Physics 53 Exam 2 Dr. Alward Wednesday, March 4, 2009

1. Three hanging masses connected by strings (see figure) are pulled upward by a hand exerting a 200 N force What is the tension (in N) in the string connecting the 7-kg and the 2-kg masses? (Don't forget to account for gravity.)

(a) 34.35
(b) 18.45
(c) 83.35
(d) 64.22
(e) None of these

2. A force of 400 N acting at an angle θ above the horizontal pulls a 10 kg block along a horizontal surface. The coefficient of kinetic friction is 0.20. What must be θ, in degrees, to cause the block to have an acceleration of 4 m/s^2?

(a) 19.19
(b) 22.41
(c) 28.43
(d) 65.96
(e) None of these

3. Three forces in a plane act on a 4-kg mass. The magnitudes (in newtons) and directions in degrees measured with respect to the positive x-axis, rotated counter-clockwise, are **A** = <100, 40º>, **B** = <140, 220º>, and **C** = <80, 300º>. What is the acceleration of the mass, in m/s^2?

(a) 23.86
(b) 11.56
(c) 34.90
(d) 27.32
(e) None of these

4. A 5-kg block is sliding down an inclined plane. The angle between the incline and the horizontal is 23º. The coefficient of kinetic friction between the block and the plane is 0.20. What is the acceleration of the block, in m/s^2?

(a) zero
(b) 2.98
(c) 3.03
(d) 3.26
(e) None of these

5. A rope of length 2.2 m has a "breaking strength" of 3000 N. A 5-kg ball is rotating in a *horizontal* circle at the end of this rope. What is the maximum number of revolutions per minute this rope and ball can make without breaking the rope?

(a) 157.70
(b) 145.32
(c) 111.90
(d) 88.78
(e) None of these

6. How quickly (in seconds) could a 2000 W machine lift a 100-kg object on the ground to the top of 40-m building, assuming the object is lifted at constant speed?

(a) 581
(b) 234
(c) 49
(d) 196
(e) None of these

7. A horizontal force acting on an object varies with position according to the equation $F(x) = 4 + 2x$, where F is in newtons, and x is in meters. How much work in joules will this force do as the object moves from $x = 0$ m to $x = 3$ m?

(a) 25
(b) 19
(c) 40
(d) 64
(e) None of these

8. A 40-kg object at the origin ($x = 0$), moving horizontally to the right at 20 m/s, is acted on by a force that varies with position according to $F(x) = 500 + 30xe^{-0.2x}$, where F is in newtons, and x is in meters. What will be the speed of the object (in m/s) when it's at $x = 5$ m?

(a) 29.45
(b) 23.13
(c) 34.56
(d) 78.45
(e) None of these

9. The power output of a machine varies with time according to the equation, $P(t) = 1000/(t + 3)$, where P is in watts, and t is in seconds. How much work (in joules) will the machine do from $t = 2$ s to $t = 5$ s?

(a) 567.50
(b) 470.00
(c) 810.00
(d) 500.00
(e) None of these

10. A 3-kg ball at the end of a 4-m long string revolves on a frictionless table top at constant speed in a vertical circle at the rate of 10 revolutions per minute. What work (in joules) does the string do on the ball during one revolution?

(a) zero
(b) 45.67
(c) 108.90
(d) 66.78
(e) None of these

11. A 10-kg block is pulled up an inclined plane by a rope exerting a 200 N force parallel to the incline. The angle between the incline and the horizontal is 30º. The coefficient of friction between the block and the plane is 0.20. What total work (in joules) will have been done on the block after it has been moved 4 meters up the plane?

(a) 643.89
(b) 543.32
(c) 403.90
(d) 536.10
(e) None of these

12. A 6-kg object falling from rest from a height of 300 meters acquires a speed 70 m/s just before striking the ground. What is the magnitude of the work done (in joules) on the object by air resistance?

(a) 3260
(b) 2940
(c) 4120
(d) 6040
(e) None of these

13. The potential energy function associated with a conservative force is given by the equation, $U(x,y,z) = -5x^2ye^{2z}$, where U is in joules, and x, y, and z are in meters. What is the magnitude of the force at the coordinates (-2, 1, 0)?

(a) 48.99
(b) 34.59
(c) 67.83
(d) 123.59
(e) None of these

14. A spring with spring constant k = 500 N/m is aligned vertically. Atop the spring, a 3-kg mass is pressed downward, compressing the spring by 0.40 m, but is not attached to the spring. When the mass is released, it shoots upward, leaves the spring and reaches a certain maximum height above the location of the top of the spring before the mass was placed on it. What is the maximum height, in meters?

(a) 1.22
(b) 1.78
(c) 0.96
(d) 0.57
(e) None of these

15. The force on an object is given by $F(x) = -2x^2e^x$, where F is in newtons, and x is in meters. What is the change in the object's potential energy (in joules) when the object moves from x = 2.1 m, to x = 2.5 m?

(a) 49.78
(b) 123.45
(c) 43.09
(d) 122.89
(e) None of these

16. A 4-kg object sliding at speed 5 m/s along smooth horizontal surface (see figure) encounters a rough surface, 1.5 meters wide. The coefficient of kinetic friction over the rough surface is 0.20. After leaving the rough surface, the object continues over smooth surface until it strikes the end of a horizontally-aligned spring, whose spring constant is 200 N/m, and whose opposite end is attached to a wall. What will be the maximum compression of the spring, in meters?

(a) 0.62
(b) 0.88
(c) 0.98
(d) 1.17
(e) None of these

17. A rod of length 2.4 meters is of non-uniform density, having a linear density in kg/m given by the equation, $\lambda(x) = 50 + 8x^2$, where λ is in kg/m, and x is in meters, where x is measured from the left end of the rod, where the density is least. Where is the x-coordinate of the center of mass of the rod, in meters?

(a) 2.28
(b) 2.19
(c) 1.89
(d) 1.46
(e) None of these

18. An object of mass 60 kg moving to the right at 20 m/s collides head-on with a 40 kg object moving to the left at a speed of 20 m/s. The objects stick together. How much of the original total energy (in joules) of the objects before collision was "lost" during the collision i.e., used to deform the objects and create heat and sound, and other forms of energy?

(a) 12.600
(b) 6,800
(c) 19,200
(d) 9.600
(e) None of these

19. A pitched ball having a mass of 200 grams (0.200 kg), moving at 55 m/s, is struck by a bat that delivers an impulse of magnitude 27 kg-m/s, in the opposite direction. What is the speed (in m/s) of the ball after it leaves the bat?

(a) 45
(b) 55
(c) 66
(d) 80
(e) None of these

20. An object moving at unspecified speed to the right along the x-axis, suffers a glancing blow with an object of equal mass at the origin. One of the objects moves at speed 37.50 m/s at an angle of 30º above the x-axis, while the other moves at an angle of 60º below the x-axis. What is the speed (in m/s) of the object that travels below the x-axis?

(a) 25.00
(b) 21.65
(c) 12.55
(d) 18.50
(e) None of these