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Level 1 Physics 2022

90939 Demonstrate understanding of aspects of heat

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.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (//). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: FOUR METAL STRIPS FIXED ON RING

Four different metal strips are each attached to a ring, and each strip has a blob of wax at its end. The aim of this experiment is to determine which wax will melt first when heat is applied to the four strips at the centre of the ring. The table below shows the specific heat of each metal.

Metal	Specific heat capacity
aluminium	921 J kg^{-1} $°C^{-1}$
brass	402 J kg^{-1} $°C^{-1}$
iron	460 J kg^{-1} $°C^{-1}$
copper	377 J kg^{-1} $°C^{-1}$

(a) Name the type of heat transfer that is occurring during this experiment.

(b) Explain the order in which the wax blobs will melt, using the specific heat capacity of each metal.

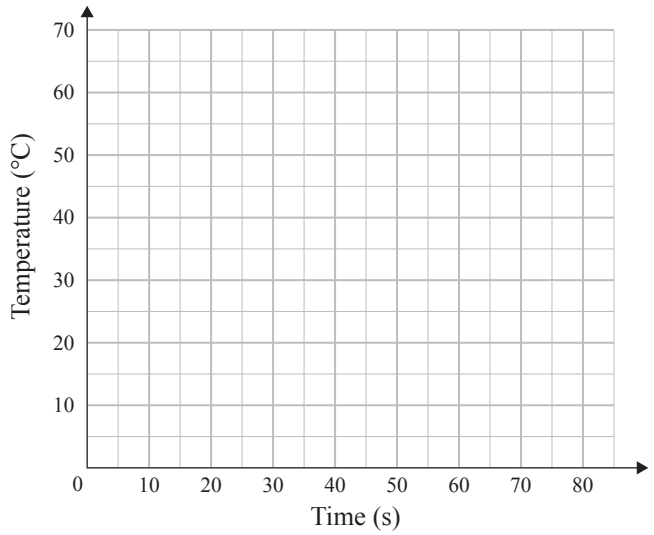
(c) Calculate the mass of the wax blob on the end of the metal if it took 30 seconds to raise the temperature of the wax blob from its starting temperature of 20 °C to its melting temperature of 55 °C when heated with 20 W of power.

The specific heat capacity of paraffin wax is 2130 J kg^{-1} $°C^{-1}$.

(d) Paraffin wax melts at 55 °C. It takes 45 s for the wax to fully melt, once the wax reaches 55 °C.

Using the information in parts (c) and (d), draw the heating curve for wax from its solid state to its liquid state.

Label the states and name the phase change.



If you need to redraw your response, use the diagram on page 10.

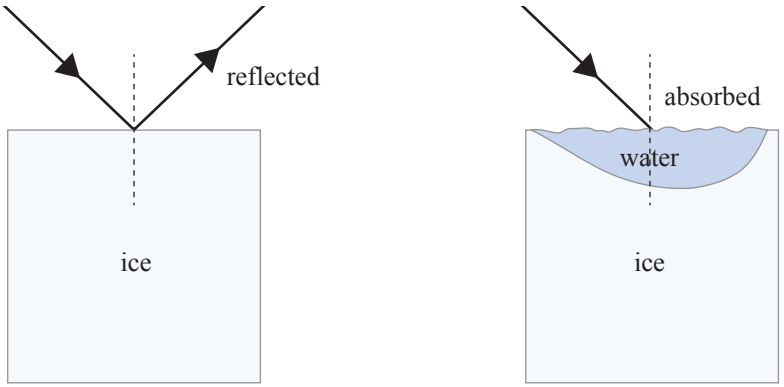
QUESTION TWO: GLOBAL WARMING

Global warming increases the rate that the polar ice caps are melting. When the ice caps start to melt, pools of water, called melt ponds, form on top of the ice, as shown below.

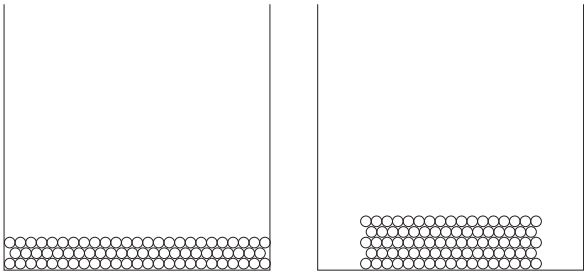
Source: https://www.theguardian.com/environment/2013/sep/18/how-fast-is-arctic-sea-ice-melting

(a) Define the term latent heat.

(b) Explain, using the diagrams below and the ideas of **heat transfer**, why ice with water on top melts faster than pure ice.



(c) Explain, in terms of kinetic theory, one similarity AND one difference between a solid and a liquid. Start by labelling the solid and the liquid in the diagrams below.



Question Two continues on the following page.

(d) The Sun's power is 1.3×10^9 W and heats an ice cap of mass 2.5×10^8 kg (approximately 1 square km of ice), with 65% of the Sun's energy being reflected.

Calculate how many days it will take to melt the ice cap, using the above information.

Latent heat of fusion of ice (water) = 330 000 J kg^{-1}.

QUESTION THREE: HAND SANITISER

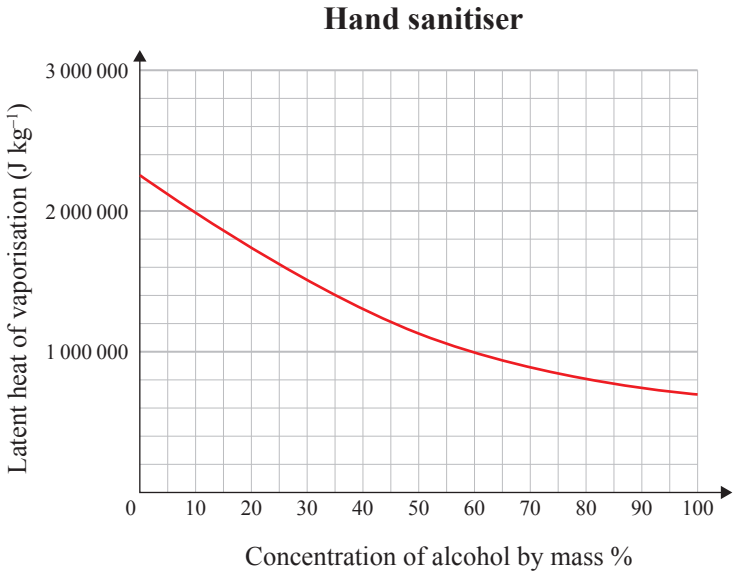
Tim wanted to learn more about hand sanitiser and how it works. Hand sanitiser is a disinfectant that uses alcohol.

(a) Calculate the heat energy required to evaporate 5 g of hand sanitiser with a latent heat of 879 J g^{-1}.

Question Three continues on the following page.

(b) Tim finds out that hand sanitiser must contain 60% to 90% alcohol to be effective. This gives enough time for the alcohol to kill most of the germs before it evaporates. The most effective has a concentration of 70%, mixed with aloe vera gel, which is mostly water.

Explain, using the graph below, why the latent heat of vaporisation of hand sanitiser goes down as the percentage of alcohol by mass goes up.



(c) Tim put some hand sanitiser onto his hands and rubbed it around. He noticed that his hands suddenly felt colder.

Using the table below, compare the specific heat capacity AND latent heat of evaporation of water and isopropyl alcohol to help explain why Tim's hands feel cold.

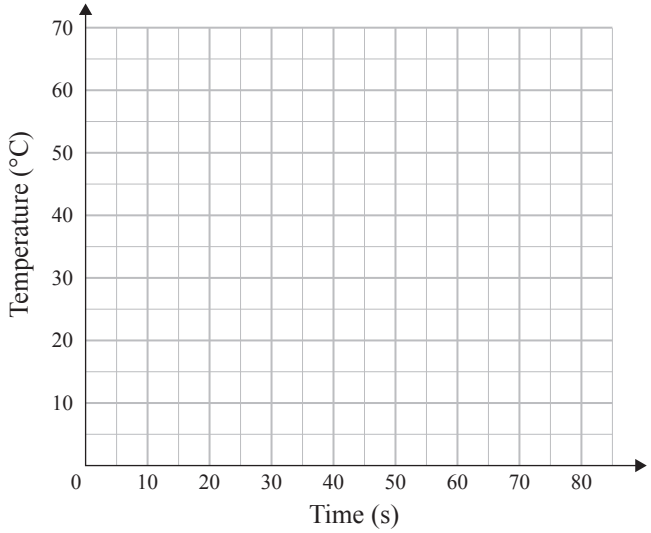
	Specific heat capacity	**Latent heat of vaporisation**
Water	4200 J kg^{-1} $°C^{-1}$	2 260 000 J kg^{-1}
Isopropyl alcohol	2604 J kg^{-1} $°C^{-1}$	779 000 J kg^{-1}

(d) Tim needed to use his hand sanitiser in his car after he went shopping on a hot day. When he opened the plastic container the hand sanitiser gushed out.

Explain, using the kinetic theory of matter, why the hand sanitiser gushed out.

SPARE DIAGRAM

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



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

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QUESTION NUMBER