Questions on Thermal Energy MS

1. Equation

Recall of $pV = nRT$ 1

Moles of air

Estimate of temperature ≈20 ^{o}C [Range 0 – 39] **(1)**

Use of equation, including conversion of temperature to K AND sensible volume **(1)**

Evaluation: $n = pV/RT = 1.0 \times 10^{5}$ Pa $\times 20 \times 10^{-6}$ m^{3} /8.31 × 293

$= 8 \times 10^{-4}$ **(1)** 3

Volume of bubble

($V \propto T$ since p and n constant) **(1)**

so volume smaller **(1)** 1

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2. Temperature of fire

Heat lost by stone = heat gained by water
OR $(mc\Delta\theta)_{\text{stone}} = (mc\Delta\theta)_{\text{water}}$ **(1)**
198 kg × 1100 J kg^{-1} °C^{-1} × Δθ
= 513 kg × 4200 J kg^{-1} °C^{-1}
× (100 °C – 18 °C) [i.e. Δ*E* for water] **(1)**
Δθ = 810 °C **(1)**
θ = 910 °C **(1)** 4

Why temperature of fire higher than calculated

Energy from stones greater than calculated/stones are hotter than **(1)**
this at the start (since heat to surroundings)

+ additional detail, e.g.

Heat lost by stones while transferred/stones not heated through –
effective *m* smaller/ last stone probably provided more than enough **(1)** 2
energy for final increase/some heat lost by water

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3. Calculation of energy to heat water

$\Delta E = mc\Delta\theta$
= 0.2 kg × 4200 J kg.$^{-1}$ °C^{-1} **(1)**

× (75 °C – 22 °C) **(1)**

[i.e. subst *mc* **(1)** subst Δ θ **(1)**]

= 44 500 J **(1)** 3

Calculation of maximum thermal energy from heater

$\Delta E = P\Delta t$
OR Δ*E* = 2500 W × 6 s **(1)**

15 000 J **(1)** 2

Explanation of which suggestion) most likely to be correct

Reservoir, as heater supplies insufficient energy in 6 s [ecf] **(1)** 1

Effect of heat losses

More energy would be required **(1)** 1

[7]

4. Diagram:

F↑ **(1)**

mg or W ↓ **(1)** 2

Excess pressure:

P = *mg* / *A* **(1)**

= 0.12 × 9.81 / π ×(9 ×10^{-3})^2 **(1)**

= 4.6 kPa **(1)** 3

Estimates and calculation:

Volume of gas ≈ between 0.1 and 2 litre (0.1 – 2 ×10^{-3} m $^{-3}$) **(1)**

Temperature of gas ≈ 0° – 25°C **(1)**

PV = *nRT* OR *n* = *PV/RT* [Allow e.c.f. from wrong estimates] **(1)**

= 104.6 **(1)**

×10^3 ×V_{gas}/ 8.3 1 ×(T_{gas} + 273) **(1)**

0.008 – 0.14 **(1)**

[Significant figure penalty for > 2 significant figures] Max5

[10]