PHYS 105 · Chapter 8: Potential Energy and Conservation of Energy

Final-Exam Review — questions from PSU past final exams (Terms 182 – 242)

Constant: g = 9.81 m/s² · The source of each question is shown in [brackets].

Part 1: Multiple-Choice Questions (18)

Indicate the answer choice that best completes the statement or answers the question.

8.1 Potential Energy

Q1. *Which of the following is an example of a conservative force?* **[Final 222]**

A *Friction force*
B *Air resistance*
C *Tension*
D *Spring force*

Q2. *The gravitational potential energy of an object:* **[Final 222]**

A *depends on the height.*
B *depends on the horizontal position.*
C *depends on the velocity.*
D *none of the above.*

Q3. *The change in the gravitational potential energy of an object, ΔU, is always equal to:* **[Final 182]**

A *negative the change in its kinetic energy*
B *negative the work done by non-conservative forces*
C *negative the work done by gravity*
D *none of the above*

Q4. *A 40 kg object rises to a height of 5 m above the ground. What is its potential energy?* **[Final 221]**

A *1962 J*
B *1962 W*
C *1962 J/s*
D *1962 N*

Q5. *A 2 kg barbell is lifted 5 m above the ground. Taking the ground as U = 0, what is its gravitational potential energy at this height?* **[Final 232]**

A *49 J*
B *19.6 J*
C *98 J*
D *9.8 J*

Q6. *A person of mass 88 kg standing on top of Mt. Everest has a gravitational potential energy of 7.64×10^{6} J (sea level as U = 0). What is his altitude?* **[Final 222]**

A *200 m*
B *700×10^{6} m*
C *8850 m*
D *7.64 m*

Q7. *A 20 kg object rests on a table 1.6 m above the ground. It is then lifted to a height of 8.7 m above the ground. What is the change in its gravitational potential energy?* **[Final 231]**

A *1393 J*
B *314 J*
C *707 J*
D *190 J*

Q8. *A spring with a force constant of 551 N/m is compressed by 2.47 cm. Determine the potential energy stored in the spring.* **[Final 242]**

A *6.88 J*
B *0.34 J*
C *0.17 J*
D *1720 J*

8.2 Conservation of Mechanical Energy

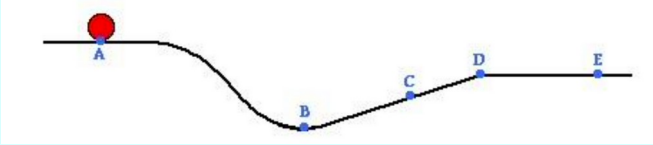
Q9. *When a girl is jumping rope, where does she have the most gravitational potential energy?* **[Final 231]**

A *at the bottom, when she bends her knees*
B *at the top, before she comes down*
C *in the middle of her jump*
D *at the bottom, when she lands*

Q10. *When an object thrown vertically upward reaches the highest point of its path:* **[Final 232]**

A *its U is maximum and its K is zero.*
B *its U is minimum and its K is maximum.*
C *its U is zero and its K is zero.*
D *its U is constant and its K is maximum.*

Q11. *Use the diagram for this question and the next two. Neglect friction. As the object moves from point A to point D, the sum of its gravitational potential and kinetic energies:* **[Final 211]**



A *decreases only.*
B *decreases, then increases.*
C *increases, then decreases.*
D *remains the same.*

Q12. *(Same diagram.) At which point does the object have the minimum gravitational potential energy?* **[Final 211]**

A *Point A*
B *Point B*
C *Point C*
D *Point D*

Q13. *(Same diagram.) The object's kinetic energy at point C is less than its kinetic energy at which point?* [Final 211]

A *Point A*
B *Point B*
C *Point C*
D *Point D*

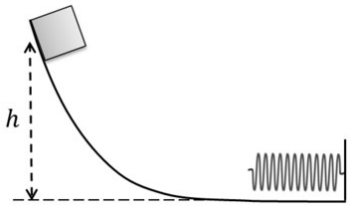
Q14. *An arrow is drawn back so that 50 J of potential energy is stored in the stretched bow and string. Assuming no energy losses, when released the arrow will have a kinetic energy of:* [Final 221]

A *50 J*
B *more than 50 J*
C *less than 50 J*
D *not enough information*

Q15. *Two penguins slide from rest down frictionless hills of the same height. Penguin 1's hill slopes at 30° and Penguin 2's at 60°. Which penguin is faster at the bottom? (Use conservation of mechanical energy.)* [Final 242]

A *Penguin 1 is faster.*
B *Penguin 2 is faster.*
C *Both have the same speed.*
D *The heavier penguin is faster.*

Q16. *A 0.15 kg block starts from rest at a height of 32 cm and slides down a frictionless surface to hit a spring on a horizontal surface, as shown. If the maximum compression of the spring is 3 cm, what is the spring constant?* [Final 182]



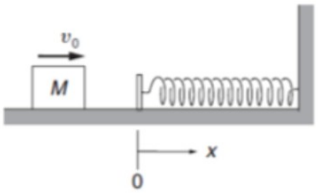
A *15.7 N/m*
B *1250.4 N/m*
C *1045.3 N/m*
D *940.5 N/m*

8.4 Work Done by Non-conservative Forces

Q17. *A 0.12 kg apple falls from rest from a height of 3.5 m and hits the ground with a speed of 5.1 m/s. What is the magnitude of the work done on the apple by non-conservative forces (air resistance)?* [Final 182]

A *1.56 J*
B *5.68 J*
C *4.12 J*
D *2.56 J*

Q18. *A 4 kg block slides on a horizontal surface with an initial speed of 9 m/s. At x = 0 it hits a spring (k = 700 N/m) and starts to experience friction ($\mu_k = 0.2$), as shown. Find the maximum compression of the spring.* [Final 211]

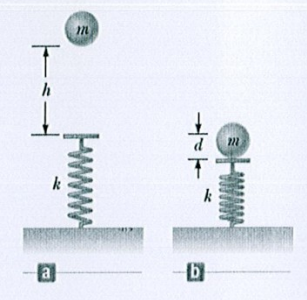


A *122.1 cm*
B *3.43 cm*
C *66.92 cm*
D *14.92 cm*

Part 2: Problems (8)

Solve the following problems and show your work in detail.

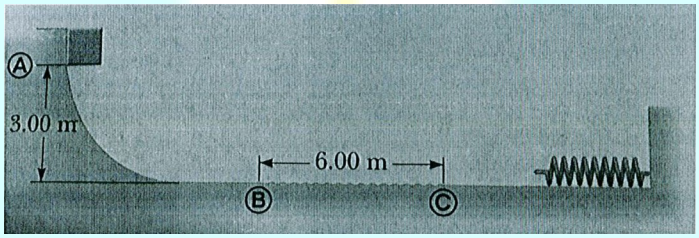
Problem 1. *A sphere of mass 9 kg is dropped from rest from a height h = 3.2 m above the top of a spring (k = 1600 N/m) mounted vertically on the floor, as shown.* [Final 202]



a) *Calculate the speed of the sphere when it hits the top of the spring.*

b) *Calculate the maximum compression of the spring.*

Problem 2. *A 10 kg block is released from rest at point A (3.00 m high). The track is frictionless except between B and C (length 6.00 m). The block travels down the track, hits a spring (k = 2250 N/m) and compresses it by 0.3 m before coming to rest momentarily.* [Final 202]

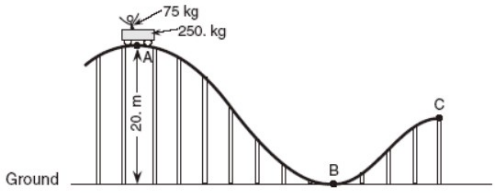


a) *Determine the speed of the block at point B.*

b) *Determine the speed of the block at point C.*

c) *Determine the coefficient of kinetic friction between B and C.*

Problem 3. *A 250 kg roller-coaster car carrying a 75 kg passenger is initially at rest at point A, 20 m above the ground. Neglect friction.* **[Final 221]**



a) *Calculate the mechanical energy of the roller coaster at point A.*

b) *Calculate the speed of the roller coaster at point B (ground level).*

Problem 4. *At an amusement park, a swimmer uses a water slide to enter the main pool. She starts with a speed of 0.840 m/s, slides without friction and descends through a vertical height of 2.31 m.* **[Final 222]**

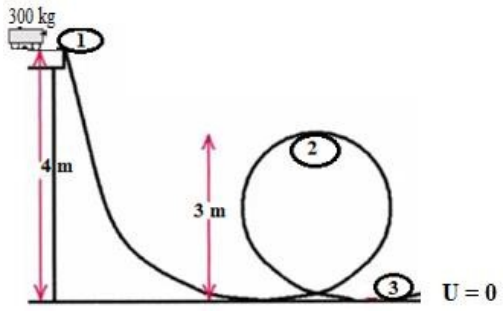
a) *Use conservation of energy to find her speed at the bottom of the slide.*

Problem 5. *A 76 kg diver jumps from a 15 m high diving board (take the water surface as U = 0).* **[Final 231]**

a) *Find his gravitational potential energy on the board.*

b) *Use conservation of energy to find his speed as he reaches the water surface.*

Problem 6. *A 300 kg roller-coaster cart starts from rest at point 1 on the track shown. Neglect friction (U = 0 at point 3).* **[Final 232]**



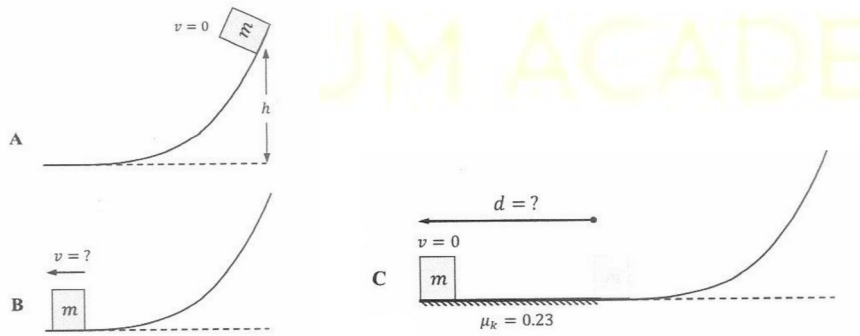
a) *Calculate the gravitational potential energy U at points 1, 2 and 3.*

b) *Calculate the kinetic energy K at points 1, 2 and 3.*

c) *Calculate the mechanical energy E at points 1, 2 and 3.*

d) *Calculate the speed at point 3 using conservation of energy.*

Problem 7. *A block of mass m = 0.5 kg is released from rest at a height h = 0.46 m on a frictionless ramp (Figure A) and slides to the bottom (Figure B). It then moves on a rough horizontal surface (μ_k = 0.23) until it stops (Figure C).* **[Final 241]**

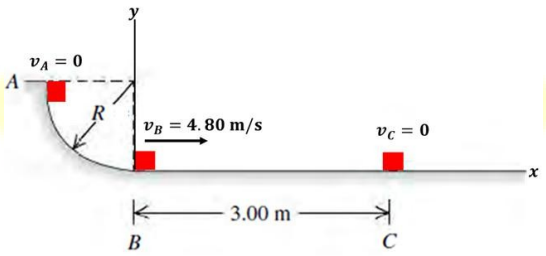


a) *Using conservation of mechanical energy, find the speed v of the block at the bottom of the ramp.*

b) *Use the work–energy theorem to find the net work done on the block on the horizontal surface.*

c) *Using the work from part (b), find the stopping distance d.*

Problem 8. *A 0.200 kg package is released from rest at point A on a rough track that forms a quarter-circle of radius 1.60 m. It reaches point B with a speed of 4.80 m/s, then slides 3.00 m on a rough horizontal surface before stopping at point C. (Take U = 0 at the level of B and C.)* **[Final 242]**



a) *Calculate the mechanical energy of the package at point B and at point C.*

b) *Find the work done by friction from B to C (work of non-conservative forces).*

c) *Find the friction force and the coefficient of kinetic friction on the horizontal surface.*

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d) *Calculate the gravitational potential energy of the package at point A.*
