Multiple Choice questions. Circle the correct answer. No work needs to be shown.

(6 pts) 1. A small rock of mass $m$ is attached to a strong string and whirled in a vertical circle of radius $R$. When the rock is at the lowest point in its path, the tension in the string is five times the weight of the rock. At this point the speed of the rock is

(a) $\sqrt{2gR}$
(b) $\sqrt{3gR}$
(c) $2\sqrt{gR}$
(d) $3\sqrt{gR}$
(e) $\sqrt{5gR}$
(f) $\sqrt{6gR}$
(g) none of the above values

(6 pts) 2. An object released from rest at the top of a 30.0° incline slides down the incline to the bottom of the incline. During this motion the work done on the block by the friction force on the block is

(a) positive
(b) negative
(c) zero

(6 pts) 3. When an object moves from point $A$ to point $B$, gravity does positive work on the object. When the object moves from point $A$ to point $B$, its gravitational potential energy

(a) stays the same
(b) increases
(c) decreases

(6 pts) 4. Boxes $A$ and $B$ are at rest on a horizontal frictionless surface with a compressed spring of negligible mass between them. Box $A$ has mass 2.0 kg and box $B$ has mass 4.0 kg. When the spring is released the two boxes move off in opposite directions and the spring is left behind. After the boxes have moved away from the spring,

(a) the magnitude of the momentum of $A$ is less than the magnitude of the momentum of $B$
(b) the magnitude of the momentum of $A$ is greater than the magnitude of the momentum of $B$
(c) the magnitude of the momentum of $A$ equals the magnitude of the momentum of $B$
(d) the kinetic energy of $A$ equals the kinetic energy of $B$
(6 pts) 5. A box is pulled by a force $F$ up a ramp that is inclined at $37.0^\circ$ above the horizontal. The direction of this force is $60.0^\circ$ above the horizontal. The force has magnitude 60.0 N. The box travels a distance of 5.00 m along the surface of the ramp. How much work does the force $F$ do during this displacement of the box?

(a) 300 J  
(b) 150 J  
(c) 240 J  
(d) 276 J  
(e) none of the above answers

On the following problems show all your work. Partial credit will be given if earned. Write your answers in the blanks provided.

(18 pts) 6. The strange planet Zztop has mass $8.00 \times 10^{25}$ kg. Zztop is spherical and has uniform density. If an object of mass 0.600 kg is projected straight upward from the surface of Zztop with an initial speed of 16.0 m/s, it returns to the surface in a time of 8.00 s after it is projected upward.

(a) What is the magnitude of the acceleration due to gravity near the surface of Zztop?

\[ \text{An. } 4.0 \text{ m/s}^2 \]

(b) What is the radius of planet Zztop?

\[ \text{An. } 3.65 \times 10^7 \text{ m} \]
(18 pts) 7. A small rock with mass 0.200 kg is attached to one end of a 4.00 m long light string and moves in a horizontal circle with constant speed. The angle between the string and the vertical direction is 53.0° and is constant.

(a) What is the tension in the string?

Ans. 3.26 N

(b) What is the magnitude of the acceleration of the rock?

Ans. 13.0 m/s²

(c) How long does it take the rock to complete one revolution?

Ans. 3.12 s
8. A stone with mass 0.800 kg rests on a horizontal frictionless surface. A bullet with mass 0.0200 kg traveling horizontally at speed $v_{Ai}$ strikes the stone and rebounds horizontally at a speed of $v_{Af}$ in a direction perpendicular to its original motion. After being hit by the bullet, the stone is moving at 6.00 m/s in a direction 30.0° from the original direction of motion of the bullet. What are the speeds $v_{Ai}$ and $v_{Af}$ of the bullet before and after the collision?

\[
\begin{align*}
\text{Ans. } v_{Ai} &= 2.08 \text{ m/s} \\
\text{Ans. } v_{Af} &= 1.20 \text{ m/s}
\end{align*}
\]
(18 pts) 9. A small block with mass 0.400 kg is placed against a compressed spring at the bottom of a 37.0° incline. The compressed spring has 50.0 J of elastic potential energy stored in it. The spring is released and the block moves a distance of 12.0 m along the incline before momentarily coming to rest.

(a) How much work does the friction force do on the block during the motion?

Ans. $-21.7 \text{ J}$

(b) What is the coefficient of kinetic friction $\mu_k$ between the block and the incline?

Ans. $0.578$