A-Level Physics: **s25 41**

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(if fully correct, thermal energy for compression = $2U - W$ and thermal energy for cooling = $-U$:
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3(a)(i)	N: number of molecules (of the gas)
	m: mass of one molecule (of the gas)
	$\langle c^2\rangle$: mean square speed (of molecules)
3(a)(ii)	$pV = NkT$
	$NkT = \frac{1}{3}Nm\langle c^2\rangle$ **and** $E_K = \frac{1}{2}m\langle c^2\rangle$ leading to $E_K = (3/2)\,kT$
3(b)	$\frac{1}{2} \times 3.34 \times 10^{-27} \times 9300^2 = (3/2) \times 1.38 \times 10^{-23} \times T$
	$T = 6980$ K
3(c)(i)	$L = F \times 4\pi d^2$
	$L = 2.52 \times 10^{-8} \times 4\pi \times (4.16 \times 10^{16})^2$ $= 5.48 \times 10^{26}$ W
3(c)(ii)	$L = 4\pi\sigma r^2 T^4$ $5.48 \times 10^{26} = 4\pi \times 5.67 \times 10^{-8} \times r^2 \times 6980^4$
	$r = 5.69 \times 10^8$ m
3(d)	(very high pressure so) molecules are (very) close together (*not just 'nearer'*)
	forces between molecules are not negligible **or** volume of molecules not negligible compared with gas volume

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<tr><td>4(a)</td><td>• particles are in (continuous) random motion
• particles have negligible volume (compared with the gas)
• negligible forces between particles (except during collisions)
• (all) collisions (perfectly) elastic
• time of collision negligible (in comparison with time between collisions)
Any two points, 1 mark each</td></tr>
<tr><td rowspan="2">4(b)(i)</td><td>(general starting equation) $pV = nRT$</td></tr>
<tr><td>$T = (2pV / nR)$ where R is the (molar) gas constant</td></tr>
<tr><td rowspan="3">4(b)(ii)</td><td>sketch: straight vertical line XY from (V, $2p$) to (V, p)</td></tr>
<tr><td>straight horizontal line YZ from (V, p) to ($2V$, p)</td></tr>
<tr><td>curve with gradient increasing from Z to X from ($2V$, p) to (V, $2p$)</td></tr>
<tr><td rowspan="5">4(b)(iii)</td><td>XY work done on gas correct (= 0)</td></tr>
<tr><td>ZX increase in internal energy correct (= 0)</td></tr>
<tr><td>YZ work done on gas correct (= $-pV$)</td></tr>
<tr><td>XY increase in internal energy such that the increase in internal energy column adds up to zero</td></tr>
<tr><td>all three thermal energies transferred such that $\Delta U = q + w$ in each row

(completely correct answer:
<table>
<tr><td>change</td><td>ΔU</td><td>Q</td><td>w</td></tr>
<tr><td>X to Y
Y to Z
Z to X</td><td>$-U$
[$+U$]
0</td><td>$-U$
$U + pV$
$-W$</td><td>0
$-pV$
[$+W$]</td></tr>
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