



## 2023 Trial Examination

STUDENT  
NUMBER

--	--	--	--	--	--	--	--

Letter

--

# PHYSICS

## Unit 1 – Written examination

Reading time: 15 minutes  
Writing time: 1 hour and 30 minutes

### QUESTION & ANSWER BOOK

#### Structure of book

<i>Section</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
<b>Areas of Study</b>		
1. How are light and heat explained?	6	30
2. How is energy from the nucleus utilised?	6	30
3. How can electricity be used to transfer energy?	9	30
		Total 90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- A scientific calculator is permitted in this examination.
- A double-sided A3 cheat sheet is allowed

#### Materials supplied

- Question and answer book of 28 pages.

#### Instructions

- Print your name in the space provided on the top of this page.

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

**Instructions**

Where an answer box has a unit printed in it, give your answer in that unit.  
Where answer boxes are provided, write your answers in the box.  
In questions worth more than 1 mark, appropriate working should be shown  
Unless otherwise indicated, diagrams are not to scale

**Area of Study 1 – How are light and heat explained?**

**Question 1 (1 mark)**

Which of the following statements best describes the electromagnetic (EM) waves.

- A. They are transverse waves travelling at the speed of light,  $c$  in all mediums.
- B. They are longitudinal waves travelling in a straight line
- C. They are transverse waves travelling at the speed of light,  $c$  in a vacuum.
- D. They are transverse waves that require a medium to propagate.

**Question 2 (1 mark)**

Heating the air in a hot air balloon lowers its density and causes it to rise and then float. According to the kinetic energy model, the best explanation for this effect is

- A. An increase in the thermal energy of the systems the air molecules gain energy and gain speed which results in a lower density compared to its surrounding.
- B. The temperature of the air inside the balloon increases causing it to become hot and rise which pushes the balloon up.
- C. As the temperature increases, the volume of the balloon decreases making it lighter and less dense which causes it to float.
- D. As the air molecules gain energy they rise and escape from the balloon causing its overall mass to decrease and rise.

**Area of Study 1- continued**

**Question 3 (1 mark)**

The average temperature of Earth is  $16^{\circ}\text{C}$  and it emits most of its energy in the infrared range of the electromagnetic spectrum as re-radiation. Calculate the maximum wavelength of this re-radiated energy. [ $\lambda_{max} T = 2.898 \times 10^{-3}$ ]

- A.  $10 \mu\text{m}$
- B.  $1.0 \mu\text{m}$
- C.  $1.06 \times 10^{-5} \text{m}$
- D.  $1.8 \times 10^{-4} \text{m}$

**Question 4 (9 marks)**

a. A 25 m long Aboriginal dugout canoe is anchored at Yarra River. When the crest of one of the waves is at the front of the canoe, the trough of the same waves reaches the back. It was noticed that exactly 14 waves completely pass the front of the canoe in 7 minutes and the peak-to-peak height of each wave was 2 m.

i. Calculate the amplitude of the waves

---

---

---

(1 mark)

ii. Determine the wavelength of each wave.

---

---

---

---

(2 marks)

**Area of study 1 – continued**  
**TURN OVER**

iii. Determine the frequency of the waves

---

---

---

---

---

(2 marks)

Hz

iv. Find the speed of the waves in 2 decimal places.

---

---

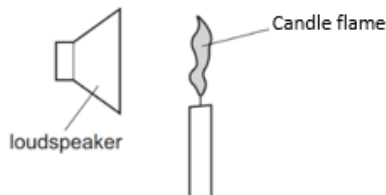
---

---

(1 mark)

$\text{ms}^{-1}$

**b.** To investigate sound waves, a physics student placed a candle in front of a loudspeaker. The speaker produces sound waves causing air particles to vibrate. The student notices that the vibrating air particles make the candle flame vibrate in the same direction as the air particles. Draw the direction of vibration on the candle flame using arrows and identify the nature of sound waves.



(2 marks)

Blank box for drawing and labeling.

- c. Nearly all of the energy available on Earth comes from sun in the form of solar radiation. List the three main types of electromagnetic spectrum radiation emitted from the sun.

(1 mark)

--	--	--

**Question 5 (10 marks)**

- a. A group of physics students' setup an experiment to investigate refraction of light. They aim a laser pointer to a glass prism as shown in Figure 1 below.

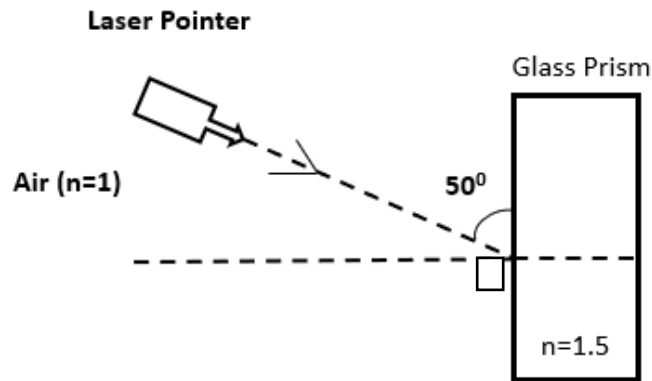


Figure 1

- i. Draw an arrow at the air-glass boundary to show how the light ray refracts as it enters the glass. (1 mark)
- ii. Determine the angle of refraction.

---

---

---

---

---

---

---

---

---

---

0
---

(2 marks)

**Area of study 1 – continued  
TURN OVER**

- b. One of the students suggests that when light enters glass, its speed changes causing refraction due to a change in both its wavelength and frequency.

Identify the misconception in the student's statement

---

---

---

---

---

(2 marks)

- c. The students then observe how light re-enters air from the glass prism. Calculate the angle of incidence when the angle of refraction is  $90^{\circ}$

---

---

---

---

0
---

(1 mark)

- d. Optical fibres are replacing copper cables for communication because they are cheap, light and can carry more data. They are made up of a glass core material and coated with glass cladding. When light enters the core, it reflects totally internally. State the two conditions for total internal reflection to occur.

---

---

---

---

(2 marks)

**Area of study 1 – continued**

e. Identify one use of UV radiation and one use of gamma rays in our society.

---

---

---

---

(2 marks)

**Question 6 (8 marks)**

Earth ovens were a common traditional method of cooking food in a several countries. Shown is an example of an earth oven used by the Māori communities.

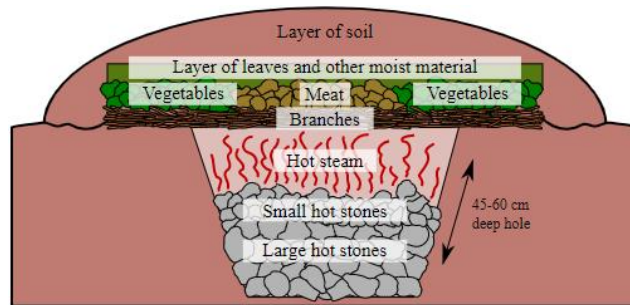


Figure 1: Ref: [https://upload.wikimedia.org/wikipedia/commons/6/62/Maori\\_earth\\_oven.svg](https://upload.wikimedia.org/wikipedia/commons/6/62/Maori_earth_oven.svg)

a. The pit contains red hot stones, and the food is placed at the top, covered by a layer of soil as shown in Figure 1. Convection is the main method of heat transfer from the hot stones. Explain how heat is transferred in an earth oven via the process of convection.

---

---

---

---

---

---

---

(1 mark)

**Area of study 1 – continued**  
**TURN OVER**

- b. The heating element of a hot water jug is positioned at the bottom of the unit.  
How does this setup ensure that all water can reach the boiling point if the heat element only heats up the water at the bottom area?

---

---

---

---

---

---

---

---

(2 marks)

- c. The water jug can hold 2 kg of water. Fardeen heated the water from a room temperature of  $21^{\circ}\text{C}$  to its boiling point. the jug maintains its temperature until all water is evaporated completely.
- i. Determine the amount of energy that must be transferred to the water to raise its temperature from  $21^{\circ}\text{C}$  to boiling point. ( $c = 4200\text{ Jkg}^{-1}\text{K}^{-1}$ )

---

---

---

---

---

---

kJ
----

(2 marks)



ii. Calculate the amount of energy required to change liquid water to steam (gas).

---

---

---

---

---

kJ
----

(1 mark)

**d.** Vaporisation of water molecules from the earth’s atmosphere is a process where heat is absorbed from the environment. This phenomenon should cool planet earth down, however water vapour is said to be responsible for more than 50% of the Earth’s greenhouse effect.

Explain how vaporisation causes the Earth’s temperature to increase.

---

---

---

---

---

---

---

---

---

---

---

(2 marks)

**END OF AREA OF STUDY 1  
TURN OVER**

**Area of Study 2 - How is energy from the nucleus utilised?**

**Question 7 (1 mark)**

Which of the following is a source of the Sun's energy?

- A. Fusion of protons
- B. Fusion of carbon nuclei
- C. Exothermic chemical reactions
- D. Fission of uranium-235

**Question 8 (1 mark)**

When Uranium -236 undergoes fission reaction, one of the products has an atomic mass number of 137. What is the most likely element produced?

- A. Silver
- B. Gold
- C. Barium
- D. Rubidium

**Question 9 (1 mark)**

If all the energy released in a reaction were converted into alpha particles containing 3.9 MeV, the mass defect of this reaction is closest to

- A.  $3.85 \times 10^{-25}$  kg
- B.  $6.93 \times 10^{-30}$  kg
- C.  $6.65 \times 10^{-27}$  kg
- D.  $6.35 \times 10^{-13}$  kg



- ii. If a patient is injected with Technetium- 99m, what fraction of the original amount will have decayed after 36 hours.

---



---



---

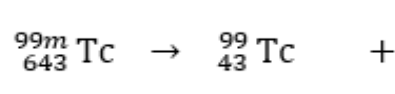
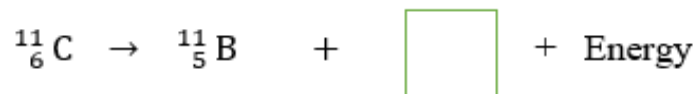
(2 marks)

- c. The table below shows the properties of  $\alpha$ ,  $\beta$ ,  $\beta^+$  and  $\gamma$  radiation.

Property	Radiation Type
No mass	
Charge of +2	
Emits positron	
Neutrons decay into a proton	

Complete the above table by filling in the correct radiation type corresponding to its property. (2 marks)

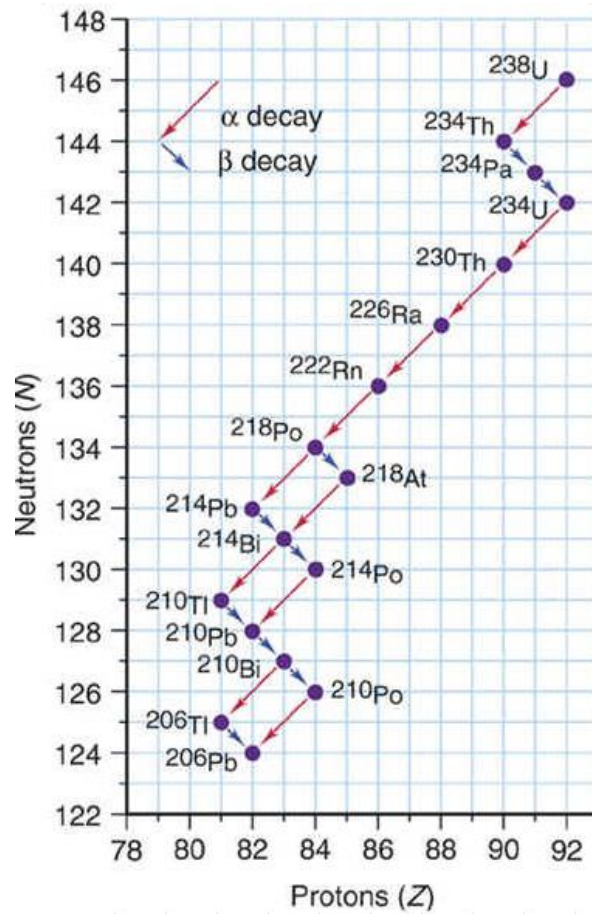
- d. Complete the following decay equations by calculating both atomic and mass numbers and then finding the missing particle. (3 marks)



Area of study 2 - continued

**Question 11 (10 marks)**

a. Shown in Figure 3 below is the Uranium decay series where  $^{238}_{92}\text{U}$  decays to gradually transform into stable  $^{206}_{82}\text{Pb}$



**Figure 3**

Ref: <http://www.kentchemistry.com/links/Nuclear/naturalTrans.htm>

i. Define the term decay series.

---



---



---

(1 mark)

**Area of study 2 - continued  
TURN OVER**

ii. How many alpha decays did Uranium 238 undergo to become Po -208?

---

---

---

(1 mark)

b. A 80 kg person absorbs 0.072 J of energy due to ionisation radiation.

i. Determine the absorbed dose.

---

---

---

(1 mark)

ii. Calculate the equivalent dose of the energy was delivered by alpha particles of quality factor 15

---

---

---

(1 mark)

**Area of study 2 - continued**

c. If the energy delivered is replaced by x-rays of quality factor 1, explain whether this will increase or decrease biological damage to the person. Support your answer with calculations.

---

---

---

---

---

---

---

---

---

---

(3 marks)

d. Yttrium -90 is a radioisotope used to treat non-Hodgkin's lymphoma and liver cancer. Outline a general process of how medical radioisotopes are used for therapy and identify two common side effects.

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

(3 marks)

**Area of study 2 – continued**  
**TURN OVER**

**Question 12 (8 marks)**

- a. To produce nuclear energy the nucleus of a radioisotope undergoes fission reaction. This isotope is said to lose a small amount of mass.

Explain how nuclear energy is generated from this process and what happens to this lost mass.

---

---

---

(2 marks)

- b. Uranium -236 emits two or three neutrons with nuclear reactions.

- i. State the name of this reaction

(1 mark)

- ii. In some fission reactions a moderator is used to slow down the neutrons. One such moderator is water. Identify another commonly used moderator.

(1 mark)

- iii. Some isotopes absorb free neutrons which prevents a sustainable chain reaction to occur. Identify a process to overcome this difficulty.

---

---

---

(1 mark)

**Area of study 2 – continued**



c. Figure 5 shows a binding energy -per-nucleon graph.

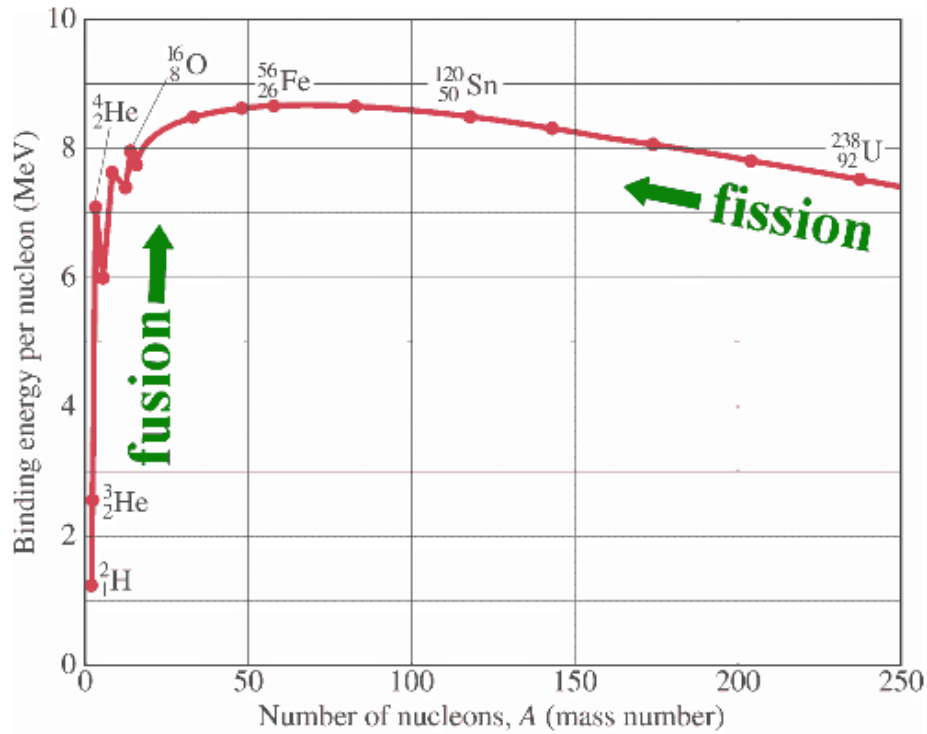


Figure 5

i. Identify the most stable nucleus from the above graph.

(1 mark)

ii. Circle the correct option in the table shown below to identify the nuclear reaction and stability of Helium and Sn.

Nucleus	Nuclear Reaction	Stability
${}^3_2\text{He}$	Fusion / Fission	stable / unstable
${}^{120}_{50}\text{Sn}$	Fusion / Fission	stable / unstable

(2 marks)

**END OF AREA OF STUDY 2  
TURN OVER**

**Area of Study 3 - How can electricity be used to transfer energy?**

**Question 13 (1 mark)**

A 4000 W heater operates for 2 hours. If the price for household electricity is 25 cents per kWh, what is the cost of running the heater for 2 hours?

- A. \$200.00
- B. \$2.00
- C. \$4.00
- D. \$8.00

**Question 14 (1 mark)**

Which of the following is true about the residual current device (RCD)

- A. The current in the active wire flows in the same direction as in the neutral wire.
- B. It is useful only when the current flows to the earth and not through an individual between the active and neutral wires.
- C. It operates by automatically resting the circuit current to the required value.
- D. The RCD has a metal strip which melts when excessive current flows through it.

**Question 15 (1 mark)**

A kitchen circuit has the following operating appliances; a 300 W toaster, 1500 W kettle, 1 kW microwave, a 315 W refrigerator, and a 60 W food processor. The circuit is protected by a fuse.

Which one of the following is an appropriate rating of the fuse to ensure the safety of the circuit if a voltage of 230 V, 50Hz is supplied to the kitchen?

- A. 13.5 A
- B. 12.0 A
- C. 14.0 A
- D. 13.7 A

**Question 16 (9 marks)**

a. A 12 V battery delivers a current of 5.0 A which passes through a load and flows for 2 minutes and 20 seconds.

i. Determine the number of electrons that passes through in 2 minutes and 20 seconds.

---

---

---

(2 marks)

ii. How much energy does the 12 V battery provide?

---

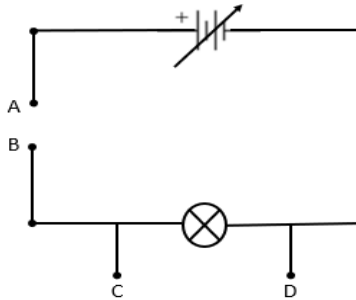
---

---

(2 marks)

**Area of study 3 – continued**  
**TURN OVER**

b. A light bulb is connected to a 6 V variable power supply as shown below in Figure 6.



**Figure 6**

To complete the circuit two electrical meters need to be connected from point A to B and C to D.

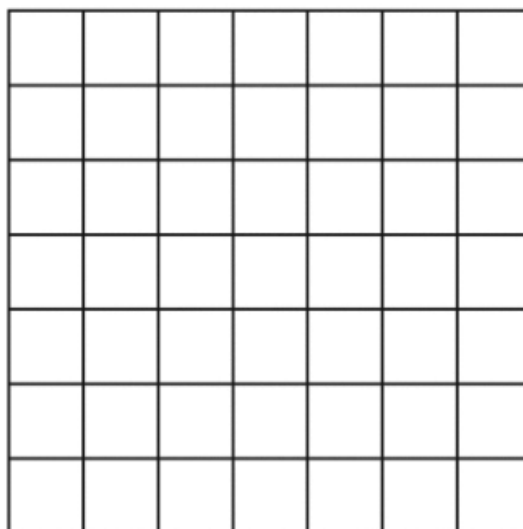
i. Draw and label two electrical meters that need to be connected in these two positions.

(2 marks)

c. The table below shows the voltage and current readings for the light bulb.

<b>I (Amps)</b>	<b>V (Volts)</b>
0	0
1	2
2	4
3	6

i. Sketch a graph of voltage (y-axis) against current on the grid provided.



(1 mark)

**Area of study 3 – continued**

ii. Calculate the gradient of the graph.

---

---

---

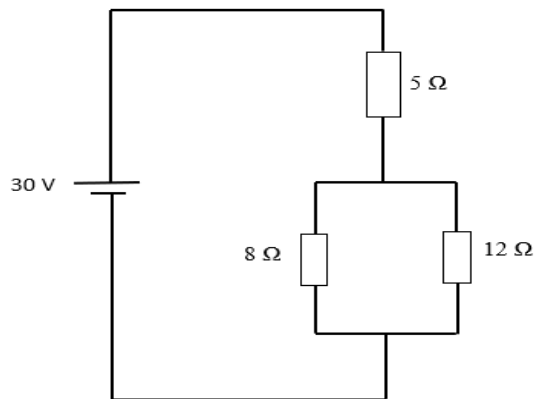
(1 mark)

iii. What does the gradient represent.

(1 mark)

**Question 17 (9 marks)**

a. Three resistors are arranged in a circuit diagram as shown in Figure 7 below.



**Figure 7**

i. Determine the effective resistance of the circuit.

---

---

---

(2 marks)

**Area of study 3 – continued**  
**TURN OVER**

ii. Calculate the voltage across the  $5\ \Omega$  resistor.

---

---

---

---

(2 marks)

iii. Determine the current through the  $12\ \Omega$  resistor.

---

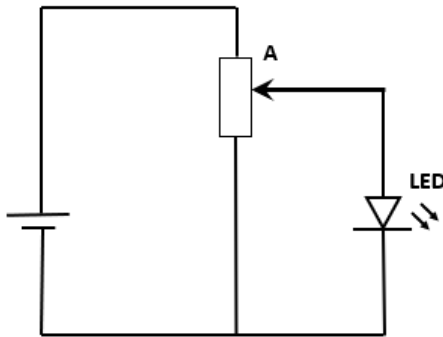
---

---

---

(2 marks)

b. A circuit setup consists of an electrical component A which acts as a dimmer switch as shown in Figure 8 below.



**Figure 8**

i. Name the electrical component A.

(1 mark)

**Area of study 3 – continued**

ii Explain how this electrical component controls the brightness of the LED.

---

---

---

---

---

---

---

---

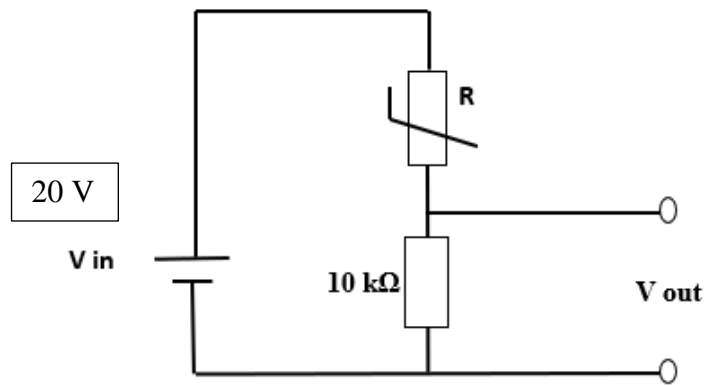
---

---

(2 marks)

**Question 18 (9 marks)**

a. A voltage divider circuit consists of a 20V supply voltage, 10 kΩ fixed resistor, and a NTC thermistor as shown in Figure 9 (a) below.



**Figure 9 (a)**

**Area of study 3 – continued  
TURN OVER**

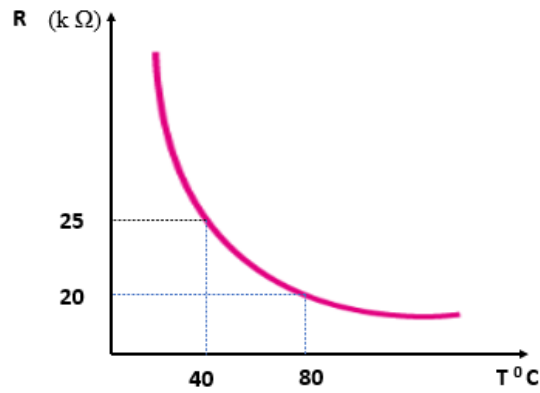


Figure 9 (b)

Figure 9 (b) shows how the resistance of the thermistor varies with time.

The thermistor is labelled as NTC (negative temperature coefficient).

i. Explain why the thermistor is stated as NTC.

---



---



---



---

(1 mark)

ii. Determine the amount of current flowing in the circuit when the temperature of the thermistor is  $80^{\circ}C$ .

---



---



---



---

mA
----

(2 marks)

Area of study 3 – continued



- b. A second electrical circuit is constructed using an LED and component B as shown in Figure 10 below.

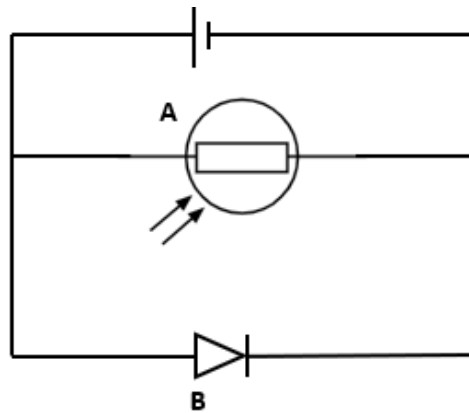


Figure 10

- i. State the name of the electrical component B.

(1 mark)

- ii. LEDs are quite cheap to compared to incandescent light. Outline another advantage of LEDs over incandescent light bulbs.

---

---

---

---

(1 mark)

Area of study 3 – continued  
**TURN OVER**

2023 PHYSICS EXAM

c. The household (AC) electrical systems in Melbourne can be modelled as simple direct current (DC) circuits. Houses are connected to the  $230\text{ V}_{\text{RMS}}$  at 50 Hz to the main electrical grid.

i. What does the  $230\text{ V}_{\text{RMS}}$  mean in terms of the direct current (DC)

---

---

---

---

(1 mark)

ii. Provide one reason why homes are mostly built with parallel circuits.

---

---

---

---

(1 mark)

d. A common household appliance is the electrical toaster. Inside the toaster an earth wire is permanently connected to its metal casing.

i. State the common colour of the earth wire

Colour:
---------

(1 mark)

ii. Outline the function of this earth wire

---

---

---

(1 mark)

**END OF AREA OF QUESTION AND ANSWER BOOK**

**Formula and Data Sheet:**

Wave equation	$v = f\lambda$
Snell's law	$n_1 \sin \theta_1 = n_2 \sin \theta_2$
Refractive index and wave speed	$n_1 v_1 = n_2 v_2$
Wien's Law:	$\lambda_{max} T = 2.898 \times 10^{-3} \text{ m K}$
Heat Capacity	$Q = mc\Delta T$
Latent Heat	$Q = mL$
Specific heat of solid water	$2.108 \times 10^3 \text{ J Kg}^{-1} \text{ K}^{-1}$
Specific heat of liquid water	$4.187 \times 10^3 \text{ J Kg}^{-1} \text{ K}^{-1}$
Specific heat of gaseous water	$3.34 \times 10^5 \text{ J Kg}^{-1} \text{ K}^{-1}$
Latent heat of fusion of water	$3.34 \times 10^5 \text{ J Kg}^{-1}$
Latent heat of vaporisation of water	$2.27 \times 10^6 \text{ J Kg}^{-1}$
Binding Energy	$E = mc^2$
Speed of light, c	$3 \times 10^8 \text{ ms}^{-1}$
Electric charge	$Q = It$
Electric Work	$W = QV$
Power	$P = \frac{E}{t} = VI$
Voltage	$V = IR$
Resistors in series	$R_{TOTAL} = R_1 + R_2 + \dots + R_N$
Resistors in parallel	$\frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N}$
Electronic Charge	$1.6 \times 10^{-19} \text{ C}$

### Periodic Table of the Elements

Atomic Number		Symbol		Name		Atomic Mass	
1	IA	1	H	Hydrogen	1.008	1	1.008
2	IIA	2	He	Helium	4.0026	2	4.0026
3	IIIA	3	Li	Lithium	6.941	3	6.941
4	IVA	4	Be	Beryllium	9.0122	4	9.0122
5	VA	5	B	Boron	10.811	5	10.811
6	VIA	6	C	Carbon	12.011	6	12.011
7	VIIA	7	N	Nitrogen	14.007	7	14.007
8	VIIIA	8	O	Oxygen	15.999	8	15.999
9	VIIIA	9	F	Fluorine	18.998	9	18.998
10	VIIIA	10	Ne	Neon	20.180	10	20.180
11	I	11	Na	Sodium	22.990	11	22.990
12	II	12	Mg	Magnesium	24.305	12	24.305
13	IIIA	13	Al	Aluminum	26.982	13	26.982
14	IVA	14	Si	Silicon	28.086	14	28.086
15	VA	15	P	Phosphorus	30.974	15	30.974
16	VIA	16	S	Sulfur	32.06	16	32.06
17	VIIA	17	Cl	Chlorine	35.45	17	35.45
18	VIIIA	18	Ar	Argon	39.948	18	39.948
19	I	19	K	Potassium	39.098	19	39.098
20	II	20	Ca	Calcium	40.078	20	40.078
21	IIIB	21	Sc	Scandium	44.956	21	44.956
22	IVB	22	Ti	Titanium	47.88	22	47.88
23	VB	23	V	Vanadium	50.942	23	50.942
24	VIB	24	Cr	Chromium	51.996	24	51.996
25	VIB	25	Mn	Manganese	54.938	25	54.938
26	VIB	26	Fe	Iron	55.845	26	55.845
27	VIB	27	Co	Cobalt	58.933	27	58.933
28	VIB	28	Ni	Nickel	58.69	28	58.69
29	VIB	29	Cu	Copper	63.546	29	63.546
30	VIB	30	Zn	Zinc	65.38	30	65.38
31	IIIB	31	Ga	Gallium	69.723	31	69.723
32	IVB	32	Ge	Germanium	72.63	32	72.63
33	VB	33	As	Arsenic	74.922	33	74.922
34	VIB	34	Se	Selenium	78.96	34	78.96
35	VIIA	35	Br	Bromine	79.904	35	79.904
36	VIIIA	36	Kr	Krypton	83.80	36	83.80
37	I	37	Rb	Rubidium	85.468	37	85.468
38	II	38	Sr	Strontium	87.62	38	87.62
39	IIIB	39	Y	Yttrium	88.906	39	88.906
40	IVB	40	Zr	Zirconium	91.224	40	91.224
41	VB	41	Nb	Niobium	92.906	41	92.906
42	VIB	42	Mo	Molybdenum	95.94	42	95.94
43	VIB	43	Tc	Technetium	98.906	43	98.906
44	VIB	44	Ru	Ruthenium	101.07	44	101.07
45	VIB	45	Rh	Rhodium	102.91	45	102.91
46	VIB	46	Pd	Palladium	106.36	46	106.36
47	VIB	47	Ag	Silver	107.87	47	107.87
48	VIB	48	Cd	Cadmium	112.41	48	112.41
49	IIIB	49	In	Indium	114.82	49	114.82
50	IVB	50	Sn	Tin	118.71	50	118.71
51	VB	51	Sb	Antimony	121.76	51	121.76
52	VIB	52	Te	Tellurium	127.6	52	127.6
53	VIIA	53	I	Iodine	126.90	53	126.90
54	VIIIA	54	Xe	Xenon	131.29	54	131.29
55	I	55	Cs	Cesium	132.91	55	132.91
56	II	56	Ba	Barium	137.33	56	137.33
57	IIIB	57-71		Lanthanide Series			
58	IVB	58	Ce	Cerium	140.12	58	140.12
59	VB	59	Pr	Praseodymium	140.91	59	140.91
60	VIB	60	Nd	Niodymium	144.24	60	144.24
61	VIB	61	Pm	Promethium	144.91	61	144.91
62	VIB	62	Sm	Samarium	150.36	62	150.36
63	VIB	63	Eu	Europium	151.96	63	151.96
64	VIB	64	Gd	Gadolinium	157.25	64	157.25
65	VIB	65	Tb	Terbium	158.93	65	158.93
66	VIB	66	Dy	Dysprosium	162.50	66	162.50
67	VIB	67	Ho	Holmium	164.93	67	164.93
68	VIB	68	Er	Erbium	167.26	68	167.26
69	VIB	69	Tm	Thulium	168.93	69	168.93
70	VIB	70	Yb	Ytterbium	173.05	70	173.05
71	VIB	71	Lu	Lutetium	174.97	71	174.97
72	VIIA	72	Hf	Hafnium	178.49	72	178.49
73	VB	73	Ta	Tantalum	180.95	73	180.95
74	VIB	74	W	Tungsten	183.84	74	183.84
75	VIB	75	Re	Rhenium	186.21	75	186.21
76	VIB	76	Os	Osmium	190.23	76	190.23
77	VIB	77	Ir	Iridium	192.22	77	192.22
78	VIB	78	Pt	Platinum	195.08	78	195.08
79	VIB	79	Au	Gold	196.97	79	196.97
80	VIB	80	Hg	Mercury	200.59	80	200.59
81	IIIB	81	Tl	Thallium	204.38	81	204.38
82	IVB	82	Pb	Lead	207.2	82	207.2
83	VB	83	Bi	Bismuth	208.98	83	208.98
84	VIB	84	Po	Polonium	209	84	209
85	VIIA	85	At	Astatine	210	85	210
86	VIIIA	86	Rn	Radon	222	86	222
87	I	87	Fr	Francium	223	87	223
88	II	88-103		Actinide Series			
89	III	89	Ac	Actinium	227	89	227
90	IV	90	Th	Thorium	232.04	90	232.04
91	V	91	Pa	Protactinium	231.04	91	231.04
92	VI	92	U	Uranium	238.03	92	238.03
93	VII	93	Np	Neptunium	237.05	93	237.05
94	VIII	94	Pu	Plutonium	244.06	94	244.06
95	VIII	95	Am	Americium	243.06	95	243.06
96	VIII	96	Cm	Curium	247.07	96	247.07
97	VIII	97	Bk	Berkelium	247.07	97	247.07
98	VIII	98	Cf	Californium	251.08	98	251.08
99	VIII	99	Es	Einsteinium	252.08	99	252.08
100	VIII	100	Fm	Fermium	257.10	100	257.10
101	VIII	101	Md	Mendelevium	258.10	101	258.10
102	VIII	102	No	Nobelium	259.10	102	259.10
103	VIII	103	Lr	Lanthanum	260.11	103	260.11