Solutions and suggested mark scheme!

Total = 45mks.

45 MKS Total!

Instructions: Answer ALL the questions in the spaces provided. All numerical answers to be expressed correct to three significant figures. Show careful working out steps to score full marks allocated.

(WSHS: Solutions 2012 and Mark scheme.) Singh's ✶

Q1. Fill in the blanks by selecting the correct word from the list below. Each word may be used once or not at all. **[4 marks]**

ultra violet, convection, conductor, radiation, infra red ~~radiation~~, insulator, emitter

a) Heat transfer from the Sun to the Earth is primarily by the Infra Red (✓1) portion of the electromagnetic spectrum.

b) The process of heat transfer that allows a hot air balloon to be inflated is called convection ✓1

c) Heat loss by the process of RADIATION ✓1 from an accident victim can be minimized by wrapping the person in an aluminium foil emergency blanket.

d) The air pockets trapped between the fibres of roof insulation material reduce heat transfer because air is a poor CONDUCTOR ✓1 of heat.

Q2. On hot summer days at the beach you can sometimes see people relaxing on a deck chair with a wet cloth over their forehead. Referring to heat energy concepts, explain how a wet cloth placed on the forehead can help a person stay cool. [3 marks]

Water evaporates from wet cloth; ✓1

Energy or heat required for phase change equivalent ✓1 to LV Water Liquid to vapour (gas), is removed from the body.

This Lowers the temperature of forehead by evaporation which leaves a cooling effect on the skin. ✓1

7mks

Q3. A member of staff at a swimming pool opens a container of a chlorine based liquid cleaning chemical.

Within a few seconds his co-worker can smell the chlorine even though she is standing several metres away.

This observation is evidence of the particle nature of matter in Kinetic Molecular Theory. Explain why. [2 marks]

Liquid chlorine evaporates at the surface to Cl_2 gas. ✓(1) The air molecules collide with Cl_2 gas molecules and move them from high to low concentration by diffusion ✓(1)

Is this essential?

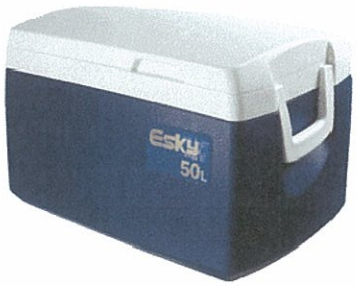
Q4, a) Explain why a cold glass cracks if it pushed suddenly into boiling hot water. [2 marks]

Hot water causes the glass's internal wall to heat up quickly ✓(1) The glass molecules are unable to expand or transfer heat to the outside wall. at the fast enough rate, hence glass cracks. ✓(1)

b) Explain why the metal copper is a better heat conductor than rubber. [2 marks]

Cu atoms has delocalised or mobile electrons ✓(1). Cu Atoms pass their vibrational Energy (Thermal) onto adjacent atoms through collisions. ✓(1) This passes thermal energy along to other atoms

6 M/4



Q5. The picture above shows an Esky, a familiar item used in summer in Australia.

a) A warm bottle of drink is placed in the Esky that contains plenty of ice. (crushed.)

List the physics principles involved in the Esky design and the process whereby the warm drink becomes cooler by being placed in the Esky for a while. [2 marks]

Warm drink cools by absorbing Latent heat (L_f) of ice (melting) at 0°C. ✓ (1)

Foam Layer prevents heat transfer by conduction; this prevents heat from entering the Esky. ✓ (1)

b) Explain briefly why is the inside of an esky, white rather than black? [2 marks]

Esky white inside to minimise or reduce heat transfer by radiation. ✓ (1)

Also white colour does not absorb or radiate heat energy well. ✓ (1)

White absorbs heat well but not colours.

Q6. A kettle contains some water. Calculate the heat energy required to change the temperature of 850 g of water from 25ºC to 100ºC and then boil half of this mass into steam at 100ºC. Show working out steps carefully to score full marks.

[4 marks]

given.

$m = 0.850\,kg$

$c_w = 4180\,J\,kg^{-1}\,K^{-1}$ (Data sheet)

$\Delta T = 100 - 25 = 75\,^{\circ}C$

$Q_w = ?$

$L_v = 2.26 \times 10^6\,J\,kg^{-1}$ (Data sheet)

$Q_s = ?$

$Q_T = ?$

$Q_w = mc\Delta T$

$= 0.850 \times 4180 \times 75$ ✓ (1)

$\therefore Q_w = 266475\,J = 2.66 \times 10^5\,J$ ✓ (1) (4 s.f.)

$Q_s = (m \div 2) \times L_v$

$Q_s = \frac{0.850}{2.0} \times 2.26 \times 10^6\,J\,kg^{-1} = 9.60 \times 10^5\,J$ ✓ (1)

$\therefore Q_T = Q_w + Q_s$

$= 2.66 \times 10^5 + 9.60 \times 10^5$

$\therefore Q_T = 1.23 \times 10^6\,J$ ✓ (1)

$Q_T = 1.23 \times 10^6\,J$

8 Mks

Q7. An 80 g block of stainless steel is heated in a furnace and then placed in an insulated polystyrene beaker containing 450 ml of water. The temperature of the water increases from 21.0°C to 42.9°C. Calculate the initial temperature of the stainless steel in the furnace. The specific heat capacity of stainless steel is 445 $Jkg^{-1}K^{-1}$ and the melting point of stainless steel is approximately 1500°C.

[4 marks]

V gap

given.

$m_{s.s} = 0.080kg$ ✓

$m_w = 0.450kg$ ✓

$\Delta T = (42.9 - 21)$

$\therefore \Delta T = 21.9°C$

let $T_{s.s.}$ = Initial Temp of s.s.

Heat Lost by Stainless steel cooling = Heat gained by water in warming ✓

$Q_{s.s.} = Q_w$ ✓(1)

$0.08 \times 445 \times (T_{ss} - 42.9) = 0.450 \times 4180 \times 21.9$

$35.6 (T_{s.s} - 42.9) = 41193.9$

$\therefore 35.6 T_{s.s} - 1527.24 = 41193.9$

$\Rightarrow T_{s.s} = \dfrac{(41193.9 + 1527.24)}{35.6}$

$\therefore T_{s.s} = \dfrac{42721.14}{35.6}$ ✓(1)

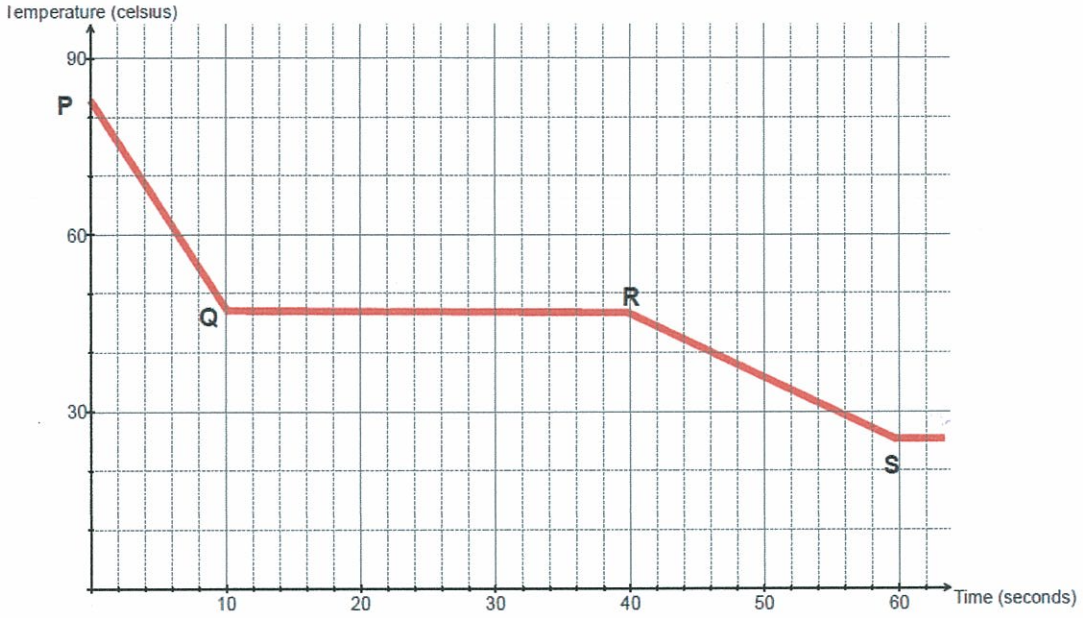
$\Rightarrow$ Initial Temp of Stainless steel $(T_{s.s.}) = 1200°C$

$\therefore T_{s.s.} = 1.20 \times 10^3 °C$ ✓

4MKS

Q8. **[10 marks]**

a) Some liquid alcohol of mass 76 grams was placed in a glass container and vaporised at 83°C. The container with the vapour was placed in a large water tank that was kept at room temperature. The change in temperature of the substance was recorded for 1 minute. There was **constant rate of energy output from the alcoholic substance** such that 132.4 J of energy was transferred out in a **60 second** time period. The graph below shows the *cooling curve* produced. Assume that heat loss to the surroundings was negligible.



Q8 (i) From the graph, what comparison can you make between the specific heat capacity of the liquid alcohol versus the specific heat capacity of its vapour? *No calculation is required.* [2 marks]

$C_{vapour\ EtOH} < C_{Liquid\ EtOH}$; gradient steeper ✓(1)
As $\Delta T \downarrow$ vapour releases less energy compared to liquid ethanol. ✓(1)

Q8 (ii) What states of matter are present during section Q to R? [1 mark]

Vapour or gas (½) and liquid (½)

Q8 (iii) Determine the latent heat of vaporisation (L_v) of the alcohol. [3 marks]

$Q = 132.4\,J$ for 60 secs.

$\therefore Q = \frac{132.4}{60} = 2.207\,J$ ✓(1)

$\therefore L_V = \frac{Q}{m}$

$L_V = \frac{2.207\,J}{0.076}$ ✓(1)

$\therefore L_V$ alcohol $= \underline{29.0\,J\,kg^{-1}} = 2.90 \times 10\,J\,kg^{-1}$ ✓(1)

6M/10

Q8. (iv) In terms of the Kinetic Molecular Theory, explain why the temperature of the substance did not decrease while energy transferred from it to the water between 10 and 40 seconds. Define **temperature** as part of your answer. [3 marks]

During At condensation (boiling point) ✓ (1)
vapour changes into liquid
internal energy is released to Water (1)
From 10–40 secs E_p ↑ changes ✓½ and E_K constant.
bond breaking occurs: ✓½
Temp^r ∝ E_K avg. of particles ✓ (1)

Q8 (v) Explain what is happening to the alcohol between R and S part of the graph, i.e. between 40 to 60 seconds time interval. [1 mark]

Liquid Ethanol cooling down; E_K ↓ as T ↓ ✓ (1)

[Q8 = 10 marks Total] 4 marks

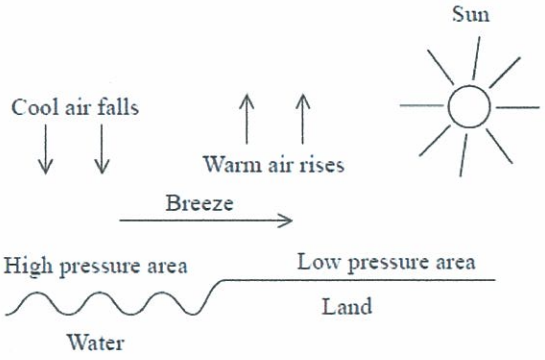
[5 marks total]

Q9.

(a) Heat energy transfer can take place by the process of convection. Name two other heat energy transfer processes.

Conduction ✓½ and Radiation ✓½ } (1)

(b) The diagram below shows how the process of convection leads to a breeze coming off the sea during daytime.



5 Mks

Q9. continued/.....

During this process the air above the land is heated by the sun and the warm air rises.

(a) Explain why warm air rises.

As air is warmed it gets lighter (dense); ✓①
Cold air (It is) displaced by warm air ✓①

(b) Define specific heat capacity.

The energy required to ~~warm~~ change the temperature of 1 kg of substance through 1°C rise in temp^{re} ✓①

$$\left[C = \frac{\Delta Q}{m \Delta T}\right]$$

(c) The land is hotter than the sea. Which has the greater specific heat capacity, land or sea?

(C_w) Sea has greater heat capacity :> C_{land}. ✓①
(Hence Land warms up quicker than/ Ocean) ✓①

(5 marks)

Please turn over for Q10

Q10. An immersion heater can supply heater can supply heat at a rate of 58.0 Js^{-1} *

↓ gap

(a) How long will it take to heat 125 g of water, originally at 22 °C, to its boiling point?

$Q = mc\Delta T$

$= 0.125 \times 4180 \times (100 - 22)$ ✓ (1)

$Q = 40755\ J = 4.08 \times 10^4\ J$

$\therefore t = \frac{Q}{P} = \frac{40755}{58.0}$ (1) ✓

$\therefore t = 702.6s = 703s$

(b) How long will it take to boil away 125 g of water at its boiling point?

$Q = mL_V$

$= 0.125 \times 2.26 \times 10^6$

$Q = 282500J$

$t = \frac{Q}{P} = \frac{282500}{58.0}$

$t = 4870.7$ ✓ (1)

$= 4871s$

(c) Why are the answers to part (a) and (b) different? Comment briefly using your knowledge of heating and cooling concepts studied.

time taken to boil > time taken to warm water up. ✓ (1)

x 7 times >

$\approx \frac{4871}{703} = 6.93$

any reasonable answer.

4 MKS total.

END OF YEAR 11 PHYSICS: HEATING and COOLING TEST 2012

GO BACK AND RE- CHECK YOUR ANSWERS