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NZQA

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MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 3 Physics, 2012

90522 Demonstrate understanding of atoms, photons and nuclei

9.30 am Tuesday 27 November 2012
Credits: Three

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Make sure that you have Resource Booklet L3–PHYSR.

In your answers use clear numerical working, words and / or diagrams as required.

Numerical answers should be given with an SI unit, to an appropriate number of significant figures.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–6 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

ASSESSOR'S USE ONLY	Achievement Criteria	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and / or relationships. ☐	Give explanations that show clear understanding in terms of phenomena, concepts, principles and / or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
Overall level of performance ☐		

You are advised to spend 30 minutes answering the questions in this booklet.

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QUESTION ONE: ENERGY FROM STARS

Nuclide	Binding energy per nucleon ($\times 10^{-13}$ J)
^{2}H	1.78
^{4}He	11.32
^{12}C	12.29
^{14}N	11.96
^{16}O	12.76
^{19}F	12.45
^{20}Ne	12.85
^{23}Na	12.98
^{40}Ca	13.68
^{55}Mn	14.02
^{58}Fe	14.07
^{62}Ni	14.07
^{206}Pb	12.60
^{238}U	12.25

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http://en.wikipedia.org/wiki/File:Binding_energy_curve_-_common_isotopes.svg

(a) Use the information in the table and the graph to answer the following questions.

(i) In the above list, nickel and iron have the highest binding energy *per nucleon*.

Explain which nuclide on the list has the highest total binding energy.

(ii) Explain how stars, which are composed mostly of ^{1}H, can release huge amounts of energy.

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(iii) If a star reaches a stage where it has formed a core rich in iron and nickel, it suddenly stops 'burning'.

Explain why this happens.

(b) When a star has used up much of its ^{1}H and ^{4}He, it begins 'carbon burning'. One of the reactions to occur is

$$^{12}_{6}C + {}^{12}_{6}C \rightarrow {}^{20}_{10}Ne + {}^{4}_{2}He$$

Calculate the energy released in this reaction, and hence determine the mass deficit in the reaction.

Energy released = _____

Mass deficit = _____

QUESTION TWO: SODIUM LAMPS

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Low pressure sodium lamps are widely used in street lighting. The lamps produce light when an electric current is passed through sodium vapour. Almost all the light from these lamps has a wavelength of 5.89×10^{-7} m.

(a) Calculate the energy for a photon of light emitted from a sodium lamp.

Energy = _____

(b) The work function for sodium is 2.28 eV.

Calculate the threshold frequency for the emission of photoelectrons from the surface of sodium metal, and hence the maximum wavelength of light that can cause photoemission.

Threshold frequency = _____

Wavelength = _____

(c) Show that light from a sodium lamp cannot cause photoemission of electrons from sodium metal.

By considering the energy transitions involved in light production and absorption, suggest a possible reason for this.

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(d) In 1802 William Wollaston noted the appearance of dark lines in the spectrum of sunlight. These lines are due to the presence of certain chemical elements in gases surrounding the Sun.

(i) Explain why sharp dark lines appear only at specific wavelengths.

(ii) Explain how a comparison between the spectrum of sunlight, with the dark lines, and the spectrum of light from a sodium lamp, can identify that sodium is one of the elements in the Sun's atmosphere.

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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