**PROBLEM 1)**

**Given:** When a car accelerates, the normal force at the tire/ground interface changes,

increasing at the rear tires and decreasing at that front. Does the same occur for the

Batmobile? The Batmobile is shown, along with its jet-engine propulsion system.

Assume an acceleration of 0.9*g*. Neglect ground/tire forces in the ***i*** direction. L1 =

1*m*, L2 = 1.8*m*, and *h* = 0.65*m*.

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**Find:** How do the normal forces change from their static values?

**PROBLEM 2)**

**Given:** A gymnast competing at the Olympics is performing a routine on the uneven bars.

After completing a flip, she approaches the higher of the two bars with a speed *v0* at

an angle *β* with respect to the ground. Assume that her body is aligned with the

horizontal at approach. The gymnast has a mass *m*, and her body has a length of *L*

with her hands and legs stretched out.



**Find:** The gymnast’s angular speed just after grabbing on to the bar?

**PROBLEM 3) (30 points)**

**Given:** A hoop with mass *m* = 10*kg* and radius *r* = 0.4*m* is rolled down a rough surface

toward a spring of stiffness *k* = 1500*N*/*m*. The surface is angled at *θ* = 45º with

respect to the horizontal, and the hoop’s mass center *G* is initially *d* = 4*m* from the

spring. The hoop rolls without slip down the incline, and its moment of inertia

about *G* is *IG* = *mr2*.

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**Find:** The initial speed *v0* of the hoop’s mass center if the maximum compression of the

spring is *δ* = 0.7*m*?