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 : 18 Marks **Time : 18 Minutes**

Mark Schemes

Q1.

(a) torque $_1$✔ = <u>moment of</u> inertia $_2$✔ × <u>angular</u> acceleration $_3$ ✔

1✔ 2✔ 3✔ 2 marks

any two of $_1$✔ $_2$✔ $_3$✔ 1 mark

Do not accept 'inertia' for 'moment of inertia' or 'acceleration' or 'rotational acceleration' for 'angular acceleration'

If = or equals, or × or multiplied by, is missing or in wrong place: 0 marks

Condone 'proportional to' for '='.

2

(b) Refers to $I = \sum mr^2$ in symbols or in words ✔

(Plate) **A** because more of the mass is distributed at a greater distance from the axis of rotation (than for plate **B**)✔

Look for I depending on radius/distance of (constituent) masses squared.

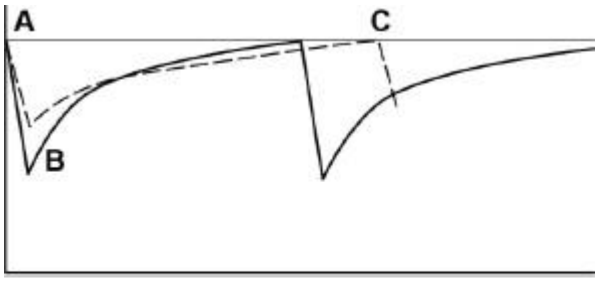
Do not accept '$I=mr^2$ ' alone

***A** alone is not enough. There must be a statement about the mass distribution or spread.*

2

(c) decrease in speed from ω_A not as much / ω_B greater ✔

curved line (from new **B**) with smaller initial gradient up to ω_A ✔



*Slope of new **AB** can be ignored unless it is shown with a much smaller gradient.*

Position of new C can vary, but shape of cycle must be similar to original.

*Do not mark beyond candidate's first **C***

2

(d) Either:

For same energy, in $E\ \frac{1}{2}\ I\ (\omega_A^2\ \omega_B^2)$, (new) ω_B will be greater for greater I and same E ✔

Accept same idea expressed in other ways, eg initial (rotational kinetic) energy greater, so less fall in speed for same energy loss (during punching).

OR

For same motor torque, greater I means smaller angular acceleration, so smaller initial slope for **BC** ✔

*If **B** to **C** curve starts at same ω_B as Figure 2 with smaller initial gradient, and their **B** to **C** takes longer time to ω_A allow:*

*For same motor torque, greater I means lower angular acceleration, so longer time for **B** to **C***

1

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Q2.

(a) $T = F \times r$ applies with some explanation of r in this context. ✔

force on pedal will vary/down force greater than up force/operator cannot keep force constant

OR

Component of force varies with position/rotation of crank

OR

Distance/radius of line of action of F from axle varies (as crank moves) ✔

Simply quoting $T = F \times r$ is not enough for MP1

2nd mark: accept: use of the term 'dead centre'
'Radius varies' is not enough

Accept idea that moment of force/torque varies with position of crank

2

(b) Relates angular impulse to change in angular momentum and to torque × time ✔

Accept answer using formulae:
Application of $T\Delta t = \Delta(I\omega)$ with understanding of symbols shown
Accept $Tt = \Delta I\omega$
Angular impulse does not have to be seen if $Tt = \Delta I\omega$ is correctly applied

If angular momentum/angular velocity reduced to zero in short time, high torque results (which will strain mechanism) ✔

$\Delta I\omega$ is fixed, t small, so T high (enough to strain mechanism)

2

(c) $\alpha = 13.8 \div 15.0 = 0.92$ (rad s^{-2}) ✔

Calculates I using $T = I\alpha$ giving 0.84 (kg m^2) ✔

OR

$\theta = 1\ (w_1 + w_2)t = 1 \times 13.8 \times 15 = 103.5$ (rad)

Calculates I using $\frac{1}{2}I\omega^2 = T\theta$ giving 0.84 (kg m^2)

$I = \frac{0.77}{0.92} = 0.84$ kg m^2

ECF for incorrect α

$I = \frac{0.77 \times 103.5}{95.2} = 0.84$ kg m^2

ECF from incorrect θ (e.g. use of max speed instead of average speed)

2

(d) Equates 3.1 N m to 'sharpening' torque + frictional torque ✔

calculates sharpening torque and equates to $F \times r$ to give $F = 9.7$ N ✔

'sharpening' torque = 2.33 N m

Condone ECF for MP2 (but do not give MP1) if total torque is added to frictional torque, but neither MP1 nor MP2 given for ignoring friction torque or using only frictional torque. Expect to see $F \times 0.24 = 3.87$ giving $F = 16.1$ N m.

No marks for $F \times 0.24 = 0.77$ giving $F = 3.2$ N m

No marks for $F \times 0.24 = 3.1$ giving $F = 12.9$ N m

2

(e) calculates any power by multiplying any **corresponding** $T \times \omega$ from any graph ✔

does this at $\frac{1}{2}\omega_0$ for 2 or 3 of the motors ✔

shows **F** is only motor to satisfy $\frac{2}{3}P_{max}$ criteria ✔

OR

calculates any power by multiplying any **corresponding** $T \times \omega$ from any graph ✔

calculates max power output of required motor as $1.5 \times 52 = 78$ W ✔

Shows only motor **F** satisfies this at $\frac{1}{2}\omega_0$ ✔

*For **E**: $P_{max} = 120 \times 0.43 = 52$ W*

$\frac{2}{3} \times 52 = 35$ W

*For **F**: $P_{max} = 150 \times 0.52 = 78$ W*

$\frac{2}{3} \times 78 = 52$ W

*For **G**: $P_{max} = 90 \times 0.64 = 58$ W*

$\frac{2}{3} \times 58 = 39$ W

3

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