PHY111 Exam Survival Guide

Experiment 2: Compound Pendulum

Process:
1. Suspend pendulum at different holes (distance D from center of mass G).
2. Measure time for 10 oscillations → Period T = t/10.
3. Plot graph T vs D. Find two distances D1, D2 where T is same.
4. L = D1 + D2 (equivalent length). Calculate g using L and T.

Calculations:
- $T = t/10$
- $L = D1 + D2$
- $g = (4\pi^2 L) / T^2$

Formulas:
- Torque: $\tau = -MgD\sin\theta \approx -MgD\theta$
- Torque: $\tau = I\alpha$
- Period: $T = 2\pi\sqrt{(I/MgD)}$
- Parallel axis: $I = I_G + MD^2 = MK^2 + MD^2$
- Equivalent length: $L = K^2/D + D$
- $g = 4\pi^2 L / T^2$

Definitions:
- Compound pendulum: Rigid body swinging under gravity about fixed axis.
- Torque: Rotational effect of force ($\tau = F \times d$).
- Moment of inertia: Resistance to angular acceleration.
- Radius of gyration: Distance giving same I if mass assumed at it.

Experiment 3: Flywheel

Process:
1. Attach mass M with rope around flywheel axle.
2. Rotate wheel n1 times → load rises h.
3. Release: load falls, wheel speeds up, detaches, then slows due to friction.
4. Count n2 revolutions until stop, time t. Measure axle radius r.
5. Use formulas to calculate I.

Calculations:
- Work by gravity: Mgh
- Energy conservation: $Mgh = 1/2\ I\omega^2 + 1/2\ Mv^2 + n1Wf$
- After detachment: $1/2\ I\omega^2 = n2Wf$
- $v = r\omega$
- Angular velocity: $\omega = 4\pi n2 / t$
- Final I: $I = (Mgh - 1/2\ M\ r^2\omega^2) / [1/2\ \omega^2(1 + n1/n2)]$

Formulas:
- $W = Mgh$
- KE flywheel = $1/2\ I\omega^2$
- KE load = $1/2\ Mv^2$
- $v = r\omega$
- Friction work = Wf n1 or Wf n2
- $\theta = 2\pi n2$
- $\omega = 4\pi n2 / t$

Definitions:
- Flywheel: Heavy rotating wheel with mass at rim.
- Moment of inertia: Rotational resistance.
- Work by gravity: Mgh.
- Conservation of energy: Total energy remains constant.

Experiment 4: Spiral Spring

Process:
1. Suspend spring, measure natural length y0.
2. Attach mass m0, extension l measured.
3. Record time for 20 oscillations $\rightarrow$ T = t/20.
4. Repeat for different m0.
5. Graphs: l vs m0 (find k), T^2 vs m0 (find effective mass).

Calculations:
- Equilibrium: m0g = kl $\rightarrow$ k = g/slope (from l vs m0 graph).
- Oscillation: $T = 2\pi\sqrt{((m0+m')/k)}$
- Squared: $T^2 = (4\pi^2/k)(m0 + m')$
- Effective mass: m' = m/3 (m = spring's own mass)

Formulas:
- Hooke's law: F = -kl
- Equilibrium: m0g = kl
- Period: $T = 2\pi\sqrt{((m0+m')/k)}$
- Effective mass: m' = m/3

Definitions:
- Hooke's law: Extension $\propto$ applied force within elastic limit.
- Spring constant k: Force per unit extension.
- Effective mass: 1/3 of spring's own mass.
- Restoring force: Force bringing system back to equilibrium.