AIR WARFARE DESTROYER ALLIANCE

PHYSICS PRACTICAL

Rotational Speed and Strobe Light

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Student's Name : _____

1) Aim of practical :

To determine with the help of a Strobe light the rotational speed of a rotor. (Flywheel of an engine, rotor of an electric motor, rotor of a toy helicopter, etc ...).

2) Materials :

>> Electric motor with speed controller.
A small remote control helicopter (diameter of main rotor about 15 cm) is ideal for use in this practical
>> Stroboscopic light

3) Modus Operandi :

1) Mark a spot on one of the blades of the rotor.
2) Start the electric motor and set a moderate constant speed.
3) Start the strobe light on the lowest frequency.
4) Increase the frequency of the strobe light until the blades appear stationary.
5) Record the corresponding frequency (in Hz).
6) Repeat these measurements for different values of rotational speeds.

4) Safety precautions :

1) Never look directly at the strobe light nor direct it towards anyone's eyes.
2) Do not touch the rotor while it is rotating.

5) Data :

	Setting # 1	Setting # 2	Setting # 3	Setting # 4
Frequency (Hz)				
Rotational speed (turns per second)				
Rotational speed (rpm)				

6) Extension #1 :

for a given setting, once you have found the rotational frequency, change the strobe light frequency to twice the previous value. What do you observe. How can you explain it ?

7) Extension #2 :

Each blade of the propellers of the Air Warfare Destroyer has a mass of 1.5 tonnes.

The diameter of the propellers is 4.65 m and the maximum rotational speed is equal to 170 RPM.

The centre of gravity of each blade is distant from the axis of the propellers by about 60 % of the maximum radius of the propellers.

Calculate the centrifuge force experienced by each blade when the propellers is turning at full speed.

Answer :

$$\text{Force} = \text{mass} \times \text{acceleration} = m \frac{v^2}{R}$$

$$v = \frac{2\ \text{Pi}\ R \times \omega\ (\text{rpm})}{60\ \text{s / min}} = \frac{2 \times 3.14 \times (0.60 \times (4.65 / 2)) \times 170}{60\ \text{s / min}}$$

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$$v = 23.34\ \text{m/s}$$

$$R = 0.6 \times (4.65 / 2) = 1.395\ \text{m}$$

$$m = 1.5\ \text{t} = 1500\ \text{kg}$$

$$F = m \times \frac{v^2}{R} = 1500 \times \frac{23.34^2}{1.395} = 585759\ \text{Newton}$$

It is the equivalent of 58 metric tonnes of traction on the base of each blade !