No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

1

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90939

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NZQA

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Level 1 Physics, 2016

90939 Demonstrate understanding of aspects of heat

2.00 p.m. Tuesday 15 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of heat.	Demonstrate in-depth understanding of aspects of heat.	Demonstrate comprehensive understanding of aspects of heat.

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 attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L1–PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

Useful information for calculation questions is available in the Resource Booklet.

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 2–12 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.

Merit

TOTAL 16

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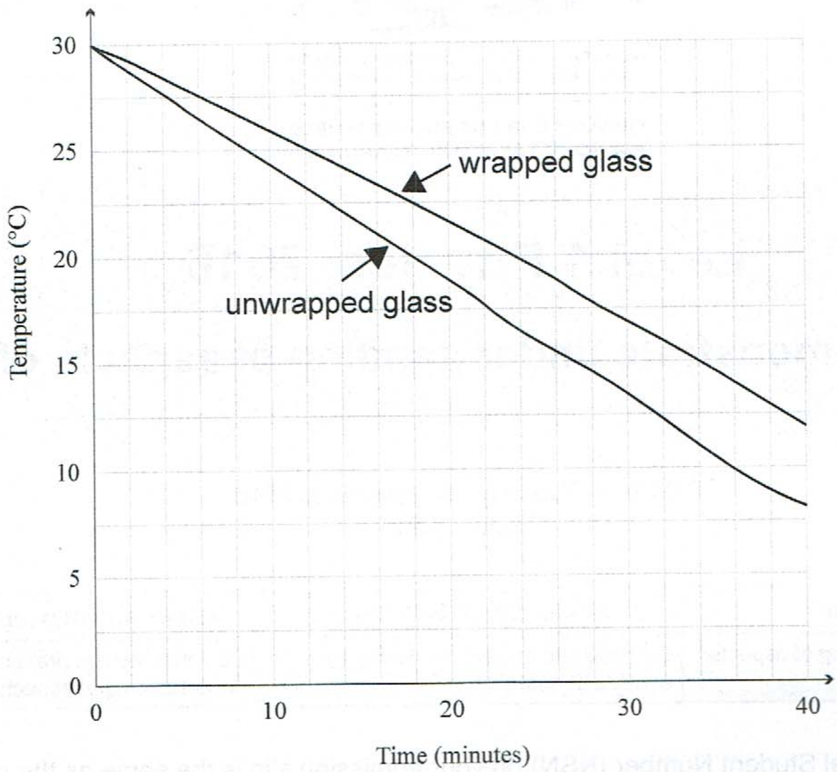
QUESTION ONE: COOLING YOUR DRINK

Bill and Ted want to find a fast way to cool down their drinking water in summer. Bill told Ted that if you wrap tissue paper around a drink and then put it in the freezer, it will cool down faster.

They decided to test this theory, so they got two identical glass bottles, and filled each glass bottle with 600 g of water. Bill and Ted then screwed on the caps and wrapped one with tissue paper. Both bottles were placed in the freezer and the results are shown in the graph below.



(a) From the graph it can be seen that both bottles lost heat energy. State where the heat energy was lost to.

The heat energy in the bottles was lost to the air in the freezer surrounding them.

(b) Both bottles were placed on the bottom of the freezer without touching each other.

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Explain, in terms of heat transfer methods, how the unwrapped bottle lost heat energy AND why this bottle would cool faster than the wrapped bottle.

The unwrapped bottle first lost its heat energy by the heat transfer method of conduction. Conduction works by having heat moving in a substance(s) that are in contact of each other & heat will move to where it is colder as the particles in the medium that have heat bump into other particles that gain the internal kindic energy & the particle bumping spreads to ~~t~~ the other parts of the substance where there is less internal kindic energy. In this case, the unwrapped bottle had its water in contact with the glass bottle. The heat energy moved onto the less hotter glass. The glass is less hotter because it loses its heat from the water to the surrounding air that it is in contact with when it is in the freezer. The unwrapped bottle cooled faster because the tissue paper in the wrapped bottle acted as an insulator to reduce heat transfer by conduction while the

(c) The power rating of the freezer is 0.2 kW.

Calculate the time in **minutes** for 600 g of water at 0°C to freeze into ice at 0°C.

$P = \frac{E}{T} \longrightarrow T = \frac{E}{P}$

Time = energy ÷ power

$= 198000 \div 200\ W$

$= 990\ s$

$Q = ml$

Energy $= ml$

$= 0.6\ kg \times 330\,000\ Jkg^{-1}$

$= 198000\ J$

Time: 16.5 minutes

(d) Bill suggested to Ted that they could try a different freezer that had a power rating of **0.4 kW**.

Explain how doubling the power rating of the freezer would affect the time taken for the 600 g of water at 0°C to freeze into ice at 0°C.

The power rating of the freezer shows how much heat energy in joules the freezer can take from its contents (such as water) in a second. Doubling the power means that the fridge will take twice the amount of joules from the water in a second so the fridge will essentially work as twice as fast if the power rating was doubled from 0.2 kW to 0.4 kW.
Also in the equation $T = \frac{E}{P}$, if the number P was larger, the time would be smaller as dividing E by a bigger number results in a smaller result so T would be smaller so less time.

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M6

QUESTION TWO: COLD DRINK

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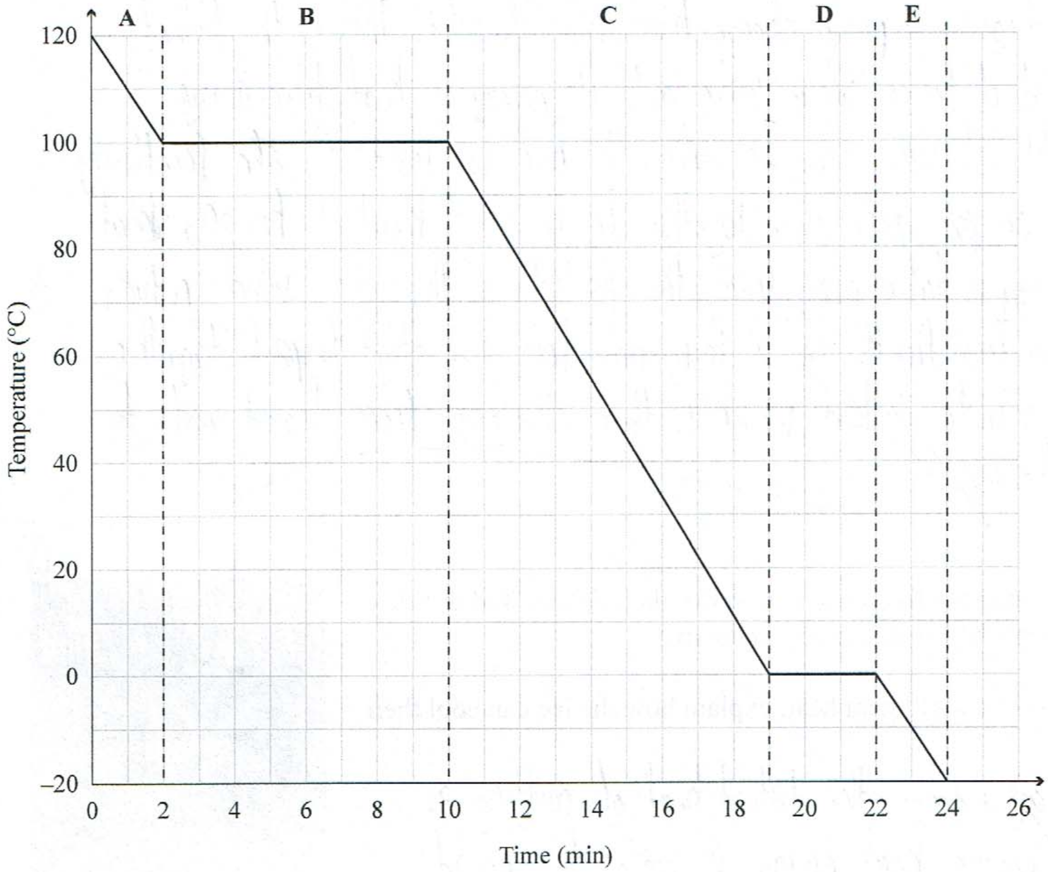
Bill and Ted want to learn more about how to cool down their drinks. They look at a graph of cooling water to help them understand the process of cooling.



(a) Use the graph above to give the names of the:

(i) phases (states of matter) of sections A, C and E

Section A: Gas Section C: liquid Section E: solid

(ii) processes occurring during sections B and D.

Section B: condensation Section D: freezing / fusion

(b) (i) Give the definition of latent heat.

latent heat is the amount of energy needed to change the state of matter of a substance whether it is giving energy or taking energy. During a phase change of latent heat, the temperature does not change as the energy needed for an object's latent heat is changing the state of the object.

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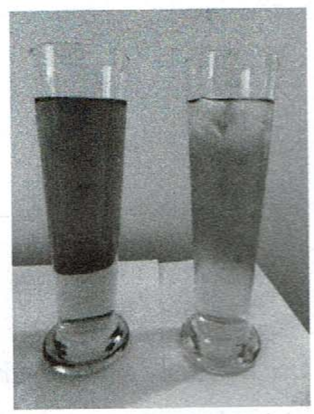
(ii) The graph on the previous page shows that the temperature is constant in Section D.

Explain, in terms of particle motion, what has happened to the water during Section D.

In section D, the temperature remains constant because it is undergoing a phase change from liquid to solid. This is the latent heat of fusion, where water gets its energy in heat taken away until it becomes ice. In water, the particles inside it are free flowing but are ~~pac~~ quite close together. In the latent heat of fusion, heat energy is taken away from the particles of the water which reduces them from free flowing & they move less and start to pack together & vibrate instead which is them changing from liquid water to solid ice.

(c) Instead of using the freezer to cool down their drinks, Ted decides to put ice into their water to cool it down.



Using the concept of latent heat, explain how the ice can cool their drinks.

Ice will ~~go~~ undergo the latent heat of melting as there is enough heat energy in water to spread to the ice by heat transfer method of conduction and the ice will recieve the heat energy of the water & it will start to melt as some of the ice particles begin to have enough energy to stop being packed together & start free flowing into liquid water. Ice cools drinks by absorbing the heat of the water & melting with water cooler than the drink. The ice absorbs heat from the surrounding water to cool the water down.

(d) Ted then puts some ice into a glass of water.

Calculate the total amount of energy required to change 65 g of ice at –5°C into 65 g of water at 8°C.

Start by calculating the energy required to raise the temperature of the ice from –5°C to 0°C.

$Q = MC\Delta T$ (Energy needed to go from $-5°C$ to $0°C$)
$= 0.065\ kg \times 4200\ J kg^{-1} \times 5$
$= 1365\ J$

$Q = ml$ (Energy needed to turn 0°C ice into 0°C water)
$= 0.065\ kg \times 330{,}000\ J kg^{-1}$
$= 21{,}450\ J$

$Q = MC\Delta T$ (Energy needed to go from 0°C to 8°C)
$= 0.065 \times 4200 \times 8$
$= 2184\ J$

$Q_{Total} = 1365 + 21{,}450 + 2184$
$= 24{,}999\ J$
round to 25000 J

Total energy: 25,000 J

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M5

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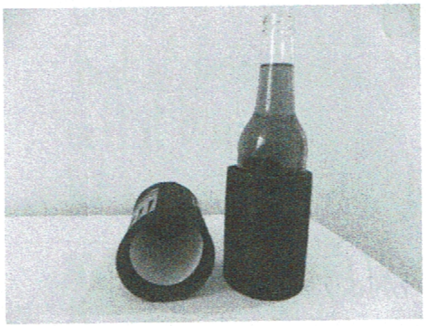
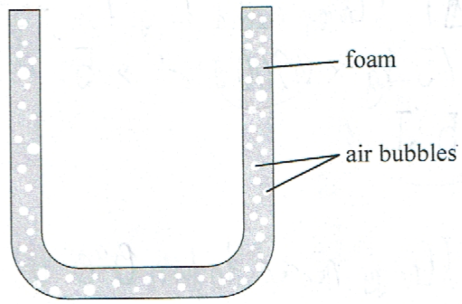
QUESTION THREE: STAY COOL

Now that Bill and Ted have cooled their water, they want to keep it cool. They have decided to invest in a bottle holder called a Koozie. A Koozie is usually made from foam rubber that will fit over a bottle. Foam rubber is a material that has been created to have air pockets inside it.





(a) Describe how the foam material of the Koozie helps to keep the drink cool.

The foam material of the Koozie is an insulator. An insulator is a material that reduces heat transfer, usually by conduction. The foam & the air together act as a barrier from the drink & the surrounding air & reduces the amount of heat from the air transferring into the water in the bottle.

(b) Bill and Ted find that their drinking water is still warming up.

State and explain any modification that could be done to the Koozie to help reduce the rate of heat energy transfer.

A modification to the Koozie that helps to reduce the rate of heat transfer is making the colour of the Koozie white. The colour white is used because it is the most effective colour in reflecting radiation that might come to the Koozie. Darker colours are more likely to absorb radiation & absorb the heat energy which could be spread to the drink which is not helpful.

The Koozie could also have another half so the whole bottle is covered. This reduces any convection inside the bottle from happening as heat could come in the bottle & circulate away the heat so covering the bottle can reduce convection in the bottle.

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(c) Bill noticed that water had **condensed** on the outside of the water bottle.

Calculate the mass of the water that condensed if 12 000 J of energy was released during the condensation process.

Give your answer in **grams**.

$Q = ml \longrightarrow m = \frac{Q}{l}$

$\left.\begin{array}{l} Q = 12000\text{ J} \\ l = 2300\,000\text{ J kg}^{-1} \end{array}\right\}$ 5.28 E-03 kg

5.28×10^{-3} kg

0.00528

Mass: 0.00528 kg

(d) In their research they found that in some countries people tend to drink hot drinks to try to increase their sweating to therefore lower their body temperature.

(i) Explain how drinking a hot drink could lower a person's body temperature.

When a person drinks a hot drink, they absorb heat energy from the drink into their body by conduction. The person now has lots of heat energy in them & their body has the need to cool down. The body starts perspiring to cool down & get rid of excess heat energy from the drink. This is as the person sweats, their heat energy on the skin will transfer onto the sweat & the sweat will have enough heat energy to evaporate. So sweat will evaporate the heat of the body to cool down to person.

There is more space for your answer on the following page.

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(ii) Explain why drinking a hot drink in high humidity would be less effective at lowering the body temperature of a person than drinking a hot drink in low humidity.

In high humidity, there is plenty of water in the air, & for there to be high humidity, there must be a high temperature for the water vapor to have enough heat energy to stay in the air. In low humidity, there is less water vapor in the air. ~~The~~ Drinking hot drinks in a high humidity would not be effective at lowering body temperature because the sweat has to evaporate with the excess body heat into the air but because the air is humid, there is nowhere for the sweat to evaporate to so the heat energy that is trying to be removed from the body will remain on the skin & the person will feel hot because they are not losing their heat energy like they would in a low humidity environment. as ~~there~~ sweat can evaporate in low humidity.

M5

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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Extra paper if required.
Write the question number(s) if applicable.

ASSESSOR'S USE ONLY

QUESTION NUMBER

1b unwrapped bottle did not have anything reducing its heat loss by conduction.

90939

Annotated Exemplars

Merit exemplar for 90939 2016		Total score	16
Q	**Grade score**	**Annotation**	
1	M6	(a) **Achieved.** This response provides evidence towards Achievement by providing a description of where heat energy was lost to. (b) **Achieved.** There is a description of heat transfer by conduction and a description of tissue paper acting as an insulator/poor conductor. For Merit, this candidate could have provided a complete explanation of the heat transfer. (c) **Excellence.** This response provides a full answer as there is a complete set of correct calculations including units. (d) **Achieved.** There is a clear description and calculation of the time taken being halved. For Merit, this candidate could have provided a more complete answer by indicating that the amount of energy needed to be transferred is constant in both cases.	
2	M5	(a) **Not Achieved.** Names of processes only partially correct. (b) (i) and (ii) **Merit.** Latent Heat incorrectly defined – it is required or given out for a change of state – but there is a correct explanation of particle motion when water freezes. (c) (i) and (ii) **Achieved.** There is a partial explanation, using the concept of latent heat, of how ice can cool drinks. (d) **Merit.** There are two correct calculations involving both heat capacity and latent heat (and one incorrect calculation) showing the three energy processes adding together for the total energy required.	
3	M5	(a) **Achieved.** This response provides evidence towards Achievement by providing a description of the good insulating properties of the foam. (b) **Merit.** This response provides evidence towards Merit by providing an explanation of a reasonable modification. (c) **Achieved.** There is a correct calculation but for merit there needs to be evidence of a correctly converted final answer from kg to g. (d) (i) and (ii) **Achieved.** There is a partial description of how sweat lowers a person's body temperature	