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NZQA

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MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 1 Physics, 2007

90184 Demonstrate understanding of heat transfer and nuclear physics

Credits: Three
9.30 am Friday 30 November 2007

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 page(s) 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.

For Assessor's use only	**Achievement Criteria**	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and / or relationships. ☐	Give concise explanations that show clear understanding in terms of phenomena, concepts, principles and / or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
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.

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

QUESTION ONE: NUCLEAR ENERGY

The following equation represents a nuclear reaction.

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{95}_{42}\mathrm{Mo} + {}^{139}_{57}\mathrm{La} + 2\,{}^{1}_{0}\mathrm{n} + \mathrm{X}\,{}^{0}_{-1}\mathrm{e}$$

(a) State what **type** of reaction this is. Explain your answer.

Reaction type _____

Explanation _____

_____

_____

(b) Calculate the value of **X** in the above reaction.

_____

_____

value = _____

(c) Moderators are an essential part of a nuclear reactor. Name a **materia**l used as a moderator in a nuclear reactor and explain its **purpose**.

Name _____

Explanation _____

_____

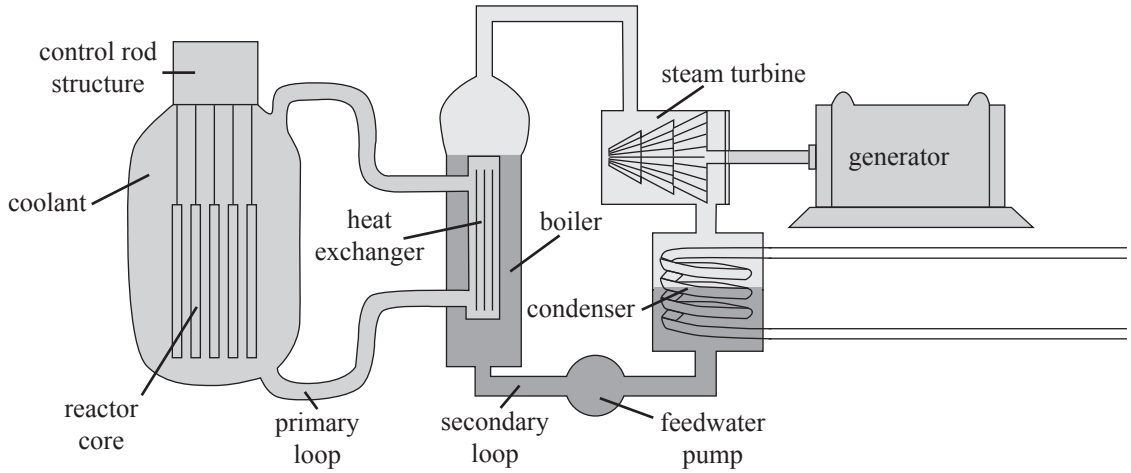
_____

_____

_____

_____

The diagram below shows the components inside a power station with a nuclear reactor.



(d) With the aid of the above diagram, explain how electricity is produced continuously in a nuclear power station.

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(e) The Sun produces energy by nuclear fusion. In a nuclear fusion reaction, a deuterium nucleus, ${}^{2}_{1}H$, and a tritium nucleus, ${}^{3}_{1}H$, are fused together to form a helium nucleus and a neutron.

Write a balanced equation for the above fusion reaction.

(f) Energy is radiated from the Sun at a rate of $\mathbf{3.8 \times 10^{26}\ W}$. Burning **1.0 million tonnes** of coal releases $\mathbf{3.0 \times 10^{16}\ J}$ of energy.

Calculate how many million tonnes of coal would need to be burned each second to match the Sun's power.

amount = _____

(g) Most of the energy released by the Sun is in the form of radiation.

Explain why no heat escapes into space by **conduction** or **convection**.

QUESTION TWO: THE ICE RINK

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Ice rinks are designed using the idea of heat transfer, which keeps a large area of ice cold, even on hot summer days. Under the ice floor, there are pipes that carry salt water. The pipes are connected to a refrigeration unit, which constantly removes heat from the salt water and keeps the ice cold.

As the cold salt water passes through the refrigerator, the liquid in the refrigerator absorbs the heat from the salt water and changes to gas.

(a) Latent heat of vapourisation of the refrigerator liquid is **139 000 J kg^{-1}**.

Calculate the **energy** lost by the salt water when **8.0 kg** of the refrigerator liquid changes to gas.

energy = _____

(b) In a rink, the ice stays frozen and yet the air around the spectators looking down on the rink is quite warm.

Explain why the air around the spectators is warmer than the air just above the ice.

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To renew the damaged ice surface, machines scrape the top layer of the ice flat. Warm water is then poured onto the surface and the water freezes to make the surface smooth again.

(c) On one occasion, the machine scrapes **75 kg** of ice and dumps it outside of the building.

Calculate the amount of energy needed to convert the **ice** at **–4.0°C** to **ice** at **0°C**.
Specific heat capacity of ice is **2 100 J kg^{-1} (°C)$^{-1}$**

energy = _____

For questions (d) and (e), use the following data.

Specific heat capacity of water = 4 200 J kg^{-1} (°C)$^{-1}$
Specific heat capacity of ice = 2 100 J kg^{-1} (°C)$^{-1}$
Latent heat of fusion of ice = 340 000 J kg^{-1}

(d) The heater in the machine warms **300 kg** of water from **15°C** to **50°C**. The electric heater has a power output of **8.5 kW**.

Calculate the **time** taken for the heater to warm **300 kg** of water from **15°C** to **50°C**.

time = _____

(e) 300 kg of water at **50°C** is now poured on to the ice to make the surface smooth again.

Calculate the amount of **energy** that must be removed from the water to turn it into ice at **0°C**.

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energy = _____

QUESTION THREE: THE ROOF

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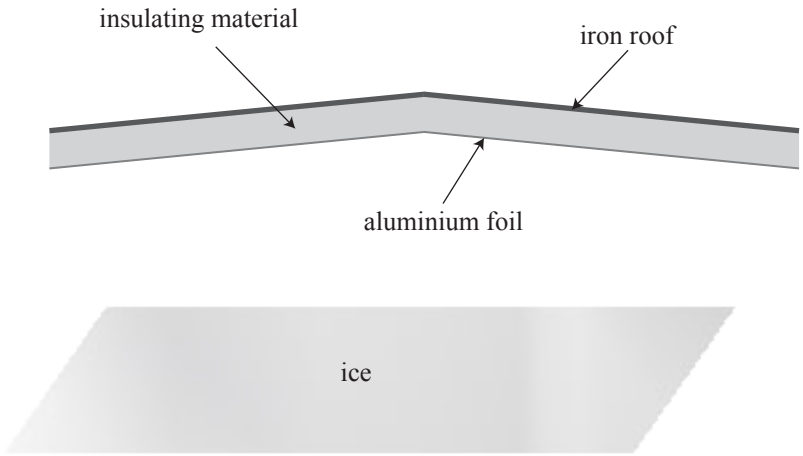
On sunny days the metal roof of the ice rink gets very hot. To prevent the heat melting the ice, a thick layer of insulating material is fitted under the roof and held in position by sheets of shiny aluminium foil.



(a) Use your knowledge of methods of heat transfer to explain how the above-mentioned roofing design will aid to keep the temperature steady inside the rink.

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(b) On a sunny day, each square metre of the earth's surface receives **65 W** of radiation from the sun.

Show that the energy reaching one square metre in **one hour** is 234 000 J.

(c) The iron roof absorbs only **12%** of 234 000 J. The mass of one square metre of the iron roof is **4.3 kg**. The temperature of the roof increases by **14.5°C** during one hour.

Calculate the **specific heat capacity** of the iron roof.

specific heat capacity = _____

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

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Question number	

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