Heat Revision for Topic Test

1a) Heat is the transfer of energy from a hotter object to a cooler object.

b) Internal Energy is the sum of the kinetic and potential energies of a substance c)

c) Temperature is a measure of the average KE of the particles

d) No, heat is energy in transit moving from hotter to colder substance

2. $T_i = 20.5°C$
$m = 20kg$
$P = 850 J/s$
$T_f = ?$
$t = 2h$

$E = P \times t$
$= 850 \times 2 \times 60 \times 60$
$= 6120\,000 J$

$Q = mc\Delta T$
$6120\,000 = 20 \times 4180 \times (T_F - 20.5)$
$T_f = \underline{93.7°C}$

3. $m = 250mL$ (water)
$m = 12.5 kg$ } 30×
$h = 1.20m$
$\Delta T = 3°C$

a) $PE = mgh$
$= 30 \times 12.5 \times 9.8 \times 1.2$
$= 4410 J$

$Q = mc\Delta T$
$4410 = 0.25 \times c \times 3$
$c = \underline{5880 J/kgK}$

b) % error $= \left(\frac{5880 - 4180}{4180}\right) \times 100 = \underline{40.7\%}$

c) As the weight dropped + stirred the water, the gravitational potential energy was converted to kinetic energy causing the particles to move. The temperature is a measure of the average kinetic energy of the particles ∴ temp. also rose

4. ~~303K~~ 373 K 100 K −273°C 100°C −213°C

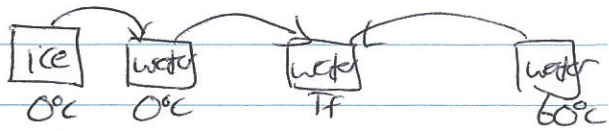
5. $m_i = 100g = 0.1kg$
$T_i = 120°C$
$m_w = 0.150kg$
$T_i = 25°C$
$T_F = 25 + 2.15°C = 27.15°C$

$Q_{hot} = Q_{cold}$
$0.1 \times c_c \times (120 - 27.15) = 0.150 \times 4180 \times 2.15$
$c_c = \underline{145 J/kgK}$

Heat Revision for Topic Test cont.

6. ice
$m = 0.03kg$

water
$m = 0.450kg$
$T_i = 60°C$
$T_F = ?$



$Q_{hot} = Q_{cold}$

$0.450 \times 4180 \times (60 - T_F) = (0.03 \times 3.4 \times 10^5) + (0.03 \times 4180 \times T_F)$

$112\,860 - 1881\,T_F = 10020 + 125.4\,T_F$

$102840 = 2006.4\,T_F$

$T_F = 51.3°C$

7. White is best reflector of heat which will reflect off heat in summer, keeping you cooler. It is the worst emitter of heat, so in winter it slows down emission of body heat keeping you warmer.

8. Ice is less dense than water, so when water starts to freeze it does so on surface. This seals the lake from exterior Low temp. (-30°C) and acts as an insulator keeping the lake above 0°C.

9. Black is best emitter of heat. Allows engines heat to be radiated out to environment to prevent engine from overheating

10. a) Silver reflects heat - traps in person's heat (reflects it back)
b) They are wet with sweat + still sweating to drop core body temp, but no longer running. The evaporation rate rapidly drops their temperature and within 15mins can be shivering. They have burnt up a lot of their food reserves to warm themselves up. The silver blanket slows down the rate of heat loss from the body as it reflects heat back to body.

11. Acts as insulator, also trapping air - also a good insulator. The body warms this layer up and prevents/slows down heat loss to the environment.

12. Both at same temp. Wood is an insulator. Steel is a conductor. The steel removes heat from fingers and conducts it away. Fingers lose a continuous stream of energy ~~aa~~ we feel this as a coldness. Wood: fingers warm up the area of wood to body temp + heat loss stops - here feels warmer.

13. COLD: Shiver: muscle contract + relax to generate heat
Goosebumps: muscles cause hairs to stand erect - trapping a layer of air between them that acts as an insulator: warms up to body temp.
Blood vessels constrict at extremities: prevent heat loss from blood in extremities (legs + arms)

Heat: Sweat: water evaporates removing latent heat from body cooling you.
Blood vessels dilate in skin - to allow for heat loss from blood to exterior.

COLD: Jumper - air trapped acts as insulator
Beanie: most heat lost through head.

15. $P = 500W$ $E = P \times t = 500 \times 10 \times 60 = 300\,000J$
$m = 0.150kg$ $Q = mL_f = 0.150 \times 3.34 \times 10^5$
$T_i = 0°C$ $= 50\,100J$
$t = 10mins.$ $t = \frac{E}{P} = \frac{50\,100}{500} = 100s.$

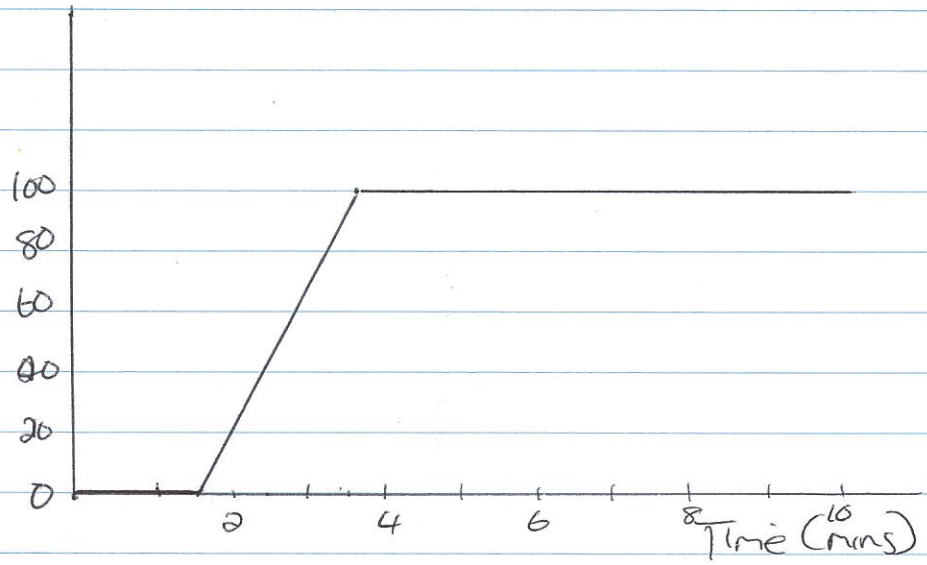
$Q = mc\Delta T = 0.15 \times 4180 \times \Delta T = 300\,000 - 50\,100 = 249900$

$Q = mc\Delta T = 0.150 \times 4180 \times 100 = 62700J$ $\Delta T = 398°C.$

$t = \frac{62\,700}{500} = 125.4s = 2.09mins$

$Q = mL_v = 0.150 \times 2.26 \times 10^6$

$= 339000\ J$



16. a) As the liquid particles in the aerosal can gain energy they start to vibrate more vigorously and ecape the forces holding them together and vaporise, gaining PE. As a gas they gain more KE and strike the continer with greater force and more frequency resulting in an increase in the pressure (force per unit area). As the pressure inside the can far exceeds outside atmospheric pressure, eventually the can ruptures.

b) Diffusion of gases: Particles of gas are shooting in all directions, they collide with one another, pushing the perfume particles in all directions until the paerfume particles occupy all available space.

c) As the steam particles loose energy they start to move slower (lose KE) and although still shooting in all directions when they collide, the force of attraction between the particles draws the particles together as the KE is too little to overcome the force. The particles release PE as they stick together becoming a liquid. They now can only slide over one another.

SHC revision.

17. $\Delta T = ?$

$m_{steel} = 5kg$

$m_{water} = 450kg$

$Q = 160 \times 10^6 J$

$Q = (mc\Delta T)_{steel} + (mc\Delta T)_{water}$

$= (5 \times 445 \times \Delta T) + (450 \times 4180 \times \Delta T)$

$= 2225\Delta T + 1881000\Delta T$

$160 \times 10^6 = 1883225\Delta T$

$\Delta T = 84.96°C = \underline{85.0°C}$

18. $m_{silver} = 0.050kg$ $T_i = 180°C$ $T_F = 24.5°C$ $c = ?$

$m_{water} = 0.1kg$ $T_i = 20.0°C$ $T_F = 24.5°C$

$Q_{hot} = Q_{cold}$

$(0.05 \times c \times (180 - 24.5)) = (0.1 \times 4180 \times 4.5)$

$7.775c = 1881$

$c = 241.9 J/kg°C$

$= 242 J/kg°C$

(silver) $= 233 J/kg°C$ ∴ possible some higher SHC metals present. eg iron $450 J/kg°C$.

OR inaccurate method

19 a) $Q = mc\Delta T$

$= 0.556 \times 4180 \times (83.5 - 25)$

$= 135\,958.68J$

$= 136\,000J$

b)

	Measurement	m	c	T_2	T_1
Abs U		$= 0.005g$	–	0.05°C	0.05°C
% U		$= \frac{0.005}{556} \times 100$	0.01%	$\Delta T = 0.05 + 0.05 = 0.1°C$	
		$= 8.99 \times 10^{-4}\%$	0.01%	$\%U(\Delta T) = \frac{0.1}{58.5} \times 100$	
				$= 0.171\%$	

$\%U(Q) = 8.99 \times 10^{-4} + 0.01 + 0.171$

$= \underline{0.182\%}$

c) $P = \frac{Q}{t} = \frac{135\,958.68}{5 \times 60} = \underline{453W}$

d) $\%\ error = \left|\frac{500 - 453}{500}\right| \times 100 = 9.36\%$ (9.4% if use banded value)