Physics 53
Final Exam
December 14, 2012
(100 points)

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Last Name First Name

- Sharing calculators is strictly forbidden.
- Using any other electronic device--including a cell phone--during the examination is also forbidden.
- Tear off this answer sheet before beginning. Only the answer sheet will be turned in.
- Write your name on this sheet twice; once above, and again on the back of this sheet.
- Please do not circle your answers. Use a pencil to darken the letter of your choice.
- Each question is worth three points. Everyone gets one free point.
- Exam ends at 11:00 am Do not wait until time is called to mark your answers.
- Place your answer sheet in the *lecture hall* (Room 120) in the plastic box on the lecture table.
- You may keep the questions sheets.

1.	(a)	(b)	(c)	(d)	(e)	14.	(a)	(b)	(c)	(d)	(e)	27.	(a)	(b)	(c)	(d)	(e)
2.	(a)	(b)	(c)	(d)	(e)	15.	(a)	(b)	(c)	(d)	(e)	28.	(a)	(b)	(c)	(d)	(e)
3.	(a)	(b)	(c)	(d)	(e)	16.	(a)	(b)	(c)	(d)	(e)	29.	(a)	(b)	(c)	(d)	(e)
4.	(a)	(b)	(c)	(d)	(e)	17.	(a)	(b)	(c)	(d)	(e)	30.	(a)	(b)	(c)	(d)	(e)
5.	(a)	(b)	(c)	(d)	(e)	18.	(a)	(b)	(c)	(d)	(e)	31.	(a)	(b)	(c)	(d)	(e)
6.	(a)	(b)	(c)	(d)	(e)	19.	(a)	(b)	(c)	(d)	(e)	32.	(a)	(b)	(c)	(d)	(e)
7.	(a)	(b)	(c)	(d)	(e)	20.	(a)	(b)	(c)	(d)	(e)	33.	(a)	(b)	(c)	(d)	(e)
8.	(a)	(b)	(c)	(d)	(e)	21.	(a)	(b)	(c)	(d)	(e)						
9.	(a)	(b)	(c)	(d)	(e)	22.	(a)	(b)	(c)	(d)	(e)						
10.	(a)	(b)	(c)	(d)	(e)	23.	(a)	(b)	(c)	(d)	(e)						
11.	(a)	(b)	(c)	(d)	(e)	24.	(a)	(b)	(c)	(d)	(e)						
12.	(a)	(b)	(c)	(d)	(e)	25.	(a)	(b)	(c)	(d)	(e)						
13.	(a)	(b)	(c)	(d)	(e)	26.	(a)	(b)	(c)	(d)	(e)						

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1. The x-coordinate of an 4-kg object moving along the x-axis is given in meters by the equation $x(t) = 200 - 6t + 2t^2$, where t is measured in seconds. How much work (in joules) will have been done on this object in the first three seconds?

a) 72
b) 64
c) 48
d) 24
e) None of these

2. The velocity of an object is $v(t) = 3t^2$, where v is in m/s, and t is in seconds. When t = 0, the object's x-coordinate was 8 m. What will be the object's x-coordinate (in meters) when t = 2.0 s?

a) 24
b) 16
c) 64
d) 72
e) None of these

3. The acceleration of an object is $a = 6t$, where a is in m/s^2, and t is in seconds. The velocity of the object at t = 0 was -10 m/s. What will be its velocity (in m/s) at t =2.0 seconds?

a) 2.0
b) 3.0
c) 4.0
d) 6.0
e) None of these

4. Two forces act on an object. Their directions are given relative to the compass directions. One force has a magnitude of 600 N and is directed 60 degrees north of east. The second force has a magnitude of 900 N and is directed 20 degrees west of north. What is the magnitude (in N) of the total force acting on the object? (Set your MODE to Degrees.)

a) 1367
b) 1165
c) 1243
d) 1201
e) None of these

5. An object slows down at the rate of -4 m/s^2. It travels 450 meters before coming to rest. What must have been its initial velocity (in m/s)?

a) 20
b) 18
c) 42
d) 60
e) None of these

6. During a certain period of time the velocity of an object moving along the x-axis increased uniformly over a 60-second period from an initial velocity of -30 m/s to its final velocity, and during this time its displacement is 2700 m. What was the final velocity, in m/s?

a) 90
b) 60
c) 80
d) 120
e) None of these

7. A bomber pilot flying at an angle of 20 degrees above the horizontal at 200 m/s at an elevation of 4900 m drops a bomb over level ground. How far horizontally (in meters) will the bomb travel before striking the ground?

a) 1800
b) 3860
c) 1790
d) 3280
e) None of these

8. An artillery projectile is fired from level ground toward the face of a tall vertical cliff 1000 meters away. The initial speed of the projectile is 500 m/s. At what angle (in degrees) should the projectile be fired in order to strike the cliff 200 m above the ground?

a) 19.2
b) 41.5
c) 12.3
d) 31.9
e) None of these

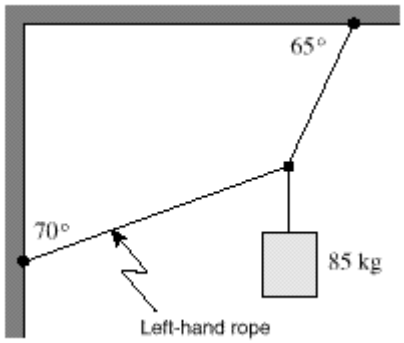
9. An object initially moving at 16 m/s at the origin at time t = 0 begins to accelerate according to the equation, a(t) = 4t. What will be the object's x-coordinate (in m) at time t = 3.00 s?

a) 33
b) 66
c) 54
d) 38
e) None of these

10. A block is on an icy (frictionless) slope that is 30 degrees above the horizontal. When a 40-N force, parallel to the incline and directed up the incline, is applied to the block, the acceleration of the sled is 2.0 m/s^2 up the incline. The approximate mass (in kg) of the block is:

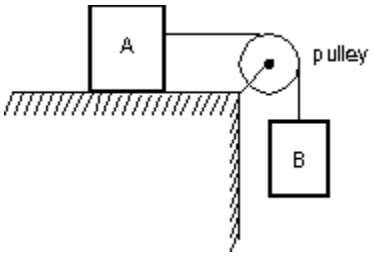
a) 7.3
b) 6.5
c) 5.4
d) 5.8
e) None of these

11. What is the approximate tension (in N) in the rope on the left?



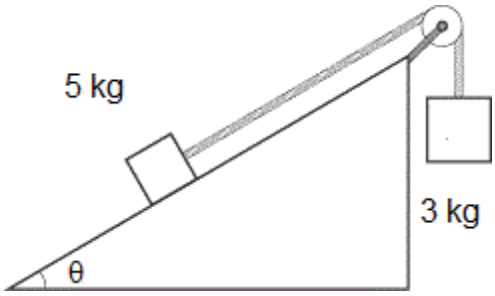
a) 500
b) 450
c) 550
d) 490
e) None of these

12. Block A is connected to block B by a string that passes over a frictionless, massless pulley. Block A is sliding to the right. The coefficient of kinetic friction between Block A and the table is 0.40. The mass of Block A is 50 kg, and the mass of Block B is 30 kg. What is the approximate tension (in N) in the string?



a) 260
b) 350
c) 290
d) 310
e) None of these

13. The 5-kg block in the figure is sliding down a ramp whose coefficient of kinetic friction is 0.10. The ramp angle θ is 70 degrees. What is the approximate acceleration of the 5-kg block (in m/s^2)?



a) 1.9
b) 2.1
c) 2.5
d) 2.8
e) None of these

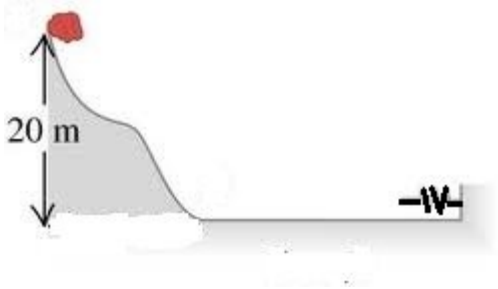
14. A 2-kg block attached to an ideal spring with a spring constant of 1000 N/m oscillates on a horizontal frictionless surface. When the spring is 0.4 m longer than its equilibrium (relaxed) length, the speed of the block is 3.0 m/s. The greatest amount of stretching of the spring (in meters) is:

a) 0.44
b) 0.96
c) 1.12
d) 1.34
e) None of these

15. A mass m moving to the right with velocity v collides head-on with a stationary object of mass 3 m. The collision is elastic. What will be the velocity of the lighter object after collision?

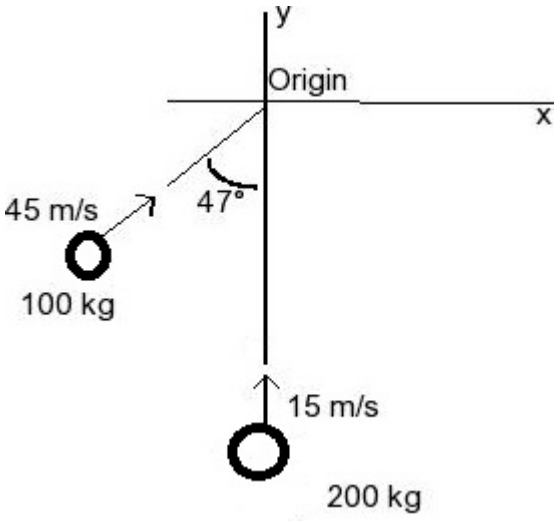
a) -v
b) -v/2
c) v/3
d) v/4
e) None of these

16. An object of mass 10 kg slides from rest down the hill in the figure, toward the spring. The spring constant is 1000 N/m. When the object has come to rest against the spring, the spring is compressed by 0.40 m. What is the magnitude of the non-conservative work (i.e., work due to friction), in joules, that was done on the object?



a) 1880
b) 1640
c) 1040
d) 960
e) None of these

17. The objects in the figure collide at the origin and stick together. What is the direction of travel of the combined object after collision, as measured in degrees above the x-axis?



a) 65.2
b) 61.5
c) 59.5
d) 56.7
e) None of these

18. An object of mass 4 kg is moving at x = 0 in along the x-axis at a velocity of 5 m/s when a net force given by F(x) = 5x begins to act on the object. What will be the object's velocity (in m/s) after it has traveled 6.0 meters?

a) 6.5
b) 7.8
c) 8.2
d) 8.4
e) None of these

19. A rod of length 3L has a linear mass density that varies according to the equation, $\rho(x) = ax$, where a is a constant, x is in meters, and ρ is in kg/m. What is the rotational inertia I of this rod about an axis that is perpendicular to the rod and passes through a point on the rod that is a distance L from the left end?

a) $15aL^4/4$
b) $9aL^2/2$
c) $8aL^3/3$
d) $7aL^2/2$
e) None of these

20. A disk starts from rest and rotates around a fixed axis, subject to a constant net torque. The work done by the torque during the first six radians of rotation is what multiple of the work done during the first two radians?

a) 1
b) 2
c) 4
d) 3
e) None of these

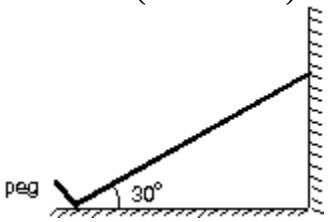
21. The torque acting on an object initially rotating at 3 rad/s at $\theta = 0$ is given by the equation, $\tau = 2\theta$, where θ is in radians, and is in τ is in m-N. The object's rotational inertia is 0.64 kg-m^2. What will be the object's rotational kinetic energy (in joules) after it has rotated through π radians?

a) 9.44
b) 10.97
c) 11.24
d) 12.75
e) None of these

22. The position vector **r** of a 3-kg particle, relative to the origin, and measured in meters, is given by $\mathbf{r} = < 2t^2, 3t, 0>$, where , r is in meters, and t is in seconds. The terms inside the angle brackets represent the time-varying x, y, and z components of the position vector. What is the speed (in m/s) of the particle at time t = 2 seconds?

a) 8.54
b) 6.56
c) 4.44
d) 9.08
e) None of these

23. A uniform ladder is 8 m long and weighs 400 N. It rests with its upper end against a frictionless vertical wall. Its lower end rests on the ground and is prevented from slipping by a peg driven into the ground. The ladder makes a 30 degree angle with the horizontal. The force (in newtons) exerted by the peg on the ladder is



a) 302
b) 312
c) 346
d) 389
e) None of these

24. A machine exerts a torque of 0.80 N·m on an object that is rotating with a constant angular velocity of 20 rad/s. What is the work done (in joules) on the object by the machine in 50 seconds?

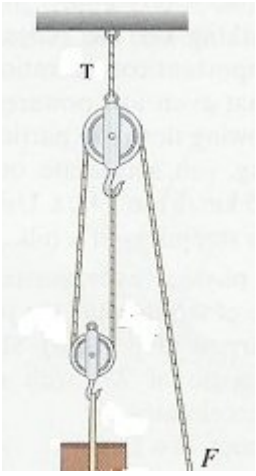
a) 120
b) 300
c) 800
d) 900
e) None of these

25. An asteroid 9.0×10^7 m from the center of Earth is moving toward Earth at 5000 m/s. What will be its approximate speed (in m/s) when it reaches Earth?

Note: $G = 6.67 \times 10^{-11}$ N-m^2/kg^2, and the mass of Earth is $M = 5.98 \times 10^{24}$ m, and the radius of Earth is 6.38×10^6 m.

a) 19,000
b) 20,000
c) 12,000
d) 17,000
e) None of these

26. A 3000 newton crate is held stationary by the pulley system below. A person is exerting a downward force F sufficient to hold the crate stationary. (The pulleys have zero masses and zero rotational inertias.) What is the tension T in the upper rope, in newtons?



a) 4500
b) 3000
c) 2000
d) 1500
e) None of these

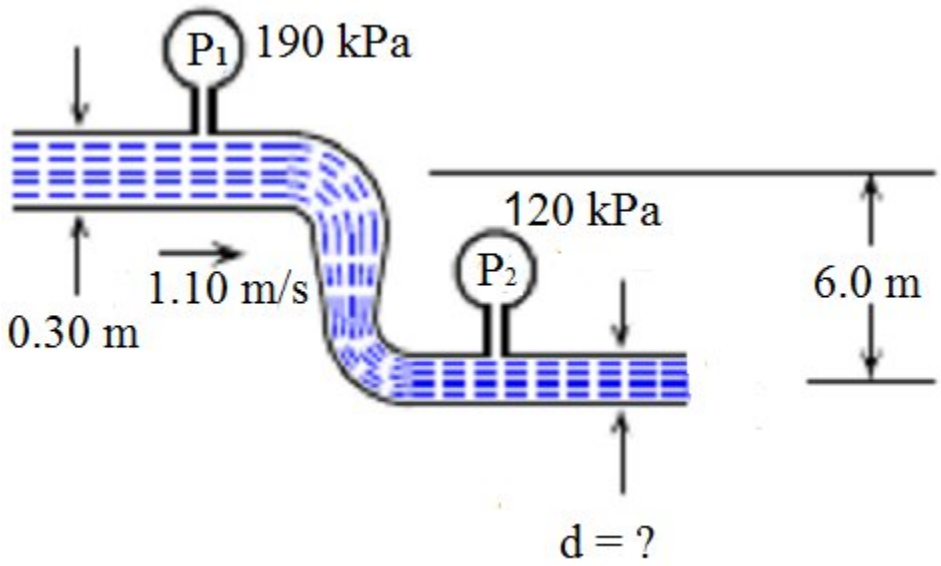
27. A wooden cubic block has a density of 600 kg/m^3. The length of each side of the cube is 0.20 m. How much force (in N) is required to push down on the block and hold it motionless completely under water?

(a) 45.98
(b) 78.44
(c) 156.80
(d) 31.36
(e) None of these

28. A block of mass m = 0.250 kg is oscillating at the end of a spring whose spring constant is 100 N/m. At time t = 0 the spring is compressed by 0.20 m and the block is moving to the left at a velocity of -6.0 m/s. What is the amplitude of the motion, in meters?

(a) 0.85
(b) 0.44
(c) 0.56
(d) 0.36
(e) None of these

29. The pressure in the water in the upper portion of the pipe below is 190,000 Pa, and the pressure in the lower portion of the pipe is 120,000 Pa. What is the diameter (in meters) of the lower pipe? Hint: first find the speed of the water in the lower pipe.



(a) 0.08
(b) 0.05
(c) 0.09
(d) 0.16
(e) None of these

30. The speed of waves on a 1.4 m rope held vertically is 3.2 m/s. The end closest to the ground is free to move, and the other end is oscillated by hand. What must be the frequency of oscillation of the hand in order to create a standing wave with four anti-nodes?

(a) 4.0
(b) 6.6
(c) 2.8
(d) 5.0
(e) None of these

31. A highway patrol car and a bus are traveling in opposite directions. The patrol car's speed is 50 m/s, and its siren frequency is 2200 hertz. What would have to be the approximate speed (in m/s) of the bus in order that the driver of the bus hear a frequency of 1700 hertz?

(a) 39
(b) 35
(c) 41
(d) 43
(e) None of these

32. Six hundred metal-stamping machines are arranged in a circle. At the center of the circle the sound level is 120 dB. How many machines would have to be turned off to reduce the sound level to 111 dB?

(a) 450
(b) 525
(c) 100
(d) 200
(e) None of these

33. Two sound sources separated by 25 m are broadcasting sound at a frequency 170 Hz, out of phase. A listener is positioned on a line connecting the speakers, 5 meters to the right from the nearest speaker, and 30 meters to the right from the other speaker. What is the least additional distance (in meters) to the right the listener has to move away from the nearest speaker in order to hear maximum sound?

(a) 1.5
(b) 2.0
(c) 1.0
(d) 0.5
(e) None of these