Access Tuition

A-Level Physics

Non-Flow Processes

Mark Scheme

Time available: 48 minutes
Marks available: 36 marks

1. (a)

Process 1	Process 2	
constant pressure	isothermal	
constant volume	adiabatic	
constant pressure	adiabatic	
constant volume	isothermal	✓

*Tick **only** in cell indicated.*

1

(b) Attempt to apply $p_1V_1 = p_2V_2$ or pV = constant ✓
$(1.00 \times 10^{-4} + 2.80 \times 10^{-4} - V)\ 1.01 \times 10^5 =$
$1.83 \times 10^5 \times (2.80 \times 10^{-4} - V)$ ✓
Leading to $V = 1.57 \times 10^{-4}$ m^3 ✓

1st mark for equating pV before to pV after plunger pushed in - in words or symbols or numbers

*2nd mark for correct substitution in **either** p_1V_1 **or** p_2V_2 **or** both*

3rd mark for answer

3

(c) steeper curve ✓
vertical line ✓
(as shown alongside)

Allow vertical line that does not come right down to end of isothermal compression line

2

(d) (In isothermal process) (for internal energy to remain constant) energy transfer must take place ✓
If change is slow there is enough/sufficient time (for energy transfer) ✓

Statements showing the First Law applied to an isothermal compression in symbols are not enough unless symbols are explained.

2

[8]

2. (a) $p_1V_1^{1.4} = p_2V_2^{1.4}$

$p_2 = p_1 (V_1/V_2)^{1.4}$

$= 1.2 \times 10^6 (9.0/6.8)^{1.4}$ ✓ $= 1.8 \times 10^6$ (Pa) ✓

$T_2 \frac{p_2V_2T_1}{p_1V_1} = \frac{1.8\times10^6 \times (6.8\times10^{-5})\times290}{1.2\times10^6\times(9.0\times10^{-5})}$ ✓

$T_2 = 328$ (K) ✓

OR use of $p_1V_1 = nRT_1$ to find n or nR ✓
and substitute in
$p_2V_2 = nRT_2$ to find T_2 ✓

1st mark for substituting correct values into either equation

2nd mark for answer p_2

3rd mark for substituting correct values into

$p_1V_1/T_1 = p_2V_2/T_2$ or $T_2 = \frac{p_2V_2T_1}{P_1V_1}$

4th mark for answer T_2

ECF for p_2

With rounding answers range from 320 to 330 K

4

(b) in adiabatic compression there is no heat transfer/$Q = 0$ ✓

If compression is quick there is no time for heat transfer ✓

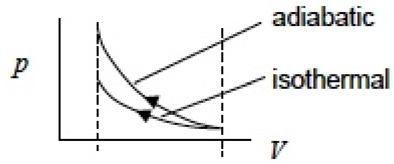
(so can be considered adiabatic)

2

(c) For isothermal compression (for same volume change) (final) pressure not as high **OR** adiabatic compression curve is steeper (on p - V diagram) than isothermal ✓ Area under a p - V curve between same volumes would be less OR addition of all $p\Delta V$ during compression will be less ✓

So less work done ✓

Give credit for these ideas shown with help of a diagram or diagrams.



Award last mark only if either or both of first two marks have been given.

3

[9]

3. (a) $p_1V_1 = 7.8 \times 10^5 \times 1.6 \times 10^{-4} = 125$ (Pa m^3)
$p_2V_2 = 1.9 \times 10^5 \times 6.6 \times 10^{-4} = 125$ (Pa m^3) **(1)**
suitably correct comment **(1)**

2

(b) (i) adiabatic → no heat enters (or leaves) gas,
rapid expansion so no time for heat transfer **(1)**

(ii) ($p_1V_1^g = p_2V_2^g$) gives $V_2 = \left(\frac{p_1V_1^\gamma}{p_2}\right)^{1/g}$

$$= \left(\frac{1.9 \times 10^5 \times (6.6 \times 10^{-4})^{1.4}}{9.8 \times 10^4}\right)^{1/1.4}$$ **(1)** $= 1.1(0) \times 10^{-3}$m^3 **(1)**

3

[5]

4. (a) (use of $pV^\gamma = constant$ gives)
$1.01 \times 10^5 \times (4.25 \times 10^{-4})^{1.4} = 1.70 \times 10^5 \times V^{1.4}$ **(1)**
V calculated correctly ($= 2.93 \times 10^{-4}$)
or substitution to show equal pV^γ **(1)**

2

(b) $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ **(1)**
$T_1 = 273 + 23 = 296$ (K) **(1)**

$T_2 = \frac{1.7 \times 10^5 \times 2.93 \times 10^{-4} \times 296}{1.01 \times 10^5 \times 4.25 \times 10^{-4}} = 343$ K (70 °C) **(1)**

3

(c) slow compression is isothermal (temperature does not increase) **(1)**
greater change in volume needed to rise to same final pressure **(1)**
(or correct pV sketches showing adiabatic and isothermal processes)
hence less **(1)** **(1)**

3

[8]

5. (a) rapid compression of air in cylinder **(1)**
gives little time for heat transfer (to or from air) **(1)**

(2)

(b) (i) $p_1V_1^\gamma = p_2V_2^\gamma$ [or pV^γ = constant] **(1)**

$$V_2 = \left(\frac{1.0 \times 10^5 \times (3.5\times10^{-2})^{1.4}}{1.5 \times 10^6}\right)^{\frac{1}{1.4}}$$ (gives 5.1×10^{-3} m^3) **(1)**

(ii) $\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ (**1**)

630K [or 360°C] **(1)**

(4)

[6]