

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Education  
 June 2002  
 Advanced Level Examination



**PHYSICS (SPECIFICATION A)**  
**Unit 9 Nuclear Instability: Electronics Option**

**PHA9/W**

Friday 21 June 2002 Afternoon Session

**In addition to this paper you will require:**

- a calculator;
- a pencil and a ruler.

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

Time allowed: 1 hour 15 minutes

**Instructions**

- Use blue or black ink or 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 paper is 40.
- Mark allocations are shown in brackets.
- The paper carries 10% of the total marks for Physics Advanced.
- A *Data Sheet* is provided on pages 3 and 4. You may wish to detach this perforated sheet at the start of the examination.
- 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.

**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.

**DATA SHEET**

**Turn over ▶**

**DATA SHEET**

**TURN OVER FOR THE FIRST QUESTION**

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**SECTION A NUCLEAR INSTABILITY**Answer **all** parts of the question.

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1 (a) State which type of radiation,  $\alpha$ ,  $\beta$  or  $\gamma$ ,

(i) produces the greatest number of ion pairs per mm in air,

.....

(ii) could be used to test for cracks in metal pipes.

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(2 marks)

(b) Specific radioisotope sources are chosen for tracing the passage of particular substances through the human body.

(i) Why is a  $\gamma$  emitting source commonly used?

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(ii) State why the source should **not** have a very short half-life.

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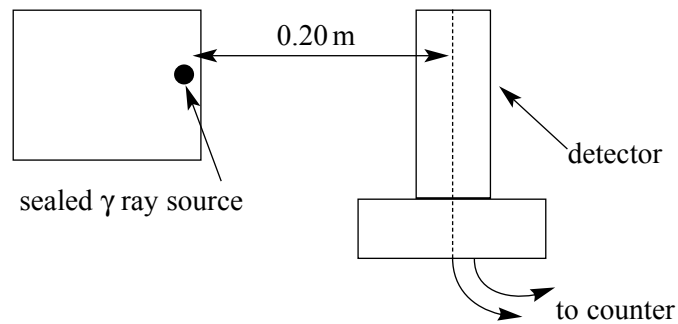
(iii) State why the source should **not** have a very long half-life.

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(3 marks)

- (c) A detector, placed 0.20 m from a sealed  $\gamma$  ray source, receives a mean count rate of 2550 counts per minute. The experimental arrangement is shown in the diagram below. The mean background radiation is measured as 50 counts per minute.



Calculate the least distance between the source and the detector if the count rate is not to exceed 6000 counts per minute.

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(5 marks)

10

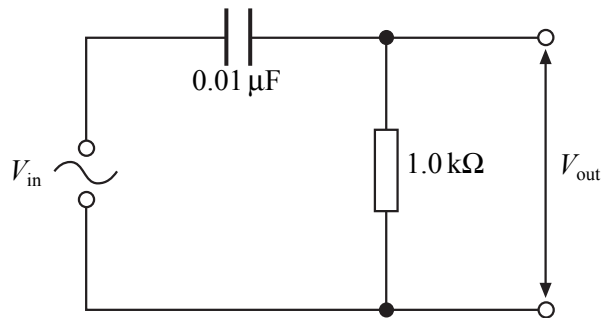
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## SECTION B ELECTRONICS

Answer **all** questions.

- 2 The figure shows the circuit of a high-pass filter. The ac source has a variable frequency.



- (a) (i) Calculate the frequency at which the reactance of the capacitor is  $1.0 \times 10^3 \Omega$ .

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- (ii) Explain why  $\frac{V_{\text{out}}}{V_{\text{in}}}$  will have a low value at low frequencies.

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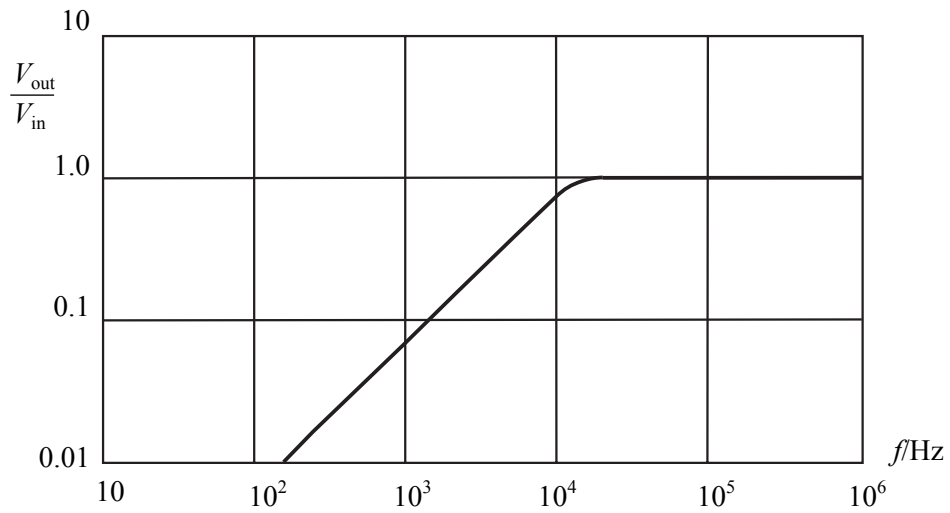
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*(4 marks)*



- (b) The variation of  $\frac{V_{\text{out}}}{V_{\text{in}}}$  with frequency for the high-pass filter is shown below.



Explain, without further calculation, the form of the characteristic.

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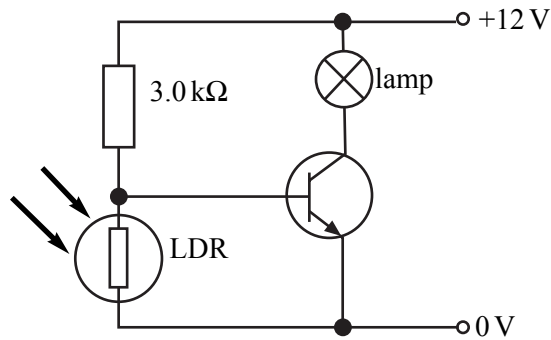
(2 marks)

6

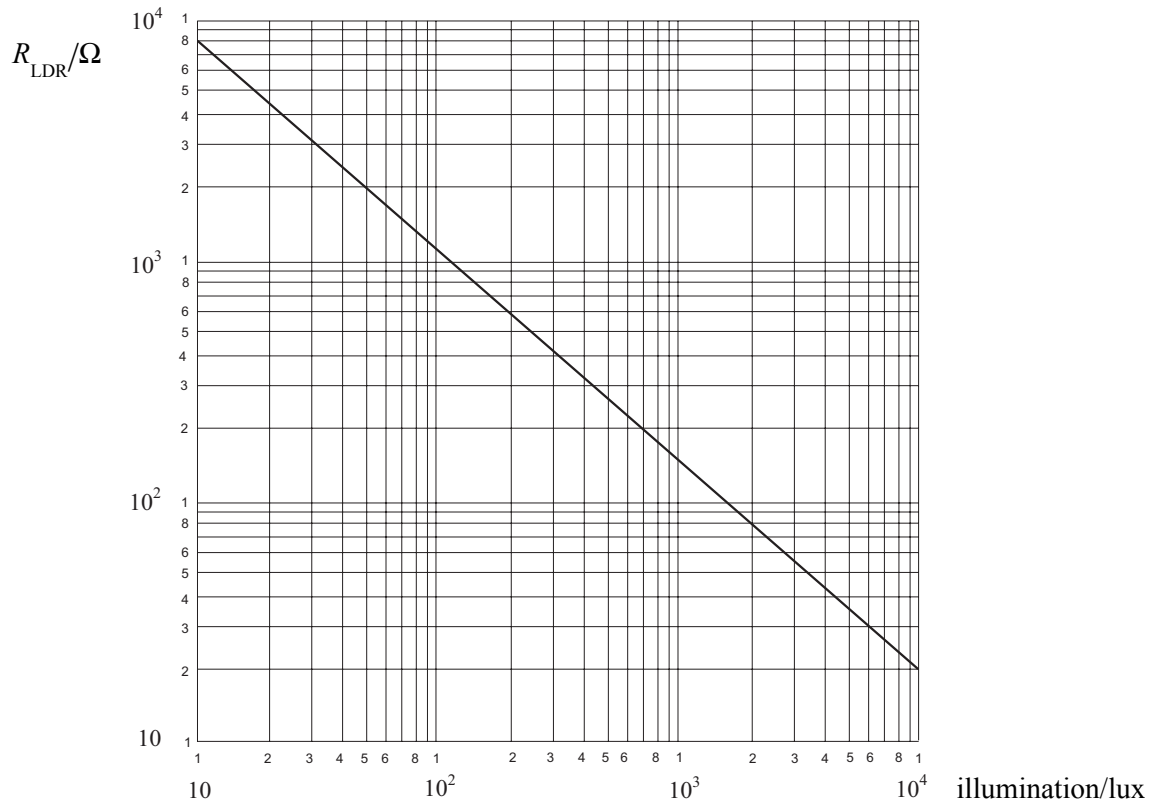
**TURN OVER FOR THE NEXT QUESTION**

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- 3 In the circuit shown in **Figure 1** the transistor is used to switch a lamp. The transistor is controlled by a light-dependent resistor (LDR). The characteristic of the LDR is shown in **Figure 2**. The transistor switches at a base-emitter voltage of 0.7 V.



**Figure 1**



**Figure 2**

- (a) (i) The intensity of the light incident on the LDR is  $6 \times 10^3$  lux.  
Explaining your reasoning, state whether the lamp is on or off.

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- (ii) The intensity of the light now decreases. Determine the intensity at which the state of the lamp changes.

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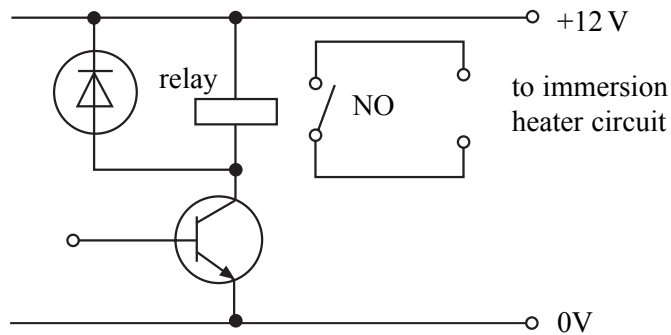
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(7 marks)

- (b) In the circuit in **Figure 3** the transistor controls the relay, which, in turn, switches a mains powered immersion heater used to heat a small fish tank.



**Figure 3**

- (i) The relay is rated at 12 V, 230  $\Omega$ . Calculate the current in the relay coil.

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- (ii) The immersion heater is rated at 12 W, 230 Vrms. Calculate the current passing through it.

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- (iii) Explain why it is necessary to have a relay to switch the immersion heater.

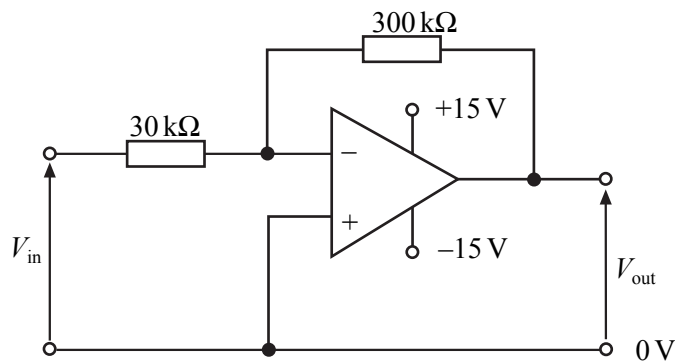
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(5 marks)

- 4 The circuit in **Figure 1** is that of an operational amplifier being used as an inverting amplifier. The power supply to the amplifier is  $\pm 15\text{ V}$ .



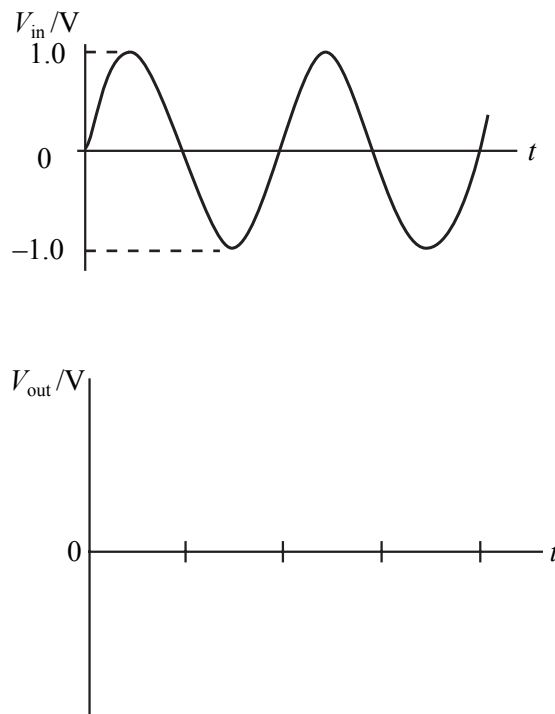
**Figure 1**

- (a) (i) Calculate the voltage gain for the amplifier circuit.

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- (ii) The input signal is sinusoidal of peak voltage  $1.0\text{ V}$ . The first graph in **Figure 2** shows the variation of the input signal. Sketch on the second set of axes the corresponding form of the output signal. Indicate values on the voltage axis.



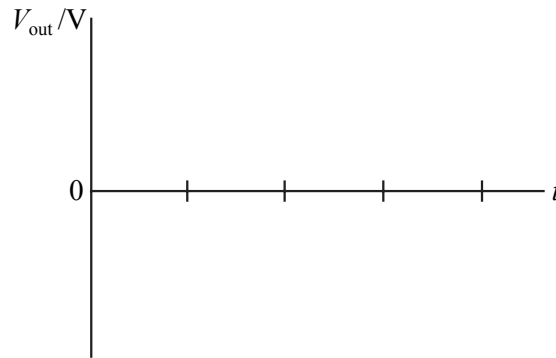
**Figure 2**

(5 marks)

- (b) The feedback resistor is now changed for a resistor of resistance  $600\text{ k}\Omega$ . Sketch a graph on the axes in **Figure 3** showing the new output signal, for the same input waveform. Indicate values on the voltage axis.

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.....



**Figure 3**

(2 marks)

$\frac{7}{7}$

**TURN OVER FOR THE NEXT QUESTION**

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5 (a) State why a mica capacitor, marked  $0.01\mu\text{F}$ , 50 V, should **not** be connected to a 40 Vrms ac supply.

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(2 marks)

(b) Give **one** advantage and **two** disadvantages, apart from cost, of an electrolytic capacitor compared with a mica capacitor with the same capacitance.

advantage .....

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disadvantage 1 .....

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disadvantage 2 .....

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(3 marks)



**END OF QUESTIONS**

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