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 : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) $p_A V_A = p_B V_B$

$V_B = \dfrac{1.0 \times 10^5 \times 9.0 \times 10^{-2}}{2.2 \times 10^5}$ ✔ (= 4.1×10^{-2} m^3)

The mark is for attempt to use Boyle's Law with correct numbers substituted.

1

(b) Use of $\dfrac{V_B}{T_B} = \dfrac{V_C}{T_C}$ ✔

OR

Use of $\dfrac{p_A V_A}{T_A} = \dfrac{p_C V_C}{T_C}$ ✔

Leading to T_C = 425 K ✔

Allow ECF from (a)

Accept any correct application of pV/T = constant

426 K if 4.09×10^{-2} m^3 used for V_B

At least 3 sig fig answer must be seen

2

(c)

Process	**Work W/J**	**Heat transfer Q/J**
A → B	−7100	−7100
B → C	4000	*14000* ✔
C → D	10 300	10 300
D → A	*−4000* ✔	−14 000

1st mark for either italicised answer correct including sign

2nd mark for both italicised answers correct including sign

Calculations might show

*W for **D** → **A** = $p\Delta V = 1.0 \times 10^5 \times (13.0 - 9.0) \times 10^{-2}$ J = 4000 J*

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(d) 1st Law applies/must be obeyed

OR $Q = \Delta U + W$ ✔

(for isothermal process) ΔU = 0 so $Q = W$ ✔

1st mark for any reference to First Law in words or equation.

2nd mark for stating ΔU = 0 (in isothermal process) and showing Q = W

2

(e) Claim is correct as

Net work = 3200 J ✔$_1$

η = 3200 / 10300 = 0.31 or 31% ✔$_2$

ηmax = $\frac{425 - 295}{425}$ = 0.31 or 31% ✔$_3$

OR

ηmax = $\frac{420 - 295}{420}$ = 0.30 or 30%

Alternative for 1st mark:

Net work = area of loop in Fig 3 = 6.5 squares × 500 J = 3250 J allow ± 250 J

If student tots up their W column in the table correctly for their values, award the 1st mark point ✔$_1$ (or if they use the area of the cycle correctly calculated)

Also award ✔$_1$ for 3200 J even if it does not agree with their table.

If they have been awarded ✔$_1$ for net work, and divide this value by 10300, give the 2nd mark point ✔$_2$

If they calculate the max theoretical efficiency correctly give ✔$_3$

Then if they have ✔$_1$, ✔$_2$ and ✔$_3$:

If there is no concluding statement award 2 marks

If the concluding statement is incorrect for their efficiencies award 2 marks

If their concluding statement is correct for their efficiencies award 3 marks

If they only get the max theoretical efficiency, award 1 mark.

If 420 K has been used allow argument that efficiencies are not (quite) the same

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(f) Isothermal processes are impossible/difficult to achieve ✔

Because engine would have to run (very) slowly

Or perfect conducting material used ✔

OR

Economiser will not store/transfer energy effectively ✔

because it will lose heat to surroundings ✔

Or unless it has large/have large surface area

Or because it will not be perfectly insulated

Accept other sensible suggestions and corresponding reasons

Answer should relate to the real engine based on 'this cycle'. Do not allow problems common to all heat engines e.g. ignore 'friction' and simple statements relating to 'heat loss to surroundings'.

Give 1 mark if student spots that

Work/power output is very small for size of engine

1 mark if they back this up.

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Q2.

(a) Weight/gravitational force AND electric/electrostatic force ✔

Equal (magnitudes) and opposite directions,

AND one direction at least specified ✔

The second mark is conditional on the first.

First mark is for naming the two forces.

Condone 'electromagnetic' for 'electric'

Do not allow field or potential for force.

Allow "force due to electric field"; "force due to magnetic field"

Penalise additional forces in MP2.

The second mark is for the relationship between them. Must include idea of size and direction.

e.g. weight down equals E force up/towards positive plate/away from negative plate.

Do not allow 'balanced' or 'in equilibrium' for equals

The forces can be in the form of formulae for MP1 and MP2 (e.g. Eq, EV/d, mg)

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(b) $m = 4\pi r^3\rho/3$ and $mg = 6\pi\eta rv$ seen ✔

$r^2 = 18\ \eta v / 4\ \rho g$ is seen in in some form, in symbols or through substituted data, ✔

Correct use of equations to obtain $r = 9.7 \times 10^{-7}$ m ✔

Do not allow backward calculation

Can be seen by substitution.

Can be seen in single equation:

$4\pi r^3\rho g/3 = 6\pi\eta rv$

Do not award if v and V confused

Do not condone 1sf answer.

Must be clear answer refers to r, not r^2 for example.

If no other mark given MP1 can be awarded if F used for mg,

and/or volume AND density equations seen separately

3

(c) The number of excess electrons on the droplet is 3 ✔

In order for each half to remain stationary, the charge would have to split equally

OR

Due to the quantisation of charge, the charge cannot split equally ✔

It is not possible for both droplets to remain stationary / the student is wrong ✔

May be seen in terms of values of charge or e

Award for idea that charge would have to be 1.5e

Evidence for MP1 and MP2 may be seen together. E.g. charge on drops are e and 2e, OR 1.6 × 10^{-19} and 3.2 × 10^{-19}

Ignore reference to particles repelling each other

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