Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) ($Q = \Delta U + W$) For adiabatic $Q = 0$ ✓ **1**

W = -ΔU W is +ve, so internal- energy / temperature must fall✓
OR negative sign shows internal energy decrease ✓ **1**

Temperature related to internal energy, so T falls✓ **1**

(b) **The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer. Guidance provided in section 3.10 of the '*Mark Scheme Instructions*' document should be used to assist in marking this question.**

Mark	Criteria	QoWC
6	All three aspects covered: An appreciation that because the input valve is open for longer, that the air consumption approximately doubled with reference to the relevant sections of fig 2 and fig 3. An understanding that the output power is given by the area within the diagram, with an approximate increase of 25% from fig 2 to fig 3. Furthermore, a discussion of an understanding of the link between power and torque including the assumption that the angular frequency does not change.	The student presents relevant information coherently, employing structure, style and sp&g to render meaning clear. The text is legible.
5	Two of the three aspects fully covered, with some	

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	detail missing from the third.	
4	One aspect fully covered, with some detail missing from the other two. Or Two aspects fully covered, with little or no relevant information about the third.	The student presents relevant information and in a way which assists the communication of meaning. The text is legible. Sp&g are sufficiently accurate not to obscure meaning.
3	All three aspects partially covered, with some detail missing from each Or One aspect fully covered, with little or no relevant information about the other two.	
2	Two aspects partially covered, with little or no relevant information about the third.	The student presents some relevant information in a simple form. The text is usually legible. Sp&g allow meaning to be derived although errors are sometimes obstructive.
1	One aspect partially covered, with little or no relevant information about the other two.	
0	Little or no relevant information about any of the three aspects.	The student's presentation, spelling punctuation and grammar seriously obstruct understanding.

The following statements are likely to be present:

Rate of consumption of air

- On fig 2 air enters from A to C, but on figure 3 from A to X
- Air consumption (hence input power) is increased because input valve open for longer
- Air consumption roughly doubled

Output torque and power

- Output power is increased because area of diagram is greater
- Output power increased but not as much as doubled
- Output power roughly increased by 25%
- Average pressure greater, so torque greater
- ω same as before so from $P = T\omega$, output power greater, comparison only valid if speed same as before

Overall efficiency

- efficiency is output power / input power

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- Input power roughly doubled but output power increased only by about 25%
- Hence efficiency decreased

6

(c) Work done (per cycle) = area of indicator diagram ✓

1 small sq = 0.1 J

1

Appropriate method for finding area eg counting squares ✓

641 small squares

1

Correct scaling factor leading to area = 64 J ± 5 J ✓

1 large sq = 2.5 J

1

P = 64 × 20 = 1280 W ✓

27 large squares

Other methods accepted eg strips

1

(d) Indicated power (is developed by air in cylinder and) does not take into account frictional losses at bearings / between cylinder and piston / in opening valves ✓

WTTE

Answer must give some indication of where friction acts.

Friction power alone is not enough.

1

[14]

Q2.

(a) η = (1450-310) / 1450 = 0.79 / 79% ✓

1

(b) Claim 1: input power = $55.5 \times 10^{6} \times 5.00 \times 10^{-3}$ = 278 kW ✓
actual claimed efficiency = 210 / 278 = 0.76 / 76% ✓

1

claim not justified because actual efficiency too close to max theoretical. ✓

1

OR claim would be justified if engine ran at max efficiency (giving 218 KW electrical power) ✓

1

Claim 2: 278 kW – 210 kW = 68 kW ✓
Judgement: claim justified because 55 kW < 68 kW ✓ (and allows for some unwanted energy loss to surroundings)

1

OR for claim 2:
any efficiency lower than 79% will give more than 68 kW of heating (WTTE) so claim justified ✓

1

[6]

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