Physics ATAR - Year 11

Thermal Physics Unit Test 2017

Name:

Teacher Name:

Mark: / 55

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Time Allowed: 50.0 Minutes

Notes to Students:

1. You must include **all** working to be awarded full marksfor a question.
2. Marks will be deducted for incorrect or absent unitsand answers stated to an incorrect number ofsignificant figures.
3. **No** graphics calculators are permitted – scientific calculators only

Additional Data

Triple point of water = 273.16 K

Thermometer Calibration: $\frac{\theta}{100} = \frac{X_\theta - X_0}{X_{100} - X_0}$

c_{glass} = 670 J kg^{-1} K^{-1}
c_{argon} = 520 J kg^{-1} K^{-1}
$c_{concrete}$ = 2.09 x 10^3 J kg^{-1} K^{-1}

First Law of Thermodynamics $\boldsymbol{\Delta U = Q - W}$
$L_{f\ butter}$ = 60.0 x 10^3 J kg^{-1}

1. An electric hot plate heats a 145 g stick of butter from its melting point at 42.0°C until it is completely melted.

(a) Calculate the amount of energy the butter has absorbed to completely change phase.

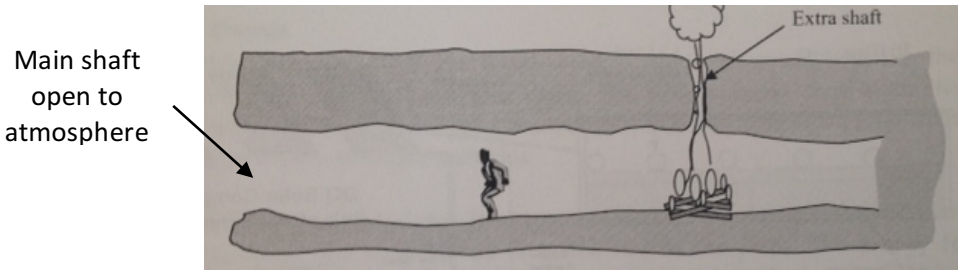
(3 marks)

(b) If the hot place consumes 13.7 kJ of energy during the melting process, calculate the efficiency of the heating process.

(3 marks)

2. In the 18th Century, mines were often ventilated with air by drilling a small extra shaft and lighting a fire beneath it. Explain how the fire helps to ventilate the mine.

(4 marks)



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3. A cylinder filled with 0.130 kg of argon (which behaves as an ideal gas), is sealed with a piston that is free to move up and down. The gas is initially at 3.00×10^2 K. The cylinder is heated from below. After a few minutes, 171 J of heat has been added to the system. The gas expands and as a result, does work on the piston, exerting an upwards force of 2.50×10^2 N over a distance of 0.0200 m.

a) Assuming no loss to the surroundings, calculate the increase in internal energy of the argon.

(4 marks)

b) Calculate the expected final temperature of the argon. State and justify any assumptions made.

(6 marks)

4. Some storage heating systems use the energy from the sun to heat a house. A large block of concrete is used to absorb energy during the day and then release this energy back in to the house at night. Over the course of a hot day, a concrete slab reaches a temperature of 32.0°C.

   A house owner discovers, around sundown, that the night is going to be very hot and she wishes to cool the slab of concrete. She uses water from the hose, initially at 15.0°C to cool the block. After she has applied 1.00×10^3 kg water, the slab and water reach an equilibrium temperature of 26.0°C.

   Assuming no losses to the surroundings, calculate the mass of the concrete slab.

   (4 marks)

5. A 2.30 kW hair dryer is used to vaporise 0.430 kg of water, initially at 22.3 °C, from a woman's hair.

(a) Calculate the heat input required for water to reach its boiling point.

(3 marks)

(b) Calculate the time you would expect this to take using the power rating of the hair dryer.

(3 marks)

(c) In reality, this process actually takes close to 180 s. Provide two reasons why this might be the case.

(2 marks)

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6. A student makes a crude thermometer in order to measure the soil temperature in his vegetable patch. He only has a few pieces of equipment to work with. These are; some resistance wire, a multimeter from his father's tool box which measures resistance plus the usual household appliances such as a fridge and a kettle.

(a) State what is required in order to calibrate the thermometer?

(2 marks)

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The resistance of the wire at various temperatures is shown below.
Resistance at the M.P. of ice = 29.8Ω
Resistance at the B.P. of water = 41.5Ω
Resistance in the soil = 31.6Ω

(b) Calculate the temperature of the soil.

(3 Marks)

(c) The soil is wet and he notices that the temperature of the surface of the soil drops considerably when it is very windy. State the reasons for this explaining your answer using the kinetic theory of matter?

(3 marks)

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7. A mass of ice with a temperature of -5.00 ^{O}C is added to a glass of tap water at a temperature of 25.0 ^{O}C. The water has a mass of 185 g while the glass has a mass of 120 g. If thermal equilibrium occurs at 3.60 ^{O}C, calculate the mass of ice that was added (Ignore any losses to the surroundings).

(6 marks)

8. Sam is a very frugal driver. In an effort to save money, he does not like to turn the refrigerated air conditioning on inside his car during summer. On the other hand, he has no problem using the heating system whenever he feels like during winter.

   The air conditioning system uses a refrigerant circuit. The refrigerant undergoes a constant cycle of vaporisation and condensation. Warm air is blown over the liquid refrigerant, causing the air to become cooled. The cooled air is driven into the passenger compartment with a fan.

a) For the air conditioning system, explain where the energy from the warm air goes and the impact this has on the refrigerant circuit.

(2 marks)

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b) Explain why the heating system is fundamentally more efficient than the cooling system.

(2 marks)

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9. On a hot summer's day, the temperature of a rough black leather steering wheel inside a car becomes much higher than the temperature of the air inside the car.

   A common interpretation of the second law of thermodynamics is that in natural conditions "Heat always flows from Hot to Cold". At first inspection, the above observation appears to disobey this law.

a) Nominate the primary source of energy and heat transfer mechanism that results in the steering wheel being heated. Explain why the steering wheel becomes hotter than the surrounding air.

(3 marks)

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b) State whether the above heat transfer mechanism obeys the second law of thermodynamics and justify your response.

(2 marks)

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END OF TEST