Student #: _____ Student Name: _____

Physics 11 Homework Unit 4: Mechanical Energy

1. A weight lifter used a circular platform attached to a harness to lift a class of 30 children and their teacher. While the children and teacher sat on the platform, he lifted them. The total weight of the platform plus people was $1.1 \times 10^4\,\text{N}$. When he lifted them a distance of $52\,\text{cm}$, at a constant velocity, how much work did he do? How high would you have to lift one child, weighing $135\,\text{N}$, in order to do the same amount of work that the weight lifter did?

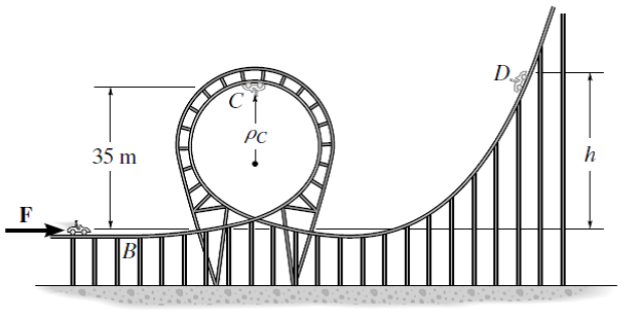
2. An energetic group of university students attempts to remove an old tree stump for use for use as firewood during a party. The students apply an average upward force of $650\,\text{N}$. The $865\,\text{kg}$ tree stump does not move after 15 minutes of continuous effort, and the group gives up. How much work did the students do on the tree stump? Explain.

3. A farmer pushes a wheelbarrow with an applied force of $124\,\text{N}$. If the farmer does $7314\,\text{J}$ of work on the wheelbarrow while pushing it a horizontal distance of $77.0\,\text{m}$, find the angle between the direction of the force and the horizontal.

4. You throw a ball directly upward, giving it an initial velocity of $10.0\,\text{m/s}$.
   (a) Neglecting friction, and using the equation for conservation of energy, what would be the maximum height of the ball?
   (b) Do you need to know the mass of the ball? Why or why not?

5. A $5000\,\text{kg}$ roller coaster is required to have a minimum speed of $10\,\text{m/s}$ at the top of the loop (point C) for safety reasons. Assuming that the track is friction-less,

   (a) What is the speed at B?
   (b) What is a minimum height h reached at D?
   (c) Do you need to know the mass of the coaster? Why, or why not?



6. A football player pushes a tackling dummy forward at a constant $0.85\,\text{m/s}$ for $11\,\text{m}$ using $7150\,\text{J}$ of energy. The tackling dummy has a mass of $120\,\text{kg}$.

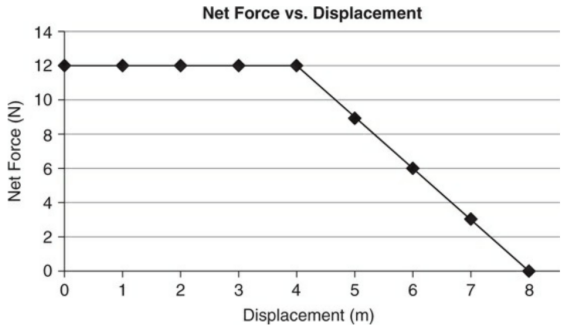
   (a) Find the force the football player exerts.
   (b) What is the frictional force the dummy exerts?
   (c) What work is done by friction as the dummy is slid along the field for $11\,\text{m}$?

7. A hockey player pushes on a $170\,\text{g}$ hockey puck from rest with his stick at an angle so the vertical force is $22\,\text{N}$ [down] and the horizontal force is $45\,\text{N}$ [forward]. Assume the ice is frictionless.
   (a) What is the actual force (both magnitude and direction) the player transmits to the puck?
   (b) How much work does the player do if he pushes the puck for $0.030\,\text{s}$?
   (c) What is the significance of the fact that both the horizontal force and motion are both forward?

8. A $50\,\text{kg}$ person is taking a ride on an elevator travelling up at a steady speed of $2.5\,\text{m/s}$. Find the time of the elevator trip if the elevator does $4.9\,\text{kJ}$ of work on the person.

9. A raindrop reaches terminal velocity very quickly as it falls to Earth due to the work done by air resistance during the descent.
   (a) If a $0.500\,\text{g}$ raindrop is formed $1.50\,\text{km}$ above Earth, calculates its speed as it struck the ground, if air resistance is ignored.
   (b) Determine the percentage of energy that is lost due to work done by air resistance if the $0.500\,\text{g}$ raindrop reaches Earth travelling only at $5.20\,\text{m/s}$.

10. The graph below shows the external force applied to a $15\,\text{kg}$ object throughout a displacement of $8.0\,\text{m}$.



(a) How much work was done on the object throughout the $8.0\,\text{m}$ displacement?
(b) If the object was initially moving at $4.0\,\text{m/s}$, before the force was applied, calculate the object's kinetic energy and speed after the work was done on it.

_____ 11. A boy pushes down on a car rolling horizontally along a road. If the boy pushes down with $10\,\text{N}$ of force as the car rolls $3.0\,\text{m}$ horizontally, the amount of work done by the boy is:

(a) $0\,\text{J}$
(b) $30\,\text{N}\cdot\text{m}$
(c) $-30\,\text{N}\cdot\text{m}$
(d) $3.3\,\text{J}$
(e) none of the above

_____ 12. What is the speed of a $0.25\,\text{kg}$ ball if its kinetic energy is $15\,\text{J}$?

(a) $1.4\,\text{m/s}$
(b) $1.9\,\text{m/s}$
(c) $2.7\,\text{m/s}$
(d) $5.5\,\text{m/s}$
(e) $11\,\text{m/s}$

_____ 13. A ball is dropped off a high cliff. Which of the following quantities increases as the ball gets closer to the ground?

(a) acceleration
(b) force of gravity
(c) gravitational potential energy
(d) kinetic energy
(e) all of the above

_____ 14. A $10.0\,\text{kg}$ crate slides across a level floor $13\,\text{m}$ against a force of friction of $7.5\,\text{N}$. If all the work done by friction is converted to heat, the thermal energy produced is:

(a) $17\,\text{J}$
(b) $49\,\text{J}$
(c) $75\,\text{J}$
(d) $98\,\text{J}$
(e) $980\,\text{J}$

_____ 15. In the process of being thrown, a $0.145\,\text{kg}$ baseball goes from rest to a speed of $156\,\text{km/h}$ over a distance of $2.05\,\text{m}$. What is the force that was exerted on the baseball?

(a) $1.9\,\text{N}$
(b) $3.3\,\text{N}$
(c) $6.6 \times 10^4\,\text{N}$
(d) $66\,\text{N}$
(e) $861\,\text{N}$

_____ 16. A $10.0\,\text{kg}$ crate initially at rest on a floor with a static and kinetic friction coefficient of 0.20 is pushed with a force of $15\,\text{N}$ for $4.0\,\text{s}$. The net work done (total work done by all forces) on the crate is:

(a) 0
(b) $10\,\text{J}$
(c) $15\,\text{J}$
(d) $60\,\text{J}$
(e) $600\,\text{J}$

_____ 17. When exiting a highway, a car slowed down from $108\,\text{km/h}$ to $90\,\text{km/h}$ over the course of $4.0\,\text{s}$. The force of the brakes was $1000\,\text{N}$. What is the work done by the brakes on the car?

(a) $4000\,\text{J}$
(b) $-4000\,\text{J}$
(c) $110\,000\,\text{J}$
(d) $-110\,000\,\text{J}$
(e) none of the above

_____ 18. In moving an object of mass $10\,\text{kg}$ through a distance of $8.0\,\text{m}$, $40\,\text{J}$ of work is done. The average force exerted is:

(a) $4.0\,\text{N}$
(b) $80\,\text{N}$
(c) $320\,\text{N}$
(d) $400\,\text{N}$
(e) $5.0\,\text{N}$

_____ 19. What is the kinetic energy of a $20\,\text{kg}$ object moving at a speed of $10\,\text{m/s}$?

(a) $100\,\text{J}$
(b) $200\,\text{J}$
(c) $1000\,\text{J}$
(d) $2000\,\text{J}$
(e) $500\,\text{J}$

_____ 20. The gravitational potential energy of a sparrow of mass $40\,\text{g}$ resting on a tree branch of height $15\,\text{m}$ is approximately: (use $E_g = 0$ on the ground)

(a) $0.60\,\text{J}$
(b) $5.9\,\text{J}$
(c) $390\,\text{J}$
(d) $600\,\text{J}$
(e) $5.9\,\text{kJ}$

_____ 21. Two objects (m_1 and m_2) have the same mass. m_1 is travelling twice as fast as m_2. The work that must be done to stop m_1 compared to m_2 is:

(a) two times greater
(b) the same
(c) four times greater
(d) half as great
(e) one quarter as great

_____ 22. When a rock is thrown straight up in the air, after it leaves the hand, the rock begins to slow down. This occurs because:

(a) the rock is gaining potential energy as it rises, and thus it must lose kinetic energy.
(b) the force of gravity acting on the rock increases as the rock rises.
(c) the forces acting on the rock are balanced.
(d) the potential energy of the rock decreases as the rock rises.

_____ 23. A $2.5\,\text{kg}$ mass at rest on a horizontal surface is acted upon by an applied horizontal force of $150\,\text{N}$. A frictional force also acts on the mass. How much work is done on the mass?

(a) 0
(b) $30\,\text{J}$
(c) $50\,\text{J}$
(d) $60\,\text{J}$
(e) $125\,\text{J}$

_____ 24. A mass of $10\,\text{kg}$, initially at rest on a horizontal friction-less surface, is acted upon by a horizontal force of $25\,\text{N}$. The speed of the mass after it has moved $5.0\,\text{m}$ is:

(a) $5.0\,\text{m/s}$
(b) $10\,\text{m/s}$
(c) $15\,\text{m/s}$
(d) $125\,\text{m/s}$
(e) $250\,\text{m/s}$

_____ 25. Galileo drops a $100\,\text{kg}$ cannonball from the top of the Tower of Pisa, at a height of $57\,\text{m}$. The kinetic energy just before striking the ground is approximately:

(a) $1.8\,\text{J}$
(b) $17\,\text{J}$
(c) $5.7 \times 10^3\,\text{J}$
(d) $5.6 \times 10^4\,\text{J}$
(e) $981\,\text{J}$

_____ 26. A $300\,\text{N}$ force is applied horizontally to a $50\,\text{kg}$ crate pushing it $2.0\,\text{m}$. The force of friction between the crate and the floor is $200\,\text{N}$. The work done by the *applied force* is:

(a) $200\,\text{J}$
(b) $400\,\text{J}$
(c) $600\,\text{J}$
(d) $980\,\text{J}$
(e) none of the above

_____ 27. A $300\,\text{N}$ force is applied horizontally to a $50\,\text{kg}$ crate pushing it $2.0\,\text{m}$. The force of friction between the crate and the floor is $200\,\text{N}$. The work done by the *frictional force* is:

(a) $200\,\text{J}$
(b) $-400\,\text{J}$
(c) $-600\,\text{J}$
(d) $980\,\text{J}$
(e) none of the above

_____ 28. Electrons with a speed of $1.0 \times 10^7\,\text{m/s}$ strike the screen of a television set. With what kinetic energy does a single electron hit the screen? (mass of electron is $9.11 \times 10^{-31}\,\text{kg}$)

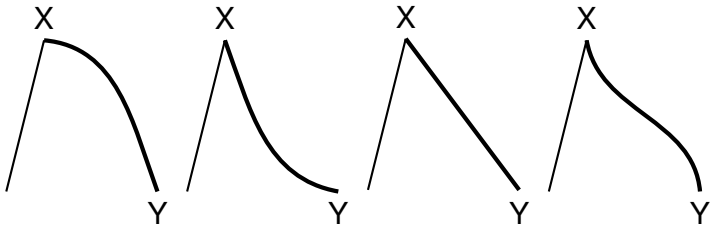
(a) $9.0 \times 10^{-38}\,\text{J}$
(b) $4.6 \times 10^{-17}\,\text{J}$
(c) $4.5 \times 10^{-24}\,\text{J}$
(d) $9.0 \times 10^{-17}\,\text{J}$
(e) $9.0 \times 10^{-24}\,\text{J}$

_____ 29. A Tesla Model S has a mass of $2000\,\text{kg}$. When it is travelling at $90\,\text{km/h}$, it has a kinetic energy of:

(a) $2.50 \times 10^4\,\text{J}$
(b) $9.00 \times 10^4\,\text{J}$
(c) $6.25 \times 10^5\,\text{J}$
(d) $8.10 \times 10^6\,\text{J}$
(e) $1.25 \times 10^6\,\text{J}$

_____ 30. A girl wants to slide down a “friction-less” playground slide. If she starts at rest from “X” and slides down to “Y”, which of the following slide shapes will give the girl the greatest possible speed upon reaching “Y”? All the slides have the same vertical height.

(a) A
(b) B
(c) C
(d) D
(e) She gets to the bottom of all the slides with the same speed.



_____ 31. A toy rocket engine generates a force (“thrust”) of $300\,\text{N}$ horizontally to the right against a $50\,\text{kg}$ rocket. The force of air resistance (“drag”) is $200\,\text{N}$. If the rocket travels horizontally $2.0\,\text{m}$, the kinetic energy gained by the rocket is approximately:

(a) $200\,\text{J}$
(b) $400\,\text{J}$
(c) $600\,\text{J}$
(d) $980\,\text{J}$
(e) none of the above