Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) $Q_C = Q_H - W = 65 - 28 = 37\ W$ ✔$_1$

COPref = 37/28 = 1.32 ✔$_2$

COPref for ideal refrigerator = 278/(308 – 278) = 9.3 ✔$_3$

If temperatures not changed to K, do not award marks ✔$_3$ and ✔$_4$
Condone consistent use of Celsius in the denominator.

Actual COP is very low compared to ideal so claim is valid ✔$_4$

No ECF for ✔$_4$ from incorrect values of COP, unless from arithmetic error.

4

(b)
- One factor from ✔$_1$
- Thermoelectric cooler is small/convenient/of simple construction/(highly) portable
- can run off batteries/solar panel
- has no moving parts
- requires low maintenance
- no risk of leaking fluids
- temperature is about 5 °C, not cooler
- low energy/power consumption (28W)

✔$_1$ for advantage from bullet point list

For ✔$_1$ accept application, eg use in hot countries, by campers, climbers, walkers etc.

For ✔$_2$

- convenience outweighs poor COP
- any COP >1 means cooling power > power supplied
- waste of electrical energy from having low COP is acceptable

✔$_2$ mark for relating answer to COP

2

[6]

Q2.

(a) (A change in which there is) no energy/heat transfer to or from the gas/system ✔

WTTE
Condone: no heat enters or leaves the system.

1

(b) $p_1 V_1^{\gamma} = p_2 V_2^{\gamma}$

$1.0 \times 10^5 \times V_1^{1.4} = 67 \times 10^5 \times V_2^{1.4}$ ✔

$\frac{V_1}{V_2}$ = 20(.2) ✔

First mark for correct substitution of data into $p_1 V_1^{\gamma} = p_2 V_2^{\gamma}$ *or* $\frac{V_1}{V_2} = \left(\frac{p_2}{p_1}\right)^{1/1.4}$

Condone POT error in MP1

Accept answer as ratio (20:1)

(calculator value = 20.15297)

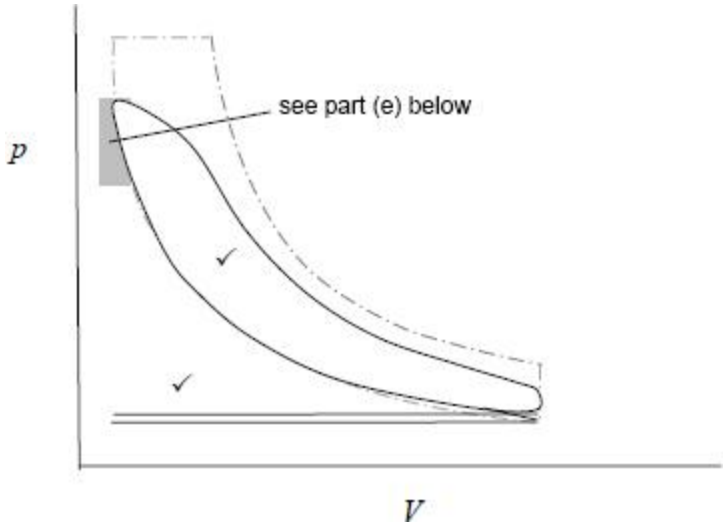
2

(c) Diesel requires a high compression ratio to give a temperature high enough to ignite fuel / for fuel to self-ignite ✔

Petrol vapour–air mixture is ignited by spark at lower pressures/temperatures ✔

2

(d)



Look for:

- *complete loop contained within/smaller than ideal loop with no sharp corners. Compression stroke may be below ideal cycle line.* ✔
- *Two close parallel lines or one single line or one narrow loop parallel to V axis at or near atmospheric pressure* ✔

2 marks for both above points provided left-hand and right-hand edges of loop and induction/exhaust loop/lines are fairly close to correct V_1 *and* V_2.

2

(e) **X** placed on/near curve anywhere in shaded area shown above

Near (but not at) top end of compression stroke on indicator diagram

Do not allow X on ideal cycle

1

(f) Any 2 from: ✔✔

- *Curved corners*: because valves take finite time to open and close

- *No constant volume process*: because engine would have to stop/piston constantly moving
- *Compression and expansion not adiabatic curves*: because energy is lost by heat transfer
- *Pumping loop/the cycle is open* because engine needs to draw in air and expel exhaust
- *Heating not at constant pressure*: because fuel injection and combustion cannot be exactly controlled
- *area of diagram is less* because energy is lost by heat transfer/incomplete combustion/CV of fuel not fully released
- *pressure not as high* because incomplete combustion/CV of fuel not fully released

The explanation of the difference must match the stated difference.

Do not accept answers which refer to smaller area as a result of friction in engine.

2

[10]

Q3.

(a) Equates initial E_p to linear E_k and rotational E_k ✔

Substitutes values and uses $V = r\omega$ ✔

Calculates V to give 0.51 m s^{-1} ✔

$9.2 \times 10^{-2} \times 9.81 \times 0.5 = (\frac{1}{2} \times 9.2 \times 10^{-2} V^2) + (\frac{1}{2} \times 8.6 \times 10^{-5} \times \frac{V^2}{0.005^2})$

$V = 0.51$ m s^{-1}

Some substitution of data must be seen for MP2

Do not allow MP3 for no consideration of linear E_k

Give 1 mark if $mgh = \frac{1}{2}I\omega^2$ used with answer 0.51 m s^{-1}

3

(b) Calculates α from $\alpha = T/I$ ✔

Attempts to use any appropriate equation(s) of motion (for angular motion) ✔

Substitutes into equation(s) of motion and calculates θ ✔

$\alpha = (8.3 \times 10^{-4}) / 8.6 \times 10^{-5} = 9.65$ rad s^{-2}

or 9.7 rad s^{-2}

$\theta = 145 \times 10 - \frac{1}{2} \times 9.7 \times 10^2 = 967$ rad or 970 rad

MP2: $\omega_2^2 = \omega_1^2 + 2\alpha\theta$ is not enough on its own as there are two unknowns.

MP2: Quoting appropriate formula(e) is not enough. There must be some attempt at substituting the data.

3

[6]