NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 1, 2003

Physics: Demonstrate understanding of heat transfer and nuclear physics (90184)

National Statistics

Assessment Report

Assessment Schedule

Physics: Demonstrate understanding of heat transfer and nuclear physics (90184)

National Statistics

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
2,228	21.8%	49.9%	25.0%	3.3%

Assessment Report

General Comments

Every candidate for a National Certificate of Educational Achievement examination paper is expected to:

- read the question and do what the question asks
- allow adequate time to complete answers
- be accurate: check and/or proofread
- use appropriate technical terms
- bring the correct equipment
- write and/or draw clearly
- use pen if work is to be eligible for reconsideration.

Candidates cannot be deemed to demonstrate understanding of heat transfer and nuclear physics unless they describe or explain concepts in both topics. It is not sufficient to show excellent understanding in only one of the topics.

Achievement requires an understanding of basic heat concepts. Merit or Excellence requires concise explanations that demonstrate clear understanding of concepts. The following misconceptions were apparent:

- that the specific heat capacity of vapour (steam) is more than that of water
- that heat transfer methods (conduction, convection, and radiation) have been used to explain phenomena like evaporation instead of applying latent heat change concepts
- that boiling is the same as evaporation
- that the coolant in the nuclear reactor is used to ‘cool’ or reduce the temperature of the reactor and not (as a heat exchange fluid) to transfer heat energy from the reactor to the heat exchanger where water is converted to steam to drive turbo-generators.

The ability to solve numerical questions on Heat Transfer with the correct answer and unit was well demonstrated by most candidates. Many candidates did not recognise that the heat change in water is not the same as the heat change in liquid brine and used the temperature changes for water to miscalculate the total heat energy needed. Care was needed to interpret the question correctly.

Most candidates demonstrated a clear understanding of nuclear structures, and were able to solve complex problems based on the synthesis of nuclear equations.

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Evidence Statement

Note: Minor computational errors will not be penalised. A wrong answer will be accepted as correct provided there is sufficient evidence that the mistake is not due to a lack of understanding. Such evidence includes:

- the last written step before the answer is given has no unexpanded brackets or terms and does not require rearranging
- the power of any number that is multiplied by a power of 10 is correct.

Italics indicate replacement evidence

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence	Code
1(a)	P: solid R: liquid	Both states named correctly			A_1
1(b)	The solid brine is melting / changing from solid to liquid because it is gaining latent heat energy of fusion (from the Bunsen) without change in temperature	*Statement that solid is melting / latent heat energy of fusion is absorbed*	Solid is melting **and** latent heat energy of fusion is absorbed		*RA_1* M_1
1(c)	All the heat energy that is supplied is used to change the phase of the liquid brine into vapour, without change of temperature.	*Statement refers to the heat energy causing a change of state from liquid to vapour / temperature remains constant*	Heat energy is used to change the state from liquid to gas **and** without temperature change		*RA_1* M_1
1(d)	$Q = mc\Delta T = 0.5 \times 2900 \times 20$ = 29000 J (= 30000 J)	Correct answer **and** correct unit			A_2
1(e)	$P = \frac{Q}{t} = \frac{29000}{60} = 483.3$ W = 480 W **OR** $P = \frac{Q}{t} = \frac{170000}{60} = 2833 = 2800$ W **OR** $P = \frac{Q}{t} = \frac{29000 + 170000}{60} = 3317 = 3300$ W	*Some attempt at calculating power, eg using time in minutes*	Correct answer **and** correct unit in W or watts (not Js^{-1})		*RA_2* M_2

1(f)	Total $Q = 29000 + 170 \times 10^3 + mc\Delta T$ = 29000 + 170000 + (0.5 × 3200 × 120) = 29000 + 170000 + 192000 = 391000 J = 390 000 J	*Correct calculation for any part* ***OR** recognition that three energy values have to be added*	*Working shows correct process but calculation not accurate*	Correct answer Unit not required	*RA_2* *RM_2* E_2
1(g)	The vapour contains **more heat energy** than the liquid at the same temperature because it contains **latent heat of vaporisation** as well as the heat energy due to its temperature. And so the **extra heat** energy in the vapour which is **released on condensing** causes a worse scald.	*Mention of vapour containing more heat energy*	*Recognition that vapour contains more heat energy **and** latent heat of vaporisation is released*	The **difference** is clearly explained in terms of heat energy, latent heat of vaporisation, and release of heat on condensation to cause scald	*RA_1* *RM_1* E_1

2(a)	(1) Conduction (2) Convection (1) Radiation (2) Conduction	*One correct method in each situation in correct position – (1) or (2) **OR** two correct methods and positions in one situation*	Both methods correct, in order, in both situations		*RA_1* M_1
2(b)	This is because of **cooling by evaporation** when **heat energy is removed** from the body to change from the liquid state to the vapour state. **Latent heat** of vaporisation is required to evaporate, making them feel cold.	*The cooling effect of evaporation / heat energy is removed from the body / latent heat involved*	*Heat energy is needed to evaporate the water*	Cooling effect is clearly explained	*RA_1* *RM_1* E_1

3(a)	6 12 6 6 6 6 14 6 6 8	**All numbers** in the table are correct			A_2
3(b)(i)	Fission: Splitting/breaking apart of nucleus (not atom/element/particle) with the release of a large amount of energy Fusion: Joining/combining nuclei (not atoms/elements/particles) with the release of a tremendous amount of energy	**Both** types described correctly			A_1
3(b)(ii)	Fusion Non-nuclear Fission	**Two** out of three situations described correctly			A_1
3(c)(i)	Coolant: heat exchange fluid to transfer energy from the reactor core to the turbines Moderator: to slow down neutrons so that they collide with nuclei Fuel: to provide a source of neutrons/fissionable material so that nuclear reaction may occur	***Two of**: Idea that coolant's function concerns energy transfer; or idea that the moderator affects neutron speed; or fuel provides material for reaction*	**All three** functions described correctly		*RA_1* M_1

3(c)(ii)	Coolant: water/CO_2/sodium Moderator: graphite/carbon/heavy water/hydrocarbon Fuel: uranium/plutonium	**Two** materials named correctly			A_1
3(c)(iii)	Control/**slow down the rate of nuclear reaction** because boron rods **absorb neutrons** (absorb all but one of the neutrons produced by each fission of a uranium atom). If this did not happen, the reaction would become an out-of-control **chain reaction**.	*Control rods change/slow down reaction rate* or *control rods absorb neutrons*	*Control rods slow down the nuclear reaction by absorbing neutrons*	Function explained clearly and correctly, mentioning extra/excess neutrons being absorbed.	*RA_1* *RM_1* E_1
3(d)(i)	a = 92 – 35 = 57	Correct answer			A_2
3(d)(ii)	X = 235 + 1 – 148 – 85 = 3	**Correct answer**			A_2
3(e)	$4\,{}_{1}^{1}\mathrm{H} \rightarrow 1\,{}_{2}^{4}\mathrm{He} + 2\,{}_{+1}^{0}\mathrm{e}$	*Atomic number and mass number of He correct, **OR** mass number of e^+ correct*	*Atomic number and mass number of He correct, **AND** mass number of e^+ correct*	All numbers are correct	*RA_2* *RM_2* E_2

Judgement Statement

Judgement statements (formerly referred to as sufficiency statements) help students understand how their overall results for each standard were arrived at.

Achievement	Achievement with Merit	Achievement with Excellence
7 × **A** including 2 × A2 ***and*** at least 1 × A1 in each of heat and nuclear	Achievement ***plus*** 5 × **M** including 1 × M2	Merit ***plus*** 1 × E1 ***and*** 1 × E2