Mark scheme

Specific heat capacity

Physics 0625 · Paper 4 (Extended)

Total marks

75

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	8	9	Total
5	7	7	8	8	9	9	10	12	**75**

Question 1 [5]

1 **(a)** (Q/E =) Pt **or** 2400 × 50 C1
1.2×10^5 (J) C1
(c =) $Q/m\Delta T$ **or** $1.2 \times 10^5/(1.5 \times 32)$ (condone 2400/(1.5 × 32))
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) C1
2.5×10^3 J/(kg °C) **or** 2.5 J/(g °C) (condone missing brackets)
(allow e.c.f. from candidate's $Q = 1.2 \times 10^5$) A1 [4]

(b) (student's value) too large **and** heat lost to surroundings/kettle/evaporation B1 [1]

[Total: 5]

Question 2 [7]

2 **(a)** mass of block m B1
initial temperature θ_1 and final temperature θ_2 B1
time of heating t B1
voltage / p.d. V AND current I B1

(b) (c =) $VIt \div [m(\theta_2 - \theta_1)]$
OR $Pt \div [m(\theta_2 - \theta_1)]$ **OR** $E \div [m(\theta_2 - \theta_1)]$ as appropriate to symbols defined in **(a)**
numerator correct B1
denominator correct B1

(c) (more) thermal energy / heat lost (to surroundings) so temperature rise is less
OR more thermal energy / heat input required for same temperature rise B1

[Total: 7]

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Question 3 **[7]**

3 **(a)** $c = Q/(m\Delta\theta)$ B1

(b) **(i)** d = m / V in any form OR (m =) Vd OR 0.0036×1000 C1
3.6 kg A1

(ii) (E =) Pt OR 8500×60 OR 510 000 J OR 5.1×10^5 J C1
$\Delta\theta = Q/mc$ OR $\Delta\theta = Pt/mc$ in any form OR $5.1 \times 10^5/(3.6 \times 4200)$ C1
= 34 (°C) A1

OR $\Delta\theta$ = P / (mass per second × c) (C1)
= 8500 / [(0.0036 / 60) × 4200 (C1)
= 34 (°C) (A1)

outflow temp = 15 + 33.73 = 49 °C B1

[Total: 7]

Question 4 **[8]**

4 **(a)** energy/heat required to increase temperature
- of 1 kg / 1 g / unit mass (of the substance) B1
- by 1 °C / 1 K / unit temperature B1

(b) $E = mc\Delta\theta$ in any form OR $(c =) E \div m\Delta\theta$ C1
$E = Pt$ in any form OR 420×95 (= 39 900) C1
$\Delta\theta$ = [40.5 – 19.5] OR 21 C1
(c = 39 900 ÷ 42 =) 950 J / (kg °C) A1

(c) any two separate points from: max. B2
- lagging / insulation (around block) OR insulate (the block)
- raise temperature of block by a smaller amount OR heat for a shorter time OR use lower power heater <u>for same time</u> OR higher power <u>for same temperature rise / shorter time</u>
- polish the surface of the block OR wrap the block in shiny material OR paint (shiny) white
- reduce initial temperature of block (to below room temperature) OR raise temperature of room
- reduce draughts

[Total: 8]

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Question 5 [8]

5(a)	energy transferred per unit mass per unit temperature change	**A2**
	(thermal) energy (transferred) per unit temperature change	(C1)
5(b)(i)	(m =) 2.2 kg	**A2**
	$m = \rho V$ in any form **OR** 910 × 0.0024	(C1)
5(b)(ii)	7.0×10^5 J **OR** 700 000 J	**A2**
	$c = \Delta E / \{ m\Delta\theta \}$ **OR** (ΔE =) $mc\Delta\theta$ **OR** 2.2 × 2000 × 160 **OR** 2.184 × 2000 × 160	(C1)
5(b)(iii)	1700 W	**A2**
	(P =) E / t **OR** 700 000 / 7 × 60 **OR** 704 000 / 7 × 60 **OR** 698 880 / 7 × 60	(C1)

Question 6 [9]

6 **(a)** heat/energy to raise/change temperature M1
of 1 kg/g/unit mass through 1°C/1K/unit temperature A1

(b) **(i)** darker colours absorb more OR lighter/shiny colours absorb less B1

(ii) **1.** 182 B1
2. (mass of $1m^2$ =) volume × density OR $D = M/V$ OR (1 ×) 0.01 × 7800 C1
78 kg A1
3. $Q = mc\theta$ B1
182 = 78 × 450 × θ (e.c.f. from **1**,**2**) C1
0.00519 °C/s OR 5.19×10^{-3} °C/s (e.c.f. from **1**,**2**) A1

[Total: 9]

Question 7 [9]

7(a)	(average) KE of particles increases / particles move faster	**B1**
7(b)(i)	$\rho = m / v$ **OR** (m =) ρv	**M1**
	$1\ cm^3 = 1 \times 10^{-6}\ m^3$ **OR** $250\ cm^3 = 2.5 \times 10^{-4}\ m^3$ **OR** $1000 \times 2.5 \times 10^{-4}$ (= 0.25 kg)	**A1**
7(b)(ii)	47000 J	**A3**
	($\Delta\theta$ =) 65 – 20 °C **OR** ($\Delta\theta$ =) 45 °C	C1
	$E = mc\Delta\theta$ **OR** (E =) $mc\Delta\theta$ **OR** (E =) 0.25 × 4200 × 45	C1
7(b)(iii)	thermal energy also transferred to the pan / surroundings **OR** thermal energy escapes from the water (as it is being heated)	**B1**
7(c)	any **two** from: • (aluminium saucepan) takes longer to heat the water • more (thermal) energy is needed (with aluminium pan for the same increase in temperature) • (because aluminium) has a higher specific heat capacity	**B2**

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Question 8 **[10]**

8 **(a)** heat/energy to raise/change temperature — M1
of 1 kg/1g/unit mass through 1°C/1K — A1
(mention of change of state scores zero)

(b) Q = mcθ (for θ accept t, T, Δθ, Δt, or ΔT) — B1
23800 = 0.93 × c × (41.3 – 13.1) — C1
907.5 or 907 or 908 or 910 J/(kg °C) or J/(kg K) at least 2 sig. figs — A1
(for unit in **(b)** and **(c)(i)** condone no brackets and extra solidus)

(c) **(i)** 1212.9 or 1200 or 1210 or 1213 or 1214 J/(kg °C) or J/(kg K) — B1

(ii) more energy lost (to surroundings) — B1
(average) temperature is higher/initial temperature higher/no cooling time allowed/temperature rise is lower/time of heating may be longer/ rate of heating may be lower — B1

(d) insulate block/provide lid/cover with shiny foil)
start & finish same amount below & above room temperature) any 2 — B1 + B1
get heater up to temperature before inserting)
put oil in gap between heater & block)

[Total: 10]

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Question 9 **[12]**

9 **(a)** **(i)** <u>electrical method</u>

lagged container + lid		
liquid (allow) water		5 points 3
heater in liquid		4 points 2
heater connected to electrical supply (seen or stated)		3 points 1
voltmeter and ammeter appropriately connected (seen)		
thermometer		B3

OR

<u>mixtures method</u>

lagged container		
liquid		5 points 3
hot solid/hot liquid		4 points 2
means of heating hot solid / liquid (seen or stated)		3 points 1
means of weighing hot solid / liquid / use of known mass (seen or stated)		
thermometer		B3

(ii) <u>electrical method</u>

initial & final temps of liquid OR temp rise	–1 e.e.o.o.	
voltmeter reading (however expressed)		
ammeter reading (however expressed)		
heating time		
mass of liquid		B3

OR

<u>mixtures method</u>

initial and final temps of liquid OR temp rise	–1 e.e.o.o.	
initial and final temps of added solid / liquid OR temp drop		
mass of added solid / liquid		
mass of liquid		
SHC of added solid / liquid		B3

(b) **(i)** $Q = mc\theta$ in any form B1
100.6 – 12 OR 88.6 C1
0.8 × 3900 × 88.6 C1
276 432 J A1

(ii) $Q = Wt$ OR (t =) candidate's **(i)**/620 C1
445.858 s ecf **(i)** A1 [12]

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