Thermal Properties of Materials

Mark Scheme 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Thermal Properties of Materials
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(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 M1
w = 30 J, q = 0 so ΔU = 30 J ..... A1 [3]

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

[Total: 8]

2 **(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]

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

(b) (i) To make allowance 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 - ½ × 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)

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)

5 **(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]

6 **(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 boili A1 [2]