Practice Question Set For A-Level

Subject : Physics

Paper-3 Topic: Section B (Section 11_ Engineering Physics)

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Name of the Student:____

Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

(a) (i) Appreciates *pV* should be constant for isothermal change (by working or statement) $W = p\Delta V$ is TO

Allow only products seen where are approximately 150 for 1 mark
Penalise J as unit here

M1

Demonstrates *pV* = constant using 2 points (on the line) set equal to each other or conclusion made or **shows** that for V doubling that *p* halves (worth 2 marks)
need to see values for p and V

Products should equal 150 to 2 sf
Accept statement that products are slightly different so not quite isothermal

A1

Demonstrates *pV* = constant using 3 points (on the line) with conclusion
Need to see values for p and V

Products should equal 150 to 2 sf
Accept statement that products are slightly different so not quite isothermal

A1
3

(ii) Adiabatic therefore no heat transfer **or**
Adiabatic therefore *Q* = 0

B1

Work is done by gas therefore *W* is negative **or**
Work is done by gas therefore energy is removed from the system

B1

ΔU is negative therefore internal energy of gas decreases **or** energy is removed from the system therefore internal energy of gas decreases or work done by the gas so internal energy decreases

Allow
$-\Delta U = -W$ *or* $\Delta U = -W$

B1
3

(iii) Uses pV/T = *constant or uses* $pV=nRT$ *or uses* $pV=NkT$
e.g. makes T subject or substitutes into an equation with p_A and V_A or p_C and V_C (condone use of n = 1) or their $\frac{(pV)_A}{(pV)_C}$

V_a read off range
= 2.5 to 2.6 (× 10^{-4})
p_A = 600 × 10^3
V_C read off range
= 8.5 to 8.6 (× 10^{-4})
p_C = 140 × 10^3

C1

Correct substitution of coordinates (inside range) into $\frac{(pV)_A}{(pV)_C}$
With consistent use of powers of 10

$(pV)_A$ range is 150 to 156 and $(pV)_C$ range is 119 to 120.4

C1

1.2(5) Allow range from 1.2 to 1.3

Accept decimal fraction : 1

A1
3

(b) Energy per large square = 10(J) **or** states that work done is equal to area under curve (between A and B)
or energy per small square = 0.4(J)
or square counting seen on correct area

Must be clear that area represents energy either by subject of formula or use of units on 10 or 0.4

Alternative:
W = area of a trapezium
(with working)
or *W =* $P_{mean} \times \Delta V$ ***or***
W = 450 × 10^3 × 2.5 × 10^{-4}
or *W = area of a rectangle + area of a triangle (with working)*

B1

Number of large squares = 10.5 to 11.5 seen and (W) = *number of squares × area of one square (using numbers)*
Range = 105 to 115 (J)
Or

Number of small squares = 263 to 287 seen <u>and</u> (W) = *number of squares × area of one square (using numbers)*
Range = 105 to 115 (J)

States that actual work done would be lower because of curvature of line

B1
2

(c) (Total energy removed per s =) 4560 (J)
or number of cycles per s = 40
or (Mass per second =) 114 ÷ 68400 in rearranged form
or their energy ÷ (c ΔT) **or** their energy ÷ 68400

C1

0.067 (kg) seen Allow 0.066 (kg) here
or allow V / t = 1.67 × 10^{-3} ÷ 1100
or ($\frac{V}{t}$) = $\frac{E}{\rho c \Delta\theta}$ and correct **substitution** seen

Condone E = 114 (J) **or** temperature = 291(K)

C1

= 0.061 × 10^{-3} or 6.06 × 10^{-5} (m^3)

A1
3

[14]

Q2.

(a) (i) Clear statement that for isothermal pV =constant or $p_1V_1 = p_2V_2$ ✓
Applies this to any 2 points on the curve AB ✓
e.g. 1.0 × 10^5 ×1.2 × 10^{-3} = 4.8 × 10^5 × 0.25 × 10^{-3}
120 = 120

Allow pV = c applied to intermediate points ***estimated*** *from graph e.g. V = 0.39 ×* 10^{-3}*, p = 3 ×* 10^5

2

(ii) $W = p\,\Delta v$
= 4.8 × 10^5 × (0.39 − 0.25) × 10^{-3}
= 67 J ✓

1

(b)

	Q / J	W / J	ΔU / J	
process A → B	−188	−188	0	✓
process B → C	+235	(+)67	(+)168	✓
process C → A	0	+168	−168	✓

whole cycle	+47	+47	0	✓

Any horiz line correct up to max 3
Give CE in B → C if ans to ii used for W
<u>If no sign take as +ve</u>

max 3

(c) $\eta_{overall}$ = 47 / 235 = 0.20 or 20% ✓

1

(d) Isothermal process would require engine to run very slowly / be made of material of high heat conductivity ✓
Adiabatic process has to occur very rapidly / require perfectly insulating container / has no heat transfer ✓
Very difficult to meet both requirements in the same device ✓
Very difficult to arrange for heating to stop exactly in the right place (C) so that at end of expansion the curve meets the isothermal at A ✓

Do not credit bald statement to effect
adiabatic / isothermal process not possible - must give reason
Ignore mention of valves opening / closing, rounded corners, friction, induction / exhaust strokes

wtte

max 2

[9]