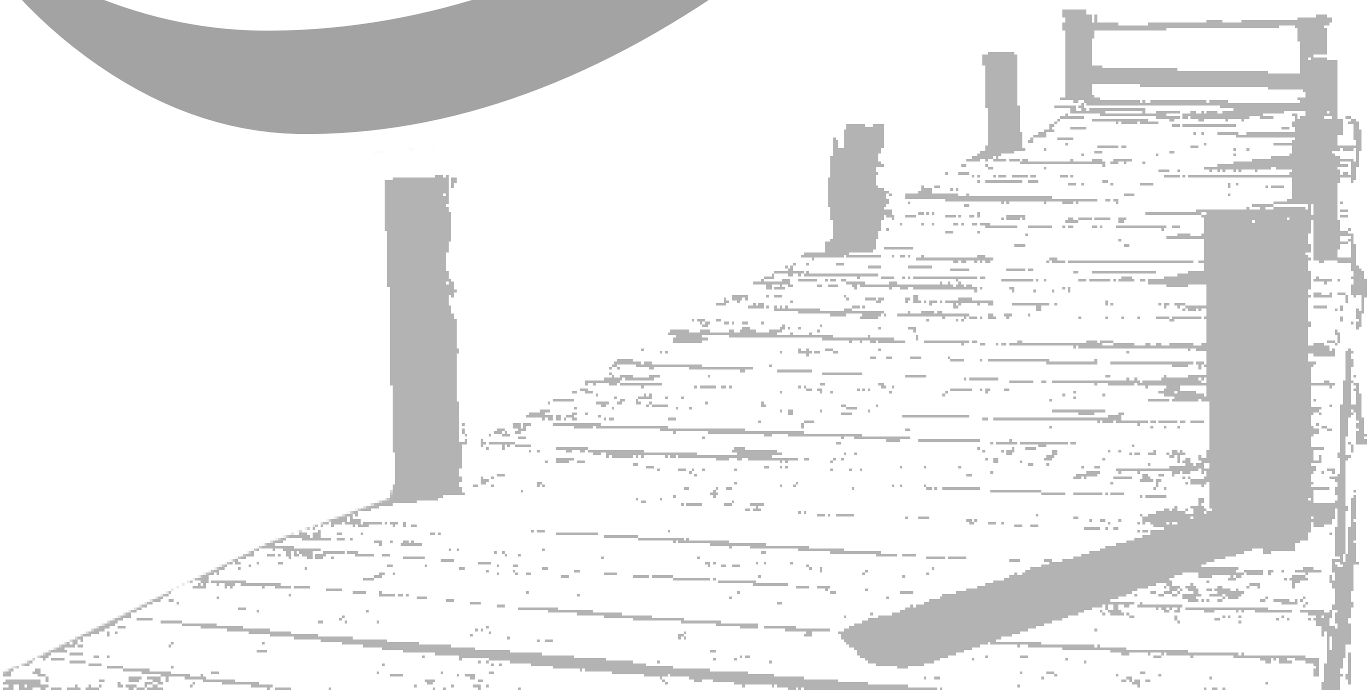
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 5: Approved specimen question paper

Version 1.3



Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

Leave blank

General Certificate of Education
2010
Advanced Examination

version 1.3

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS A PHYA5
Unit 5 Nuclear and Thermal Physics

Section A

SPECIMEN PAPER

Time allowed: 55 minutes

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

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- A *Data and Formula Booklet* is provided as a loose insert.

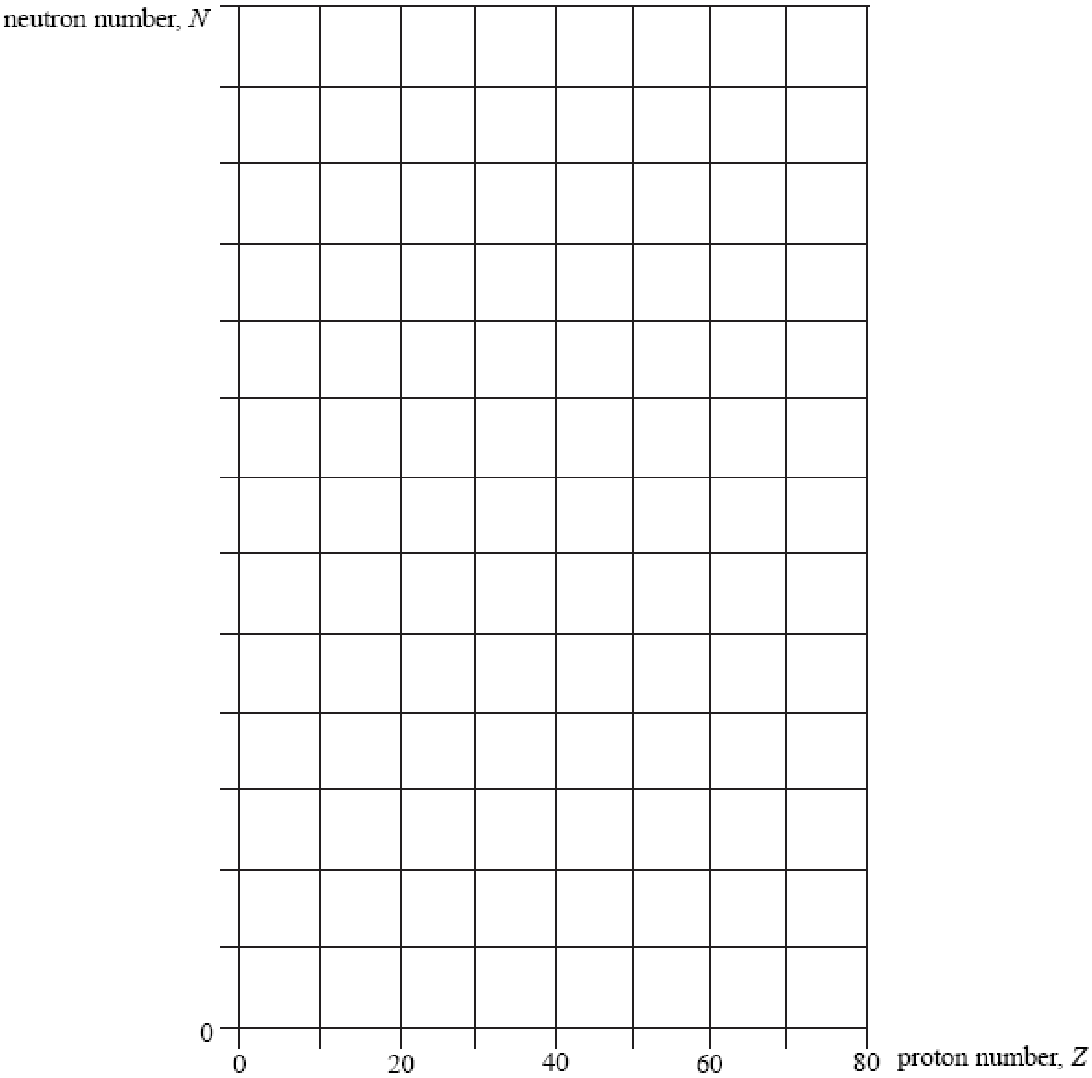
Information

- The maximum mark for this paper is 40.
- The marks for the questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers. You will be assessed on your quality of written communication where indicated in the question.

Section A

The maximum mark for this section is 40 marks. You are advised to spend approximately 55 minutes on this section.

1 (a) Sketch, using the axes provided, a graph of neutron number, N, against proton number, Z, for stable nuclei over the range $Z = 0$ to $Z = 80$. Show suitable numerical values on the N axis.



(2 marks)

(b) On the graph indicate, for each of the following, a possible position of a nuclide that might decay by

(i) α emission, labelling the position with **W**,

(ii) β^- emission, labelling the position with **X**,

(iii) β^+ emission, labelling the position with **Y**.

(3 marks)

(c) Used fuel rods from a nuclear reactor emit β^- particles from radioactive isotopes that were not present before the fuel rod was inserted in the reactor. Explain why β^- emitting isotopes are produced when the fuel roads are in the reactor.

....

....

....

....

(3 marks)

(d) A nuclear power station is a reliable source of electricity that does not produce greenhouse gases but it does produce radioactive waste. Discuss the relative importance of these features in deciding whether or not new nuclear power stations are needed.

The quality of your written answer will be assessed in this question.

....

....

....

....

....

....

....

....

....

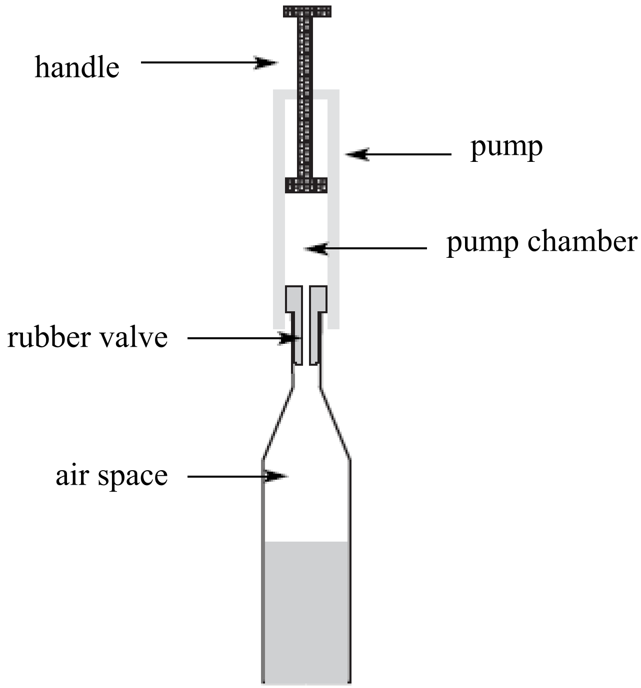
....

(6 marks)

Total 14 marks

2 Some liquids in open bottles deteriorate exposure to air. **Figure 1** shows one device used to reduce this deterioration. It consists of a rubber valve that is inserted into the neck of the bottle together with a pump that is used to remove some of the air in the bottle through this rubber valve. On an up-stroke of the pump, air enters the pump chamber from the bottle. On the down-stroke, the rubber valve closes and the air in the chamber is expelled to the atmosphere through another valve (not shown) in the handle.

Figure 1



(a) There is 3.5×10^{-4} m^3 of air space in the bottle and the volume of the pump chamber changes from zero at the beginning of the up-stroke to 6.5×10^{-5} m^3 at the end of the up-stroke. The initial pressure of the air in the bottle is that of the atmosphere with a value of 99 kPa.

Assuming the process is at constant temperature, calculate the pressure in the bottle after one up-stroke of the pump.

....

....

....

....

(3 marks)

(b) Calculate the number of molecules of air originally in the air space in the bottle at a temperature of 18 °C.

....

....

....

....

(3 marks)

(c) Explain how the kinetic theory of an ideal gas predicts the existence of a gas pressure inside the bottle. Go on to explain why this pressure decreases when some of the air is removed from the bottle.

....

....

....

....

....

....

....

....

....

(5 marks)

Total 11 marks

3 In an experiment to measure the temperature of the flame of a Bunsen burner, a lump of copper of mass 0.12 kg is heated in the flame for several minutes. The copper is then transferred quickly to a beaker, of negligible heat capacity, containing 0.45 kg of water, and the temperature rise of the water measured.

Specific heat capacity of water = 4200 J kg^{-1} K^{-1}
Specific heat capacity of copper = 390 J kg^{-1} K^{-1}

(a) (i) The temperature of the water rises from 15ºC to 35ºC. Calculate the thermal energy gained by the water.

thermal energy gained = ...

(ii) Calculate the temperature reached by the copper in the flame. Assume no heat is lost when the copper is transferred.

temperature = ...

(4 marks)

(b) When the lump of copper entered the water, some of the water was turned to steam.

(i) The specific latent heat of vaporisation of steam is 2.25 MJ kg^{-1}. What further measurement would need to be made to calculate the energy used to produce this steam?

....

....

(ii) Without further calculation, describe how this further measurement should be used to obtain a more accurate value of the flame temperature.

....

....

....

....

(3 marks)

Total 7 marks

4 Potassium-42 decays with a half-life of 12 hours. When potassium-42 decays, it emits β^- particles and gamma rays. One freshly prepared source has an activity of 3.0×10^7 Bq.

(a) To determine the radiation dose absorbed by the scientist working with the source, the number of gamma rays photons incident on each cm^2 of the body has to be known.

One in every five of the decaying nuclei produces a gamma ray photon. A scientist is initially working 1.50 m from the fresh source with no shielding. Show that at this time approximately 21 gamma photons per second are incident on each cm^2 of the scientist's body.

(3 marks)

(b) The scientist returns 6 hours later and works at the same distance from the source.

(i) Calculate the new number of gamma ray photons incident per second on each cm^2 of the scientist's body.

number of gamma photons per second per cm^2 = ...

(ii) Explain why it is not necessary to consider the beta particle emissions when determining the radiation dose the scientist receives.

....

....

....

(5 marks)

Total 8 marks