	Centre Number	Candidate Number
Candidate Name ______________________		

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE
General Certificate of Education Advanced Level

PHYSICS **9243/2**

PAPER 2

Tuesday **8 JUNE 1999** Afternoon 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator and/or Mathematical tables
Ruler (300 mm)

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

For numerical answers, **all** working should be shown.

Your answers to Questions 5, 8(d) and (e) must be in continuous prose.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

The quality of your language will be taken into account in the marking of your answers to Questions 5, 8(d) and (e).

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
8	
Quality of Language	
TOTAL	

This question paper consists of 15 printed pages and 1 blank page.

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For Examiner's Use

1 **(a)** An A Level student suggests a number of equations, not all of which are correct. The equations are given in the table below. Place a tick or a cross in the last column to indicate whether a consideration of the units involved makes each equation possible (✓) or impossible (✗). [4]

surface area of a sphere = $\frac{4}{3}\pi r^3$	
speed of a wave = $\frac{\lambda}{T}$	
period of an oscillating pendulum = $2\pi\sqrt{\frac{g}{l}}$	
pressure of a gas = $\frac{1}{3}\rho\langle c^2\rangle$	

r, l, λ are distances, c is a speed, g is an acceleration, T is a time and ρ is a density.

(b) Give an SI unit and an estimate of the magnitude of each of the following physical quantities. (Marks will be awarded for the correct order of magnitude of each estimate, not for its accuracy.) [7]

	magnitude	unit
the weight of an adult		
the power of a hair drier		
the energy required to bring to the boil a kettleful of water		
the resistance of a domestic filament lamp		
the wavelength of visible light		

2 A water wave of amplitude 0.50 m is travelling in water which is 2.0 m deep, as illustrated in Fig. 2.1.

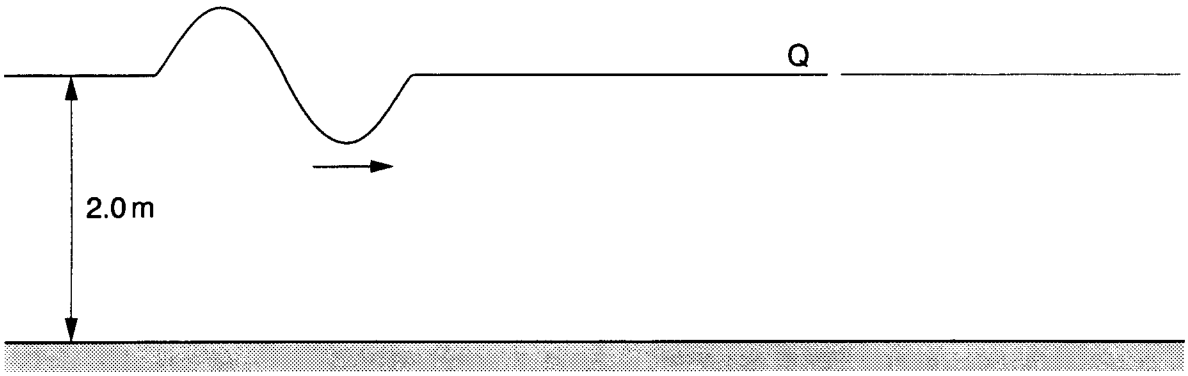

Fig. 2.1

Water waves travel with a speed v which is dependent on the depth of water h and is given by the equation

$$v = \sqrt{gh}$$

where g is the acceleration of free fall. As there is a greater depth of water beneath the crest of a water wave than beneath the trough, wave crests will travel faster than wave troughs.

(a) Determine the depth of water beneath the crest of the wave.

depth = ... m [1]

(b) For the wave illustrated in Fig. 2.1, calculate the speed of travel of

(i) the crest,

speed of crest = ... m s^{-1}

(ii) the trough.

speed of trough = ... m s^{-1}
[3]

(c) On Fig. 2.1, draw a suggested shape of the wave a little later as it passes Q. [2]

For Examiner's Use

3 **(a)** Explain what is meant by

(i) the moment of a force,

....

....

....

(ii) the torque of a couple.

....

....

....

[4]

(b) A desk lamp is illustrated in Fig. 3.1.

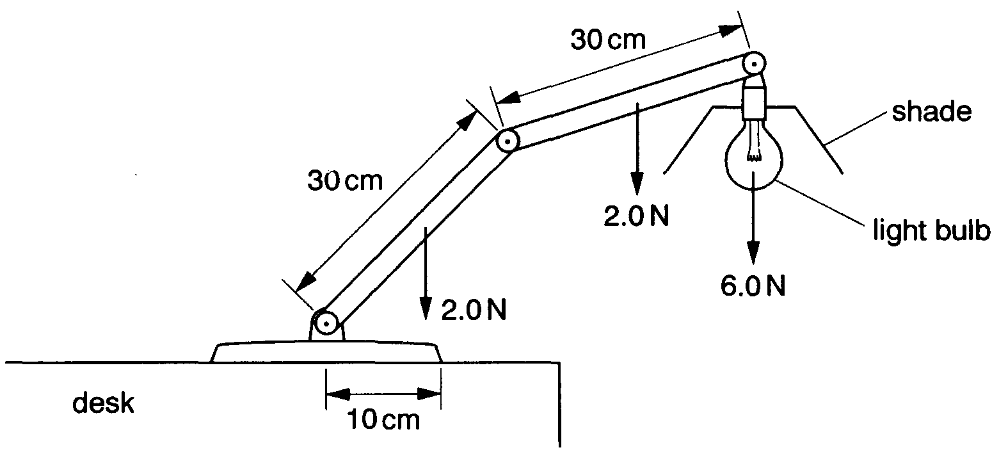

Fig. 3.1

The lamp must be constructed so that it does not topple over when fully extended as shown in Fig. 3.2. The base of the lamp is circular and has a radius of 10 cm. Other dimensions are shown on the figure. The total weight of the light bulb and shade is 6.0 N and each of the two uniform arms has weight 2.0 N.

For Examiner's Use

Fig. 3.2

(i) On Fig. 3.2, draw an arrow to represent the weight of the base.

(ii) The lamp will rotate about a point if the base is not heavy enough. On Fig. 3.2, mark this point and label it P.

(iii) Calculate the following moments about P.

1. moment of first arm

moment = ... N m

2. moment of second arm

moment = ... N m

3. moment of light bulb and shade

moment = ... N m

(iv) Use the principle of moments to calculate the minimum weight of base required to prevent toppling.

weight = ... N
[7]

For Examiner's Use

4 **(a)** An isolated capacitor of capacitance 200 μF has a potential difference across it of 30 V. Calculate

(i) the charge stored on one plate of the capacitor,

charge = ... C

(ii) the energy stored by the capacitor.

energy = ... J
[4]

(b) An uncharged capacitor of capacitance 100 μF is then connected across the charged 200 μF capacitor in **(a)**. For this combination, state which electrical quantity

(i) will have the same total value before and after connection, ...

(ii) will be the same for each of the capacitors after connection. ....
[2]

(c) Calculate the total energy stored by the two capacitors in **(b)** after they have been connected.

energy = ... J [5]

For Examiner's Use

5 (a) Describe an experiment which demonstrates Brownian motion.

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....

....

....

.... [5]

(b) Explain how Brownian motion provides evidence for the kinetic model of matter.

....

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....

....

....

....

....

....

.... [3]

6 (a) Electrons in a cathode-ray tube leave the cathode with negligible speed at a potential of –9000 V and are accelerated to an anode at a potential of –200 V. For an electron in this tube calculate

(i) the gain in electrical potential,

electrical potential gain = ...

(ii) the loss in potential energy,

potential energy loss = ... J

(iii) the gain in kinetic energy,

kinetic energy gain = ... J

(iv) the speed on reaching the anode.

speed = ... m s^{-1} [6]

(b) Explain why **(a)(i)** is a gain but **(a)(ii)** is a loss.

....

.... [2]

(c) While travelling between the anode and the screen of a cathode-ray tube, electrons move through adjacent electric and magnetic fields, as illustrated in Fig. 6.1.

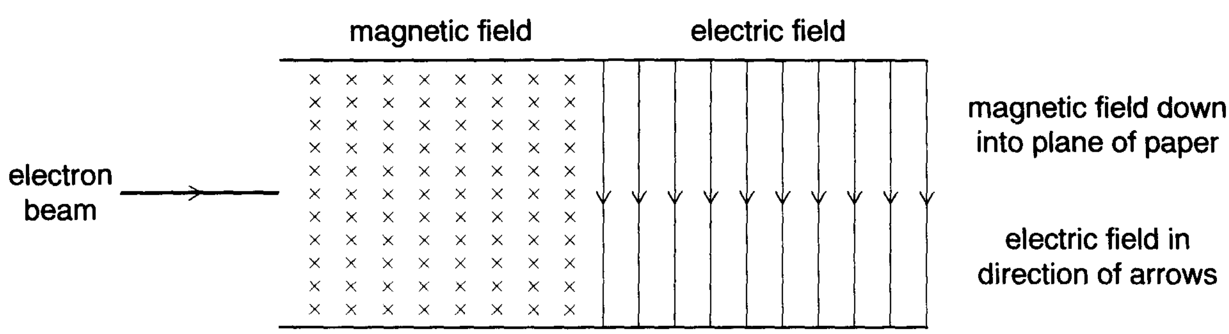

Fig. 6.1

On Fig. 6.1, sketch a possible path of an electron through both fields. [3]

For Examiner's Use

7 Fig. 7.1 shows four energy levels for electrons in a hydrogen atom. It shows one transition, which results in the emission of light of wavelength 486 nm.

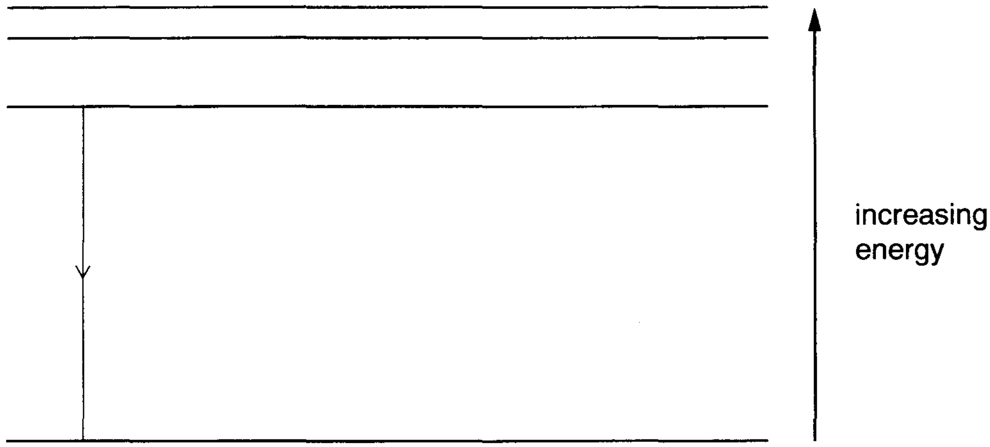

Fig. 7.1

(a) On Fig. 7.1, draw arrows to show

(i) another transition which results in the emission of light of shorter wavelength (label this transition L),

(ii) a transition which results in the emission of infra-red radiation (label this transition R),

(iii) a transition which results from absorption (label this transition A).

[4]

(b) Calculate the energy change which an electron has to undergo in order to produce light of wavelength 486 nm.

energy change = ... J
[4]

[Turn over

8 The decay of radioactive materials is a random process. On average, nuclides which decay rapidly exist for a shorter time than nuclides which decay slowly. It is common practice when making calculations on decay to make use of the half life of a nuclide. One difficulty that arises with these calculations is when the radioactive material is a mixture of two or more nuclides. This question considers the case when a mixture of two radioactive nuclides is present. In decommissioning a nuclear power station, this difficulty is compounded by the presence of about a hundred different radioactive nuclides in significant quantities.

(a) Explain what it means to say that radioactive decay is a *random process.*

....

....

....

....

.... [2]

(b) State two physical quantities which cause change of phase of matter but which do not cause a change in the rate of decay of a radioactive material.

1. ....

2. .... [2]

(c) Fig. 8.1 gives the variation with time of the total activity A_{mix} of a mixture of cobalt and nickel together with the separate activities A_C and A_N due to the cobalt and nickel.

time / year	A_C / Bq	A_N / Bq	A_{mix} / Bq	ln (A_{mix} / Bq)
0	6900	250	7150	8.87
5	3540	241	3781	8.24
10	1820	232	2052	7.63
20	479	215	694	6.54
30	126	199	325	5.78
40	33.3	185	218	5.38
50	8.79	172	181	5.20
60	2.32	159	161	5.08
70	0.611	147	148	5.00
80	0.161	137	137	4.92
90	0.0425	127	127	4.84
100	0.0112	118	118	4.77

Fig. 8.1

A graph showing how ln(A_{mix} / Bq) varies with time is plotted in Fig. 8.2.

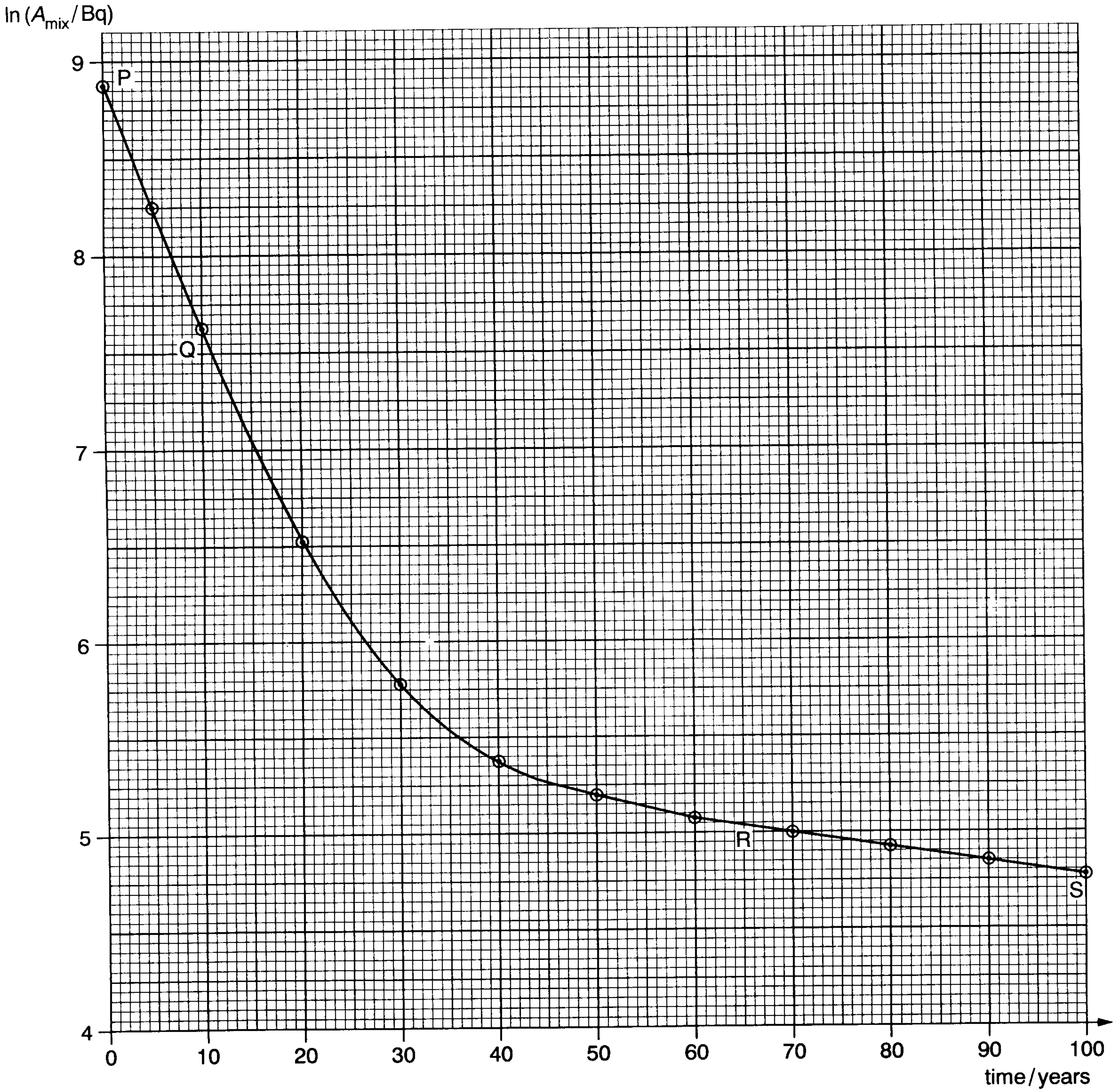

Fig. 8.2

[Turn over

(i) Explain the following.

1. PQ on the graph corresponds mainly to the decay of cobalt.

....

....

....

2. RS on the graph corresponds mainly to the decay of nickel.

....

....

3. The shape of QR is a curve.

....

....

(ii) Determine the following gradients.

1. the gradient of PQ

2. the gradient of RS

gradient of PQ = ...

gradient of RS = ...

(iii) Given that the general decay law is of the form $x = x_0\exp(-\lambda t)$, use the gradients found in **(ii)** to *estimate* values of the decay constants for the cobalt and the nickel nuclides.

decay constant of cobalt = ...

decay constant of nickel = ...

(iv) Use your answer to (iii) to calculate the half-life of the cobalt.

half-life = ... year
[10]

(d) Suggest whether these two nuclides, with these activities, would pose any hazard if found when de-commissioning a nuclear reactor.

....

....

....

.... [2]

(e) In an actual reactor, activities of radioactive materials can often be 10^{12} times larger than those given in Fig. 8.1. Explain when and why each of these two nuclides would pose the greater hazard.

....

....

....

....

....

....

.... [4]

Quality of language [4]