General Certificate of Education
January 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION A) PA04
Unit 4 Waves, Fields and Nuclear Energy

Section A

Monday 28 January 2002 Morning Session

In addition to this paper you will require:
- an objective test answer sheet;
- a black or blue ball-point pen;
- a calculator;
- a question paper/answer book for Section B (enclosed).

Time allowed: The total time for Section A and Section B of this paper is 1 hour 30 minutes

Instructions
- Use a blue or black ball-point pen. Do **not** use pencil.
- Answer **all** questions in this section.
- For each question there are four responses. When you have selected the response which you think is the most appropriate answer to a question, mark this response on your answer sheet.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book **not** on the answer sheet.

Information
- The maximum mark for this section is 30.
- Section A and Section B of this paper together carry 15% of the total marks for Physics Advanced.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data Sheet* is provided on pages 3 and 4. You may wish to detach this perforated sheet at the start of the examination.
- The question paper/answer book for Section B is enclosed within this question paper.

Data Sheet

- A perforated Data Sheet is provided as pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- You may wish to detach this sheet before you begin work.

SECTION A

In this section each item consists of a question or an incomplete statement followed by four suggested answers or completions. You are to select the most appropriate answer in each case.

1 A simple pendulum and a mass-spring system are taken to the Moon, where the gravitational field strength is less than on Earth. Which line, **A** to **D**, correctly describes the change, if any, in the period when compared with its value on Earth?

	period of pendulum	period of mass-spring system
A	decrease	decrease
B	increase	increase
C	no change	decrease
D	increase	no change

2 A body moves with simple harmonic motion of amplitude A and frequency $\frac{b}{2\pi}$.

What is the magnitude of the acceleration when the body is at maximum displacement?

A zero

B $4\pi^2 Ab^2$

C Ab^2

D $\frac{4\pi^2 A}{b^2}$

3 A progressive wave in a stretched string has a speed of $20\,\text{m}\,\text{s}^{-1}$ and a frequency of 100 Hz. What is the phase difference between two points 25 mm apart?

A zero

B $\frac{\pi}{4}$ rad

C $\frac{\pi}{2}$ rad

D π rad

4 Which one of the following statements about stationary waves is true?

A Particles between adjacent nodes all have the same amplitude.

B Particles between adjacent nodes are out of phase with each other.

C Particles immediately on either side of a node are moving in opposite directions.

D There is a minimum disturbance of the medium at an antinode.

5 In a double slit interference arrangement the fringe spacing is w when the wavelength of the radiation is λ, the distance between the double slits is s and the distance between the slits and the plane of the observed fringes is D. In which one of the following cases would the fringe spacing also be w?

	wavelength	distance between slits	distance between slits and fringes
A	2λ	$2s$	$2D$
B	2λ	$4s$	$2D$
C	2λ	$2s$	$4D$
D	4λ	$2s$	$2D$

6 Using a diffraction grating with monochromatic light of wavelength 500 nm incident normally, a student found the 2nd order diffracted maxima in a direction at 30° to the central bright fringe. What is the number of lines per metre on the grating?

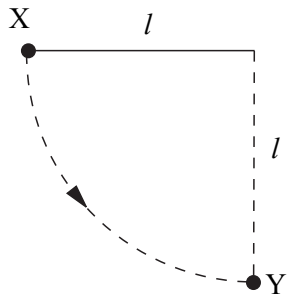
A 2×10^4

B 2×10^5

C 4×10^5

D 5×10^5

7



A ball of mass m, which is fixed to the end of a light string of length l, is released from rest at X. It swings in a circular path, passing through the lowest point Y at speed υ. If the tension in the string at Y is T, which one of the following equations represents a correct application of Newton's laws of motion to the ball at Y?

A $T = \frac{m\upsilon^2}{l} - mg$

B $T - mg = \frac{m\upsilon^2}{l}$

C $mg - T = \frac{m\upsilon^2}{l}$

D $T + \frac{m\upsilon^2}{l} = mg$

8 The gravitational potential difference between the surface of a planet and a point P, 10 m above the surface, is $8.0\,\text{J kg}^{-1}$. Assuming a uniform field, what is the value of the gravitational field strength in the region between the planet's surface and P?

A $0.80\,\text{N kg}^{-1}$

B $1.25\,\text{N kg}^{-1}$

C $8.0\,\text{N kg}^{-1}$

D $80\,\text{N kg}^{-1}$

9 If the potential difference between a pair of identical, parallel, conducting plates is known, what is the only additional knowledge required to determine the electric field strength between the plates?

A the permittivity of the medium between the plates

B the separation and area of the plates

C the separation and area of the plates and the permittivity of the medium between the plates

D the separation of the plates

10 Which one of the following statements about *electric field strength* and *electric potential* is **incorrect**?

A Electric potential is a scalar quantity.

B Electric field strength is a vector quantity.

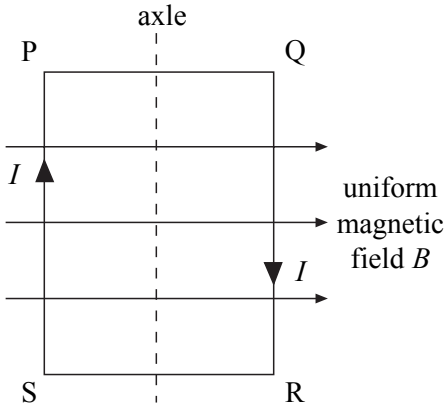
C Electric potential is zero whenever the electric field strength is zero.

D The potential gradient is proportional to the electric field strength.

11 Which line, **A** to **D**, gives correct units for both magnetic flux and magnetic flux density?

	magnetic flux	magnetic flux density
A	$\mathrm{Wb\,m^{-2}}$	Wb
B	Wb	T
C	$\mathrm{Wb\,m^{-2}}$	$\mathrm{T\,m^{-2}}$
D	$\mathrm{T\,m^{-2}}$	$\mathrm{Wb\,m^{-2}}$

12



A coil, mounted on an axle, has its plane parallel to the flux lines of a uniform magnetic field B, as shown. When a current I is switched on, and before the coil is allowed to move,

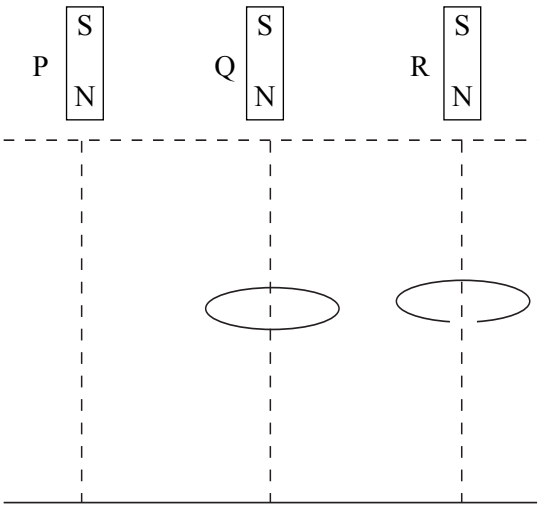
A there are no forces due to B on the sides SP and QR.

B there are no forces due to B on the sides PQ and RS.

C sides SP and QR tend to attract each other.

D sides PQ and RS tend to attract each other.

13



Three identical magnets P, Q and R are released simultaneously from rest and fall to the ground from the same height. P falls directly to the ground, Q falls through the centre of a thick conducting ring and R falls through a ring which is identical except for a gap cut into it. Which one of the statements below correctly describes the sequence in which the magnets reach the ground?

A P and R arrive together followed by Q.

B P and Q arrive together followed by R.

C P arrives first, followed by Q which is followed by R.

D All three magnets arrive simultaneously.

14 What is the mass difference of the $^{7}_{3}\mathrm{Li}$ nucleus?

Use the following data:
mass of a proton = 1.00728 u
mass of a neutron = 1.00867 u
mass of $^{7}_{3}\mathrm{Li}$ nucleus = 7.01436 u

A 0.93912 u

B 0.04051 u

C 0.04077 u

D 0.04216 u

15 The moderator in a nuclear reactor is sometimes made of graphite. What is the purpose of the graphite?

A to absorb all the heat produced
B to decrease the neutron speeds
C to absorb α and γ radiations
D to prevent the reactor from going critical

END OF SECTION A

Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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January 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION A) PA04
Unit 4 Waves, Fields and Nuclear Energy

Section B

Monday 28 January 2002 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a ruler.

Time allowed: The total time for Section A and Section B of this paper is 1 hour 30 minutes

Instructions
- Use a blue or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this Section is 30.
- Mark allocations are shown in brackets.
- Section A and Section B of this paper together carry 15% of the total marks for Physics Advanced.
- You are expected to use a calculator where appropriate.
- In questions requiring description and explanation you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.
- A *Data Sheet* is provided on pages 3 and 4 of Section A. You may wish to detach this perforated sheet at the start of the examination.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions.

1

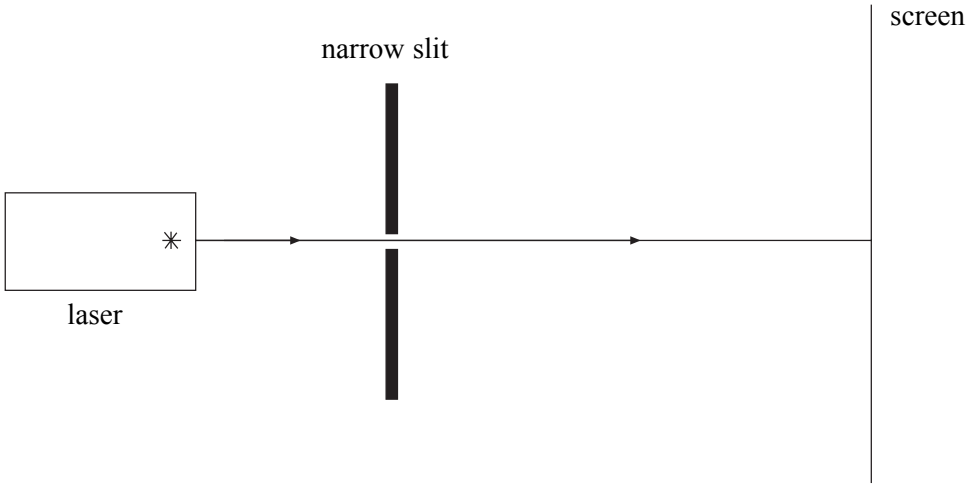

Figure 1

Red light from a laser is passed through a single narrow slit, as shown in **Figure 1**. A pattern of bright and dark regions can be observed on the screen which is placed several metres beyond the slit.

(a) The pattern on the screen may be represented as a graph of intensity against distance along the screen. The graph has been started in outline in **Figure 2.** The central bright region is already shown. Complete this graph to represent the rest of the pattern by drawing on **Figure 2**.

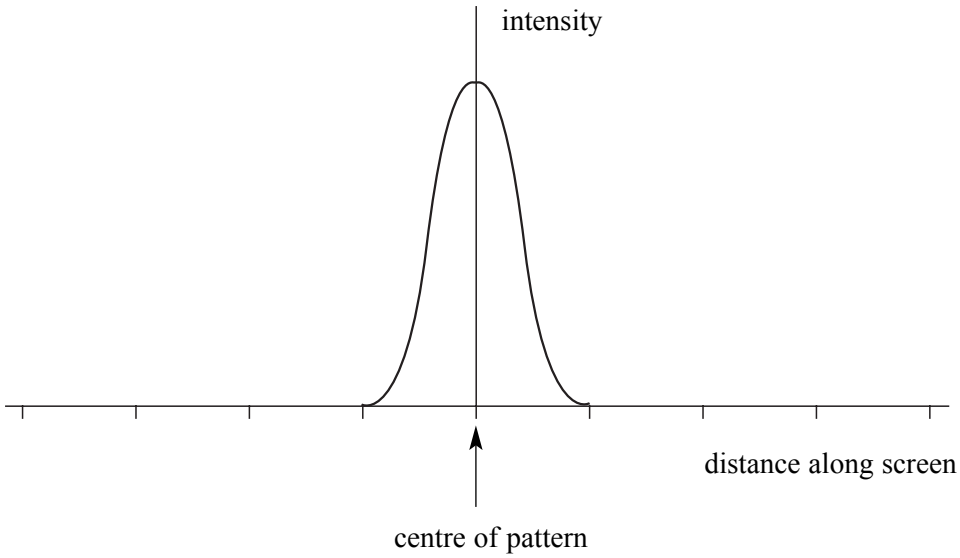

Figure 2

(4 marks)

(b) State the effect on the pattern if each of the following changes is made separately.

(i) The width of the narrow slit is reduced.

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(ii) With the original slit width, the intense red source is replaced with an intense source of green light.

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(3 marks)

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TURN OVER FOR THE NEXT QUESTION

2

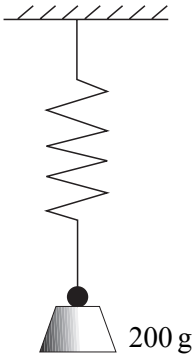

Figure 1

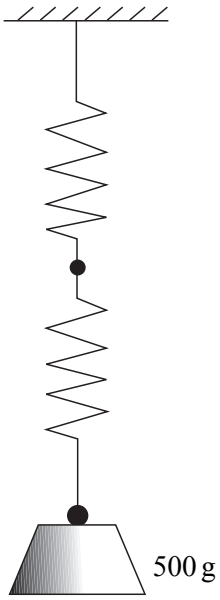

Figure 2

(a) When a 200 g mass is suspended from a spring, as in **Figure 1**, it produces an extension of 3.5 cm. Calculate the spring constant, *k*, for this spring.

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(2 marks)

(b) A spring identical to that in part (a) is joined to the lower end of the original one and a 500 g mass is suspended from the combination, as shown in **Figure 2.**

(i) State the value of the new spring constant for this combination of two springs.

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(ii) When the 500 g mass is displaced it performs small vertical oscillations. Calculate the number of oscillations made in one minute.

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(3 marks)

5

3 (a) A 2.0 μF capacitor is charged through a resistor from a battery of emf 4.5 V. Sketch a graph on the axes below to show how the charge stored, Q, varies with the potential difference, V, across the capacitor during the charging process. Mark appropriate values on the axes of the graph.

(2 marks)

(b) (i) Show that the energy stored by a charged capacitor is given by $E = \frac{1}{2}QV$.

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(ii) Calculate the energy stored by the capacitor in part (a) when the potential difference across it is 1.5 V.

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(5 marks)

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4 (a) An electron moves parallel to, but in the opposite direction to, a uniform electric field, as shown in **Figure 1**.

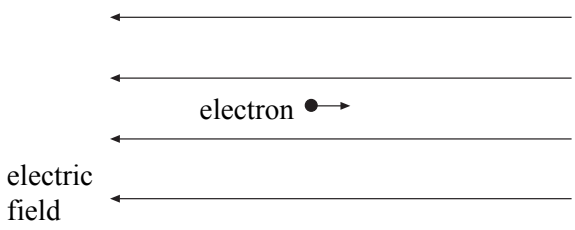

Figure 1

(i) State the direction of the force that acts on the electron due to the electric field.

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(ii) What is the effect of this force on the motion of the electron?

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(2 marks)

(b) An electron, which is travelling in a horizontal path at constant speed, enters a uniform vertical electric field as shown in **Figure 2**.

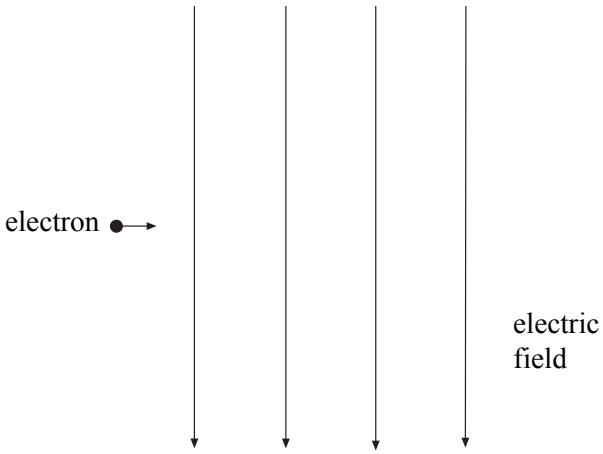

Figure 2

(i) Sketch on **Figure 2** the path followed by the electron.

(ii) Explain the motion of the electron whilst in this field.

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(3 marks)

5

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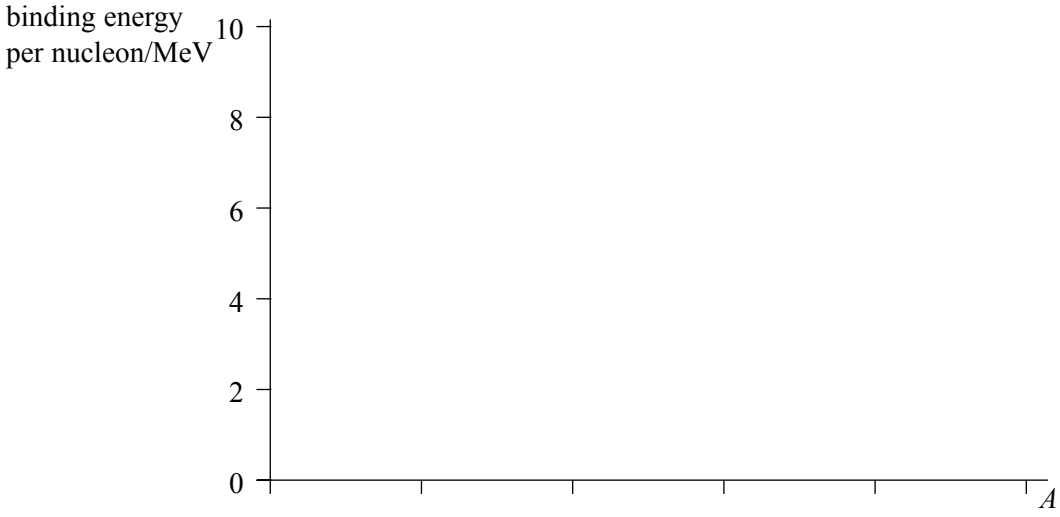

(a) On the axes above, sketch a graph to show how the average binding energy per nucleon depends on the nucleon number, A, for the naturally occurring nuclides. Show appropriate values for A on the horizontal axis of the graph. *(3 marks)*

(b) (i) Briefly explain what is meant by *nuclear fission* and by *nuclear fusion.*

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(ii) Describe how the graph in part (a) indicates that large amounts of energy are available from both the fission and the fusion processes.

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(3 marks)

6

END OF QUESTIONS