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90184

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 1 Physics, 2003

90184 Demonstrate understanding of heat transfer and nuclear physics

Credits: Three
9.30 am Thursday 20 November 2003

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 answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 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.

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Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Recall or describe phenomena, concepts or principles. ☐	Describe or explain how phenomena, concepts, principles, or relationships are interrelated. ☐	Explain or analyse phenomena in terms of concepts, principles, or relationships. ☐
Solve problems with direction. ☐	Solve problems by selection. ☐	Solve problems requiring more than one step or the synthesis of information. ☐
Overall Level of Performance (all criteria within a column are met) ☐		

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

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You may find the following formulae useful.

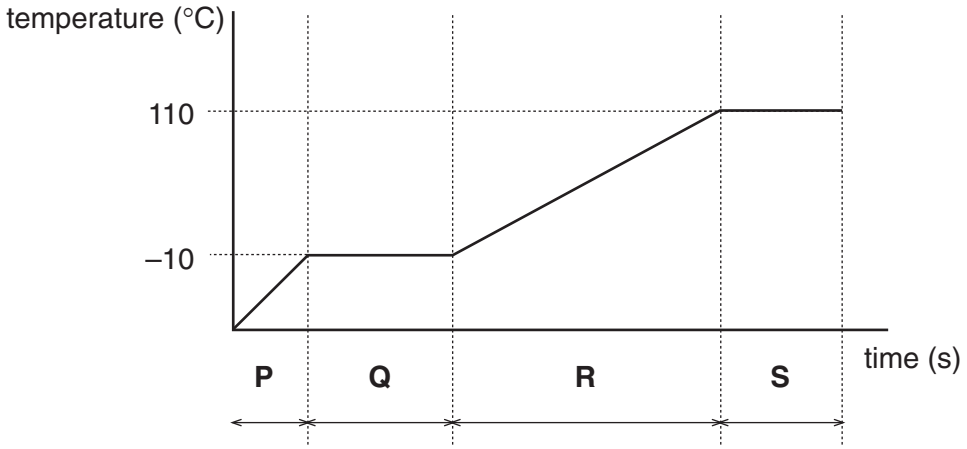
$$Q=mc\Delta T \qquad P=\frac{E}{t}$$

QUESTION ONE: Heat Energy

Two students, Sarah and Matthew, were experimenting with some brine (salt water). They measured out 0.5 kg of brine into a beaker and froze it with a thermometer immersed in the brine. The beaker was then heated at a constant rate using a Bunsen burner. Sarah measured the temperature at regular intervals.

Matthew plotted the following graph of their results.

Graph of temperature against time for heating brine



(a) Name the **phase** (state of matter) of the brine during sections P and R of the graph.

P: _____

R: _____

(b) The graph shows that the **temperature** is **constant** during section Q. Explain what is happening to the brine during this section.

_____

_____

_____

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(c) For section S of the graph, explain what happens to the **heat energy supplied** in relation to the **temperature** and the **phase** of the contents of the beaker.

(d) Use the formula $Q=mc\Delta T$ to calculate the amount of heat energy required to raise the temperature of 0.5 kg of frozen brine from –30°C to –10°C. The specific heat capacity of frozen brine is 2900 J kg^{-1} $(°C)^{-1}$. Give the correct unit with your answer. Ignore any heat loss to the surroundings during heating.

heat energy = _____ ____(unit)

(e) If it takes one **minute** for the frozen brine to melt, calculate the power of the Bunsen flame. Give the correct unit with your answer.

power = _____ ____(unit)

(f) To melt the frozen brine, 170 kJ of energy is needed. Bring together information to calculate the **total** amount of heat energy that would be needed to raise the temperature of 0.5 kg of frozen brine from –30°C to 110°C.
The specific heat capacity of liquid brine is 3200 J kg^{-1} $(°C)^{-1}$.

total heat energy = _____ ___(unit)

(g) The students have an accident with their experiment and the beaker of boiling salt water tips over. Clearly explain why Sarah gets a worse scald (burn) from the **vapour** than Matthew gets from the **liquid** at the same temperature.

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QUESTION TWO: Heat Transfer

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(a) There are three methods by which heat may be transferred from one point to another.

Complete the following table by stating **in the correct order** the TWO main methods of heat transfer in each situation.

Situation	Methods of heat transfer
Heat travels from the flame of a gas stove and heats the water in a pot on top of the stove.	(1) _____ (2) _____
Heat from the sun warms a brick wall right through to the other side of the wall.	(1) _____ (2) _____

(b) A group of friends is at the beach on a sunny day. When they come out of the sea after swimming, they complain of feeling much colder than before. Clearly explain **why** the swimmers feel colder after their swim than before they went into the water.

_____

_____

_____

_____

_____

QUESTION THREE: Nuclear Physics

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(a) The element carbon has several isotopes, two of which are carbon 12 ($^{12}_{6}C$) and carbon 14 ($^{14}_{6}C$).

Complete the following table for these two isotopes of carbon.

Symbol	Atomic number	Mass number	Number of protons	Number of electrons	Number of neutrons
$^{12}_{6}C$					
$^{14}_{6}C$					

(b) There are two kinds of nuclear reaction, nuclear **fission** and nuclear **fusion**.

(i) Give a clear description of nuclear fission and of nuclear fusion.

Nuclear fission: _____

_____

Nuclear fusion: _____

_____

(ii) For each of the following reactions, state whether it is nuclear or non-nuclear. If it is nuclear, specify the **type** of nuclear reaction.

Situation	Fission, fusion or non-nuclear
A star	
Fireworks	
An atomic bomb	

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(c) A nuclear reactor is a piece of equipment that can be used to produce power to supply electricity or to power a nuclear submarine, etc. A reactor has several parts, each of which has a particular function. Complete the following table by stating:

(i) the **function** of each part

(ii) the **material** from which each part is made.

Name of reactor part	Function	Material
Coolant		
Moderator		
Fuel		

(iii) A nuclear reactor also has **control rods** that are made of boron and can be lowered into or withdrawn from the core of the reactor. Explain clearly and fully the **function** of control rods in a nuclear reactor.

(d) A possible nuclear fission reaction is

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{148}_{@}La + {}^{85}_{35}Br + \square\,{}^{1}_{0}n + \text{energy}$$

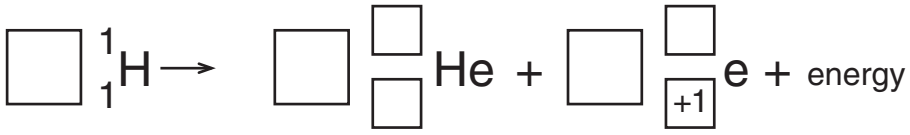
(i) Use charge conservation to calculate the value represented by @ in the above equation.

Value of @: _____

(ii) Calculate the value for the $\square$ in the above equation.

Value for $\square$: _____

(e) The net result of the series of nuclear fusion reactions that take place in the sun is that hydrogen (H) is converted into helium (He) and positive electrons. The reaction can be summarised by the following equation:



Given that the atomic number of helium is 2 and its mass number is 4, complete the above equation by writing the correct numbers in each of the SIX empty boxes.

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Extra paper for continuation of answers if required.
Clearly number the question.

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Question Number

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