Temperature

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Temperature
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **65 minutes**

Score: **/54**

Percentage: **/100**

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

1 **(a) (i)** at 22.5 °C, R_T = 1600 Ω or 1.6 kΩ — C1
total resistance = 800 Ω — A1 [2]

(ii) *either* use of potential divider formula *or* current = 9 / 2000 (4.5 mA) — C1
V = (0.8/2.0) × 9 *or* V = (9/2000) × 800
= 3.6 V — A1 [2]

(b) (i) total resistance = 4/5 × 1200 — C1
= 960 Ω — A1 [2]

(ii) for parallel combination, 1/960 = 1/1600 + 1/R_T
R_T = 2400 Ω / 2.4 kΩ — C1
temperature = 11 °C — A1 [2]

(c) e.g. only small part of scale used / small sensitivity — B1
non-linear — B1 [2]
(*any two sensible suggestions, 1 each, max 2*)

2 **(a** operates on / takes signal from sensing device — B1
(so that) it gives an voltage output — B1 [2]

(b) thermistor and resistor in series between +4 V line and earth — M1
V_{OUT} shown clearly across *either* thermistor *or* resistor
V_{OUT} shown clearly across thermistor — A1 [3]

(c) e.g. remote switching
switching large current by means of a small current
isolating circuit from high voltage
switching high voltage by means of a small voltage/current
(*any two sensible suggestions, 1 each to max. 2*) — B [2]

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

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

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

4 **(a)** temperature scale calibrated assuming linear change of property with temperature
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]

5 **(a) (i)** 27.2 + 273.15 or 27.2 + 273.2 C1
300.4 K A1 [2]

(ii) 11.6 K A1 [1]

(b) (i) ($<c^2>$ is the) mean / average square speed B1 [1]

(ii) $\rho = Nm/V$ with N explained B1
so, $pV = 1/3\ Nm<c^2>$ B1
and $pV = NkT$ with k explained B1
so mean kinetic energy / $<E_K> = \frac{1}{2}m<c^2> = 3/2\ kT$ B1 [4]

(c) (i) $pV = nRT$
$2.1 \times 10^7 \times 7.8 \times 10^{-3} = n \times 8.3 \times 290$ C1
$n = 68$ mol A1 [2]

(ii) mean kinetic energy $= 3/2\ kT$
$= 3/2 \times 1.38 \times 10^{-23} \times 290$ C1
$= 6.0 \times 10^{-21}$ J A1 [2]

(iii) realisation that total internal energy is the total kinetic energy C1
energy $= 6.0 \times 10^{-21} \times 68 \times 6.02 \times 10^{23}$ C1
$= 2.46 \times 10^5$ J A1 [3]

6 **(a) (i)** 1 deg C corresponds to (3840 – 190) / 100 Ω C1
for resistance 2300 Ω, temperature is 100 × (2300 – 3840) / (190 – 3840)
temperature is 42 °C A [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 = $0.095 \times 4.2 \times 10^3 \times (28 - \theta)$ C
$3960 + (0.012 \times 4.2 \times 10^3 \times \theta) = 0.095 \times 4.2 \times 10^3 \times (28 - \theta)$ C
θ = 16°C A1 [4]
(answer 18°C – melted ice omitted – allow max 2 marks)
(use of (θ – T) then allow max 1 mark)