Potential Energy and Energy Conservation: Exercises

1. A block with mass number $m$ is dropped from rest. It falls a distance $h$ onto a spring with spring constant $k$. What is the maximum compression $\Delta y_{\text{max}}$ of the spring?
   (a) $m | \vec{g} | h/k$.
   (b) $2m | \vec{g} | h/k$.
   (c) $\sqrt{m} | \vec{g} | h/k$.
   (d) $\sqrt{2m} | \vec{g} | h/k$.
   (e) None of the above.

2. A rock with mass number $m$ falls from height $h$ and sinks a distance $\Delta y$ into the ground ($\Delta y \ll h$). What is the average force of the ground against the rock?
   (a) $m | \vec{g} | h/\Delta y$.
   (b) $2m | \vec{g} | h/\Delta y$.
   (c) $\sqrt{m} | \vec{g} | h/\Delta y$.
   (d) $\sqrt{2m} | \vec{g} | h/\Delta y$.
   (e) None of the above.

3. A ball is released, from rest, at the left side of the loop-the-loop, at the height shown below. If the radius of the loop is $R$ and there is no friction, to what vertical height does the ball rise to on the other side?
   (a) Less than $R$.
   (b) $R$.
   (c) $2R$.
   (d) Greater than $2R$.
   (e) None of the above.
4. Two cars, starting from rest at the same place, travel by different routes to the same destination. One of the cars passes the other as they drive through it. Which of the following statements will be true?

(a) The work done by friction during the trip was the same for both.
(b) The total work done on both is the same.
(c) The work done by gravity is the same on both.
(d) The work done by gravity on both is positive.
(e) None of the above.

The following information pertains to problems 5-7.

“Three blocks A, B, and C are each pushed by a force, \( \vec{F} \), of the same magnitude in the same direction across a frictionless horizontal surface over the same displacement \( \Delta s \). The mass numbers of the blocks are related as \( m_A > m_B > m_C \).”

5. Which block will be traveling the fastest after \( \Delta s \)?

(a) A
(b) B
(c) C
(d) All will have the same velocity magnitude.
(e) There’s not enough information to tell.
(f) None of the above.

6. Which of the blocks would have the greatest kinetic energy after \( \Delta s \)?

(a) A
(b) B
(c) C
(d) All will have the same kinetic energy.
(e) There’s not enough information to tell.
(f) None of the above.

7. Which of the blocks will have received the greatest impulse after \( \Delta s \)?

(a) A
(b) B
(c) C
(d) All will have received the same impulse.
(e) There’s not enough information to tell.
(f) None of the above.
The following information pertains to problems 8 and 9.

“Three springs of the same relaxed length $\ell_0$ have spring constants $k_1 > k_2 > k_3$. The springs are suspended from the ceiling and identical masses are then hung on each of the springs. In response to these identical stretching forces, the springs stretch $\Delta\ell_1$, $\Delta\ell_2$, and $\Delta\ell_3$, respectively.”

8. The elongations are related as:
   (a) $\Delta\ell_1 > \Delta\ell_2 > \Delta\ell_3$.
   (b) $\Delta\ell_1 < \Delta\ell_2 < \Delta\ell_3$.
   (c) $\Delta\ell_1 = \Delta\ell_2 = \Delta\ell_3$.
   (d) none of the above.

9. The potential energies stored in each spring are related as:
   (a) $U_1 > U_2 > U_3$.
   (b) $U_1 < U_2 < U_3$.
   (c) $U_1 = U_2 = U_3$.
   (d) none of the above.

10. If a constant force $\vec{P}$ acts on an object with mass number $m$ as it displaces $\Delta \vec{r}$, what is
   (a) the work $W_{\vec{P} \cdot \Delta \vec{r}}$ done by $\vec{P}$ on the object?
   (b) the potential energy $U(\vec{r})$ gained by the object assuming its velocity remains unchanged during the interaction.

11. A simple pendulum is made from a very light, non-stretchable string of length $\ell$ and a very small sphere with mass number $m$. The sphere is displaced from vertical (at full string length) to an angle $\theta$.
   (a) In this position, what is its potential energy relative to its position when it is hanging vertically?
   (b) If released from rest from this position, what will be the magnitude of its velocity be at it’s lowest point?

12. A toy rocket launcher has a mass number $m_l$ and the toy rocket has an initial mass of $m_r$. After firing the rocket horizontally, the launcher rolls backward (recoils) up a smooth plane inclined at an angle $\theta$, reaching a height $h$. What was the magnitude of rocket’s velocity $|\vec{v}|$ at launch?