Hampton Park Secondary College

Through knowledge we grow

Student's Name: _____

Home Group: _____

Senior School Examinations

Semester 1 2011

Student Number

Figures									
Words									

YEAR 11

Physics Unit 1

Written Examination

QUESTION AND ANSWER BOOK

Structure of book

Number of questions	*Questions to be answered*	*Number of marks*
Area 1 – Nuclear Physics and Radiation	15	42
Area 2 – Electricity	15	56
Area 3 – Energy from the Nucleus	18	35

Reading Time: 10 minutes

Completion Time: 80 minutes

- Students are permitted to bring into the examination room: pens, pencils, coloured pencils, templates, highlighters, erasers, set squares sharpeners and rulers,
- Students are not permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- Students may bring a scientific calculator into this exam (NOT graphical or CAS)
- Students may bring a single double-sided summary sheet into this exam

Materials Supplied

- Question and answer book
- Additional writing paper should you need it.

Instructions

- Write your name, your Home Group and your class teacher's name in the space provided on this page.
- Write your student number in numerals and words in the space provided above on this page.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Area 1: - Nuclear Physics & Radioactivity

The following information applies to questions 1 – 5. Scientists at the "Huge Hadron Collider", a new supercollider, have managed to create a new element, which they are calling Element X. They have managed to determine the basic atomic structure:

$$^{209}_{117}X$$

Question 1: How many neutrons does element X contain?

	2 marks

Question 2: How many nucleons does element X contain?

	2 marks

Question 3: List a possible isotope of element X

	2 marks

Question 4: How many electrons would be found in an uncharged atom of element X?

	2 marks

Question 5: If element X where unstable, what type of decay is most likely?

	2 marks

Question 6: The equation that represents the α-decay of Polonium is:

A $^{209}_{84}Po \rightarrow {}^{4}_{2}He + {}^{205}_{82}Pb + {}^{1}_{0}n$

B $^{209}_{84}Po \rightarrow {}^{4}_{2}He + {}^{205}_{82}Pb$

C $^{209}_{84}Po \rightarrow {}^{205}_{82}Pb + 2({}^{1}_{0}n) + 2({}^{1}_{1}H)$

D $^{209}_{84}Po \rightarrow {}^{205}_{82}Pb + 4({}^{1}_{0}n)$

2 marks

Question 7: How many α particles and β particles are emitted in the decay series from $^{235}_{92}U$ to $^{207}_{82}Pb$?

A 7 α-particles and 4 β –particles

B 4 α-particles and 7 β –particles

C 14 α-particles and 8 β –particles

D 8 α-particles and 14 β –particles

2 marks

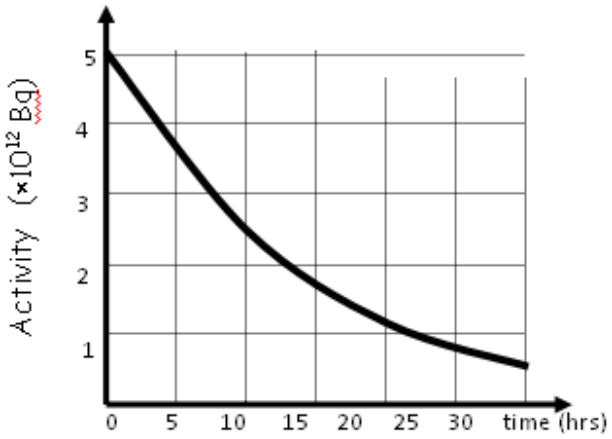
Question 8: Alpha, beta and gamma are three types of radioactive decay. Complete the following table showing the properties of these types of decay by submitting correct values for a, b and c.

	Lost from Nucleus	Change in **A**	Change in **Z**
Alpha Decay (α)	$^{4}_{2}\alpha$	**a.**	**-2**
Beta Decay (β)	$^{0}_{-1}e$	**0**	**b.**
Gamma Decay	**c.**	**0**	**0**

Given that beta decay is a high speed electron emitted from the nucleus, and that the nucleus does not contain electrons, explain where this emitted electron comes from. You must include a nuclear equation to justify your response.

5 marks

The following information applies to questions 9 to 11 below:
A Geiger counter is used to measure the radioactive Disintegrations from a sample of a certain radioisotope. The count rate recorded is shown in the graph below



Question 9: What is the half-life of this sample?

A 5 hours
B 10 hours
C 15 hours
D 20 hours

2 marks

Question 10: What is the activity (in TBq) after 3 half lives

A 3.5
B 2.5
C 1.7
D 0.6

2 marks

Question 11: The radioisotope is declared safe to dispose of after it's activity drops below 500 GBq. After how many hours will this occur?

A 0 hours
B 10 hours
C 22 hours
D 35 hours

2 marks

The following information applies to questions 12 and 14:
Carbon Dating is a technique used to determine the age of organic material. The activity (rate of decay) of ^{14}C atoms in the sample is measured. ^{14}C has a half life of 5730 years.

Question 12: Explain how the activity of ^{14}C in an organic sample can be used to determine its age.

3 marks

Question 13: Carbon dating is only effective for objects that are less than 60,000 years old. Explain why this is the case

3 marks

The following information applies to Question 14:
Archeologist in South Australia have dug up a spear during an excavation at an aboriginal site. They measure the rate of decay of ^{14}C in 2g of the wood to be 5 MBq. A 2g sample of modern wood has a decay rate of 40 MBq. How old is the Spear?

3 marks

Question 15:

Which of the following is the most damaging radiation dose?

A 200 **µGy** of gamma radiation

B 20 **µGy** of alpha radiation

C 50 **µGy** of beta radiation

Explain your answer:

3 marks

Question 16:

Which of the following is the most damaging radiation dose?

A 200 **µSv** of gamma radiation

B 20 **µSv** of Alpha radiation

C 50 **µSv** of beta radiation

Explain your answer:

3 marks

END OF AREA 1

AREA 2:- Electricity

The following information applies to questions 1 and 2:
A conductor transmits a current of 3μA for 1 hour.

Question 1: How many coulombs of charge have passed any given point?

	2 marks

Question 2: How many electrons have passed any given point?

	2 marks

The following information applies to questions 3 and 4:
A wire is carrying a current of 5.0mA. In 2 minutes, the current transfers 10 J of energy into a circuit element.

Question 4: What is the voltage across that element?

	2 marks

Question 5: What is the resistance of that element?

	2 marks

Question 6: 1.0 volt is the same as:

A. $1.0\ A\Omega^{-1}$ B. $1.0\ J\ \Omega^{-1}$ C. $1.0\ JC^{-1}$ D. $1.0\ AC^{-1}$

1 mark

Question 7: 1.0 Ampere is the same as:

A. $1.0\ V\ \Omega^{-1}$ B. $1.0J\ \Omega^{-1}$ C. $1.0C\ \Omega$ D. $1.0V\ \Omega$

1 mark

Question 8: 1.0 Watt is the same as:

A. $1.0\ V\ \Omega^{-1}$ B. 1.0 VA C. $1.0\ JC^{-1}$ D. $1.0\ V\ \Omega$

1 mark

Question 9: A heater, rated a 1500W is left on for 8 hours overnight.

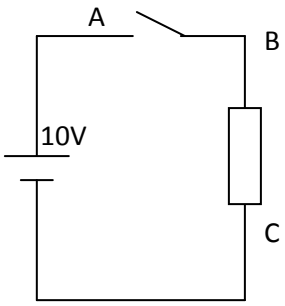
a) How many kWh of energy did it use?

2 marks

b) How many Joules of Energy did it use?

2 marks

Question 10: Kim sets a simple circuit consisting of a battery, a switch and a resistor. The voltage supply is 10V, as per the diagram to the right.



a) Before the switch is closed, what is the voltage between A and B?

	1 mark

b) Once the switch is closed, a current of 2A flows around the circuit. Determine the value of the resistor.

	2 marks

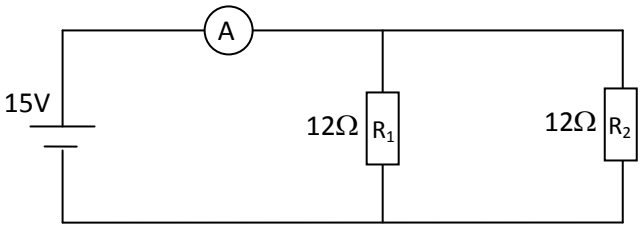
c) Determine the power dissipated in the circuit

	2 marks

d) Determine the energy transformed in the resistor if the circuit is active for one minute.

	2 marks

Question 11: Betty sets up an electric circuit shown below. Each resistor was measured to be 12Ω. The voltage supplied is 15 V



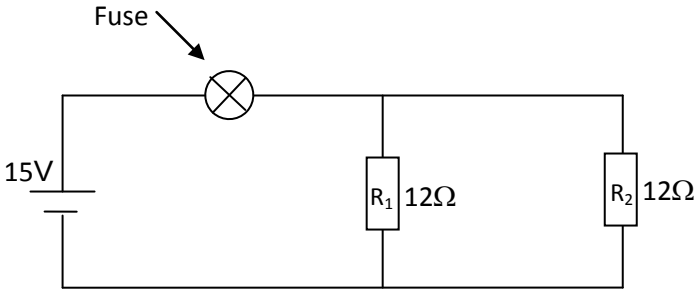
a) Determine the current through R_1.

2 marks

b) Determine the current through the Ammeter.

2 marks

Betty is concerned about electrical safety, so she replaces the ammeter with a 5A fuse.



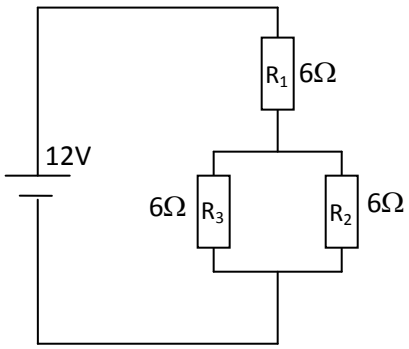
c) Explain how this 5A fuse works.

2 marks

3 How many 12Ω resistors could Betty place in parallel before the fuse blows?

	3 marks

Question 12: John sets up the circuit shown below. All of the resistors are rated at 6Ω and the voltage supplied is 12V.



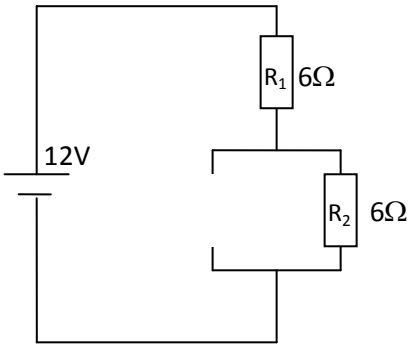
a) What is the voltage across resistor R_2?

	2 marks

b) What is the current through resistor R_3?

	2 marks

Resistor R_3 breaks and leaves a gap as shown below



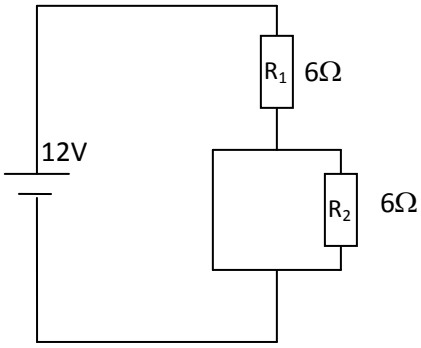
c) What is the voltage drop across R_2 now?

	2 marks

d) What is the current through R_2 now?

	2 marks

John fixes the circuit by adding in a wire where R_3 used to be as shown below.



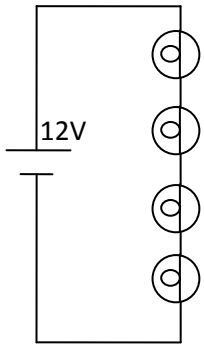
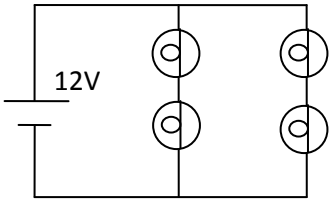
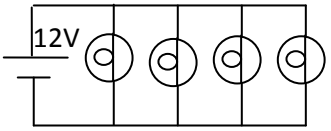
e) What is the Voltage across R_2?

	2 marks

f) What is the current through R_2?

	2 marks

Question 13: Kath is trying to set up some lights in her house. She has four 6V light globe and a 12V power supply. Note that because the light bulbs are designed for 6V, they will explode if a higher voltage is placed across them. You can assume that the light bulbs have a resistance of 3Ω. Kath considers the following three configurations

Configuration A	*Configuration B*	*Configuration C*
		

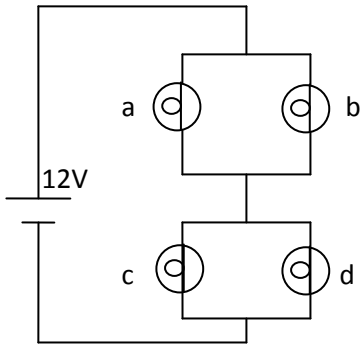
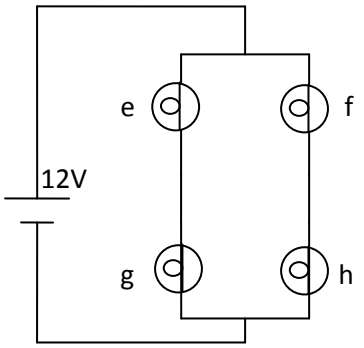
a) What is the major problem with circuit C?

2 marks

b) Which configuration is brighter? **Configuration A** or **Configuration B**? Use calculations to support your answer.

3 marks

Kim now helps Kath by showing her two configurations (**D and E**) that were able to obtain 6V across each of the 4 light globes, thus they all have the same intensity.

Configuration D	***Configuration E***
	

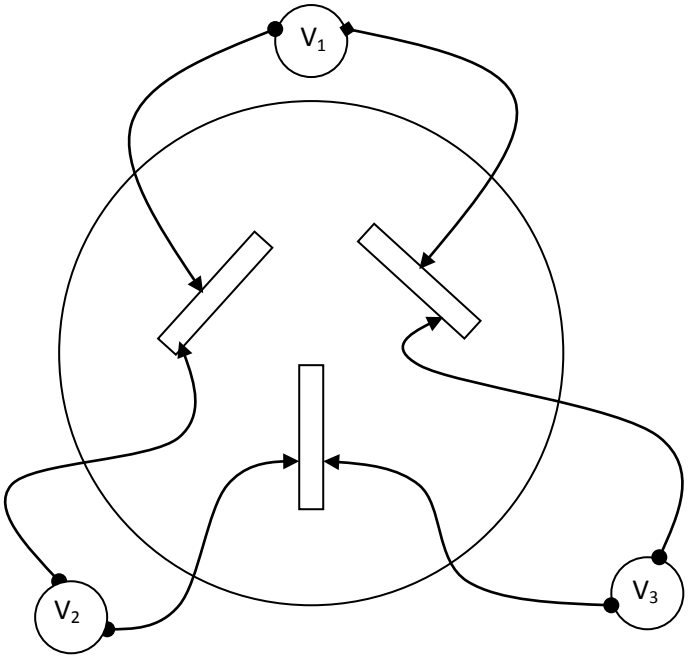
c) What will happen to the other globes in configuration D if globe ***a*** breaks?
Remember the globes must not receive more than 6.0 V. You must use calculations to support your answer.

2 marks

d) What will happen to the other globes in configuration E if globe ***e*** breaks?
Remember the globes can not receive more than 6.0 V.

2 marks

The following information applies to Questions 14 and 15:
The diagram below represents a standard Australian power socket. The elements labelled V1 – V3 are voltmeters



Question 14: Which Voltmeters would have the same reading?

	1 mark

Question 15: What frequency and voltage are supplied to Australian homes through the domestic electricity network?

	1 mark

END OF AREA 2

AREA 3 :– Energy from the Nucleus

Question 1: Which one of the following best describes the process of nuclear fusion?

a. The joining of two lighter nuclei to form a larger, more stable nucleus
b. The splitting of a suitable heavier element into two smaller nuclei
c. The running of a nuclear power station
d. The creation of sunshine

2 marks

Question 2: In a nuclear fission reactor, substances like graphite and heavy water are used as moderators. The purpose of the moderator is to:

A. to slow the fast neutrons produced by the fission
B. to absorb a proportion of the neutrons
C. to cool the reactor core
D. to absorb the radiation released during fission
E. to provide the first neutron to start the reactor

2 marks

Question 3: In a nuclear reactor control rods made of Boron or Cadmium are inserted in the core. The purpose of the control rods is

a. to slow the fast neutrons produced by the fission
b. to absorb a proportion of the neutrons
c. to cool the reactor core
d. to absorb the radiation released during fission
e. to provide the first neutron to start the reactor

2 marks

Question 4: The uranium that is used as the fuel for a nuclear reactor has been enriched so that its uranium-235 content is around:

A. 0.7%
B. 3%
C. 10%
D. 95%

2 marks

Question 5: The average number of neutrons released per fission is 2.5. If a reactor is to operate safely, what proportion of the emitted neutrons must react with ^{235}U nuclei?

a. 0.0
b. 0.25
c. 0.4
d. 1.0

	2 marks

Question 6: The value of *x* in the fission reaction $^{1}n + ^{235}U \rightarrow ^{142}Xe + ^{90}Sr + x^{1}n$ is

a. 1
b. 2
c. 3
d. 4

	2 marks

Question 7: Uranium-235 releases an average of about 2.5 neutrons during each fission, whereas plutonium-239 releases an average of about 2.7 neutrons. Which of the following is true?

a. Neither Uranium-235 nor Plutonium-239 is fissile
b. Uranium-235 has a lower critical mass than Plutonium-239
c. Uranium-235 has a higher critical mass than Plutonium-239
d. Uranium-235 is not fissile, Plutonium-239 is fissile

	2 marks

Use the following where necessary 1 amu = 1.66054×10^{-27} kg $c = 3\times10^{8}$m/s

The following information relates to questions 8 to 11

The mass of one ^{7}Li atom is 7.01600455amu. One ^{9}B atom has a mass of 9.0133288amu. These two atoms are fused to form ^{16}O which has a mass of 15.9949146amu

Question 8: What is the mass in kg of one ^{7}Li atom?

(1 mark)

Question 9: What is the mass in kg of one ^{9}B atom?

(1 mark)

Question 10: What is the mass in kg of one ^{16}O atom?

(1 mark)

Question 11: Explain why energy is released in the fusion of ^{7}Li and ^{9}B

(2 marks)

The following information relates to questions 12 to 13.

The reaction $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 2^{1}_{0}n$ produces 2.6×10^{-11} J of energy.

Question 12: Which side of the reaction has the greater mass?(circle)

Left side Right Side

(1 mark)

Question 13: What is the difference in mass between the two sides of the equation?

(2 marks)

Question 14: In the following nuclear reaction what is the value of X?

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + X\ ^{1}_{0}n$$

(2 marks)

Question 15: A common fusion reaction is the fusing of hydrogen-3 with hydrogen-2 to create helium-4 plus a neutron. Write down the nuclear equation for this reaction. You must include all atomic numbers and mass numbers

(2 marks)

Question 16: Uranium is mined from uranium-rich ore bodies. When the uranium is mined it consists of two different isotopes, uranium-235 and uranium-238. Circle the correct answers

a) Which isotope makes up the most of the mined uranium? U-235 U-238

a) Which of the two isotopes is fissile? U-235 U-238

(2 marks)

Question 17: Name the main components of a nuclear fission power plant

(4 marks)

Question 18: Outline the process by which a nuclear fission power plant produces electricity

(3 marks)

END OF EXAM