

PJD



OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

PHYSICS B (ADVANCING PHYSICS)
Field and Particle Pictures

2864/01

Friday **20 JUNE 2003** Afternoon 1 hour 10 minutes

Candidates answer on the question paper.
Additional materials:
Data, Formulae and Relationships Booklet
Electronic calculator

Candidate Name	Centre Number	Candidate Number									
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TIME 1 hour 10 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Show clearly the working in all calculations, and give answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

- You are advised to spend about 20 minutes on Section A and 50 minutes on Section B.
- The number of marks is given in brackets [] at the end of each question or part question.
- Four marks are available for the quality of written communication in Section B.
- The values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.

FOR EXAMINER'S USE		
Section	Max.	Mark
A	20	
B	50	
TOTAL	70	

This question paper consists of 16 printed pages.

Answer **all** the questions.

Section A

1 Here is a list of units.

A **C** **J C⁻¹** **T**

Choose the correct unit for

(a) electric potential

(b) magnetic flux density

[2]

2 Fig. 2.1 shows a loop of flux in an electromagnet.

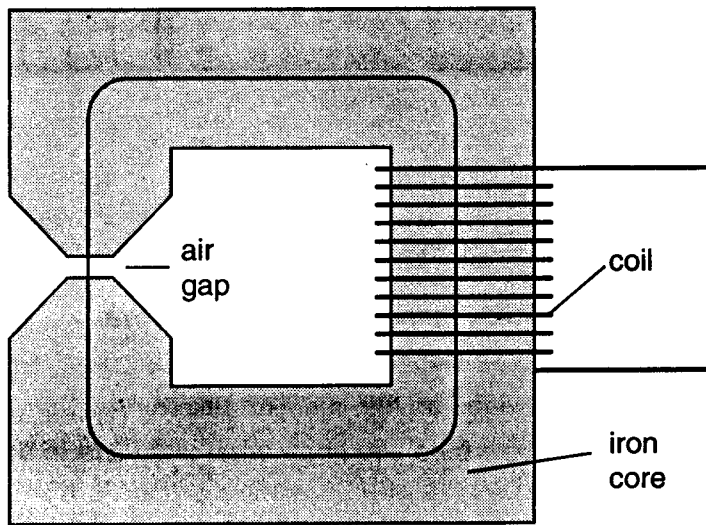


Fig. 2.1

(a) The flux density in the air gap is greater than the flux density in the iron core.

Show this by drawing **two** more loops of flux for the electromagnet.

[2]

(b) Here are some changes to the electromagnet.

- A** decrease the number of turns in the coil
- B** decrease the gap between the poles
- C** decrease the current in the coil

Which **one** of these changes will **increase** the flux density in the gap between the poles?

answer [1]

3 Silicon-31 is an emitter of beta particles. It has a half life of 9.4×10^3 s.

(a) Show that its decay constant λ is about $7 \times 10^{-5} \text{ s}^{-1}$.

[1]

(b) The activity of a radioactive source can be calculated with the relationship

$$\frac{\Delta N}{\Delta t} = -\lambda N.$$

Use the relationship to show that the decay constant has units of s^{-1} .

[1]

(c) Calculate the number of silicon-31 atoms needed to make a source of activity $3 \times 10^3 \text{ Bq}$.

number of atoms = [1]

4 Fig. 4.1 shows some equipotential lines around an electricity power cable at +500 V.

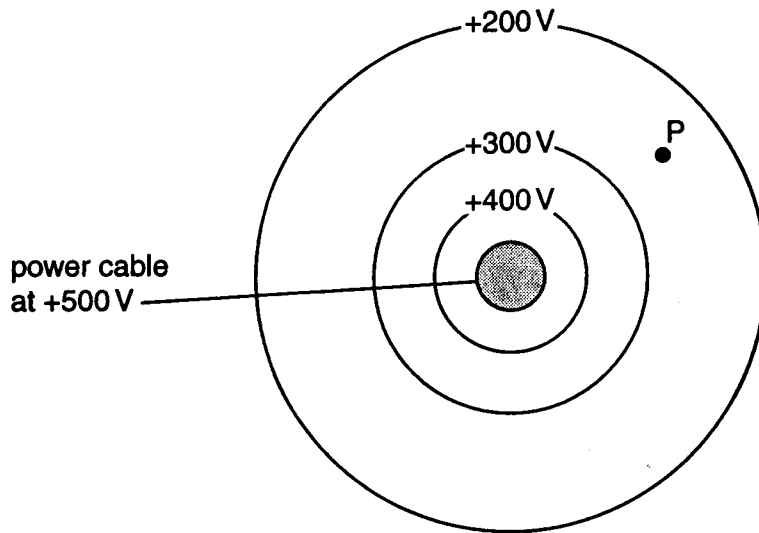


Fig. 4.1

(a) What feature of the diagram shows that the electric field strength is **strongest next to the power cable**?

[1]

(b) On Fig. 4.1, draw a line to represent the direction of the electric field at **point P**.

[2]

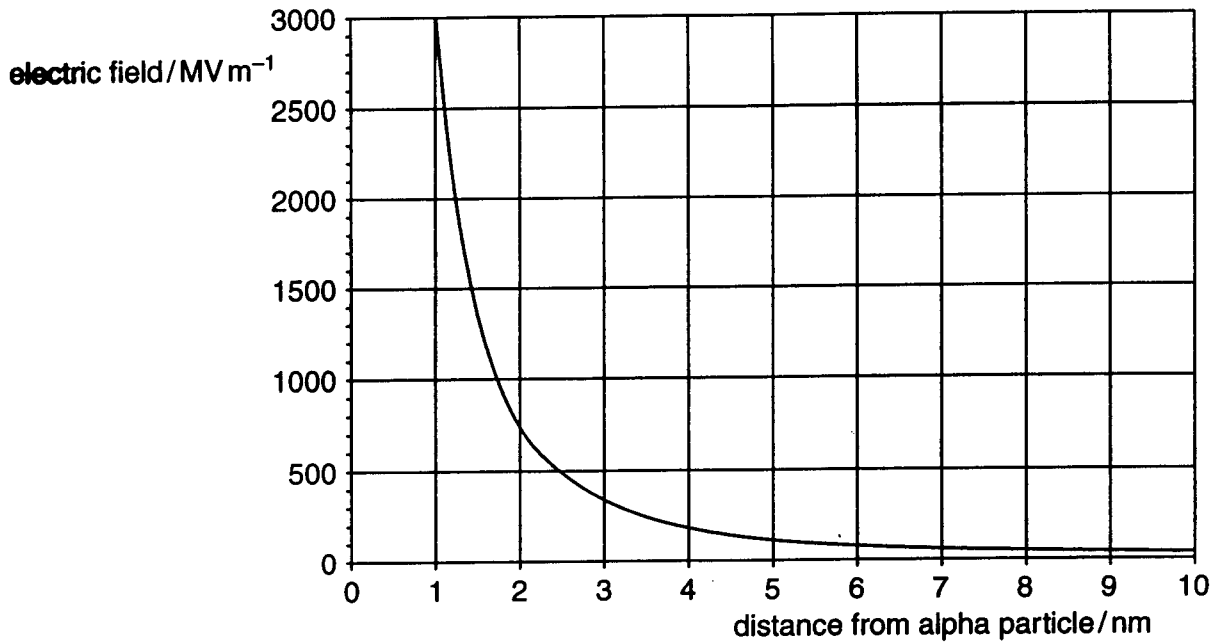
5 Here are some facts about the scattering of a beam of high energy electrons **from a sample of protons**.

- A Most of the electrons in the beam are not scattered at all.
- B Some electrons are scattered through large angles.
- C New particles, other than protons and electrons, are emitted from **the sample**.

Which **one** of these facts provides the best evidence for the presence of **quarks in protons**?

answer [1]

- 6 The graph shows how the electric field strength, in MV m^{-1} , around an alpha particle, changes with distance, in nm, from its centre.



- (a) Show that the area of one square of the grid represents a potential of 0.5 V.

[1]

- (b) The graph can be used to estimate the electrical potential at a point 1.0 nm from the centre of an alpha particle.

Shade the correct area on the graph for this estimate.

[1]

- 7 The typical dose equivalent for a chest X-ray is 2×10^{-4} Sv.
A dose equivalent of 1 Sv gives a person a 3% probability of developing cancer.

Calculate the probability of a person developing cancer from one chest X-ray per year for 25 years.

probability = % [2]

- 8 Fig. 8.1 shows the construction of a commercial transformer.

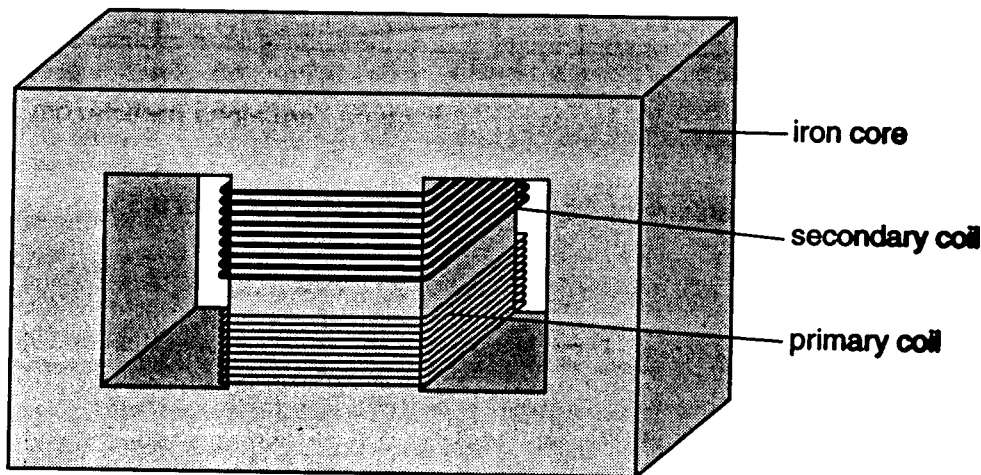


Fig. 8.1

- (a) Here are some facts about the construction of the transformer.

- A Both coils are wound on the same part of the core.
- B The wire in the secondary coil is thicker than the wire in the primary coil.
- C The iron core is made from thin sheets.

Which **one** of these facts ensures that the rate of change of magnetic flux in the primary coil is equal to that in the secondary coil?

answer [1]

- (b) The primary coil of the transformer has 1000 turns and the secondary coil has 200 turns. The primary coil is connected to a 400 V, 50 Hz supply.

Calculate the voltage across the secondary coil, and state its frequency.

voltage = V

frequency = Hz
[3]

[Section A Total: 20]

Section B

In this section, four marks are available for the quality of written communication.

9 This question is about using changing magnetic flux to control the current in an electric circuit.

(a) Fig. 9.1 shows a fluorescent tube.

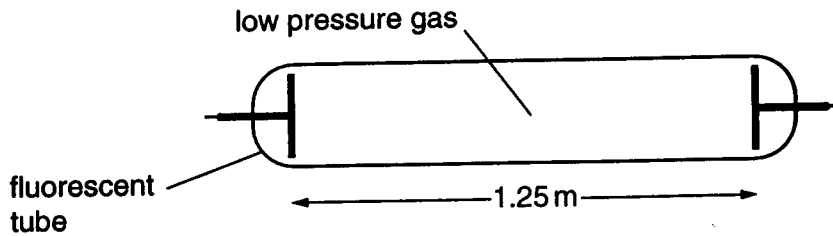


Fig. 9.1

The tube contains a low pressure gas. The gas is normally an electrical insulator. When an alternating potential difference is applied across the tube, the electric field between the electrodes helps to ionise the gas, making it into a conductor.

- (i) The maximum potential difference across the electrodes is 325 V. The distance between the electrodes is 1.25 m.
Calculate the maximum electric field strength between the electrodes.

field strength = V m^{-1} [2]

- (ii) Suggest how the electric field helps to ionise the gas.

[2]

(b) Fig. 9.2 shows the fluorescent tube in series with a choke.

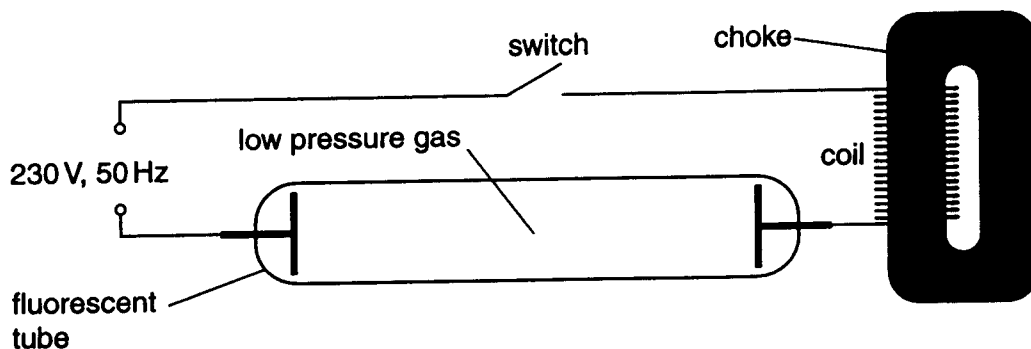


Fig. 9.2

The **choke** is a low resistance coil of wire wound on a loop of iron. This controls the current in the tube when it is conducting. The graph of Fig. 9.3 shows how the **flux linkage** through the choke coil changes with time when the tube is conducting.

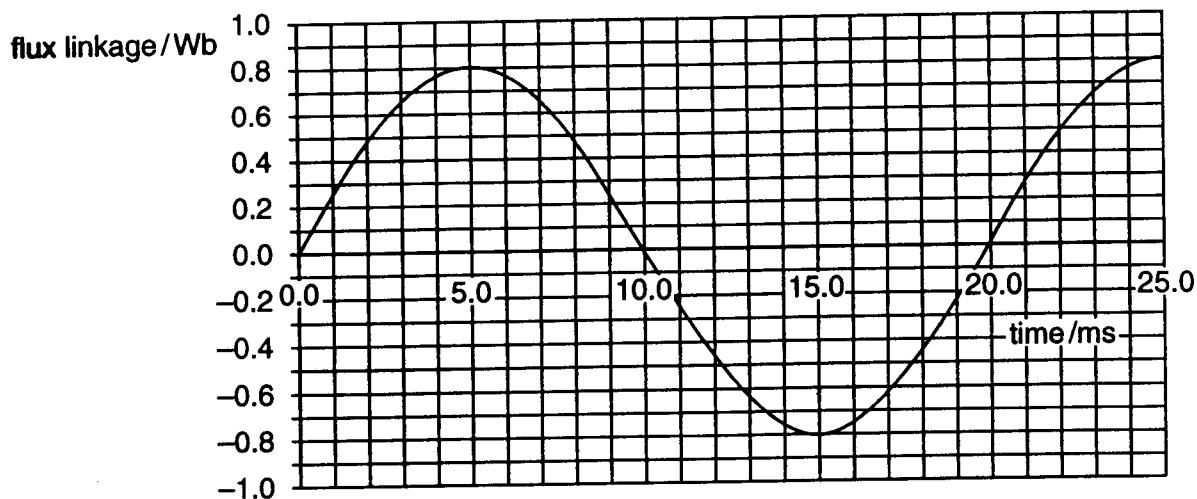


Fig. 9.3

- (i) By measuring a suitable gradient on the graph, find the peak voltage across the coil. Show the gradient clearly on the graph.

peak voltage = V [2]

- (ii) Draw on the graph to show how the voltage across the coil changes with time. The vertical scale is not important.

[1]

- (c) Use ideas about electromagnetism to suggest how the choke in Fig. 9.2 prevents the alternating current in the tube from becoming too large.

[2]

[Total: 9]

10 This question is about the elastic scattering of protons from a nucleus of lead-206.

(a) Fig. 10.1 shows the path A followed by a proton, scattered by a nucleus of lead-206.

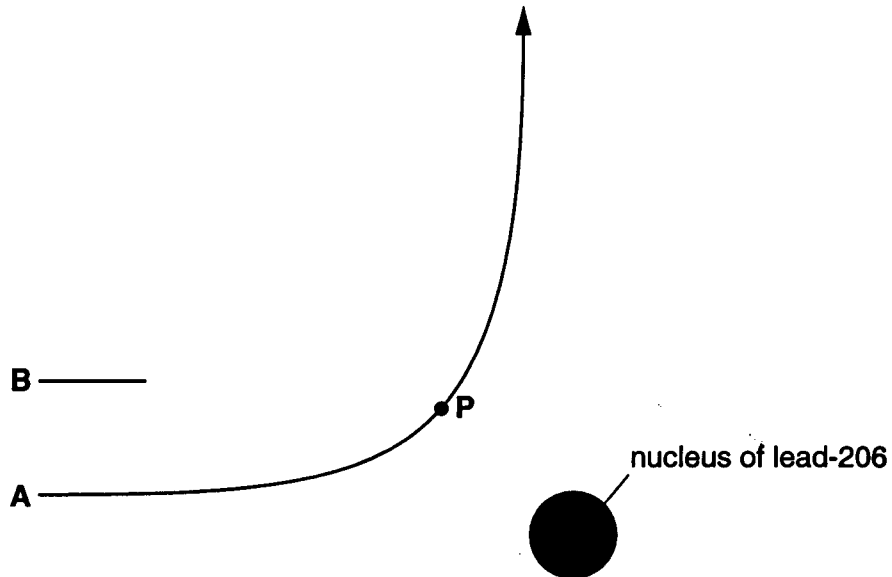


Fig. 10.1

(i) On Fig. 10.1, sketch the path B followed by another proton with the same initial energy.

[3]

(ii) Explain why these protons follow different paths.

[2]

(b) The distance of closest approach to the nucleus for the proton on path **A** is 3.4×10^{-14} m. A lead nucleus contains 82 protons.

(i) Calculate the force on the proton due to the nucleus at this distance.

$$k = 1/4\pi\epsilon_0 = 9.0 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

force = N [3]

(ii) On Fig. 10.1, draw an arrow to show the direction of the force on the proton when it is at point **P**. [1]

(c) The proton following path **A** is scattered through 90° . When lead is bombarded with a beam of monoenergetic protons, one proton in every 100 million is scattered through more than 90° .

State and explain what will happen to this fraction when the energy of the protons in the beam is increased.

[2]

[Total: 11]