WILLETTON SENIOR HIGH SCHOOL
Y11 PHYSICS

HEATING FUNDAMENTALS TEST – 2019

Student Name: Solutions

/45

Teacher	(Please tick one box)	
Dr Pitts	G-1	□
Mr Dopson	G-2	□
	G-3	□
Mrs Munshi	G-4	□
Mr Boughton	G-5	□

Time: 1 Hour

NOTE:

1. Calculations must show **clear working** with **formulae.**
2. State your final answers to **three significant figures.**
3. Marks may be allocated for clear and logical setting out
4. State assumptions if working on open ended type questions.

1. Write a brief statement (with reference to energy transfer) to explain each of the following observations. (2 marks each)

a) The temperature inside a black car initially increases at a higher rate than the temperature inside a white car when left standing in the sun.

Black absorbs heat at a greater rate than a white coloured car. This means that the Black car will reach a higher temperature earlier than the white car. (2)

Black absorbs all wavelengths of light & reflects none. White reflects all wavelength of light and therefore absorbs the least energy compared to Black (2)

b) Inland daytime temperatures are usually higher than those at places near the coast.

- Land surfaces are normally darker than water and will absorb more solar radiation than water (reflects radiation). (1)
- Due to the difference of specific heat the land (lower) will increase in temperature faster than water (higher). (1)
- On the coast the water will be at a lower temperature and the air will be cooler. As the land heats up a LP is created and cooler air (HP) replaces the warmer air – hence cooler (1)

~~Hot Convection!~~

c) In winter time, walking bare-footed across a tiled floor is much colder than walking on a carpeted floor

Tile feel colder because the tile is a better heat conductor than carpet. Heat from your foot moves quickly away from your skin. Carpet is a poor conductor (insulator) thus heat is not (small) transfered from your skin.

- Conductor
- heat transfer.

d) Using a damp cloth to remove a hot container from an oven may result in severe burns.

* The damp (water) cloth at room temperature may increase in temperature in a short time. Where heat energy is transferred from the hot container to the water (cloth) and increase the temperature
* This energy increase may effect a phase change (to steam) or reach a high temperature that may cause severe burns.
* Cw is high but with sufficient Energy transfer the temp may increase to a level where burning may occur.

2. You have been given a thermometer with a numbered graduated scale. Without using another known instrument for measuring temperature, explain how you would scientifically verify that the thermometer scale is in Celsius?
Answer the question in point form. **(2 marks)**

ice bath @ 0°C

Reading on therm should be '0°C' (1)

Boiling water @ 100°C

Reading on thermometer should be 100°C (1)

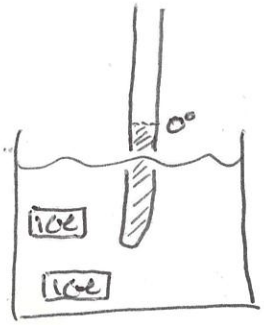
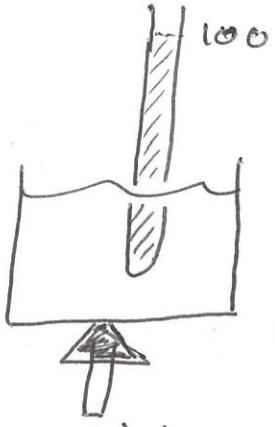


Diagram OR Description to explain.



Body temp

32 - 36°C okay

Room Temp

No! unless explained!

30°C
90°F ✓
303 K

3. For the following statements (1) to (4), select the option (A, B, C, D or E) which best describes its association with a method of heat transfer. **(2 marks)**

OPTIONS	
A	Convection currents
B	Expansion of solids
C	Radiation
D	Conduction
E	Expansion of liquids

STATEMENTS		Selected option
1	Hot air balloons.	A
2	Operation of a mercury-in-glass thermometer.	E
3	The bases of frying pans are sometimes made of copper.	D
4	An aluminium window frame feels cold when you touch it on a cold day.	D

4. A 65.0 g pellet of Noohopium metal is heated to 135°C and is quickly placed into a 120 g glass beaker containing 320 g of water at a temperature of 25.0°C. The final maximum equilibrium temperature is 30.9°C (assume no heat loss). Specific heat of glass = 0.84×10^3 J kg^{-1} K^{-1}. Determine the specific heat of the Noohopium metal. **(4 marks)**

$m_N = 0.065$ kg
$T_N = 135°C$
$m_g = 0.12$ kg
$m_w = 0.32$ kg
$T_w = 25°C$
$T_f = 30.9°C$
$C_g = 840$ J kg^{-1} k^{-1}
$C_w = 4180$ "
$C_N = ?$

Noohopium water/glass

$Q_L = Q_g$ (1)

$m_N C_N \Delta T_N = m_w C_w \Delta T_w + m_g C_g \Delta T_w$

135
$\Delta T_N = 104.1$
30.9
$\Delta T_w = 5.9$
25

$C_N = \dfrac{(m_w C_w + m_g C_g)\ \Delta T_w}{m_N\ \Delta T_N}$ *

(−1)

$= \dfrac{(0.32 \times 4180 + 0.12 \times 840)\ 5.9}{0.065 \times 104.1}$ (1)

$= \dfrac{(1337.6 + 100.8)\ 5.9}{6.7665}$

$= \dfrac{8486.5}{6.7665} = 1254.2$

$= 1.25 \times 10^3$ J kg^{-1} k^{-1} (1)

7891.84 + 594.72 / 6.7665

(1) layout OR logical setting out

watch
mass errors
Temp "
s.f
units

5. In making iced tea 1.75 kilograms of hot tea at 100°C is cooled to 0.0°C using a quantity of ice at 0.0 °C. (The specific heat of ice tea = 4.18×10^3 J kg^{-1} K^{-1})

(a) Show your work to determine whether or not 2.00 kilograms of ice added to the hot tea will achieve a final temperature of 0.0°C. **(3 marks)**

Note: various methods/strategies.

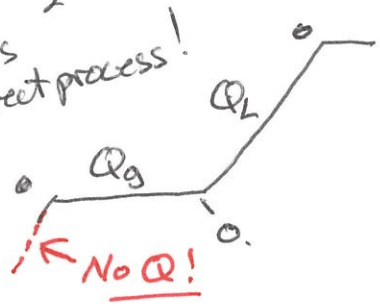
error $-\frac{1}{2}$ unless incorrect process!

$Q_{g\,ice} = Q_{L\,water}$ (1)

$m L_{fi} = m_w C_w \Delta T$

$2 \times 3.34 \times 10^5 = 1.75 \times 4180 \times 100$ (1)

$668{,}000 \neq 731{,}500$ J (1)



∴ 2 kg of ice is insufficient $-\frac{1}{2}$

IE more ice is required.

(b) What is the final temperature achieved with adding 2 kilograms of ice? **(3 marks)**

$Q_g = Q_L$

$m L_{fi} + m_i C_w \Delta T = m_w C_w \Delta T_{(100 - T_f)}$ — (1)

$6.68 \times 10^3 + 8360\, T_f = 731500 - 7315\, T_f$ — (1)

$T_f = \frac{63{,}500}{15675} = 4.05103$

$= \underline{4.05\ ^\circ C}$ — (1)

(c) How much ice is required for the iced tea to achieve 0.0°C? **(2 marks)**

$Q_g = Q_L$

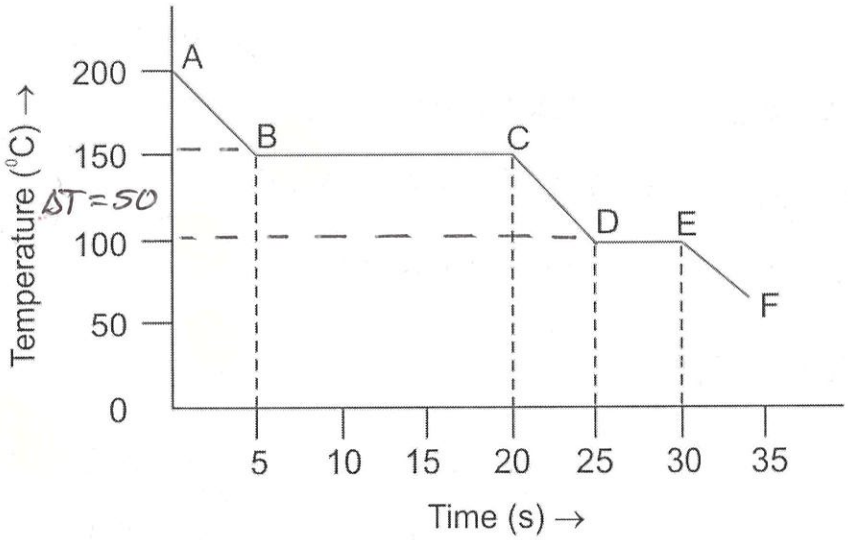
$m_i L_{fi} = m_w C_w \Delta T_w$ — $\frac{1}{2}$ — 731,500

$m_i = \frac{1.75 \times 4180 \times 100}{3.34 \times 10^5}$ — $\frac{1}{2}$

$= 2.190119$

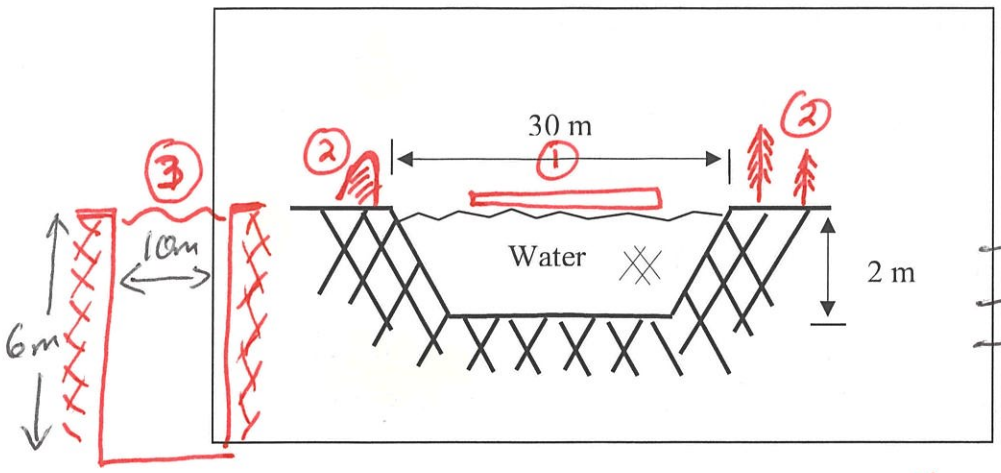
$m_i = \underline{2.19\ kg}$ — (1)

6. The diagram below shows a graph of temperature against time for a particular substance that has a mass of 0.2 kg which has been cooled at a constant rate of 2000W each second from a high temperature to a low temperature. Use the letters to answer the following questions and explain your answers. **(5 marks)**



	Question	Answer	mk
(a)	At which point is the substance completely solid.	E, E-F	½
(b)	Which section, or sections, of the graph show the substance in two states at the same time.	B-C, D-E	½
	Explain your answer. A phase change is occuring at these sections eg B-C steam – liquid D-E liquid – solid where E_K does not change but E_p does.		1
(c)	Which section of the graph shows the liquid phase?	C-D	½
	Determine the specific heat of the liquid phase. $C = \frac{Q}{m\Delta T} = \frac{2000 \times 5}{0.2 \times 50}$ — main error! $= 1000\ J\,kg^{-1}K^{-1}$	C = ∴	1
(d)	At which point do the molecules of the substance have the largest average Kinetic Energy?	A	½
	Explain your answer. Temperature is proportional to Kinetic E. ∴ Point A, highest temp = highest E_K.		1

7. Many farms use in ground dams to store water for livestock and other farming needs. The cross sectional diagram below shows the design and dimensions of an in ground farm dam that is full of water. **(4 marks)**



No!
- Fans to oppose wind
- use a water tank
- solidify the water.

Suggest 2 modifications (without cooling the water) to the design of dam to help reduce the loss of water through evaporation.
Explain the purpose or reason for your modifications.

Modification 1 Place a cover over the surface (floating)	3. Change the dimensions ie deeper but same volume
Reason Reduce the surface area exposed to air * Amount of evaporation reduced proportionally to area covered.	with a deeper dam (same volume) the surface area will reduce, hence evaporation also reduces
Modification 2 Build side walls or grow trees on side of wall.	4. place a roof over the dam.
Reason Provides a barrier to reduce the volume of wind across the surface. * Evaporation is reduced due to saturation of the air.	Blocks the sunlight & thus reduces the temperature of the water, thus reducing evaporation

shade

5. Place olive oil on the surface.
Olive oil has a lower evaporation rate compared to water

Fish bowl

8. Solar hot water systems convert electromagnetic energy from the sun to thermal energy in the water in the heater. How much solar energy does a solar heater need to absorb to raise the temperature of 165 kg of water from 22.0 °C to 85.0 °C? Assume that the system converts only 70% the solar energy to thermal energy of the water. (3 marks)

$M_w = 165\,kg$
$C_w = 4180$
$\Delta T = 63°C$
$\eta = 70\%$

$Q_w = M_w C_w \Delta T$ (1)
$= 165 \times 4180 \times 63$
$Q_{70\%} = 43,451,100\ J$ (1)

$Q_{100\%} = Q_{70} \times \frac{100}{70}$ — watch for error!
$= 62,073,00$
$= 62.1\ MJ$ (1)
$6.21 \times 10^7\ J$

9. On Master Chef a competitor pours 920g of soup at 95.0 °C into a 120g china bowl with a specific heat capacity of 1085 $Jkg^{-1}K^{-1}$. The soup raises the temperature of the china bowl from 22.0 °C to 82.0 °C. Determine the specific heat capacity of the soup. (3 marks)

$M_S = 0.92\,kg$
$T_S = 95°C$
$M_c = 0.12\,kg$
$C_c = 1085$
$\Delta T_c = 60°C$

soup Bowl
$Q_L = Q_g$
$M_S C_S \Delta T_S = M_c C_c \Delta T_c$ (1)
$0.92 \cdot C_S\ 13 = 0.12 \times 1085\ 60$ (1)
$11.96\ C_S = \frac{7812}{11.96} = 653.17$

95
$\Delta T_S = 13°$
82
$\Delta T_c = 60°$
22

$C_S = 6.53 \times 10^2\ J\,kg^{-1}K^{-1}$ (1)

10. The diagram to the right shows a cross section of a thermos flask. Explain the purpose of the three heat concept characteristics listed below in the design of these thermos flasks. (6 marks)

Vacuum:

The slight vacuum between 2 glass(?) walls prevents heat loss by:

Conduction – no contact of bodies

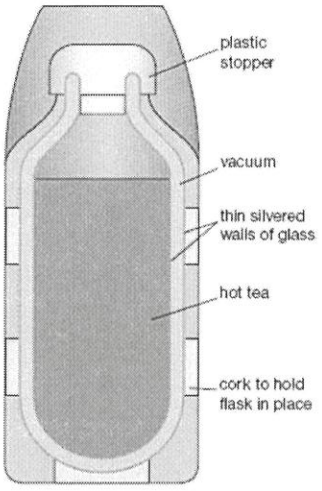
Convection – no substance for convection to occur.

Thin silvered walls of glass:

The silvered walls reflect radiation from heat. This prevents heat loss (or gain) and help maintain the high(low) temperature.

Cork to hold the flask in place: Heat concept! IE heat stability

* Cork is used due to its low thermal conductivity properties (poor transfer of heat) IE insulator.
* Reduces conductivity or heat loss



☺ CONGRATULATIONS: ☺
YOU HAVE COMPLETED THE 1st Y11 PHYSICS TEST