Science Department
Year 11 2020

Christ Church
Grammar School

ATAR PHYSICS
UNIT 1
TEST 2020

SOLUTIONS

Teacher: JRM PCW JH SA
(Please circle)

Time allowed for this paper
Working time for paper: 50 minutes.

Instructions to candidates:

- You must include **all** working to be awarded full marks for a question.
- 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.

Mark:	/ 46
=	%

1. Non physics people often use the word heat when they actually mean temperature or even internal energy (thermal energy) of the object. Explain the difference between these three concepts.

(3 marks)

Description	Marks
Temperature: average kinetic energy of the particles of an object.	1
Internal energy: sum of the kinetic and potential energy of the particles that make up an object.	1
Heat: the transfer of energy from an object at a higher temperature	1
Total	3

2. Calculate the specific heat capacity of an alloy if it requires 3.20×10^4J of energy to heat 1.20kg of the alloy from 15.0°C to 92.5°C

(3 marks)

Description	Marks
$\Delta Q = mc\Delta T$	1
$3.20\times10^4 = 1.20 \times c \times 77.5$ $c = 3.20\times10^4 / 1.20 \times 77.5$	1
c = 344 $Jkg^{-1}K^{-1}$	1
Total	3

3. A small espresso coffee machine contains 0.500kg of water at 20.0°C. Calculate how much energy is required to change the water into steam at 100.0°C

(3 marks)

Description	Marks
$\Delta Q = mc\Delta T + mL$	1
$\Delta Q = 0.5 \times 4180 \times 80 + 0.5 \times 2.26\times10^6$	1
$\Delta Q = 1.29 \times 10^6$ J (allow 1.30×10^6 J if student rounds Q values then adds)	1
Total	3

4. Madhuri is shopping for a new LPG hot water system for her caravan. She knows she'll need one that can heat 65.0 kg of water from 20.0°C to 65.0°C. Given that LPG contains 25.0MJ of energy per kilogram and the heater is 43.0% efficient, calculate how much LPG will be required to heat a full tank of water.

(6 marks)

Description	Marks
$\Delta Q = mc\Delta T$	1
$\Delta Q = 65 \times 4180 \times 45$ $\Delta Q = 1.22 \times 10^7$ J	1
Only 43% efficient, so need to modify ΔQ: $\Delta Q = 1.22 \times 10^7 / 0.43$ $\Delta Q = 2.84 \times 10^7$ J	2
Now use the value above to work out how much LPG needed: amount$=2.84 \times 10^7 / 25 \times 10^6$ amount =1.14 kg	2
Total	6

5. Jason wants to add the exact amount of ice to his 250.0g drink which has a specific heat capacity of 3.99×10^3 $Jkg^{-1}K^{-1}$ so that it cools it from 36.0°C to 7.00°C. The ice comes from the freezer where it is kept at a temperature of -6.00°C. Assuming his cup is fully insulated, calculate the mass of ice that must he added.

(5 marks)

Description	Marks
ΔQdrink$= mc\Delta T$	1
$\Delta Q = 0.25 \times 3990 \times 29$ $\Delta Q = 2.89 \times 10^4$ J	1
All of this energy is given to the ice, which gains energy from the drink in three stages: ice warms to freezing point, melts, and the water then warms to 7°C. $2.89 \times 10^4 = m\, c$ice ΔTice + $m\, L$fusion water + $m\, c$water ΔTwater	1
$2.89 \times 10^4 = m \times 2100 \times 6 + m \times 3.34 \times 10^5 + m \times 4180 \times 7$ $2.89 \times 10^4 = 12600m + 334000m + 29260m$	1
$2.89 \times 10^4 = 378560m$ $m = 2.89 \times 10^4 / 378560$ m =0.0769 kg or 76.9 g	1
Total	5
Common error: ci = 4180, m = 0.0125 kg max 4 marks omit Lf = m = 0.69 kg max 4 marks	

OR: (see next page for Qlost + Qgained = 0)

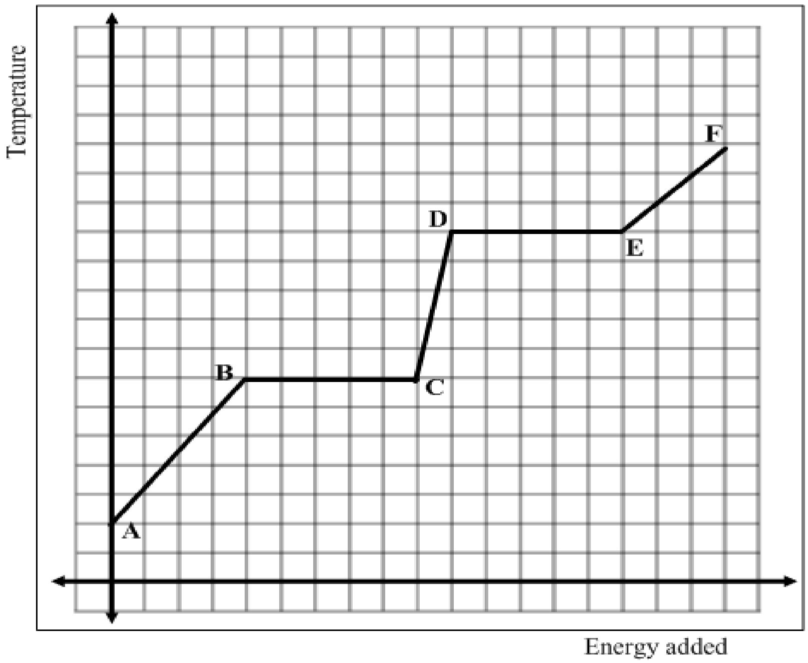
Description	Marks
Qlost + Qgained = 0 $m\,c$drink ΔTdrink + $m\,c$ice ΔTice + $m\,L$fusion water + $m\,c$water ΔTwater = 0	1
- 0.25 × 3990 × (7-36) + m × 2100 × (0- -6) + m × 3.34×10^5 + m × 4180 × (7 – 0) = 0	1
- 2.89×10^4 + 12600m + 334000m + 29260m = 0 2.89×10^4 = 378560m m = 2.89×10^4 / 378560	2
m =0.0769 kg or 76.9 g	1
Total	5
Common error: ci = 4180, m = 0.0125 kg max 4 marks omit Lf = m = 0.69 kg max 4 marks	

6. In an experiment a material is being heated at a constant rate producing the graph below.

(a) Indicate on the graph where the material is present in both the liquid and gas phases at the same time.

(1 mark)

Description	Marks
D-E	1
Total	1



(b) Describe using kinetic theory of matter what is occurring during this section of the graph.

(2 marks)

Description	Marks
D-E liquid boiling and becoming gas no change in temp	1
Energy supplied used to increase potential energy of particles intermolecular bonds breaking.	1
Total	2

(c) Explain how the specific heat of this material relates to the graph and compare the specific heat for each of the sections. (4 marks)

Description	Marks
Specific heat of the substance relates to the **inverse** of the gradient of the graph	1
DC greatest gradient, smallest inverse hence specific heat of substance in liquid phase is lowest	1
AB next biggest gradient, hence next smallest inverse and therefore next smallest specific heat for solid phase	1
EF smallest gradient, greatest inverse and therefore greatest specific heat of gas phase	1
Total	4

7. Explain the following using your understanding of the Kinetic Particle model for matter.

(a) Water can evaporate even when it has not reached 100 °C

(2 marks)

Description	Marks
In any sample of water there are a wide range of different kinetic energies possessed by water molecules	1
Some of the particles near the surface have enough kinetic energy to break free of the bonds, and these can leave the water/evaporate	1
Total	2

(b) When some of the sweat evaporates from a person's skin, the sweat that remains on our skin is cooler and thus acts to cool us down.

(2 marks)

Description	Marks
When water evaporates, only the particles with the highest kinetic energy leave the liquid.	1
This leave the remaining liquid with a lower average kinetic energy, thus it is cooler and cools us down	1
Total	2

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8. Using appropriate terminology, explain why a bathtub of water at 20 °C can melt much more ice than a pot full of boiling water even though it might be at 100 °C.

(3 marks)

Description	Marks
A bathtub of water has significantly more molecules	1
and although their average kinetic energy is lower (temperature) than the boiling water	1
the TOTAL internal energy of the particles in the bathtub is greater due to their higher number, and as such they can melt more ice	1
Total	3

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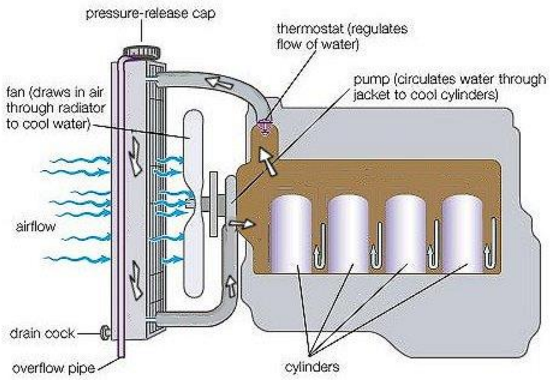
9. The diagram to the right shows the engine cooling system of a standard car. The radiator at the front is coloured black and filled with water which flows through the engine absorbing heat before cycling back.



(a) Explain why the radiator is black.

(2 marks)

Description	Marks
Dark colours absorb/radiate heat at a greater rate than light colours	1
Drawing more heat from the coolant and transfers to air	1
Total	2

(b) Explain why water is a good choice as a coolant.

(2 marks)

Description	Marks
Water has a high specific heat content	1
This means it can absorb a lot of heat energy with minimal increase in temperature in comparison to other substances	1
Total	2

(c) Why does the radiator have a large number of fins in its construction?

(2 marks)

Description	Marks
Fins increase surface area allowing increasing the rate of heat transfer via radiation	1
Which draws heat from the coolant at a greater rate	1
Total	2

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10. Many scientists are employed at the Australian Antarctic Territory. They need to be able to survive in the conditions of extreme cold there when they are outside their research station. With reference to the three main methods of heat transfer, give one physics-based example for each which outlines how heat loss can be minimised when they are outside in the elements.

(6 marks)

Description	Marks
Clothing made of thick insulating materials	1
which reduces rate of heat transfer via conduction (dQ/dt $\propto \frac{1}{L}$ and $\propto$ k)	1
Insulated clothing which traps a warm layer of air next to the body	1
Still air is an insulator and prevents transfer of heat away from the body by convection	1
Covering entire body	1
minimise the amount of bare skin exposed to the environment and hence, heat loss via radiation	1
White surface	1
Has a lower emissivity and reduces the rate of radiation emitted from the body	1
Inner reflecting surface	1
Reflects radiated infrared radiation back towards body to reduce rate of heat loss.	1
Total	6

END OF TEST