		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

ATTENTION:Each question has only one correct answer and is worth one point. Be sure to fill in completely the circle that corresponds to your answer on the answer sheet. Use a pencil (not a pen). Only the answers on your answer sheet will be taken into account.

1. A curling stone of mass 20 kg is given an initial velocity on the ice of 2 m/s. The coefficient of kinetic friction between the stone and the ice is 0.01. How far does the stone slide before it stops?

(a) 160 m (b) 20 m (c) 40 m (d) 200 m (e) 80 m

2. Which of the following is not a valid potential energy function for the spring force $F = -kx$?

(a) $(1/2)kx^2$ (b) $(1/2)kx^2 + 10J$ (c) $(1/2)kx^2 - 10J$ (d) None of the above is valid (e) $(-1/2)kx^2$

3. Which one is correct about the force $\vec{F} = Cy^2\hat{j}$ where C is a negative constant?

(a) This force never becomes zero (b) Unit of constant C is $N.m^2$ (c) F is a non-conservative force (d) F is a conservative force (e) Potential energy due to this force is equal to $-2Cy$

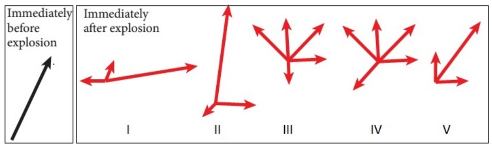
4. You use your hand to stretch a spring to a displacement x from its equilibrium position and then slowly bring it back to that position. Which is true for the whole process?

(a) None of the above statements is true. (b) The spring's ΔU is positive. (c) The spring's ΔU is negative. (d) The hand's ΔU is negative. (e) The hand's ΔU is positive.

5. Which of the following is a unit of energy?

(a) kilowatt-hour (b) newton-meter (c) joule (d) kgm^2/s^2 (e) all of the given

6. A fireworks projectile is traveling upward as shown on the right in the figure just before it explodes. Sets of possible momentum vectors for the shell fragments immediately after the explosion are shown. Which sets could actually occur?



(a) IV (b) V (c) III (d) I (e) II

7. Rank the following objects in terms of kinetic energy. Which case defines the highest energy?

(a) A 10-kg cannonball with a speed of 120 m/s (b) A 120-kg American football player with a speed of 10 m/s (c) A proton with a mass of 6.10^{-27} kg and a speed of 2.10^8 m/s (d) An asteroid with mass 10^6 kg and speed 500 m/s (e) A high-speed train with a mass of 180,000 kg and a speed of 300 km/h

8. Two objects with masses m_1 and m_2 are moving along the x-axis in the positive direction with speeds v_1 and v_2, respectively, where v_1 is less than v_2. The speed of the center of mass of this system of two bodies is

(a) less than v_1. (b) equal to v_1. (c) greater than v_1 and less than v_2. (d) equal to the average of v_1 and v_2. (e) greater than v_2.

9. Starting at t=0, a horizontal net force $\vec{F} = 0.4t\hat{i} - 0.6t^2\hat{j}$ is applied to a box that has an initial momentum $\vec{p} = -3\hat{i} + 4\hat{j}$. What is the momentum of the box at t=2.00 s?

(a) $2.4\hat{i} + 2.2\hat{j}$ (b) $2.2\hat{i} - 2.2\hat{j}$ (c) $-2.2\hat{i} + 2.4\hat{j}$ (d) $2.4\hat{i} - 2.2\hat{j}$ (e) $2.2\hat{i} + 2.4\hat{j}$

10. A ball attached to the end of a string is swung around in a circular path of radius r. If the radius is doubled and the linear speed is kept constant, the centripetal acceleration

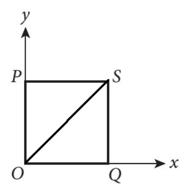
(a) increases by a factor of 2. (b) decreases by a factor of 4. (c) decreases by a factor of 2. (d) increases by a factor of 4. (e) remains the same.

11. A one-dimensional rod has a linear density that varies with position according to the relationship $\lambda(x) = cx$, where c is a constant and $x = 0$ is the left end of the rod. Where do you expect the center of mass to be located?

(a) To the left of the middle of the rod (b) At the right end of the rod (c) The middle of the rod (d) At the left end of the rod (e) To the right of the middle of the rod

Questions 12-14

A variable force acting on a 1.0 kg particle moving in the xy-plane is given by $F(x, y) = (x^2\hat{i} + y^2\hat{j})$ N, where x and y are in meters. Suppose that due to this force, the particle moves from the origin, O, to point S, with coordinates (3 m,3 m). The coordinates of points P and Q are (0 m,3 m) and (3 m,0 m), respectively.



12. What is the work performed by the force as the particle moves along the path O-P-S ?

(a) 36 J (b) 0.9 J (c) 27 J (d) 9 J (e) 18 J

13. What is the work performed by the force as the particle moves along the path O-S ?

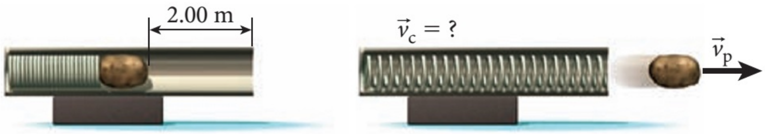
(a) 18 J (b) 9 J (c) 36 J (d) 0.9 J (e) 27 J

14. Now assume there is friction between the particle and the xy-plane, with μ=0,1. Determine the net work done by all forces on this particle when it takes OPS path. Take $g = 10.0m/s^2$.

(a) 9 J (b) -6 J (c) 18 J (d) 12 J (e) 24 J

Questions 15-19

A potato cannon is used to launch a potato on a frozen lake, as shown in the figure. The mass of the cannon, m_c, is 10 kg, and the mass of the potato, m_p, is 1.0 kg. The cannon's spring (with spring constant $k = 1.10^2$ N/m) is compressed 2.0 m. Prior to launching the potato, the cannon is at rest. The potato leaves the cannon's muzzle moving horizontally to the right. Neglect the effects of the potato spinning. Assume there is no friction between the cannon and the lake's ice or between the cannon barrel and the potato.



15. What are the direction and magnitude of the cannon's velocity, v_c, after the potato leaves the muzzle?

(a) Cannon does not move (b) To the left with $\sqrt{20/11}$ m/s (c) To left with $\sqrt{40/11}$ m/s (d) To the left with $\sqrt{30/11}$ m/s (e) To the right with $\sqrt{20/11}$ m/s

16. What is the total mechanical energy of the potato/cannon system before firing of the potato?

(a) 0 J (b) 100 J (c) 300 J (d) 200 J (e) 400 J

17. What is the total mechanical energy of the potato/cannon system after firing of the potato?

(a) 300 J (b) 200 J (c) 400 J (d) 0 J (e) 100 J

For questions 18 and 19:

Now, the normal force acting on the potato is constant through the motion of the potato in the muzzle and it is 20 N and kinetic friction coefficient between the muzzle and the potato is 0.5;

18. What are the direction and magnitude of the cannon's velocity, v_c, after the potato leaves the muzzle?

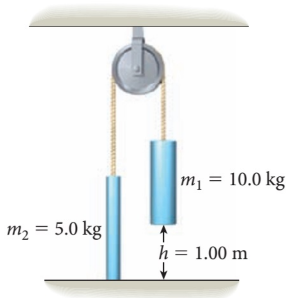
(a) To left with $\sqrt{38/11}$ m/s (b) To the right with $\sqrt{19/11}$ m/s (c) To the left with $\sqrt{19/11}$ m/s (d) To the left with $\sqrt{28/11}$ m/s (e) Cannon does not move

19. What is the total mechanical energy of the potato/cannon system after the potato leaves the muzzle?

(a) 190 J (b) 0 J (c) 200 J (d) 90 J (e) 290 J

Questions 20-21

Two masses are connected by a light string that goes over a light, frictionless pulley, as shown in the figure. The 10.0-kg mass is released and falls through a vertical distance of 1.00 m before hitting the ground. Take $g = 10.0m/s^2$.



20. How fast the 5.00-kg mass is moving just before the 10.0-kg mass hits the ground?

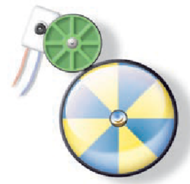
(a) $\sqrt{20/3}$ m/s (b) $\sqrt{2/3}$ m/s (c) 2/3 m/s (d) 4/3 m/s (e) $\sqrt{4/3}$ m/s

21. What is the maximum height attained by the 5.00-kg mass.

(a) 2/3 m (b) 3/2 m (c) 1 m (d) 4/3 m (e) 5/2 m

Questions 22-25

In a department store toy display, a small disk (disk 1) of radius 0.100 m is driven by a motor and turns a larger disk (disk 2) of radius 0.500 m. Disk 2, in turn, drives disk 3, whose radius is 1.00 m. The three disks are in contact, and there is no slipping. Disk 3 is observed to sweep through one complete revolution every 30.0 s. Take $\pi = 3$.



22. What is the angular speed of disk 3?

(a) 0.4 rad/s (b) 2 rad/s (c) 0.1 rad/s (d) 0.2 rad/s (e) 10 rad/s

23. What is the ratio of (disk1/disk2/disk3) the tangential velocities of the rims of the three disks?

(a) 1/2/10 (b) 10/2/1 (c) 5/2/1 (d) 1/2/5 (e) 1/1/1

24. What is the angular speed of disks 1 and 2?

(a) 0.2 and 0.4 rad/s (b) 0.4 and 0.2 rad/s (c) 2.0 and 0.2 rad/s (d) 0.4 and 2.0 rad/s (e) 2.0 and 0.4 rad/s

25. If the motor malfunctions, resulting in an angular acceleration of 0.100 rad/s^2 for disk 1, what are disks 2 and 3's angular accelerations?

(a) 20 and 20 $mrad/s^2$ (b) 100 and 200 $mrad/s^2$ (c) 10 and 20 $mrad/s^2$ (d) 10 and 10 $mrad/s^2$ (e) 20 and 10 $mrad/s^2$