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STAV Publishing 2009

Student name

PHYSICS

Unit 1

Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

	Number of Areas of study	Number of Areas of study to be answered	Number of marks
Section A – Areas of study	2	2	70

	Number of Detailed studies	Number of Detailed studies to be answered	Number of marks
Section B – Detailed studies	1	1	20
		Total	**90**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, mobile phones and/or any other unauthorised electronic devices.

Materials supplied

- Core question and answer book of 12 pages. The question and answer book has a detachable data sheet in the centrefold and a detachable multiple choice answer sheet inside the front cover.
- Detailed Study Book of 4 pages.

Instructions

- Detach the data sheet from the centre of this book, and the answer sheet for multiple choice questions, during reading time.
- Write your **name** on the top of this page and on the answer sheet for multiple choice questions.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple choice questions and the Detailed Study Book inside the front cover of this book.

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ABN 61 527 110 823

AREA 1 – Nuclear physics and radioactivity

Questions 1 to 3 refer to the following information.

An isotope of helium is shown on the right:

$$^{4}_{2}He^{2+}$$

Question 1.

Which of the following best describes an "isotope"?

A Isotopes have the same mass number but different atomic numbers.

B Isotopes have the same number of nucleons but have a different ionic charge.

C Isotopes have the same number of protons but different mass numbers.

D Isotopes have the same atomic number but have a different number of electrons.

[2 marks]

Question 2.

How many neutrons are there in this particular isotope of Helium?

[2 marks]

Question 3.

Another name for this isotope of Helium is:

[2 marks]

Question 4.

A possible equation for the production of beta particles is:

$$^{14}_{6}C \rightarrow {}^{X}_{Y}Z + {}^{0}_{-1}e$$

a) What is the value of **X** in the above equation? **X =**

b) What is the value of **Y** in the above equation? **Y =**

c) What is the element **Z** in the above equation? **Z =**

[3 × 1 = 3 marks]

Question 5.

Alpha, beta and gamma decay are three types of radioactive decay. Fill in the missing sections (a, b, c) of the following table for these types of decay.

	Particle lost from nucleus	Change in mass number of decaying nucleus	Change in atomic number of decaying nucleus
Alpha decay (α)	$^{4}_{2}He$	a.	-2
Beta decay (β)	$^{0}_{-1}e$	0	b.
Gamma decay (γ)	$^{0}_{0}\gamma$	0	c.

[3 × 1 = 3 marks]

Question 6.

Place the three decay types, alpha, beta and gamma, in order of penetrating ability from most penetrating to least penetrating.

→ →

most least

[2 marks]

Question 7.

When measuring decay rates with a Geiger-Muller tube and an electronic counter the numbers observed have to be adjusted for background radiation. What is background radiation and where does it come from?

[3 marks]

Questions 8 to 10 refer to the following information

In an industrial factory that produces 6.0 m lengths of gas pipe, a radioactive source is used to test the thickness of the pipe wall. A radioactive source is placed **inside** the pipe and passed along the pipe while a detector is placed **outside** the pipe and moved in unison with the source.
The following table shows the results obtained for the count at different positions inside one of the pipes.

Position (m)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Count rate (Bq)	75	77	73	76	75	63	57	50	55	67	75	77

Question 8.

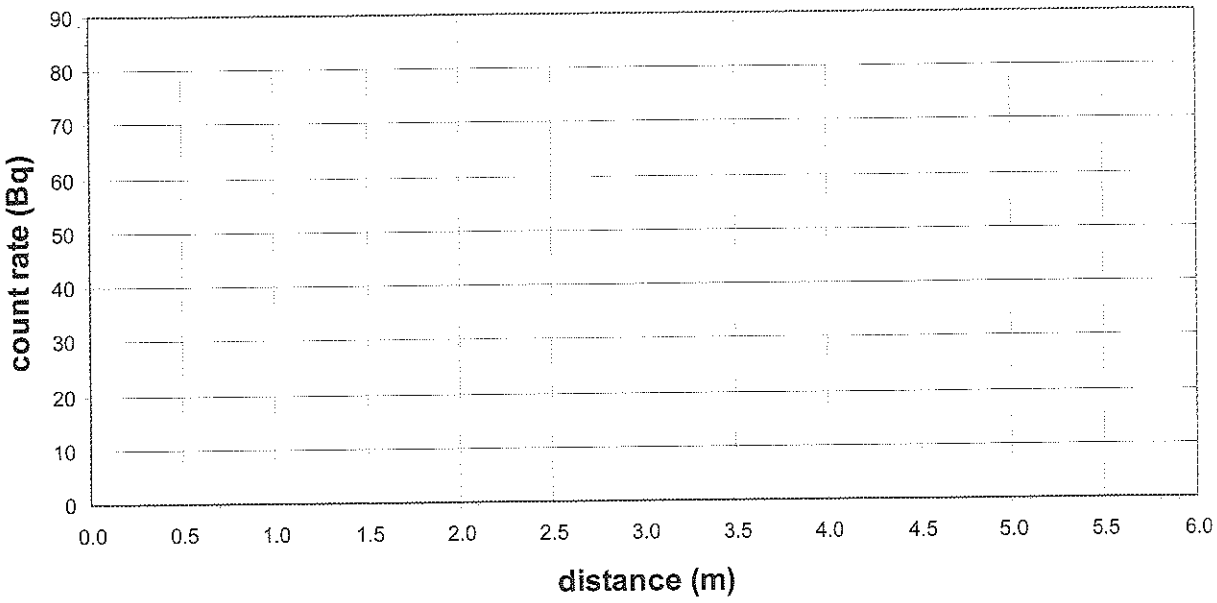
Explain what the unit Becquerel measures.

[2 marks]

Question 9.

Plot the data points from the table on the axes below.

Marks will be given for accurate and neat graphing.



[2 marks]

Question 10.

Give a possible explanation for the variation in count rate at around 4.0 m.

[2 marks]

Question 11.

What percentage of a radioactive material, with a half life of 40 seconds, is left after 8 minutes? Show working.

%

[3 marks]

Core – Nuclear Physics and Radioactivity & Electricity

1	half life : radioactive decay	$N = N_o(½)^n$
2	absorbed dose	$\text{absorbed dose (Gy)} = \frac{\text{energy absorbed (J)}}{\text{mass (kg)}}$
3	dose equivalent	$\text{dose equivalent (Sv)} = \text{absorbed dose (Gy)} \times \text{quality factor}$
4	electrical current	$I = \frac{Q}{t}$
5	voltage = potential difference	$V = \frac{E}{Q}$
6	electric power	$P = \frac{E}{t} = VI = \frac{V^2}{R} = I^2 R$
7	electrical energy	$E = VIt$
8	Ohm's Law	$R = \frac{V}{I}$ or $V = IR$
9	resistors in series	$R_{series} = R_1 + R_2 + \ldots R_n$
10	resistors in parallel	$R_{parallel} = (R_1^{-1} + R_2^{-1} + \ldots)^{-1}$
11	electrical charge carried by 1 electron	1.6×10^{-19} C
12	1 kilowatt-hour (kWh)	3.6×10^6 J

Detailed Study 1 – Astronomy

1	angular magnification	$M = \frac{\theta_1}{\theta_o}$

Detailed Study 2 – Astrophysics

1	parallax angle	$\theta = \frac{1}{d}$
2	Einstein's equation	$E = \Delta m\, c^2$
3	1 parsec	3.086×10^{16} m
4	1 Astronomical Unit	1.50×10^{11} m
5	1 light-year	9.46×10^{15} m
6	1 atomic mass unit	1.7×10^{-27} kg
7	speed of light in a vacuum	3.0×10^8 ms^{-1}

Detailed Study 3 – Energy from the Nucleus

1	Einstein's equation	$E = m\, c^2$
2	speed of light in a vacuum	3.0×10^8 m s^{-1}
3	1 atomic mass unit	1.7×10^{-27} kg

Detailed Study 4 – Investigations: Flight

1	power	$P = \frac{E}{t}$ or $P = F\,v$
2	equation of continuity	$Q = v_1 A_1 = v_2 A_2$
3	Bernoulli's equation	$½\rho\, v_1^2 + \rho\, g h_1 + P_1 = \text{constant}$
4	glide ratio (lift-to-drag ratio)	$\text{glide ratio} = \frac{\text{glide distance}}{\text{loss of altitude}}$
5	torque	$\tau = F\, d$

Detailed Study 5 – Investigations: Sustainable energy sources

1	efficiency	$\text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}}$
2	power	$P = \frac{E}{t}$
3	pressure	$P = \frac{\text{force}}{\text{area}}$

Detailed Study 6 – Medical Physics

1	acoustic impedence	$Z = \rho\, v$
2	reflection of ultrasound	$\frac{I_r}{I_o} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$

Prefixes

n = nano = 10^{-9}
μ = micro = 10^{-6}
m = milli = 10^{-3}
k = kilo = 10^3
M = mega = 10^6
G = giga = 10^9

END OF DATA SHEET

Questions 12 to 14 refer to the following information

A 75 kg man accidentally received an overall radiation exposure which infused his body with 1.3 joules of energy. The accident occurred when a transport container was dropped from the back of a truck due to insufficient care taken in tying down the load. The man was standing 15 m across the street from the truck when the accident occurred.

Question 12.

What is the radiation dose received by the man in this accident? Show working.

Gy

[2 marks]

Question 13.

What is the dose equivalent received by the man?

Sv

[2 marks]

Question 14.

What assumption have you made in answering the previous question and how can you justify this assumption?

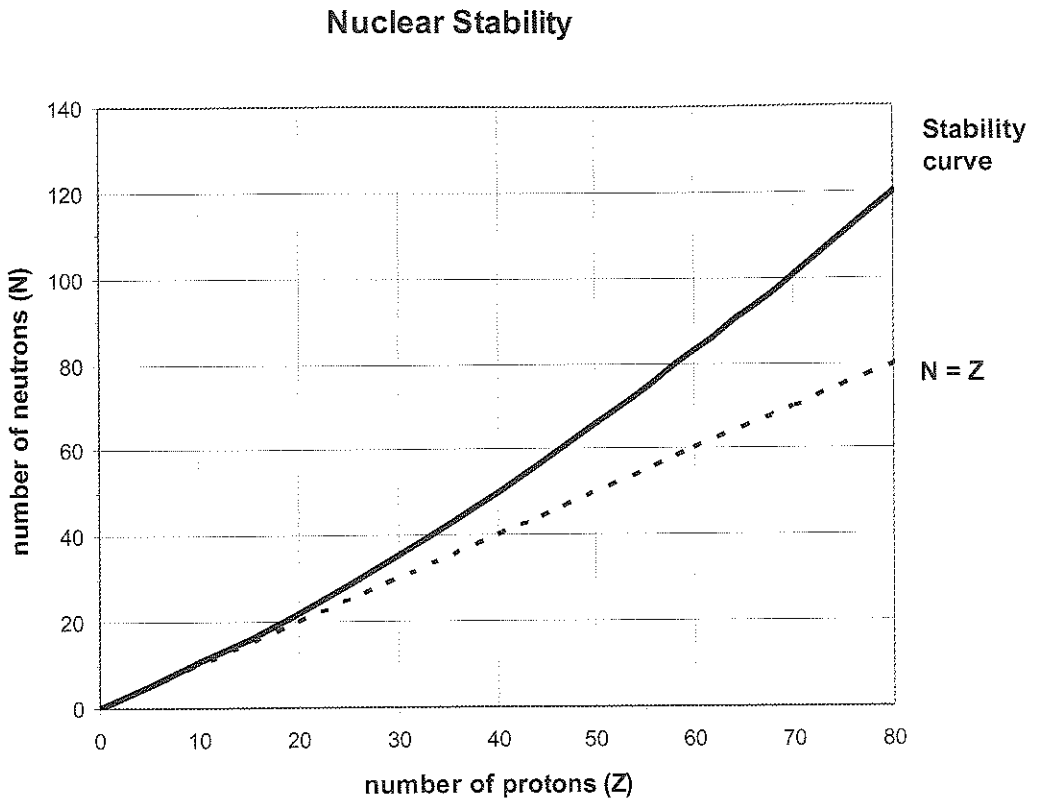
Assumption

Justification

[1 + 2 = 3 marks]

Question 15.

The solid line on the graph below shows neutron number against proton number for known stable nuclei. Other nuclei could be plotted on this chart but such nuclei are unstable and would undergo decay to more stable nuclei.



Which of the following statements about the decay process to produce a more stable nucleus is correct? (One or more answers may be possible)

A Nuclei which lie above the curve are likely to decay by the emission of a β–particle.

B Nuclei which lie below the curve are likely to decay by the emission of a β–particle.

C Nuclei which lie above the curve are likely to decay by the emission of an α–particle.

D Nuclei which lie below the curve are likely to decay by the emission of an α–particle.

[2 marks]

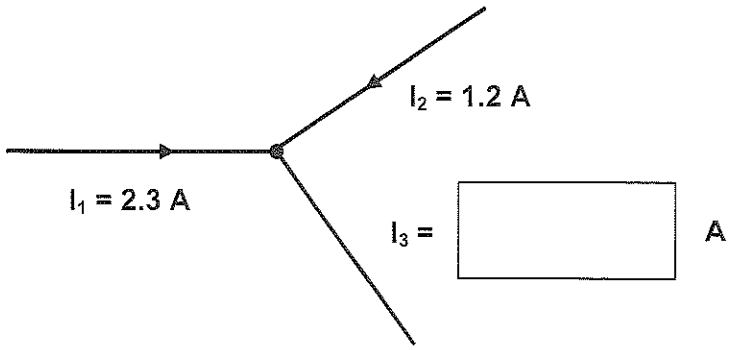
END OF STUDY AREA 1 – NUCLEAR PHYSICS AND RADIOACTIVITY

AREA 2 – Electricity

Question 1.

The currents I_1 and I_2 are flowing into a junction as indicated on the following diagram.

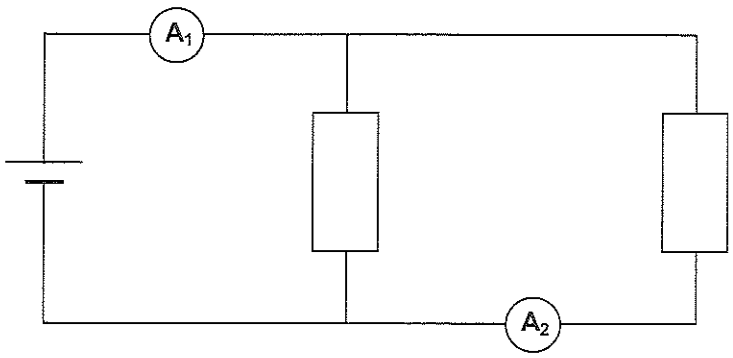
On the diagram give the size and indicate the direction, with an arrow, of the current I_3.



[2 marks]

Question 2.

In the following circuit the current through ammeter A_1 is 0.5 A. The resistors are of equal value.



What is the current in ammeter A_2?

A

[2 marks]

Question 3.

A current of 1.5 amperes is measured flowing through a different ammeter.

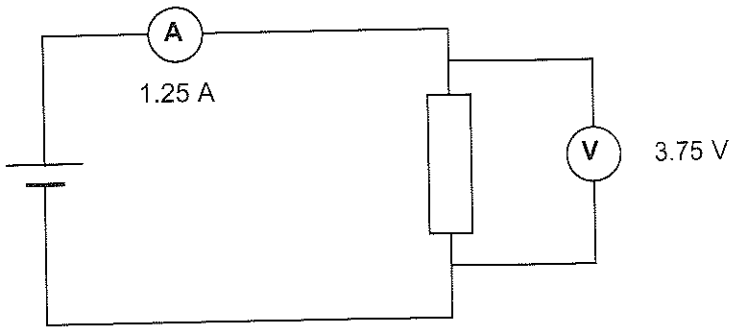
How much charge passes through this ammeter in 1½ minutes? Show working.

C

[2 marks]

Questions 4 and 5 refer to the following information

In the following circuit the ammeter is reading 1.25 ampere and the voltmeter is reading 3.75 V.



Question 4.

What is the magnitude of the resistance in this circuit? Show working.

Ω

[2 marks]

Question 5.

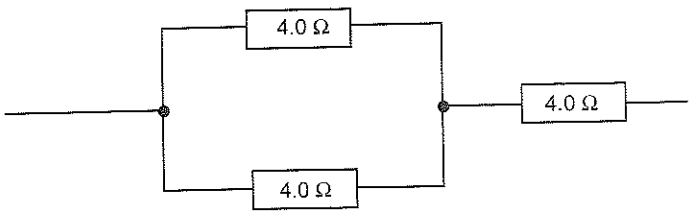
What is the voltage supplied by the battery?

V

[2 marks]

Question 6.

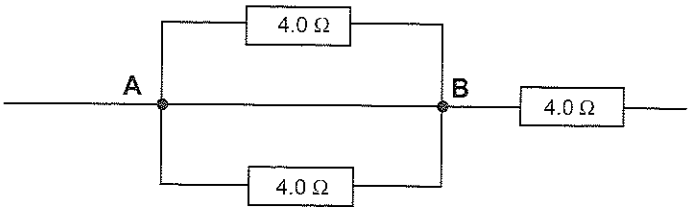
What single resistor could replace the following 3 resistor combination? Show working.



Ω

[3 marks]

Questions 7 and 8 refer to the following information



Question 7.

What single resistor could replace the three resistor combination shown above?

Ω

[2 marks]

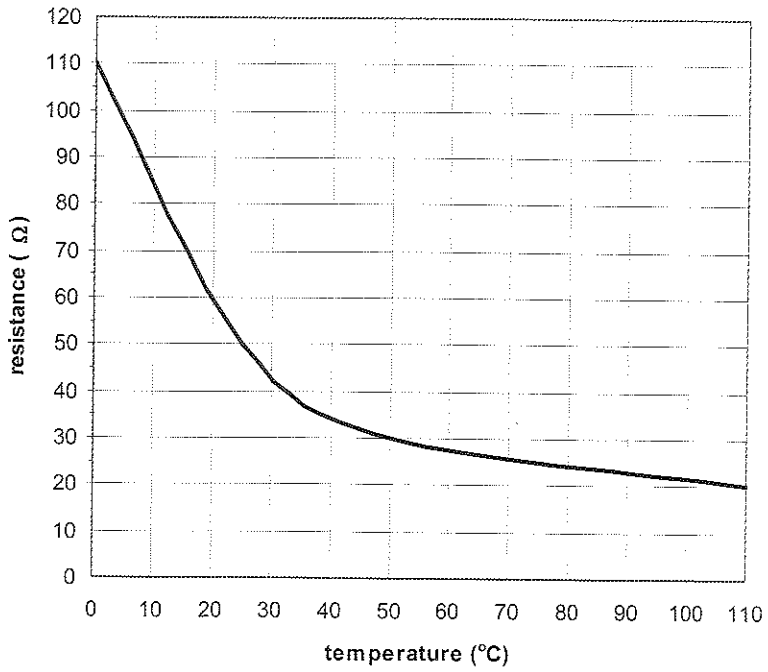
Question 8.

What is the name for the direct path from point **A** to point **B**?

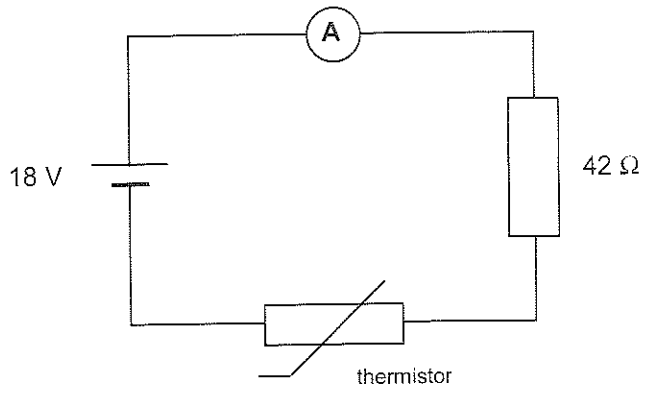
[2 marks]

Questions 9 and 10 refer to the following information

A thermistor has the following resistance - temperature characteristic.



The Thermistor is placed in the following circuit.



Question 9.

What current flows through the ammeter when the temperature is 50 °C? Show working.

A

[3 marks]

Question 10.

The Thermistor is considered to be a **non-ohmic** device.

Explain what is meant by the term **non-ohmic** in this context.

[2 marks]

Questions 11 to 13 refer to the following information

A student is studying for her exams in the cold winter months. She uses a 1200 W single bar radiator to try and keep warm. She studies 3 hours per night 5 nights a week for a period of 4 weeks with the radiator on.

Question 11.

How many kilowatt-hours of energy did she use in this time to heat her room? Show working.

kWh

[2 marks]

Question 12.

Convert one night's kilowatt-hours into joules. Show working.

J

[2 marks]

Question 13.

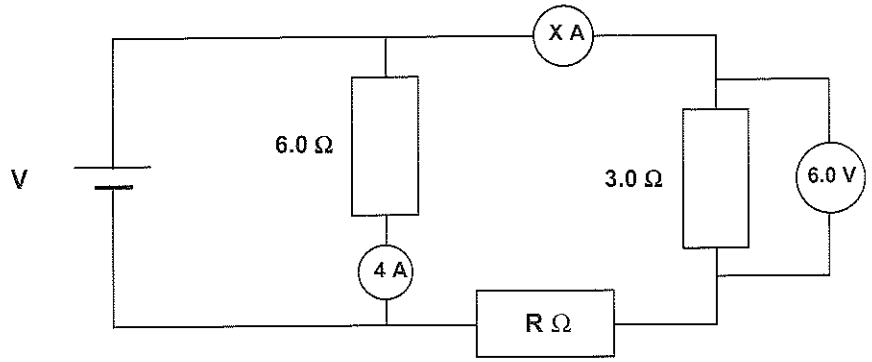
The electricity company charges $0.15 per kWh. How much does the radiator cost to run for **one week**?

$

[2 marks]

Questions 14 to 16 refer to the following information

The following circuit diagram shows a three resistor combination with some unknown values **X** and **R**.



Question 14.

What is the size of the current X in the ammeter? Show working.

X = A

[2 marks]

Question 15.

What is the size of the resistance R? Show working.

R = Ω

[3 marks]

Question 16.

What is the size of the voltage supplied by the battery?

V

[2 marks]

END OF STUDY AREA 2 - ELECTRICITY