Mark schemes

1 (a) Tick in 4th box

1

(b) (i) (using heat energy = *ml*)

energy = 0.047 × 3.3 × 10^5 = 1.6 × 10^4 (J) ✓ (1.55 × 10^4 J)

answer alone gains mark

1

(ii) (heat in from water = heat supplied to melt and raise ice temperature)

1.8 × 10^4 = 1.6 × 10^4 + (energy to raise temp of ice)

energy to raise temp of ice = 2 × 10^3 (J) ✓

answer alone gains mark allow 2, 2.5 or 3 × 10^3 *J*

allow CE if substitution is shown

1.8 × 10^4 *– (b)(i)*

1

(iii) (using heat energy = $mc\Delta T$)

c = 2 × 10^3 / 0.047 × 25

= 2 × 10^3 ✓ (1.7 × 10^3) (note there is a large range of correct answers)

J kg^{-1} K^{-1} or J kg^{-1} $^{o}C^{-1}$ ✓ (allow use of dividing line but don't allow ^{o}K and $^{o}C^{-1}$ is not the same as C^{-1})

only allow CE if substitutions are seen

c = (b)(ii) / 0.047 × 25

= b(ii) × 0.851

allow 1 sig fig.

common answers:

for 2.5 × 10^3 *J gives 2.1 ×* 10^3 *or 2 ×* 10^3

for 3 × 10^3 *J gives 2.6 ×* 10^3 *or 3 ×* 10^3

2

[5]

2 (i) (heat supplied by glass = heat gained by cola)

(use of $m_g\ c_g\ \Delta T_g = m_c\ c_c\ \Delta T_c$)

1st mark for RHS or LHS of substituted equation

$0.250 \times 840 \times (30.0 - T_f) = 0.200 \times 4190 \times (T_f - 3.0)$ ✓

2nd mark for 8.4°C

$(210 \times 30 - 210\ t_f = 838\ T_f - 838 \times 3)$

$T_f = 8.4(1)$ (°C) ✓

Alternatives:

8°C is substituted into equation (on either side shown will get mark) ✓

resulting in 4620J~4190J ✓

or

8°C substituted into LHS ✓ *(produces ΔT = 5.5°C and hence)*

= 8.5°C ~ 8°C ✓

8°C substituted into RHS ✓

(produces ΔT = 20°C and hence)

= 10°C ~ 8°C ✓

2

(ii) (heat gained by ice = heat lost by glass + heat lost by cola)

NB correct answer does not necessarily get full marks

(heat gained by ice = $mc\Delta T + ml$)
heat gained by ice = $m \times 4190 \times 3.0 + m \times 3.34 \times 10^5$ ✓
(heat gained by ice = $m \times 346600$)

3rd mark is only given if the previous 2 marks are awarded

heat lost by glass + heat lost by cola
= 0.250 × 840 × (8.41 – 3.0) + 0.200 × 4190 × (8.41 – 3.0) ✓
(= 5670 J)

(especially look for m × 4190 × 3.0)

the first two marks are given for the formation of the substituted equation not the calculated values

m (=5670 / 346600) = 0.016 (kg) ✓

if 8^oC is used the final answer is 0.015 kg

or (using cola returning to its original temperature)
(heat supplied by glass = heat gained by ice)
(heat gained by glass = 0.250 × 840 × (30.0 – 3.0))
heat gained by glass = 5670 (J) ✓
(heat used by ice = $mc\Delta T + ml$)
heat used by ice = $m(4190 \times 3.0 + 3.34 \times 10^5)$ ✓ (= m(346600))

m (=5670 / 346600) = 0.016 (kg) ✓

3

[5]

3 (a) the energy required to change the state of a unit mass of water to steam / gas ✓
when at its boiling point temperature / 100°C / without a change in temperature) ✓

allow 1 kg in place of unit
allow liquid to vapour / gas without reference to water
don't allow 'evaporation' in first mark

2

(b) (i) thermal energy given by copper block (= $mc\Delta T$)
= 0.047 × 390 × (990 – 100)
= 1.6×10^4 (J) ✓
2 sig figs ✓

can gain full marks without showing working
a negative answer is not given credit
sig fig mark stands alone

2

(ii) thermal energy gained by water and copper container
($= mc\Delta T_{water} + mc\Delta T_{copper}$)
$= 0.050 \times 4200 \times (100 - 84) + 0.020 \times 390 \times (100 - 84)$
or
= 3500 (J) ✓ (3485 J)
available heat energy ($= 1.6 \times 10^4 - 3500$) $= 1.3 \times 10^4$ (J) ✓

allow both 12000 J and 13000 J

allow CE from (i)
working must be shown for a CE
take care in awarding full marks for the final answer – missing out the copper container may result in the correct answer but not be worth any marks because of a physics error
(3485 is a mark in itself)
ignore sign of final answer in CE
(many CE's should result in a negative answer)

2

(iii) (using Q = *ml*)
$m = 1.3 \times 10^4 / 2.3 \times 10^6$
= 0.0057 (kg) ✓
Allow 0.006 but not 0.0060 (kg)

allow CE from (ii)
answers between 0.0052 → 0.0057 kg resulting from use of 12000 and 13000 J

1

[7]

4 (a) (use of $\Delta Q = m\,c\,\Delta T$)

$30 \times 98 = 0.100 \times c \times 14$ ✓

$c = 2100$ (J kg^{-1} K^{-1}) ✓

2

(b) (use of $\Delta Q = m\,l + m\,c\,\Delta T$)

$500 \times 98 = 0.100 \times 3.3 \times 10^5$ ✓ $+ 0.100 \times 4200 \times \Delta T$ ✓

($\Delta T = 38$ °C)

T = 38°C ✓

3

(c) the temperature would be higher ✓

as the ice/water spends more time below 25°C

or heat travels in the direction from hot to cold

or ice/water first gains heat then loses heat

any **one** line ✓

2

[7]

5 (a) (i) energy = 800 × 60 = 48 × 10^3 J **(1)**

(ii) (use of $\Delta Q = mc\Delta\theta$ gives) 48 × 10^3 = 60 × 3900 × $\Delta\theta$ **(1)**
$\Delta\theta$ = 0.21 K **(1)** (0.205 K)
(allow C.E. for value of energy from (i)) 3

(b) $\Delta Q = ml$ gives 500 × 60 **(1)** = m × 2.3 × 10^6 **(1)**
m = 0.013 kg **(1)**

3

(c) not generating as much heat internally **(1)**
still losing heat (at the same rate)
[or still sweating] **(1)**
hence temperature will drop **(1)**

lmax 2

[8]

6 (a) (i) quantity of energy supplied to unit mass **(1)**

which raises temperature by 1°C [or 1K] **(1)**

(ii) quantity of energy required to change state of unit mass **(1)**

solid to liquid [or ice to water] **(1)**

without change of temperature **(1)**

(max 4)

(b) (i) Q (= $mc\Delta\theta$) = 0.15 × 1200 × (58 – 18) = 7200 (J) **(1)**

$$P = \frac{7200}{5 \times 60} = 24 \text{ W}$$ **(1)**

(ii) Q = 24 × 7 × 60 = 10080 (J) **(1)**

0.15l = 10080 gives l = 67200 J kg^{-1} **(1)**

(iii) 24 × 4 × 60 = 0.15 × s_L × (94 – 58) **(1)**

gives s_L = 1070 J kg^{-1} K^{-1} **(1)**

(6)

[10]

7 (a) (i) energy/heat input needed to change liquid into gas/vapour when at its boiling point/without change of temperature

M1

energy per unit mass/1 kg

A1

(ii) idea that more energy has to be supplied to separate molecules than to break solid bond
or
for vaporisation work is done against atmospheric pressure
or
Idea that there is a greater change in PE in L-G than S-L

B1

3

(b) (i) $ml = Mc\Delta\theta$ or energy gain by water = 89250 (J)
$m \times 2.3 \times 10^6 = 0.25 \times 4200 \times 85$

C1

m = 0.0388 kg

A1

total mass = 0.289 (0.29) kg (0.25 + their m)

B1

(ii) energy from steam is needed to raise temperature of the cup

or

energy/heat will be lost to the surroundings/cup/tube during the heating

B1

4

[7]