**ENGINEERING PHYSICS**

**1-2 Moment of inertia**

1. $I = 0.68\ kgm^2$, $\omega_1 = 0\ rads^{-1}$, $\omega_2 = 3.7\ rads^{-1}$, $t = 9.2\ s$

$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{3.7 - 0}{9.2} = 0.402\ rads^{-2}$

$T = \alpha I = 0.402 \times 0.68 = 0.273\ldots.\ Nm$

$= 0.27\ Nm$ to 2 sf

2. $m = 7.4\ kg$, $r = 0.090\ m$, $F = 7.0\ N$ tangentially

(a) (i) moment of inertia of the disc, $I = \frac{1}{2} MR^2 = \frac{1}{2} \times 7.4\ 0.090^2$

$= 0.02997$

$= 0.030\ kgm^2$

(ii) $T = Fd = 7.0 \times 0.090 = 0.63\ Nm$

(b) $t = 15.0\ s$, $\omega_1 = 0\ rads^{-1}$, $\omega_2 = ?\ rads^{-1}$, $I = 0.030\ kgm^2$, $T = 0.63\ Nm$, $F = 7.0\ N$

(i) $T = I\alpha$ therefore $\alpha = \frac{T}{I} = \frac{0.63}{0.030} = 21\ rads^{-2}$

(ii) $\theta = \omega_0 t + \frac{1}{2} \alpha t^2 = (0 \times 15) + \frac{1}{2} \times 21 \times 15^2 = 2362.5\ rad$ (2400 rad to 2 sf)

No of turns $= \frac{\theta}{2\pi} = \frac{2362.5}{2\pi} = 376$

3. As the moment of inertia is greater the further the mass is distributed from the axis of rotation, Y has the greater moment of inertia.

| 4. acceleration | deceleration |
|---|---|
| $t = 18\ s$ | $t = 92\ s$ |
| $\omega_0 = 0\ rads^{-1}$ | $\omega_0 = ?\ rads^{-1}$ |
| no of turns = 36 | no of turns = 87 |
| $\omega = ?\ rads^{-1}$ | $\omega = 0\ rads^{-1}$ |

(a) (i) No of turns $= \frac{\theta}{2\pi}$ therefore $\theta = 2\pi \times$ no of turns $= 2\pi \times 36$

$= 72\pi$

$= 226\ rad$

$\theta = \omega_0 t + \frac{1}{2} \alpha t^2$ but $\omega_0 = 0\ rads^{-1}$ so $\theta = \frac{1}{2} \alpha t^2$

Hence $\alpha = \frac{2\theta}{t^2} = \frac{2 \times 226}{18^2} = 1.396\ldots.. = 1.40\ rads^{-2}$

(ii) $\theta = 2\pi \times$ no of turns $= 2\pi \times 87$

$= 174\pi$

$= 547\ rad$

$\alpha = \frac{2\theta}{t^2} = \frac{2 \times 547}{92^2} = 0.129\ldots.. = 0.13\ rads^{-2}$

(b) T = 26 Nm to accelerate

(i) $T_1 = I\alpha_1$ and $T_2 = I\alpha_2$ therefore $\frac{T_1}{\alpha_1} = \frac{T_2}{\alpha_2}$ and so $\frac{T_1}{T_2} = \frac{\alpha_1}{\alpha_2}$

Let the frictional force be x - this acts on it throughout its motion

$\frac{26-x}{x} = \frac{1.40}{0.13}$ therefore $0.13(26 - x) = 1.40x$

$(0.13 \times 26) - 0.13x = 1.40x$

$3.38 - 0.13x = 1.40x$

$(1.40 + 0.13)x = 3.38$

$x = \frac{3.38}{1.53}$

$= 2.2$ Nm

(ii) $I = \frac{T}{\alpha} = \frac{26-2.2}{1.40} = 17$ kgm$^2$

OR

$I = \frac{T}{\alpha} = \frac{2.2}{0.13} = 17$ kgm$^2$