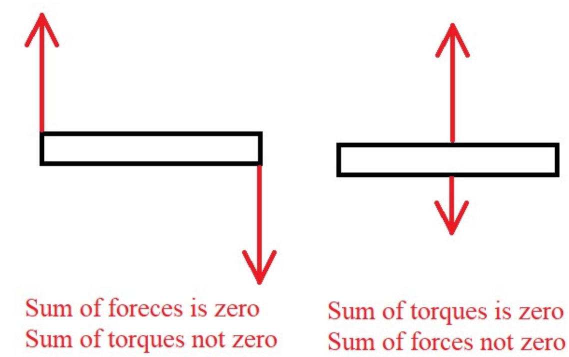
PHYS 1 Sample Exam Four Solutions

MC1) (B)

The moment of inertia of the Solid Sphere is $^2/_5 MR^2$ while the moment of the Disk is $^1/_2 mr^2$ = $½(^1/_2 M)(^1/_2 R)^2 = {}^1/_{16} MR^2$, which is much smaller than that of the Sphere.

MC2) (E)

When you see a word like ‘always,’ try to think of a counter-example; just one would do. (A) and (D) are shown to be false in the left diagram, while (B) and (C) are shown to be false in the right diagram. FYI, (A) and (D) are *contrapositives*, as are (B) and (C); whether a statement is true or false, its contrapositive is the same.



MC3) (C)

For this, we can use the parallel axis theorem:

$I_{parallel} = I_{CM} + Mh^2 = {}^2/_5 MR^2 + MR^2 = {}^7/_5 MR^2$.

MC4) (B)

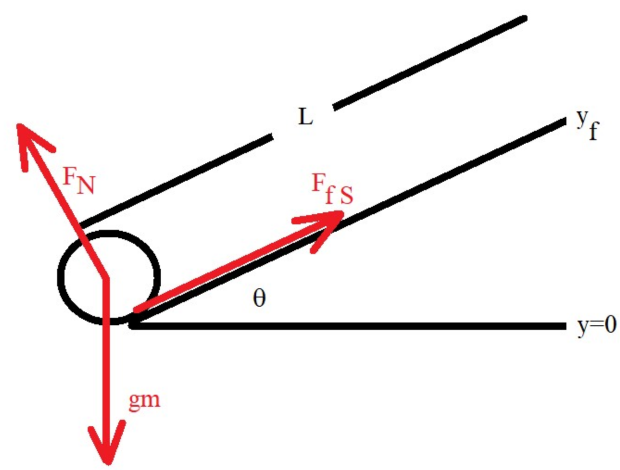
$x_{CM} = (m_1x_1 + m_2x_2)/(m_1+m_2) = (45×4 + 35×9)/(45+35) = 6.2$ m.

MC5) (A)

Due to conservation of angular momentum L, the angular speed ω will be greatest when the moment of inertia of the moon around the earth is least, and since $I = mr^2$, that will be when the moon is closest to the earth at Point A. Or, you may remember this problem from the Sample Exam III.

Problem I

The forces are shown in the figure; note that the frictional force points UP the incline. Use WE Thm.



Wg = cons

$W_{FfS} = 0$ if the sphere rolls without slipping (discussed in class)

W_N = since the normal force is always perpendicular to the path.

Then,

$0 = {}^1/_2 mv_f^2 - {}^1/_2 mv_i^2 + {}^1/_2 I\omega_f^2 - {}^1/_2 I\omega_i^2 + gmy_f - gmy_i$

Some terms are zero,

$0 = {}^1/_2mv_f^2 - {}^1/_2mv_i^2 + {}^1/_2I\omega_f^2 - {}^1/_2I\omega_i^2 + gmy_f - gmy_i$

The first two because the sphere stops, and the last because we set $y_i = 0$ by fiat.

$gmy_f = {}^1/_2mv_i^2 + {}^1/_2I\omega_i^2$

Then, we substitute in $I = {}^2/_5mr^2$ and $\omega = v/r$ to get

$gmy_f = {}^1/_2mv_i^2 + {}^1/_2{}^2/_5mr^2 (v_i/r)^2$

$gy_f = {}^1/_2v_i^2 + {}^1/_2{}^2/_5 v_i^2$

$gy_f = {}^7/_{10}v_i^2$

$y_f = 7v_i^2 /10g = 7(12^2)/10(10) = 10.1$ m

We're not quite done, we are asked to find L.

$\text{Sin}(53^o) = y_f/L \quad L = y_f/\sin(53^o) = 13.5$ m

Problem II

Use conservation of angular momentum

$L = I_i\omega_i = I_f\omega_f$

$I_i = {}^1/_2M_{disk}R_{disk}^2 + m_{twin}R_{disk}^2 + m_{twin}R_{disk}^2 = {}^1/_280(1.5)^2 + 30(1.5)^2 + 30(1.5)^2 = 225$ kg m^2

$I_f = {}^1/_2M_{disk}R_{disk}^2 + m_{twin}R_{disk}^2 + m_{twin}(R_{disk}/2)^2 = {}^1/_280(1.5)^2 + 30(1.5)^2 + 30(0.75)^2 = 174$ kg m^2

$\omega_f = I_i\omega_i / I_f = 225(7)/174 = 9.1$ rad/s

Problem III

See class Notes.

Problem IIII

$\theta_i = 0$

$\theta_f = ?$

$\omega_i = 0$

$\omega_f = 293$ rad/sec

$\alpha = ?$

t = 32 secs

A) (2800 rev/min)×(2π rads/rev)×(1 min/60 secs) = 293 rad/sec
B) Use KEq 1: $\omega_f = \omega_i + \alpha t \quad \alpha = (\omega_f = \omega_i)/t = 293 - 0)/32 = 9.2$ rad/s^2
C) Use KEq 3: $\theta = \theta + \omega_i t + {}^1/_2\alpha t^2 = 0 + (0)32 + ½(9.2)(32)^2 = 4710$ radians
D) $\tau = I\alpha = {}^1/_2MR^2\alpha = ½(0.1)(0.15)^2 9.2 = 0.0104$ Nm