

Clutch

①

$$T = \frac{\mu W (r_2 + r_1) \times 2n}{2}$$

Used (constant wear)

$$T = \frac{2 \mu W (r_2^3 - r_1^3) \times 2n}{3 (r_2^2 - r_1^2)}$$

New (constant pressure)

i) $T = ?$

$P = ?$

$N = 1800$

$d_2 = 120 \text{ mm} = 0.12 \text{ m} = r_2 = 0.06 \text{ m}$

$d_1 = 40 \text{ mm} = 0.04 \text{ m} = r_1 = 0.02 \text{ m}$

$\mu = 0.45$

$W = 900 \text{ N}$

Q1	10
Q2	10
Q3	8
Q4	7
Q5	9
	44
	50

88%

$$T = \frac{2 \mu W (r_2^3 - r_1^3)}{3 (r_2^2 - r_1^2)} = \frac{2 \times 0.45 \times 900 (0.06^3 - 0.02^3)}{3 \times (0.06^2 - 0.02^2)}$$

$= 17.55 \text{ Nm}$

$$\text{Power} = \frac{2 \pi N T}{60} = \frac{2 \pi 1800 \times 17.55}{60} = 3308.1 \text{ W}$$

ii) $W' = 900 - (DC \times K \times n)$

$DC = 1.55 \text{ mm}$

$K = 25 \text{ N/mm}$

$n = 6$

$W' = 900 - (1.55 \times 25 \times 6) = 667.5 \text{ N}$

$$T = \frac{\mu W (r_2 + r_1)}{2} \checkmark = \frac{0.45 \times 667.5 (0.06 + 0.02)}{2}$$

$$= \cancel{6.0075 \text{ Nm}} \quad 12.015 \text{ Nm} \checkmark$$

$$P = \frac{2\pi NT}{60} = \frac{2\pi 1800 \times \overset{12.015}{\cancel{6.0075}}}{60} = \cancel{1132.39 \text{ W}}$$

$$= 2264.77 \text{ W} \checkmark$$

Very good!

10/10

2)

③

$$P = 5000 \text{ W}$$

$$N = 2500 \text{ RPM} = \frac{2\pi N}{60} = 261.8 \text{ rad/s}$$

 θ

$$d = 130 \text{ mm} = 0.13 \text{ m} \pm 0.065 \text{ m}$$

$$\phi = 128^\circ = \frac{2\pi}{360} = 2.23 \text{ rads}$$

$$f_i = 750$$

$$\mu = 0.4$$

$$a) \quad V = \omega r = 261.8 \times 0.065 = 17.017 \text{ m/s}$$

$$b) \quad f_1 + f_2 = \text{Constant} \quad f_1/f_2 = e^{\mu\phi}$$

$$250 + 250 = \text{constant} = 500 \quad (1) \quad \checkmark$$

$$f_1/f_2 = e^{0.4 \times 2.23} = 2.44 \quad (2)$$

$$f_1 = 2.44 f_2 \quad \checkmark$$

$$f_1 + f_2 = \frac{500}{\cancel{360}} \quad \therefore 2.44 f_2 + f_2 = \frac{500}{\cancel{360}} \quad \therefore 3.44 f_2 = \frac{500}{\cancel{360}}$$

$$f_2 = \frac{500}{3.44} = \cancel{204.92 \text{ N}} \quad \underline{145.35 \text{ N}} \quad \checkmark$$

$$f_1 = 2.44 f_2 = 2.44 \times \frac{204.92}{145.35} = \underline{354.65 \text{ N}} \quad \checkmark$$

$$c) \quad \text{Power} = V(f_1 - f_2) = 17.017 \times (354.65 - 145.35) \quad \checkmark$$

$$= \cancel{3561.69} \quad \underline{3561.69 \text{ W}} \quad \checkmark$$

$$d) \quad n = \frac{\text{Total Power}}{\text{Power per belt}} = \frac{5000}{3561.69} = 1.4 \checkmark$$

(4)

$\therefore$ 2 belts $\checkmark$

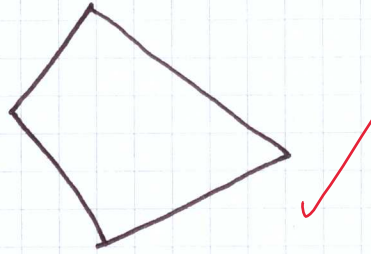
Excellent!

10/10

3)

Q

m	r	mr
A 0.8780		69.6
B 0.5120		66
C 0.895		55.1
D	40	40md

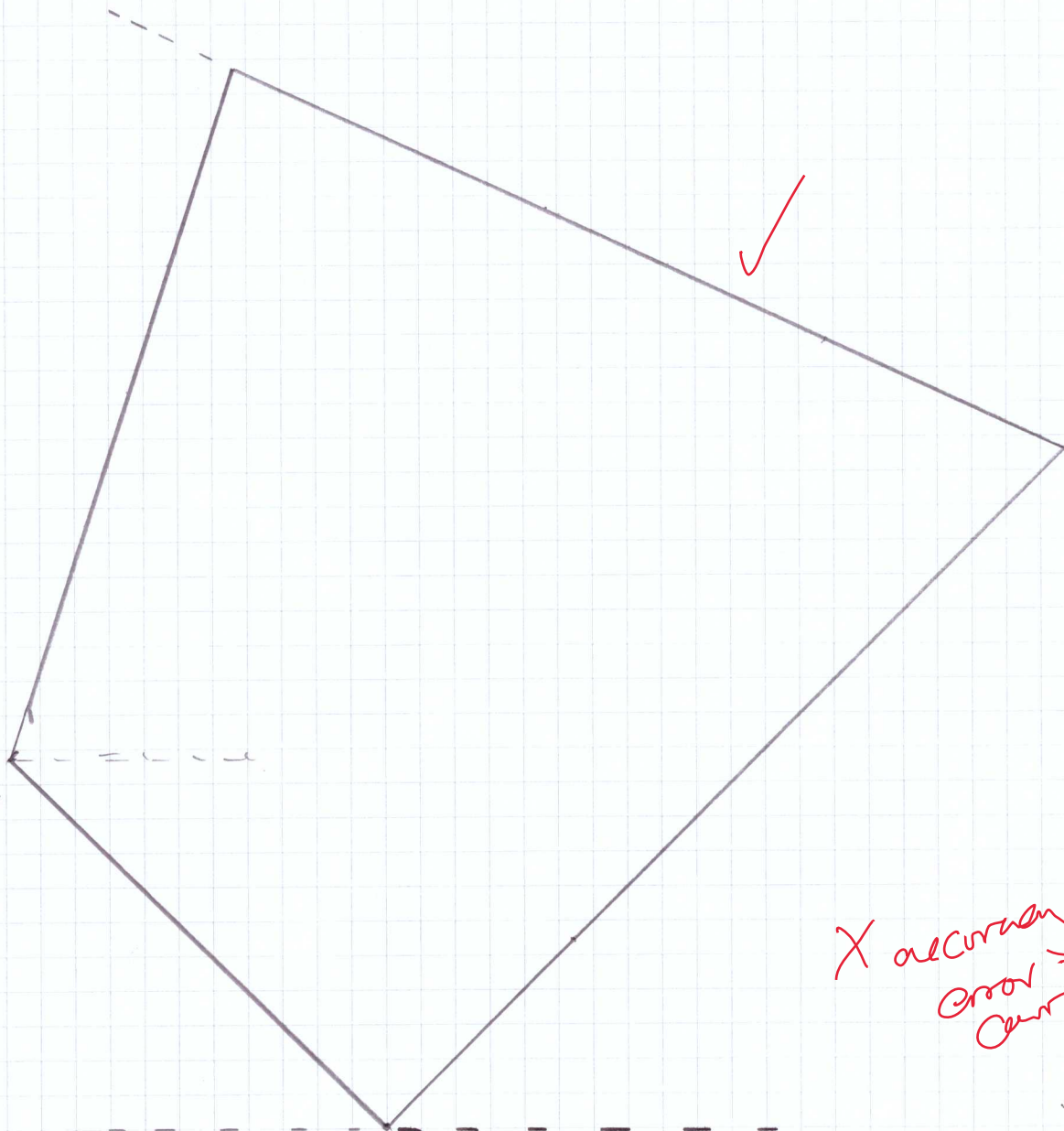


Scale = 2mm = 1kgmm *good!*

$$69.6 = 139.2$$

$$66 = 132$$

$$55.1 = 110.2$$



*X accuracy
error
carried*

(6)

$$D = \cancel{76\text{mm}} \times 0.5 = \cancel{38\text{mm}}$$

$$\cancel{40\text{md}} = \cancel{38} \therefore \cancel{\text{md}}$$

$$c) 40\text{md} = \frac{76}{2} = 38\text{kgmm} \checkmark$$

$$\text{md} = \frac{38}{40} = \underline{0.95\text{Kg}} \checkmark$$

$$d) = 46^\circ \text{ from horizontal}$$

$$\therefore 360 - \cancel{46}^\circ 46 = \underline{314^\circ} \quad \begin{array}{l} \checkmark \text{ error} \\ \text{corrected} \\ \times \text{ accuracy} \end{array}$$

8/10

4) $N_2 = 2500$ RPM
 $N_1 = 2400$ RPM

⑦

$$\omega_2 = \frac{2\pi N}{60} = \frac{2\pi 2500}{60} = 261.8 \text{ rad/s}$$

$$\omega_1 = \frac{2\pi N}{60} = \frac{2\pi 2400}{60} = 251.33 \text{ rad/s}$$

a) $\omega_m = \frac{\omega_1 + \omega_2}{2} = \frac{261.8 + 251.33}{2} = 256.565$

$$\phi = \frac{\omega_2 - \omega_1}{\omega_m} = \frac{261.8 - 251.33}{256.565} = 0.041 \text{ } 0.0408$$

b) Energy

A	EA	EA
B	EA + 526	EA + 526
C	EA + 526 - 205	EA + 321
D	EA + 526 - 205 + 45	EA + 366
E	EA + 526 - 205 + 45 - 185	EA + 181
F	EA + 526 - 205 + 45 - 185 + 48	EA + 229
G	EA + 526 - 205 + 45 - 185 + 48 - 197	EA + 32
H	EA + 526 - 205 + 45 - 185 + 48 - 197 + 10	EA + 42
I	EA + 526 - 205 + 45 - 185 + 48 - 197 + 10 - 42	EA

$$\beta W = \max e - \min e = (EA + 526) - (EA + 32) = 494 \text{ J}$$

X error comes

$$c) I = \frac{B W}{\omega m^2 \phi} = \frac{494}{256.565^2 \times 0.0408} = 0.184 \text{ Kg m}^2$$

$$d) I = \frac{M r^2}{2} \therefore \frac{2I}{r^2} = m = \frac{2(0.184)}{0.15^2} = 16.35 \text{ Kg}$$

~~Thickness = \frac{Mass}{Density} = \frac{16.35}{7850}~~

$$\text{Thickness} = \frac{\text{Volume}}{\text{Area}}$$

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} \therefore \text{Volume} = \frac{\text{mass}}{\text{Density}}$$

$$\text{Volume} = \frac{16.35}{7850} = 0.002 \text{ m}$$

$$\pi r^2 = \pi 0.15^2 = 0.071 \text{ m}$$

$$\text{Thickness} = \frac{0.002}{0.071} = 0.028 \text{ m}$$

good!

7/10

5) $t_a = 32$

$t_b = 64$

$t_c = 24$

$t_d = 36$

$N_1 = 2500$ (anti)

$T_1 = 20 \text{ Nm}$

$\eta = 0.85$

9

- a) Gears a and b must have the same pitch
Gears c and d must have the same pitch ✓

b) Anti clockwise

$GR = \frac{t_2}{t_1} = \frac{\text{Driven gear}}{\text{Driving gear}}$

$GR = \frac{t_b}{t_a} \times \frac{t_d}{t_c} = \frac{64}{32} \times \frac{36}{24} = 3$ ✓

$GR = \frac{N_1}{N_2} \therefore N_2 = \frac{N_1}{GR} = \frac{2500}{3} = 833.3 \text{ RPM}$ ✓

c) $P_1 = \frac{2\pi NT}{60} = \frac{2\pi \cdot 2500 \cdot 20}{60} = 5235.99 \text{ W}$ ✓

$P_2 = P_1 \times \eta = 5235.99 \times 0.85 = 4450.59 \text{ W}$ ✓

d) $T_2 = \frac{60 P_2}{2\pi N_2} = \frac{60 \times 4450.59}{2\pi \cdot 833.3} = 51 \text{ Nm}$ ✓

$T_1 + T_2 + T_3 = 0 \therefore T_3 = -T_1 - T_2$ ✓

$(-20) - (-51) = +31 \text{ Nm (clockwise)}$ ✓

9/10