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NZQA

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Level 1 Physics, 2017

90939 Demonstrate understanding of aspects of heat

9.30 a.m. Tuesday 28 November 2017
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 on the Resource Sheet.

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 2–14 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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QUESTION ONE: ICE STORAGE

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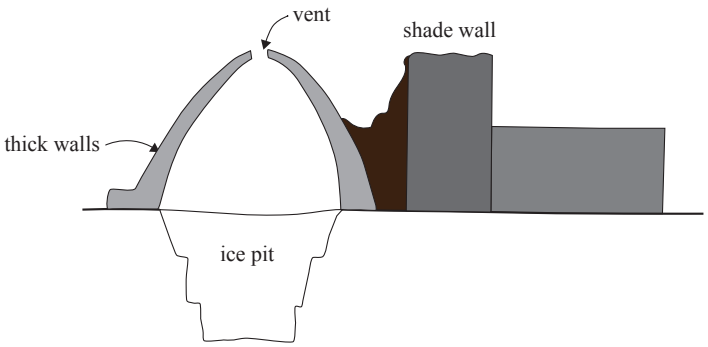
In 400 BC, Persian engineers had mastered the technique of storing ice in the middle of summer in the desert. The ice was stored in a yakhchal, or ice pit. A picture is shown below, along with a cross-sectional, schematic drawing showing where the ice was stored.

Schematic drawing of a yakhchal



The structure is comprised of a large mud brick dome rising 20 m high, with an opening at the top, and below lies a large underground space. The yakhchal were so effective that the ice often lasted the entire summer.

(a) Name the three different heat transfer methods.

(i) _____

(ii) _____

(iii) _____

(b) To help keep the ice cool, it was kept in a pit in the ground.

Explain why keeping the ice in a pit, rather than on flat ground, helped to keep it cool.

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(c) The walls of the yakhchal were up to 2 m thick.

(i) Explain how the thickness of the walls helped to keep the building cool.

(ii) Yakhchal walls were created using a special kind of mortar that was a mixture of different materials. Some of the materials and their properties are listed in the table below.

Material in mortar	**Properties**
Lime	A mineral that is white in colour
Goat hair	Consists of many coarse fibres
Sand	Crystals of silicon dioxide (glass)

Referring to the heat transfer methods named in part (a), explain how the properties of ONE of the materials in the mortar helped to keep the building cool.

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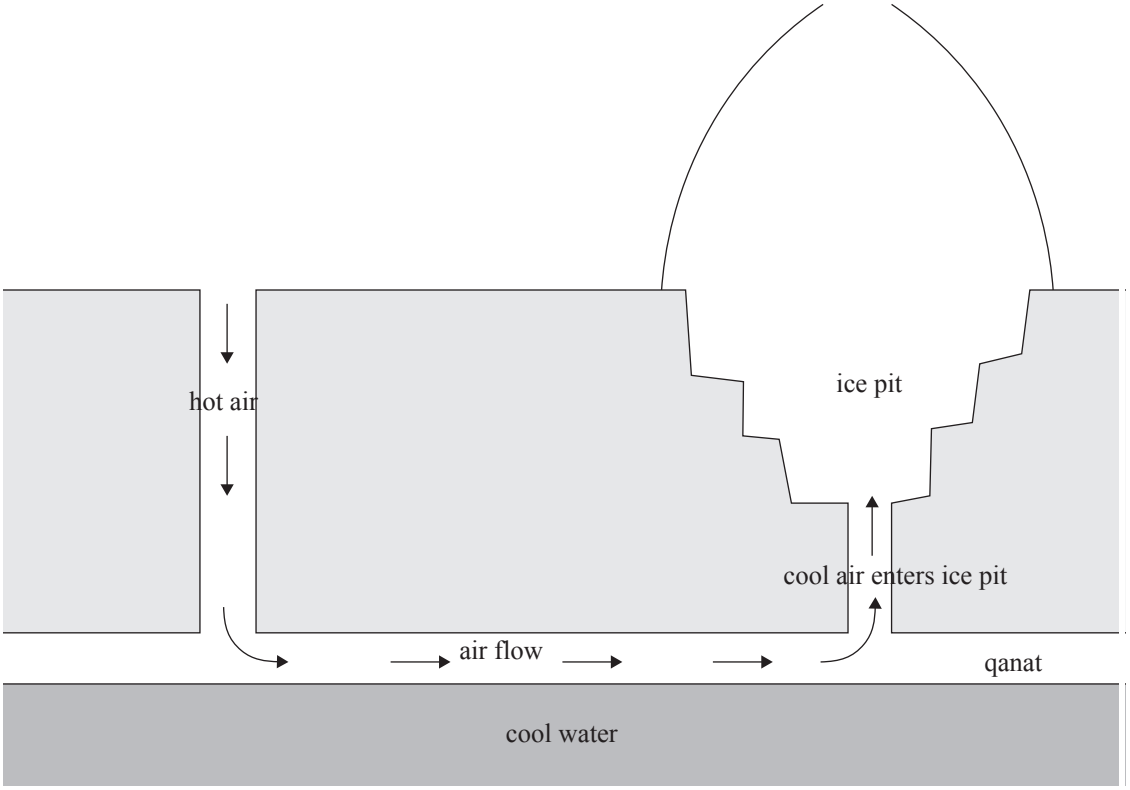
(d) Yakhchal were often built with a wind tower and a qanat (underground water source) attached to help reduce melting of the ice. Below is a diagram of how the air flow moves into the qanat as hot air, and into the ice pit as cold air.

The specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$ and the specific heat capacity of dry air is 1006 J kg^{-1} $°C^{-1}$.



(i) Explain how a qanat (underground water source) helps cool the air before it enters the ice pit.

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(ii) An empty yakhchal contains 6500 kg of dry air.

Calculate the amount of heat energy lost when the temperature of dry air in a yakhchal drops from 8°C to 3°C.

The specific heat capacity of dry air is 1006 J kg^{-1} $°C^{-1}$.

Heat energy = _____

QUESTION TWO: JUST DESSERTS

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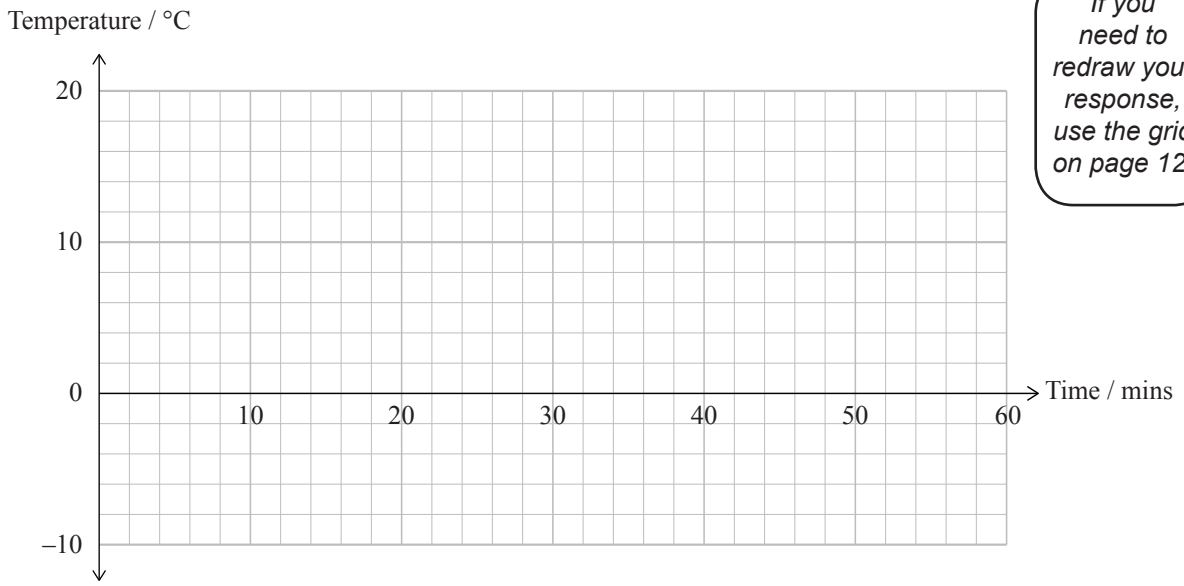
The ice in the yakhchal was often used to create the Persian frozen dessert faloodeh. Faloodeh consists of thin vermicelli noodles and a frozen syrup of sugar and water.

(a) Sketch and label a graph in the space below showing a heating curve of the frozen sugar water in the faloodeh, starting at –10°C, and as it melts and turns into a liquid, until it reaches room temperature.

The melting temperature of sugar water is –3°C and room temperature is 20°C. It takes 60 minutes for the sugar water to reach room temperature.



If you need to redraw your response, use the grid on page 12.

(b) In the space below, draw the particle arrangements of the frozen sugar water in faloodeh, and then after the sugar water has melted.

Particle arrangement of frozen sugar water	Particle arrangement of liquid sugar water

If you need to redraw your response, use the table on page 12.

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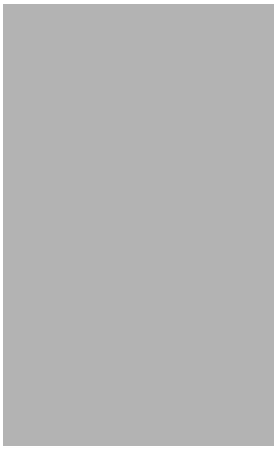
(c) Explain, in terms of particle motion and latent heat, what has happened to the energy gained by the sugar water as it melts and turns from a solid into a liquid.

(d) (i) Other desserts, such as slushies, are just ground-up ice with some coloured flavouring served up in a plastic cup. On a normal, sunny, summer's day, the amount of power the slushy receives from the sun is 98.5 watts.

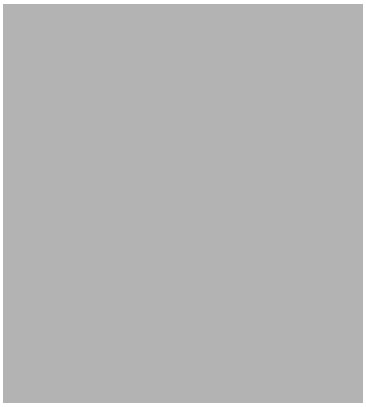
Calculate the time, to the nearest minute, for a 138 g ice slushy at 0°C to change to a liquid at 0°C.

The latent heat of fusion of ice is 330 000 J kg^{-1}.



www.frostyfruit.net/collections/slushy-flavors/products/strawberry-slushy-concentrate-1

(ii) The plastic cup is not very good at keeping the slushy cold while a person is holding it. A modification to the design was to add a plastic lid, as shown.



https://walkamileinmyissues.com/2013/05/19/boy-slushy-cookie-mayhem/

Explain how the modification helps to slow the melting of the slushy.

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QUESTION THREE: NEW BRICK DESIGN

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http://www.archboston.org/community/showthread.php?p=247616

(a) Brick buildings sometimes have cracks in them after some time. This is caused by thermal expansion and contraction.

Use the kinetic theory to explain why objects expand when heated.

(b) The design of bricks has changed from solid bricks to bricks with holes in the middle. Some designs now have a hollow honeycomb structure, as shown on the right.

The honeycomb brick has increased the insulation ability of the brick.

Explain TWO ways that the honeycomb design of the brick reduces the amount of heat transfer.

Buildings all around the world are built differently, due to different climates.

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(c) In the Greek islands, where the climate is hot, many buildings are painted white.

http://images.huffingtonpost.com/2016-02-14-1455469956-7845110-Santorinicliffs.jpg

Explain why painting buildings white helps keep the buildings cool.

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(d) A traditional early Māori building called a whare is shown on the right.

The New Zealand climate is much colder than the Greek islands, and thus the whare is designed to retain heat. It has low ceilings and small openings, is built partially underground, and has earth heaped up against the walls.

www.flickr.com/photos/tony_wasserman/5494194986

(i) Explain how TWO of these design features help the building retain heat.

(ii) To heat the whare, Māori often had a fire inside. The fire heated 15 kg of dry air which has a specific heat capacity of 1006 J kg^{-1} $°C^{-1}$.

If the fire produced 150 kJ of energy, and the air inside the building retained 40% of the energy, and the rest is lost to the environment, calculate the change in temperature of the air inside the building.

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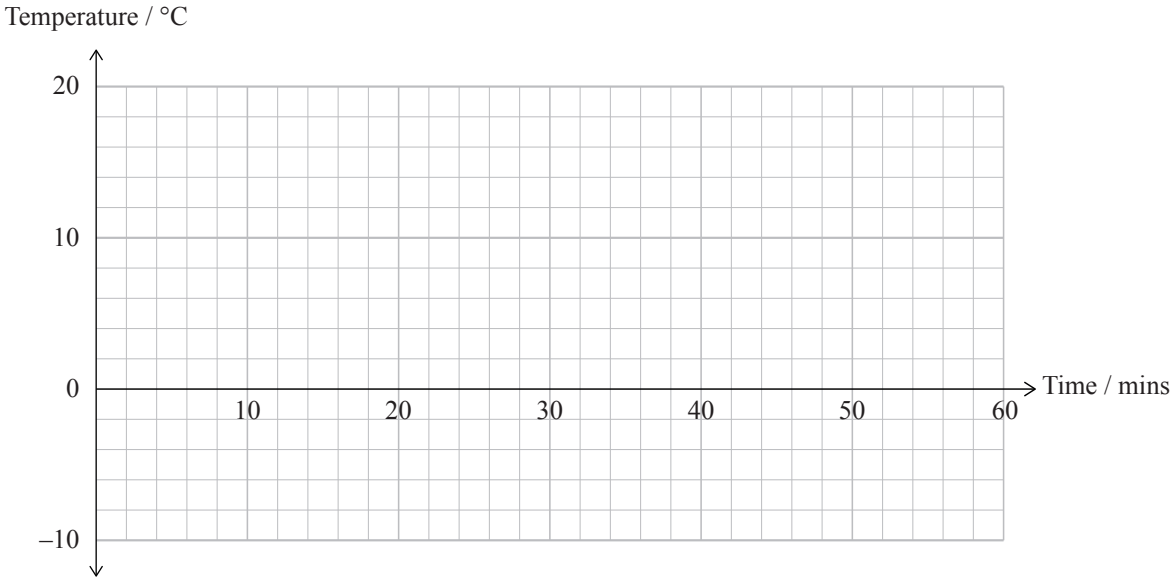
SPARE DIAGRAMS

If you need to redraw your response to Question Two (a), use the grid below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Two (b), use the table below. Make sure it is clear which answer you want marked.

Particle arrangement of frozen sugar water	Particle arrangement of liquid sugar water

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

QUESTION NUMBER

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