IB PHYSICS: Thermal Physics Markscheme

1. B **[1]**

2. A **[1]**

3. (a) (i) on — gas is compressed — 1 max

Correct answer and correct explanation.

(ii) ejected — pressure remains constant, volume reduced so temperature must go down — 1 max

Correct answer and correct explanation.

(b) work done = $p\Delta V$;

$= -1.0 \times 10^5 \times 0.4 = -0.40 \times 10^5$ J (40 kJ); — 2 max

*Sign should be consistent with (a)(i) above-work "by" and + work here would get zero for (a)(i) but **[2]** marks here.*

(c) area enclosed;

$\approx 0.6\ (\pm 0.2) \times 10^5$ J (60 kJ ± 20 kJ); — 2 max

(d) efficiency = work out/heat in;

$= \frac{60}{120} = 50\ \%\ (\pm 17\ \%)$; — 2 max

[8]

4. D **[1]**

5. A **[1]**

6. A **[1]**

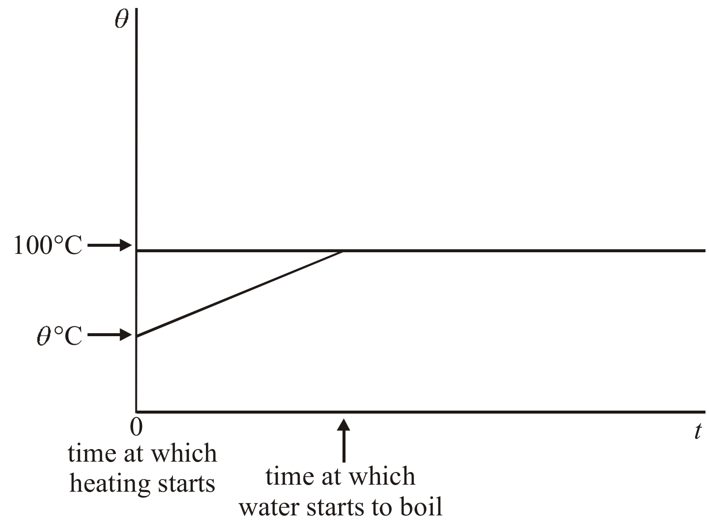
7. B **[1]**

8. (a) specific heat capacity is the amount of energy required to raise the temperature of unit mass through 1 K; — 1

(b) raising the temperature means increasing the KE of the molecules;

there are different numbers of molecules of different mass in unit mass of aluminium and water (accept different densities) and therefore different amounts of energy will be needed / *OWTTE*; — 2

(c) (i)



general shape (but constant θ range must be clear); 1

(ii) $\theta \rightarrow 100$ °C:
the KE of the molecules is increasing;

100 °C:
when the water starts to change phase, there is no further increase in KE;
the energy goes into increasing the PE of the molecules;
so increasing their separation;
until they are far enough apart to become gas / their molecular bonds are broken / until they are effectively an infinite distance apart / *OWTTE*; 5

(d) (i) total energy supplied = $400 \times 600 = 2.4 \times 10^5$ J; 1

(ii) energy required to raise temperature of water = $0.30 \times 80 \times 4.2 \times 10^3$
$= 1.0 \times 10^5$ J;
energy available to convert water to steam = $(2.4 - 1.0) \times 10^5 = 1.4 \times 10^5$ J;
mass of water converted to steam $= \dfrac{(1.4 \times 10^5)}{2.3 \times 10^6} \approx 60$ g; 3

(iii) energy is lost to the surroundings *(must specify where the energy is lost)* /
water might bubble out of pan whilst boiling / anything sensible; 1 max

[14]

9. C

[1]

10. (a) (165, 0); 1

(b) *Look for these points:*
to change phase, the separation of the molecules must increase;
Some recognition that the ice is changing phase is needed.

so all the energy input goes to increasing the PE of the molecules;
Accept something like "breaking the molecular bonds".

KE of the molecules remains constant, hence temperature remains constant; 3
If KE mentioned but not temperature then assume they know that temperature is a measure of KE.

(c) (i) time for water to go from 0 to 15° C = 30 s;

energy required = $ms\Delta\theta$ = 0.25 × 15 × 4 200 = 15 750 J;

power = $\frac{\text{energy}}{\text{time}}$ = 525 W ≈ 530 W; 3

(ii) ice takes 15 s to go from – 15 °C to 0;
energy supplied = 15 × 530 J;

sp ht = $\frac{(530\times 15)}{(15\times 0.25)}$ = 2100 J kg^{-1} K; 3

(iii) time to melt ice = 150 s;

$L = \frac{(150\times 530)}{0.25}$ = 320 kJ kg^{-1}; 2

[12]