Clearly show all appropriate work leading to the final answer. Don't forget units and indicate what your final answer is.

1) [10pts] Find the angle, in degrees, between the vectors \( \vec{A} = 3\hat{i} + 5\hat{j} - 2\hat{k} \) and \( \vec{B} = -7\hat{i} + 5\hat{j} + 6\hat{k} \).

2) [10pts] The acceleration of a rocket ship obeys the equation \( a(t) = (8.6 \text{ m/s}^3)t + 1.0 \text{ m/s}^2 \). Find the speed of the ship at \( t = 5.2 \text{ s} \) if it is at rest at \( t = 0 \).
3) [8pts] A projectile returns to its original height after 4.08 seconds, during which time it travels 76.2 meters horizontally. If air resistance can be neglected, what was the projectile's initial speed?
(Use $g = 9.80 \text{ m/s}^2$.)

4) [8pts] A box of mass 98 kg is at rest on a horizontal frictionless surface. A constant horizontal force $F$ then acts on the box, and accelerates it to the right. It is observed that it takes the box 3.7 seconds to travel 58 meters. What is the magnitude of the force?
5) [8pts] In Fig. 5.17, a block of mass 7.0 kg on a tabletop is attached by strings to vertically hanging masses, 12 kg and 10 kg, as shown. The strings and pulleys are massless, the pulleys are frictionless, but the coefficient of friction between the block and the tabletop is 0.10. Describe the motion of the block, including the magnitude and direction of the acceleration. (Use $g = 9.8 \text{ m/s}^2$.)

6) [8pts] A stone is thrown directly upward at 15.0 m/s from ground level and feels no appreciable air resistance. Use the work-energy theorem to find how high it will be when its speed has been reduced to half of its initial value.
7) [8pts] In Fig. 7.11, a block of mass 2.0 kg is placed on a compressed vertical spring that is compressed 0.050 m. (The spring and the block are not attached.) The spring is released, and it propels the block vertically upward. When the block has risen 0.60 m above its initial position, its velocity is 1.7 m/s. How much potential energy was originally stored in the spring?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

8) [8pts] A block of mass $m = 25$ kg has a speed $V$ and is behind a block of mass $M = 64$ kg that has a speed of 0.5 m/s. The surface is frictionless. The blocks collide and couple. After the collision, the blocks have a common speed of 0.9 m/s. In Fig. 8.2, the loss of kinetic energy of the blocks due to the collision is closest to:

A) 74 J  
B) 28 J  
C) 28 J  
D) 13 J  
E) 18 J
9) [8pts] In Fig. 9.6, a weightlifter’s barbell consists of two identical spherical masses each with radius 0.17 m and mass of 50 kg. The weights are connected by a 0.96 m steel rod with mass of 12 kg. Find the moment of inertia of the barbell through the axis at the center.
10) [8pts] In Fig. 11.12, a 10.0- m long bar is attached by a frictionless hinge to a wall and held horizontal by a rope that makes an angle $\theta$ of 53° with the bar. The bar is uniform and weighs 39.9 N. How far from the hinge should a 10.0- kg mass be suspended for the tension $T$ in the rope to be 177 N?
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

11) [8pts] Consider an object that drops a distance $h$ in a time of 63 s on the surface of the earth (neglecting air effects). How long would it take the same object to drop the same distance on the surface of Pluto? The mass of Pluto is $1.1 \times 10^{22}$ kg and its radius is $4.0 \times 10^5$ m.
   A) 92 s             B) 52 s             C) 120 s            D) 63 s            E) 33 s

12) [8pts] A 4.8- kg block attached to a spring executes simple harmonic motion on a frictionless horizontal surface. At time $t = 0$ s, the block has a displacement of -0.50 m, a velocity of -0.80 m/s, and an acceleration of $48.3 \text{ m/s}^2$. The force constant of the spring is closest to:
   A) 56 N/m       B) 67 N/m       C) 80 N/m       D) 73 N/m       E) 62 N/m