PART II: Work, Energy, Momentum, Impulse

Multiple-Choice

M1:

An object is constrained by a cord to move in a circular path of radius 0.5 m on a horizontal frictionless surface. The cord will break if its tension exceeds 16 N. The maximum kinetic energy the object can have is:

A) 4J B) 8J C) 16J D) 32J E) 64J

Hint: Use centripetal acceleration

M2:

An object moves in a circle at constant speed. The work done by the centripetal force is zero because:

A) the magnitude of the acceleration is zero; **B)** there is no friction; **C)** the centripetal force is perpendicular to the velocity; **D)** the displacement for each revolution is zero; **E)** the average force for each revolution is zero

Answer: C

M3:

A 3.00-kg ball swings rapidly in a complete vertical circle of radius 2.00 m by a light string. The ball moves so fast that the string is always taut. As the ball swings from its lowest point to its highest point:

a) The work done on it by gravity is -118 J and the work done on it by the tension in the string is +118 J.
b) The work done on it by gravity is +118 J and the work done on it by the tension in the string is -118 J.
c) The work done on it by gravity and the work done on it by the tension in the string are both equal to -118 J.
d) The work done on it by gravity is -118 J and the work done on it by the tension in the string is zero.
e) The work done on it by gravity and the work done on it by the tension in the string are both equal to zero.

Hint: see M2

M4:

The work done by gravity during the descent of a projectile is:

A) positive B) negative C) zero D) depends for its sign on the direction of the *y* axis E) depends for its sign on the direction of both the *x* and *y* axes

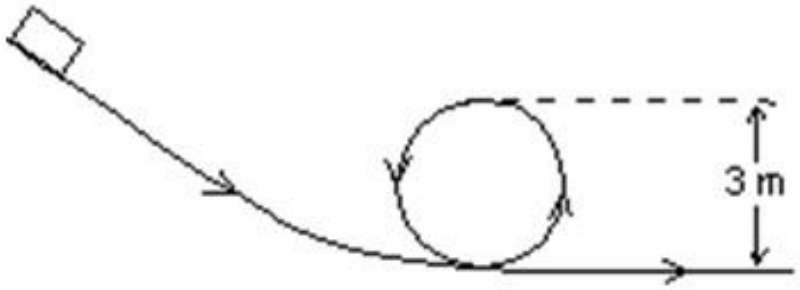
Answer: A

M5:

A force of 10 N holds an ideal spring with a 20-N/m spring constant in compression. The potential energy stored in the spring is:

A) 0.5J B) 2.5J C) 5J D) 10J E) 200J

M6:***
A small object slides along the frictionless loop-the-loop with a diameter of 3 m. What minimum speed must it have at the top of the loop in order to remain in contact with the loop?



A) 1.9 m/s B) 3.8 m/s C) 5.4 m/s D) 15 m/s E) 29 m/s

M7:
Two boys with masses of 40 kg and 60 kg stand on a horizontal frictionless surface holding the ends of a light 10-m long rod. The boys pull themselves together along the rod. When they meet the 40-kg boy will have moved what distance?
A) 4 m B) 5m C) 6m D) 10m
E) Need to know the forces they exert
Answer: C

M8:
The center of mass of a a system of particles remains at the same place if:
A) it is initially at rest and the external forces sum to zero B) it is initially at rest and the internal forces sum to zero C) the sum of the external forces is less than the maximum force of static friction D) no friction acts internally E) None of the above
ANSWER A

M9:
A 0.3 kg rubber ball is dropped from the window of a building. It strikes the sidewalk below at 30 m/s and rebounds up at 20 m/s. The magnitude of the impulse due to the collision with the sidewalk is:
A) 3.0 N-S B) 6.0 N-s C) 9.0 N-s D) 15 N-s E) 29 N-s **ANSWER D**

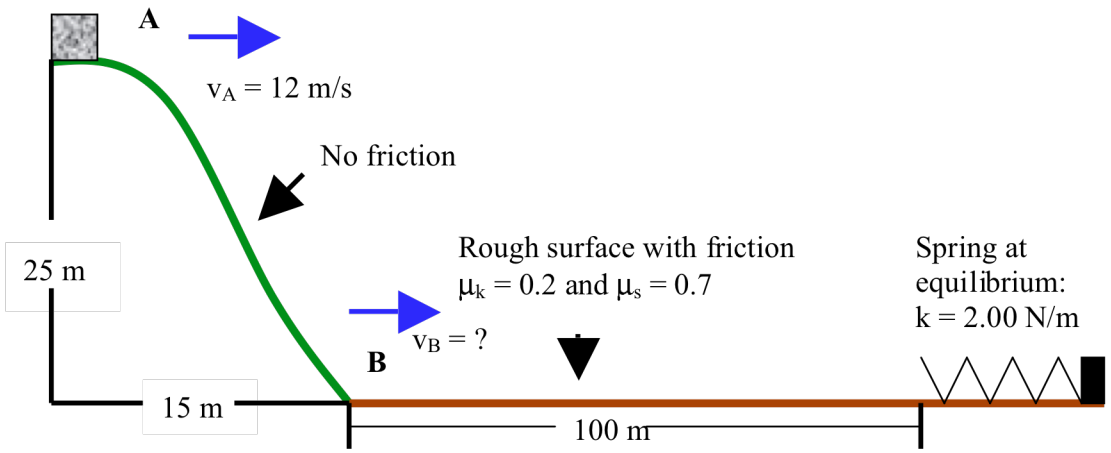
$$J = \Delta P = mv_F - mv_I = 0.3kg \times 30m \bullet s^{-1} - 0.3kg\left(-20m \bullet s^{-1}\right) = 15kg \bullet m \bullet s^{-1}$$

Go to the next pages for problems:

Problems

Problem 1

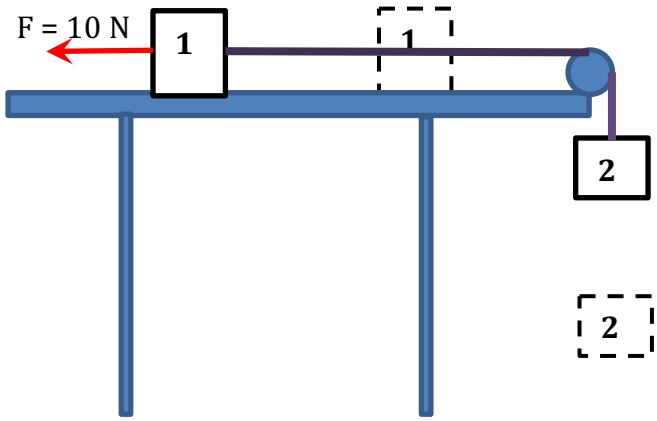
In figure below a 14 kg stone slides down a snow covered hill, leaving point A with a speed of 12 m/s. There's no friction between point A and B, but there's friction after point B, where it reaches the spring and compresses it till it comes to a stop. A) Find the speed at the bottom of the hill (point B). B) Find the maximum compression of the spring.



ANSWER: A) $v_B = 25.2 m \cdot s^{-1}$; B) x = 29.7 m.

Problem 2

In the Figure below, **box 1** (m_1 = 2 kg) rests on a table with friction ($\mu_k = 0.15$ *and* $\mu_3 = 0.3$) is connected by as ideal rope passed through a frictionless pulley to **box 2** (m_2 = 30 kg). It is release from rests, and immediately a force of 10 N acts on the **box 1** in the direction shown. After **box 2** has fallen 0.8 m find the **speed** of **box 1**.



Use $W = \Delta E_{mec} + \Delta E_{th}$, with W = 10N * 0.8 m, $\Delta E_{th} = f_k \times 0.8N$ and $\Delta E_{mec} = \Delta K + \Delta U$

Answer
V = 3.75 m/s

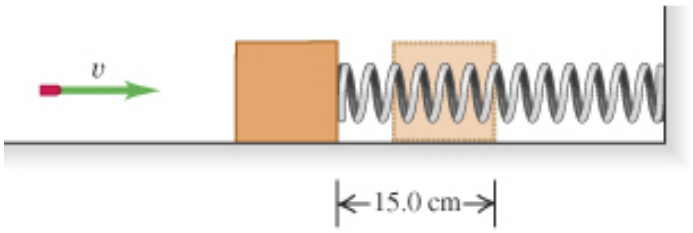
Problem 3

A **hockey puck** of mass *m = 2 kg* traveling at 4.5 m/s along the **x axis** hits another **identical hockey puck** at **rest**. A) If after the collision the **second puck** travels at a speed of 3.5 m/s at an angle of 30° **above** the **x axis**, calculate the **final velocity** of

the **first puck**? B) Calculate the **change** in **kinetic energy**, ΔK. Is the **collision elastic**? Briefly explain. **ANSWER:** A) **Velocity**: v = 2.28 m/s at 50° below the horizontal or $\vec{v} = 1.47\frac{m}{s}\hat{i} - 1.75\frac{m}{s}\hat{j}$; B) -2.8J

Problem 4

A bullet with a mass of 8.00×10^{-3} kg strikes and embeds itself in a block with mass 1.25 kg that rests on a **frictionless surface** and is attached to a coil spring with a **force constant** of $315\frac{N}{m}$. The impact compresses the spring 15.0 cm.



A) Find the **speed** of the block + bullet **just after** the **impact**. B) What was the **initial speed** (v) of the bullet **just before** it **hits** the block? C) Calculate the **impulse (magnitude and direction)** on the **box** due to its collision with the bullet.
ANSWER: A) 2.38 m/s; B) 373 m/s;

C) $J_x = P_2 - P_1 = Mv_F - 0 = (1.25kg)\left(2.38\frac{m}{s}\right) = 2.975\frac{kg \bullet m}{s}$ to the right.