(i) most α-particles pass straight through the gold undeflected,

....

....[1]

(ii) some α-particles are deflected back the way they came.

....

....[1]

[Total: 7]

18 (a) The counter of a radiation detector placed close to a radioactive source gives a count rate of 1600 counts/s. The half-life of the source is 1 week.

Ignoring background radiation, calculate the count rate

(i) 1 week after the first measurement,

count rate = ...[1]

(ii) 3 weeks after the first measurement.

count rate = ...[1]

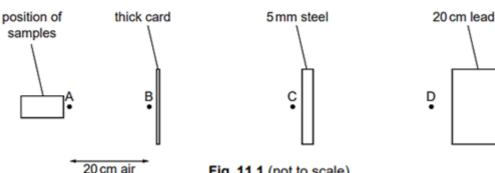**(b)** Fig. 11.1 shows the arrangement for an experiment to investigate the shielding of radioactive sources.

Fig. 11.1 (not to scale)

Samples containing three different radioactive sources are placed, one at a time, in the position shown.

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The table shows the count rates when a radiation detector is placed at the positions A to E.

Complete the table to indicate whether α-particles, β-particles or γ-rays are emitted from each sample.

	A	B	C	D	E	type of radiation emitted
sample 1	high	high	high	high	low	
sample 2	high	high	low	0	0	
sample 3	high	0	0	0	0	

[3]

(c) State which type of radiation, α, β or γ, is the most strongly ionising.

....[1]

[Total: 6]

19 (a) State, in terms of the particles in each nucleus, how the nuclei of two isotopes of the same element are different.

....[1]

(b) Fig. 11.1 shows a graph of nucleon number against proton number. The nucleus $^{212}_{83}$Bi is plotted on the graph at the cross marked P.
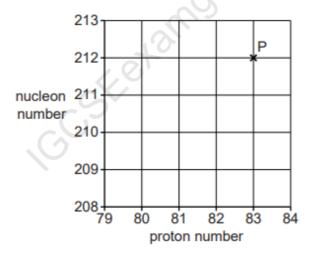

Fig. 11.1

(i) On Fig. 11.1,

1. plot a cross labelled Q for the nucleus formed when the $^{212}_{83}$Bi nucleus emits an α-particle,

2. plot a cross labelled R for the nucleus formed when the $^{212}_{83}$Bi nucleus emits a β-particle.

[4]

(ii) The half-life for the decay of $^{212}_{83}$Bi is 60 minutes.

A sample of $^{212}_{83}$Bi is placed at a fixed distance from a detector. The initial measurement of the count rate from the sample of $^{212}_{83}$Bi is 2400 counts per minute.

Calculate the count rate from the sample 5.0 hours later.

count-rate = ...[2]

[Total: 7]

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