Problem 1  Short answer  (2 points each)

A car brakes while rolling down a hill in neutral with an increasing speed. Specify whether the following quantities are positive, negative or zero. (Answer positive, negative or zero.)

[i] \( \Delta K \)  [ii] \( \Delta U \)  [iii] \( \Delta U + \Delta K \)

Problem 2  (7 points each)
(a) An astronaut with an earth weight of 150 lbs stands on the rim of a rotating space station with a radius of 250m. If the rim of the station rotates with a speed of 30 m/s, then what is the artificial weight of the astronaut in lbs?

(b) A penny sits on a rotating disk that rotates once every 0.9 s. The coefficients of static and kinetic friction between the penny and disk are 0.58 and 0.48, respectively. For the penny to not slide, what is its largest distance from the center of the disk?

Problem 3  (7 points each)
(a) A 200 g glider moves at 0.3 m/s on an air track toward a 300 g glider moving in the opposite direction at 0.1 m/s. If the collision is elastic then what are both final velocities?

(b) Before being hit by a bat, a 0.15kg baseball has a velocity of \((-40,0)\) m/s. It leaves the bat with velocity \((45,25)\) m/s. If the bat is in contact with the ball for 0.05s then what is the average force of the bat on the ball?
Problem 4 (7 points each)
(a) Junior drops a 50 gram object onto a vertical spring from a height 30 cm above the spring. If the object
compresses the spring a maximum distance of 10 cm, then what is the spring constant of the spring

(b) What is the angle between $\vec{A} = \langle 3, 12, -4 \rangle$ and the positive z-axis?

Problem 5 (7 points each)
(a) A single conservative force of $F(x) = 5x - 3$ (in SI units) acts on a 0.5 kg particle moving in one dimension.
If at $x = 0$ the particle has a speed of 3 m/s, then what is its speed at $x = 2$ m?

(b) A banked turn is designed so that in a perfectly frictionless situation a car can make a 200 m radius turn
while driving at a speed of 30 m/s without skidding. What is the angle of incline (measured from horizontal) of
the banked turn.

(c) The engine of a 1500kg car does 30000J of work while the car drives down a 4m high hill. If the car’s speed
increases from 10m/s to 14m/s, what is the work done by friction?
Problem 6 (8 points each)
(a) A 60N crate is dragged 7m on a horizontal surface by a rope pulling with a tension of 85N at an angle of 25° above horizontal. There is a friction force of 55N acting backward on the crate. There are four forces acting, tension, friction, the normal force and gravity. What is the work done by each force?

(b) A puck slows from 40m/s to 35m/s while sliding 130m on a horizontal ice surface. What is the coefficient of kinetic friction between the ice and the puck?

Problem 7 A 50gram mass moves in a vertical circle at the end of a 0.7m long string. The mass is pushed to a speed of 4m/s at the bottom.
(a) What is the tension in the string at the bottom just after the mass is pushed? (7 points)

(b) The speed at the bottom is not enough of the mass to swing in a vertical circle. At what angle, measured from the top will the string lose its tension and the mass fall out of the circle? (8 points)