MEGA LECTURE

Q1.

2 (a) $\times$
     $\times$
     ✓
     ✓   (–1 for each error or omission) .... B2   [2]

(b)   heat lost by liquid gold = $0.95m \times 129 \times \Delta T$ C1
heat gained (silver) = $0.05m \times 235 \times (1340 - 300) + 0.05m \times 105\,000$ ..C1, C1
$122.5m\Delta T = 17\,470m$
$\Delta T = 143\,K$ C1
temperature = 143 + 1340 = 1483 K ....A1   [5]

(c)   e.g. thermocouple/resistance thermometer .... B1   [1]

Q2.

6	0	–	+	(–1 for each error)		B2	
	+	+	0	(–1 for each error)		B2	
	+	+	0	(–1 for each error)		B2	[6]
					Total		[6]

Q3.

3 (a)   (thermal) energy/heat required to convert unit mass/1 kg of
solid to liquid   **M1**
with no change in temperature/at melting point   **A1**   [2]

(b) (i)   energy required to warm ice = $24 \times 10^{-3} \times 2.1 \times 10^{3} \times 15$ (= 756 J)   **C1**
energy required to melt ice at 0 °C = $24 \times 10^{-3} \times 330 \times 10^{3}$ (= 7920 J)   **C1**
total energy = 8700 J   **A1**   [3]

(ii)   energy lost by warm water = $200 \times 10^{-3} \times 4.2 \times 10^{3} \times (28 - T)$ **C1**
$200 \times 4.2 \times (28 - T) = 24 \times 4.2 \times T + 8676$ **C1**
$T = 16$ °C   **A1**   [3]
[allow 2 marks if ΔT calculated]
[allow 2 marks if $(24 \times 4.2 \times T)$ omitted]
[allow 1 mark for $224 \times 4.2 \times (28 - T) = 8676$, $T - 19$ °C]

Q4.

3 (a) gradient of graph is (a measure of) the sensitivity   **M1**
the gradient varies with temperature   **A1**   [2]

(b) $2040 \pm 20\,\Omega$ corresponds to 15.0 ± 0.2 °C   **C1**
$T/K = T/°C + 273.15$ (allow 273.2)   **C1**
temperature is 288.2 K   **A1**   [3]

MEGA LECTURE

Q5.

2 (a) (on melting,) bonds between molecules are broken/weakened
or molecules further apart/are able to slide over one another   B1
kinetic energy unchanged so no temperature change   B1
potential energy increased/changed so energy required   B1   [3]

(b) thermal energy/heat required to convert unit mass of solid to liquid   M1
with no change in temperature/ at its normal boiling point   A1   [2]

(c) (i) thermal energy lost by water = $0.16 \times 4.2 \times 100$
= 67.2 kJ   C1
$67.2 = 0.205 \times L$ C1
$L = 328$ kJ kg^{-1} A1   [3]

(ii) more energy (than calculated) melts ice   M1
so, (calculated) L is lower than the accepted value   A1   [2]

Q6.

3 (a) increasing separation of molecules / breaking bonds between molecules   B1
(allow atoms/molecules, overcome forces)
doing <u>work</u> against atmosphere (during expansion)   B1   [2]

(b) (i) 1 *either* bubbles produced at a <u>constant rate</u> / mass evaporates/lost at
<u>constant rate</u>
or find mass loss more than once and this rate should be constant
or temperature of liquid remains constant   B1   [1]
2 to allow/cancel out/eliminate/compensate for heat losses (to atmosphere)   B1   [1]
(do not allow 'prevent'/'stop')

(ii) use of *power* × *time* = *mass* × *specific latent heat*   C1
$(70 - 50) \times 5 \times 60 = (13.6 - 6.5) \times L$ C1
$L = 845$ J g^{-1} A1   [3]

Q7.

3 (a) (i) 1 deg C corresponds to $(3840 - 190) / 100 \ \Omega$ C1
for resistance 2300 Ω, temperature is $100 \times (2300 - 3840) / (190 - 3840)$
temperature is 42 °C   A1   [2]

(ii) *either* 286 K ≡ 13 °C *or* 42 °C ≡ 315 K   B1
thermodynamic scale does not depend on the property of a substance   M1
so change in resistance (of thermistor) with temperature is non-linear   A1   [3]

(b) heat gained by ice in melting = $0.012 \times 3.3 \times 10^5$ J   C1
= 3960 J
heat lost by water = $0.095 \times 4.2 \times 10^3 \times (28 - \theta)$ C1
$3960 + (0.012 \times 4.2 \times 10^3 \times \theta) = 0.095 \times 4.2 \times 10^3 \times (28 - \theta)$ C1
$\theta = 16$°C   A1   [4]
(answer 18°C – melted ice omitted – allow max 2 marks)
(use of $(\theta - T)$ then allow max 1 mark)

Q8.

4 (a) +ΔU: increase in internal energy — B1
+q: thermal energy / heat supplied to the system — B1
+w: work done on the system — B1 [3]

(b) (i) (thermal) energy required to change the state of a substance — M1
per unit mass — A1
without any change of temperature — A1 [3]

(ii) when evaporating
greater change in separation of atoms/molecules — M1
greater change in volume — M1
identifies each difference correctly with ΔU and w — A1 [3]

Q9.

3 (a) (numerically equal to) quantity of (thermal) energy required to change
the state of unit mass of a substance — M1
without any change of temperature — A1 [2]
(Allow 1 mark for definition of specific latent heat of fusion/vaporisation)

(b) either energy supplied = 2400 × 2 × 60 = 288000 J — C1
energy required for evaporation = 106 × 2260 = 240000 J — C1
difference = 48000 J
rate of loss = 48000 / 120 = 400 W — A1
or energy required for evaporation = 106 × 2260 = 240000 J — (C1)
power required for evaporation = 240000 / (2 × 60) = 2000 W — (C1)
rate of loss = 2400 − 2000 = 400 W — (A1) [3]

Q10.

3 (a) sum of potential energy and kinetic energy of atoms/molecules/particles — M1
reference to random (distribution) — A1 [2]

(b) (i) as lattice structure is 'broken'/bonds broken/forces between
molecules reduced (not molecules separate) — B1
no change in kinetic energy, potential energy increases — M1
internal energy increases — A1 [3]

(ii) either molecules/atoms/particles move faster/ $<c^2>$ is increasing
or kinetic energy increases with temperature (increases) — B1
no change in potential energy, kinetic energy increases — M1
internal energy increases — A1 [3]

Q11.

MEGA LECTURE

1 (a) (i) $Q = mc\Delta\theta$ C1
            $2300 = 0.75 \times c \times (100 - 20) / 120$ ...(if uses ±273, then –2)...... C1
            $c = 4600 \text{ J kg}^{-1} \text{ K}^{-1}$ ...(allow 1 sf)............................... A1
      (ii) $Q = mL$ C1
            $2300 = (0.375 / 420) \times L$
            $L = 2.6 \times 10^6 \text{ J kg}^{-1}$ ...(allow 1 sf)................................ A1   [5]

   (b)   e.g. heat losses, power not constant etc M1
            (do not allow if releated to s.h.c., rather than l.h.c.)
            effect on value for L .... A1   [2]

Q12.

3 (a) pV/T = constant... C1
            $T = (6.5 \times 10^6 \times 30 \times 300)/(1.1 \times 10^5 \times 540)$................. C1
            $= 985 \text{ K}$.. A1   [3]
            (if uses °C, allow 1/3 marks for clear formula)

3 (b) (i) $\Delta U = q + w$
            symbols identified correctly M1
            directions correct.. A1   [2]

     (ii) q is zero B1
            w is positive OR $\Delta U = w$ and U increases B1
            ΔU is rise in kinetic energy of <u>atoms</u> M1
            and mean kinetic energy $\propto T$ .... A1   [4]
            (allow one of the last two marks if states 'U increases so T rises')

Q13.

7   (a)   variation is non-linear   1
            two possible temperatures   1   [2]

    (b)   e.g. 1. small thermal capacity/measure $\Delta\theta$ of small object
                     /short response time
                  2 readings taken at a point/physically small
                  3 can be used to measure temperature difference
                  4 no power supply required
                     etc.   (any two, 1 mark each)   2   [2]

Q14.

MEGA LECTURE

3 (a) correct statement, words or symbols .... B1 [1]

(b)(i) $w = p\Delta V$ C1
$= 1.03 \times 10^5 \times (2.96 \times 10^{-2} - 1.87 \times 10^{-5})$
$= (-)\ 3050\ J$ .... A1 [2]

(ii) $q = 4.05 \times 10^4\ J$ .... B1 [1]

(iii) $\Delta U = 4.05 \times 10^4 - 3050 = 37500\ J$ ...no e.c.f. from (a)..................... A1 [1]
penalise 2 sig.fig. once only

(c) number of molecules $= N_A$ C1
energy $= 37500 / (6.02 \times 10^{23})$
$= 6.2 \times 10^{-20}\ J$ (accept 1 sig.fig.) .... A1 [2]

Q15.

2 (a) (i) idea of heat lost (by oil) = heat gained (by thermometer) C1
$32 \times 1.4 \times (54 - t) = 12 \times 0.18 \times (t - 19)$ C1
$t = 52.4°C$ A1 [3]

(ii) *either* ratio $(= 1.6/54) = 0.030$ *or* $(=1.6/327) = 0.0049$ A1 [1]

(b) thermistor thermometer (allow 'resistance thermometer') B1
because small mass/thermal capacity B1 [2]

(c) boiling point temperature is constant M1
further comment
e.g. heating of bulb would affect only rate of boiling A1 [2]

Q16.

2 (a) (Thermal) energy / heat required to convert unit mass of solid to liquid M1
at its normal melting point / without any change in temperature A1 [2]
(*reference to 1 kg or to ice → water scores max 1 mark*)

(b) (i) To <u>make allowance</u> for heat gains from the atmosphere B1 [1]

(ii) e.g. constant rate of production of droplets from funnel
constant mass of water collected per minute in beaker
(*any sensible suggestion, 1 mark*) B1 [1]

(iii) mass melted by heater in 5 minutes $= 64.7 - \frac{1}{2} \times 16.6 = 56.4g$ C1
$56.4 \times 10^{-3} \times L = 18$ C1
$L = 320\ kJ\ kg^{-1}$ A1 [3]
(*Use of m = 64.7, giving L = 278 kJ kg^{-1}, scores max 1 mark*
use of m = 48.1, giving L = 374 kJ kg^{-1}, scores max 2 marks)

Q17.

MEGA LECTURE

4   (a) $\Delta U = q + w$ (allow correct word equation)   B1   [1]

    (b)   *either*   kinetic energy constant because temperature constant   M1
                     potential energy constant because no intermolecular forces   M1
                     so no change in internal energy   A1   [3]
          or   kinetic energy and potential energy both constant   (M1)
                     so no change in internal energy   (A1)
                     reason for *either* constant k.e. *or* constant p.e. given (A1)

Q18.

3   (a)   e.g. two objects of different masses at same temperature   (M1)
               same material would have different amount of heat   (A1)
          e.g. temperature shows direction of heat transfer   (M1)
               from high to low regardless of objects   (A1)
          e.g. when substance melts/boils   (M1)
               heat input but no temperature change   (A1)
          any two, M1 + A1 each, max 4 .... [4]

    (b)   (i)   energy losses (to the surroundings) M1
                either   increase as the temperature rises
                or   rise is zero when heat loss = heat input ....A1   [2]

          (ii) idea of input <u>power</u> = maximum <u>rate</u> of heat loss C1
                power = $m \times c \times \Delta\theta / \Delta t$
                $54 = 0.96 \times c \times 3.7 / 60$ C1
                $c = 910 \text{ J kg}^{-1} \text{ K}^{-1}$ ....A1   [3]

                                                                        [Total: 9]

Q19.

2   (a)   sum of kinetic and potential energies of molecules / particles / atoms M1
          random (distribution) ....A1   [2]

    (b) $+\Delta U$: increase in internal energy B1
          $+q$: heating of / heat supplied to system B1
          $+w$: work done on system ....B1   [3]

    (c)   (i)   work done = $p\Delta V$ C1
                         = $1.0 \times 10^5 \times (2.1 - 1.8) \times 10^{-3}$
                         = 30 J
                $w = 30$ J, $q = 0$ so $\Delta U = 30$ J M1
                                                                                          A1   [3]

          (ii) these three marks were removed, as insufficient data was given in the question.

                                                                        [Total: 8]

Q20.

MEGA LECTURE

2 (a) temperature scale calibrated assuming linear change of property with temperature   B1
          neither property varies linearly with temperature   B1   [2]

     (b) (i) does not depend on the property of a substance   B1   [1]

         (ii) temperature at which atoms have minimum/zero energy   B1   [1]

     (c) (i) 323.15 K   A1   [1]

         (ii) 30.00 K   A1   [1]

Q21.

3 (a) temperature of the spheres is the same   B1
          no (net) transfer of energy between the spheres   B1   [2]

     (b) (i) power $= m \times c \times \Delta\theta$ where m is mass per second   C1
             $3800 = m \times 4.2 \times (42 - 18)$ C1
             $m = 38\,\text{g s}^{-1}$ A1   [3]

         (ii) some thermal energy is lost to the surroundings   M1
             so rate is an overestimate   A1   [2]

Q22.

3 (a) *either* change in volume $= (1.69 - 1.00 \times 10^{-3})$
        or   liquid volume $\ll$ volume of vapour   M1
        work done $= 1.01 \times 10^5 \times 1.69 = 1.71 \times 10^5$ (J)   A1   [2]

     (b) (i) 1. heating of system/thermal energy supplied to the system   B1   [1]

            2. work done on the system   B1   [1]

         (ii) $\Delta U = (2.26 \times 10^6) - (1.71 \times 10^5)$ C1
             $= 2.09 \times 10^6$ J   (3 s.f. needed)   A1   [2]

Q23.

MEGA LECTURE

3   (a) resonance   B1   [1]

     (b) $Pt = mc\,\Delta\theta$ C1
          $750 \times 2 \times 60 = 0.28 \times c \times (98 - 25)$ C1
          $c = 4400\,\text{J kg}^{-1}\,\text{K}^{-1}$ A1   [3]

          (use of $\Delta\theta = 73 + 273$ max. 1/3)
          (use of $t = 2s$ not $120s$ max. 2/3)

Page 3	Mark Scheme	Syllabus	Paper
	GCE A LEVEL – May/June 2014	9702	42

     (c) e.g. some microwave leakage from the cooker
          e.g. container for the water is also heated
          (any sensible suggestion)   B1   [1]

Q24.

3   (a) initially, $pV/T = (2.40 \times 10^5 \times 5.00 \times 10^{-4})/288 = 0.417$ M1
          finally, $pV/T = (2.40 \times 10^5 \times 14.5 \times 10^{-4})/835 = 0.417$ M1
          ideal gas because pV/T is constant   A1   [3]
          (allow 2 marks for two determinations of V/T and then 1 mark for V/T and p
          constant, so ideal)

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International AS/A Level – October/November 2014	9702	43

     (b) (i)   work done $= p\Delta V$
                $= 2.40 \times 10^5 \times (14.5 - 5.00) \times 10^{-4}$ C1
                $= 228\,\text{J}$ (ignore sign, not 2 s.f.)   A1   [2]

          (ii) $\Delta U = q + w = 569 - 228$
                $= 341\,\text{J}$ M1
                increase   A1   [2]