Christ Church Grammar School

Science Department
Year 11 2021

ATAR PHYSICS
UNIT 1 THERMAL PHYSICS VALIDATION TEST 2021

Student Name: **SOLUTIONS**

Teacher: JRM HKR CJO
(Please circle)

Time allowed for this paper
Working time for paper: 35 minutes

Instructions to candidates:

- You must include **all** working to be awarded full marks for a question. Answers should be expressed to 3 significant figures unless otherwise indicated.
- Marks may be deducted if diagrams are not drawn neatly with a ruler and to scale (if specified).
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

ADDITIONAL FORMULAE AND DATA

- Triple Point of water = 0.01°C = 273.16 K
- K = C + 273.15
- $Power = \frac{Energy}{time}$

Mark:	/ 38
=	%

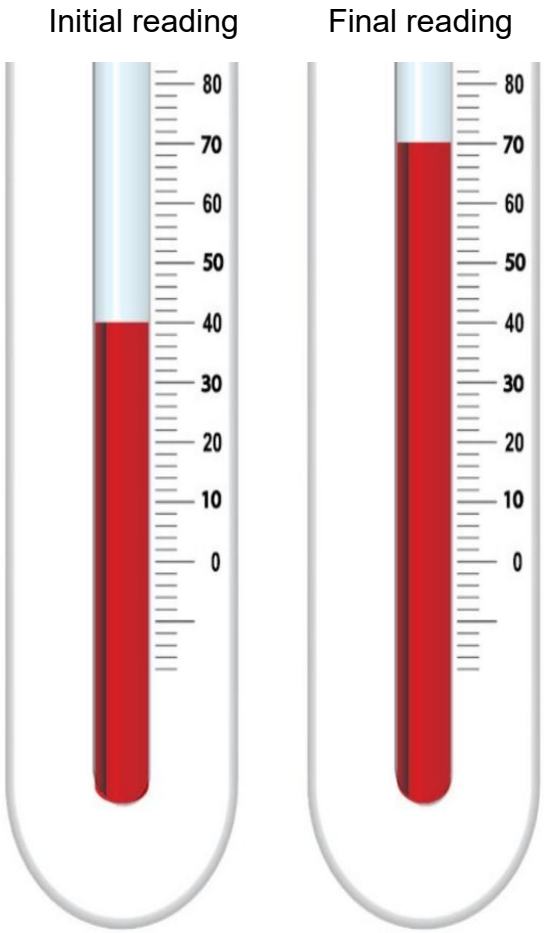
Question 1 **(3 marks)**

Explain how a kilogram of one substance can have more internal energy than a kilogram of another substance even though they are at the same temperature.

Description	Marks
Internal energy is the sum of all Ek and Ep of particles in a substance.	1
Temperature is a measure of the mean **translation** velocities/energies of particles in a substance.	1
It is possible for substances to have more Ep or other forms of Ek (rotational and vibrational) and still be at the same temperature.	1
Total	3

Question 2 **(5 marks)**

Consider the image below of two readings (in degrees Celsius) made by the same thermometer.



(a) Enter the measurements into the table below including a measure of uncertainty.

(2 marks)

(b) Convert the measurements in the first column to kelvin.

(1 mark)

	Measurement (°C)	Uncertainty (°C)	Measurement (K)
Initial temperature	40.0 or 4.0 x 10	± 1.0	313
Final temperature	70.0 of 7.0 x 10	± 1.0	343
Change in temperature	30.0 or 3.0 x 10	± 2.0	30.0

1 mark for each column correct
-1 mark for decimal place or combining uncertainty error.
Accept 2 or 3 sig fig for measurement but uncertainty must be expressed to the same precision

(b) Calculate the percentage uncertainty of the change in temperature

(2 mark)

Description	Marks
% unc. = $\frac{2.0}{30} \times 100$	1
= 6.67 %	1
Total	2

Question 3 **(5 marks)**

A 1.00 $\pm$ 0.05 kg brick initially at 25.0 $\pm$ 0.5 °C is left out in the sun where it absorbs 2.40 $\pm$ 0.10 kJ of heat. Calculate the change in temperature of the brick including a measure of absolute uncertainty.

c_{brick} = 7.50 x10^2 J kg^{-1} K^{-1}

Description	Marks
$Q = mc\Delta T$ $\quad\quad$ $\Delta T = Q/mc$	1
$= \frac{(2.40 \times 10^3)}{1.00 \times 750}$	1
= 3.20 °C (3 sig fig)	1
tot. % unc = % unc(m) + %unc(Q) $= \frac{0.05}{1.00} \times 100 + \frac{0.10}{2.4} \times 100$ = 9.17%	1
abs unc. = $\frac{9.17}{100} \times 3.20$ = 0.29 °C (2 d.p) $\Delta T = 3.20 \pm 0.29$ °C	1
Total	5

Question 4 **(6 marks)**

A 50.0 W heating element is placed in 0.350 kg of water at 15.0 °C. The element is turned on and increases the temperature to 34.4 °C.

(a) Complete the table below by adding terms such as “increasing, decreasing or constant” to explain what is happening to the water while the heating element is heating it.

(3 marks)

Property of water	Consequence
Internal energy	increasing
Mean translational kinetic energy	increasing
Potential Energy of water	constant

(b) Calculate the time taken for the water to increase to 34.4 °C.

(3 marks)

Description	Marks
$P = \frac{Q}{t} = \frac{mc\Delta T}{t}$	1
$50 = \frac{0.35(4180)(34.4-15.0)}{t}$	1
t = 568 s	1
Total	3

Question 5 **(5 marks)**

State the definitions of the following terms:

(2 marks)

Description	Marks
Thermal Equilibrium: When there is no net transfer of thermal energy between systems.	1
Heat: The transfer of thermal energy between two systems of different temperature (from high temperature to low temperature)	1
Total	2

Consider a spa containing 5.00 x10^2 kg of water at 30.0 °C and a cup of 0.400 kg of water at 70.0 °C.

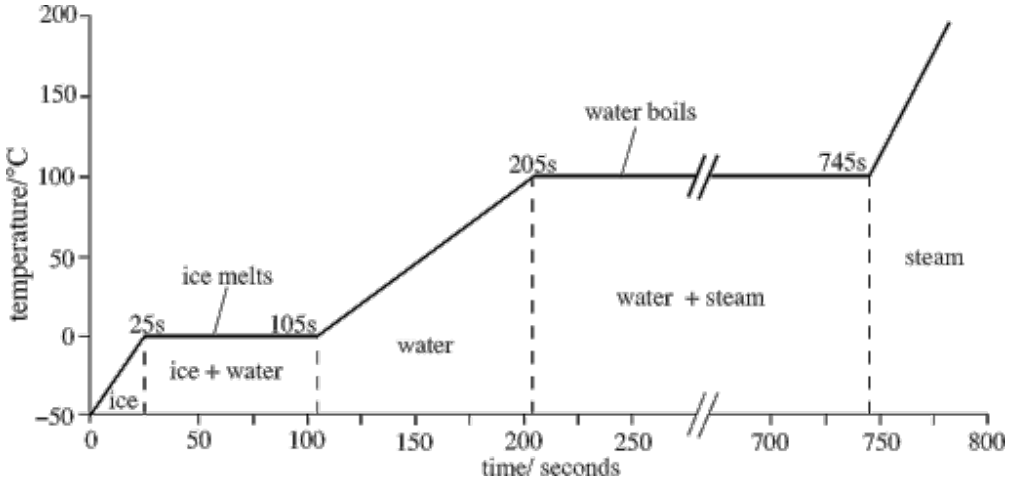
(c) State and explain, making reference to the terms “heat” and “temperature”, the direction that thermal energy would flow if a person was to place his hand (of surface temperature 35.0 °C) in both bodies of water.

(3 marks)

Description	Marks
Heat flows from regions of high temperature to regions of low temperature	1
The spa has a lower temperature, thus heat will flow from the hand to the spa	1
The cup has a higher temperature, thus heat will flow from the cup to the hand.	1
Total	3

Question 6 **(9 marks)**

Consider the heating curve of 0.100 kg of water shown below.



(a) Calculate the energy required to fully melt the ice.

(3 marks)

Description	Marks
$Q = mL_f$	1
$= 0.100\ (3.34 \times 10^{5)}$	1
$= 3.34 \times 10^4$ J	1
Total	3

(b) Calculate the energy required to heat the water from the 105 second mark to 205 second mark.

(3 marks)

Description	Marks
$Q = mc\Delta T$	1
$= 0.100(4180)(100)$	1
$= 4.18 \times 10^4$ J	1
Total	3

(c) Using the values obtained in part (a) and (b), determine if heat is supplied at a constant rate throughout the heating curve.

(3 marks)

Description	Marks
$P = Q/t = 41800/(205-105) = 418$ W	1
$P = Q/t = 33400/(105-25) = 418$ W	1
Yes, the power for each region is the same.	1
Total	3

Question 7 **(5 marks)**

0.250 kg of water at 20.0 °C is placed into a 0.500 kg aluminium pan fresh off the stove with a temperature of 150 °C. Assuming that the pan is on an insulated pad and that no significant amount of water boils off, calculate the final temperature of the water and pan system.

c_{Al} = 900 J kg^{-1} K^{-1}

Description	Marks
$Q_{gained} + Q_{Lost} = 0$ $mc\Delta T + mc\Delta T = 0$	1
$0.250(4180)(Tf - 20.0) + 0.500(900)(T_f - 150) = 0$	1
$1045(T_f - 20) + 450(T_f - 150) = 0$ $1045T_f - 20900 + 450T_f - 67500 = 0$ $1495T_f = 88400$	2
$T_f = 59.1$ °C	1
Total	5

END OF TEST