Neap:

PHYSICS VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

TEST 10: HOW ARE LIGHT AND MATTER SIMILAR? (II)

TOTAL 45 MARKS (45 MINUTES)

Student's Name: _____ Teacher's Name: _____

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

Use $c = 3.0 \times 10^{8}$ m s^{-1}, $h = 6.63 \times 10^{-34}$ Js and $h = 4.14 \times 10^{-15}$ eVs.

Question 1 (3 marks)

Figure 1 shows a light absorption and light emission spectrum for the element boron.

Figure 1

Explain the significance of the particular colours of light absorbed and emitted from the spectra in relation to the model of the atom.

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Question 2 (15 marks)

Figure 2 shows the energy level diagram for hydrogen.

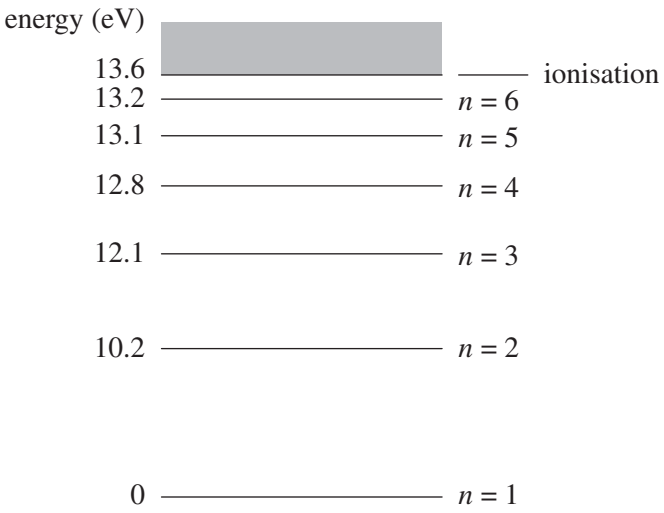

Figure 2

An electron makes a transition from the $n = 3$ to the $n = 2$ energy state.

a. Determine the energy (in joules) of the photon emitted in this transition. 2 marks

J

b. Calculate the wavelength, in nm, of the photon emitted in this transition. 3 marks

nm

A photon of energy 2.6 eV is emitted from the hydrogen atom.

c. On the energy level diagram in Figure 2, indicate with an arrows the transition corresponding to the emission of this photon. 2 marks

Part of the emission spectrum for hydrogen is shown in Figure 3. The wavelengths for red and blue spectral lines are shown

Figure 3

d. Which wavelength is the red spectral line? Provide an explanation. 2 marks

nm

An electron has a transition from the third excited state to the ground state.

e. How many different energy photons are emitted by this transition? 2 marks

A photon of energy 11 eV irradiates a hydrogen atom.

f. Explain the effect, if any, that the photon has on the hydrogen atom. 2 marks

A photon of energy 15 eV irradiates a hydrogen atom.

g. Explain the effect, if any, that the photon has on the hydrogen atom. 2 marks

Question 3 (5 marks)

Atoms are said to exist in quantised states.

a. Explain this statement making reference to the energy levels of an atom. 3 marks

b. Explain why the quantised states of an atom are evidence for the dual nature of matter. 2 marks

Question 4 (4 marks)

Geoffrey Taylor's experiment in 1909 involved the passing of photons of the same colour and, on average, one at a time towards a very fine needle and observing their passage to the striking of a screen afterwards. Over a long period of time, a pattern developed where a series of bright and dark bands were produced.

a. Explain how the results represent evidence for the wave nature of the photons. 2 marks

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b. Explain how the results represent evidence for the particle nature of the photons. 2 marks

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Question 5 (8 marks)

Heisenberg's uncertainty principle can be stated as follows:

uncertainty in the momentum of a particle × uncertainty in the position of a particle ≥ h

A stream of electrons are passed horizontally through a single slit of a particular width and a series of bright and dark bands are produced on the screen in front of the slit. In order for the electrons to be present along the length of the screen they must have developed a vertical momentum. This is shown in Figure 4.

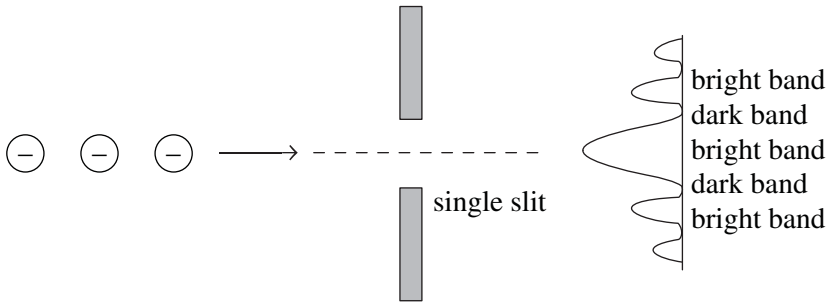

Figure 4

a. Explain why the uncertainty in the vertical position of the electron on the screen is represented by the width of the slit. 1 mark

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b. State what happens to the pattern when the slit width is slowly reduced. 1 mark

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c. As the slit width is reduced, what happens to the uncertainty in the vertical position of the electron when it strikes the screen? 1 mark

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d. In order for the pattern to change according to your answer to part **b.**, what must happen to the size of the vertical velocity and momentum of the electron? 1 mark

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e. Based on your answer to part **d.**, what must happen to the uncertainty of the vertical velocity and momentum as the slit width is reduced? 2 marks

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f. Relate your answers to parts **c.** and **e.** to Heisenberg's uncertainty principle. 2 marks

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Question 6 (2 marks)

Classical physics ideas work reliably under certain conditions.

Under what conditions does classical physics apply reliably?

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Question 7 (8 marks)

Explain how light is produced in the following sources.

a. laser 2 marks

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b. synchrotron 2 marks

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c. LED 2 marks

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d. incandescent lamps 2 marks

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