UNIVERSITY OF MANITOBA

December 10, 2009 (9:00 am – 12:00 pm)	FINAL EXAMINATION
PAPER NO.: 21	PAGE NO.: 1 of 5 (+ formula sheet)
COURSE NO.: PHYS 1050	TIME: 3 hours
EXAMINATION: Physics 1: Mechanics	EXAMINERS: F. Lin, C-M. Hu, G. Williams

All questions are of equal value. Answer all questions. No marks are subtracted for wrong answers.

Record all answers on the computer score sheet provided. **USE PENCIL ONLY!** Black pen will look good but may not be read reliably by the scoring machine. **Mark only <u>one</u> answer for each question!** Select the answer that is closest to yours.

A formula sheet is provided for your use; you may **not** use your own formula sheet or any other materials or notes. Calculators of any type are allowed, but not devices that store text or that can communicate with other such devices.

Be sure your name and student number are printed on the score sheet and the student number correctly coded in the box at the top right-hand side of the sheet.

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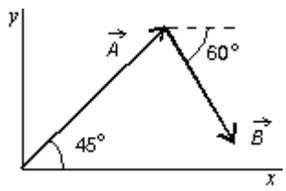
1. The x coordinate of an automobile in meters is given by $x(t) = 20t^2 - 10t^3 + 109t$ where t is in seconds. At time $t = 2.0$ s the acceleration of the auto is:

   (a) 0 m/s^2 (b) 69 m/s^2 (c) –80 m/s^2 (d) 218 m/s^2 (e) –95 m/s^2

2. In the diagram, $\vec{A}$ has magnitude 10 and $\vec{B}$ has magnitude 7. The y component of $\vec{A}+\vec{B}$ is about:

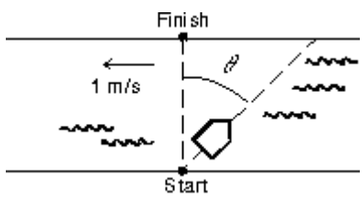


   (a) 1.0 m (b) 13.1 m (c) 3 m (d) 17 m (e) -3 m

3. A projectile is fired over level ground with an initial velocity that has a vertical component of 20 m/s and a horizontal component of 30 m/s. Using $g = 10$ m/s^2, the horizontal distance from the maximum height to the landing point is:

   (a) 40 m (b) 60 m (c) 80 m (d) 120 m (e) 180 m

4. A girl wishes to swim across a river to a point directly opposite as shown. She can swim at 2.5 m/s in still water and the river is flowing at 1 m/s. At what angle θ with respect to the line joining the starting and finishing points should she swim?



   (a) 30° (b) 45° (c) 23.6° (d) 66.5° (e) 21.8°

5. A massless rope passes over a massless pulley suspended from the ceiling. A 4-kg block is attached to one end and a 6-kg block is attached to the other end. The acceleration of the 4-kg block is: g is the gravitational acceleration.

   (a) g/4, up (b) g, down (c) g, up (d) g/5, up (e) g/9, down

6. A crate is initially at rest and then slide down a long incline that is 30° above the horizontal. If the coefficient of kinetic friction is 0.40, the speed of the crate after 5s is:

(a) 10 m/s (b) 2.4 m/s (c) 7.5 m/s (d) 8.8 m/s (e) 32.6 m/s

7. One end of a 2.0-m string is fixed, the other end is attached to a 4.0-kg stone. The stone swings in a vertical circle, passing the top point at 6.0 m/s. The tension force of the string (in newtons) at this point is about:

(a) 0 (b) 33 (c) 20 (d) 12 (e) 112

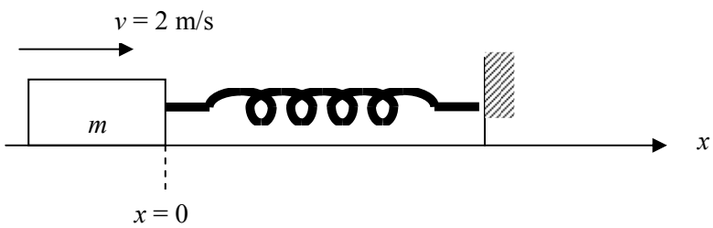
8. An ideal spring is hung vertically from the ceiling. When a 3.0-kg mass hangs at rest from it, the spring is extended 0.06 m from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 0.1 m. While the spring is being extended by the force, the work done by the spring is:

(a) –8.7 J (b) –5.4 J (c) -5.4×10^{-4} J (d) -540 J (e) 2.5 J

9. A 6×10^{-3} kg bullet is fired horizontally into a 20-kg block of wood suspended by a rope from the ceiling. The block swings in an arc, rising 3×10^{-3} m above its lowest position. The velocity of the bullet was:

(a) unknown since the heat generated in the collision was not given
(b) 8.0×10^{2} m/s
(c) 24.0 m/s
(d) 8.0 m/s
(e) 24×10^{4} m/s

10.



A mass $m = 0.1$ kg moves at speed $v = 2$ m/s at the instant it strikes a relaxed (unstretched) spring, as in the diagram above. If the spring constant is $k = 10$ N/m, what is the work done by the force of friction when the mass m first comes to rest momentarily if the coefficient of kinetic friction between the mass and the horizontal surface is $\mu_k = 0.4$.

(a) 6.5×10^{-2}J (b) -3.8×10^{2}J (c) -9.5×10^{-2}J (d) -6.5×10^{-2}J (e) -12.2×10^{-2}J

11. A wheel rotates about a fixed axis with an initial angular velocity of 20 rad/s. During a 5.0-s interval the angular velocity decreases to 10 rad/s. Assume that the angular acceleration is constant during the 5.0-s interval. How many radians does the wheel turn through during the 5.0-s interval?

(a) 95 rad (b) 85 rad (c) 65 rad (d) 75 rad (e) 125 rad

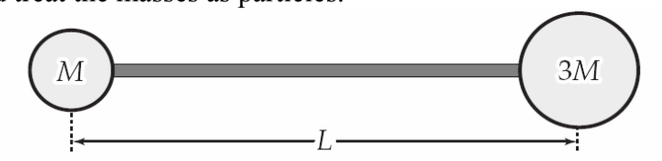
12. A thin uniform rod (length = 1.2 m, mass = 2.0 kg) is pivoted about a horizontal, frictionless pin through one end of the rod. (The moment of inertia of the rod about this axis is $ML^2/3$.) The rod is released when it makes an angle of 37° with the horizontal. What is the angular acceleration of the rod at the instant it is released?

(a) 9.8 rad/s^2 (b) 7.4 rad/s^2 (c) 8.4 rad/s^2 (d) 5.9 rad/s^2 (e) 6.5 rad/s^2

13. A disk (radius = 0.08 m) that rotates about a fixed axis starts from rest and accelerates at a constant rate to an angular velocity of 4.0 rad/s in 2.0 s. What is the magnitude of the total linear acceleration of a point on the rim of the disk at the instant when the angular velocity of the disk is 1.5 rad/s?

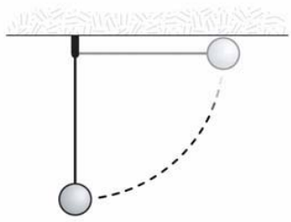
(a) 0.24 m/s^2 (b) 0.16 m/s^2 (c) 0.18 m/s^2 (d) 0.34 m/s^2 (e) 0.44 m/s^2

14. The rigid body shown rotates about an axis through its center of mass and perpendicular to the paper. If M = 2.0 kg and L = 0.8 m, what is the kinetic energy of this object when its angular speed about this axis is equal to 5.0 rad/s? Neglect the mass of the connecting rod and treat the masses as particles.



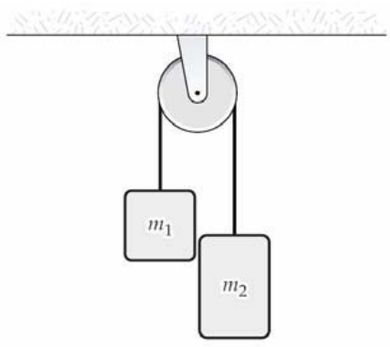
(a) 18 J (b) 15 J (c) 12 J (d) 23 J (e) 26 J

15. In the figure, a 1.6-kg weight swings in a vertical circle at the end of a string having negligible weight. The string is 2 m long. If the weight is released with zero initial velocity from a horizontal position, its angular momentum (in kg · m^2/s) at the lowest point of its path relative to the center of the circle is approximately



(a) 40 (b) 10 (c) 30 (d) 20 (e) 50

16. Two blocks, m_1 = 1.0 kg and m_2 = 2.0 kg, are connected by a light string as shown in the figure. If the radius of the pulley is 1.0 m and its moment of inertia is 5.0 kg · m^2, the acceleration of the system is



(a) (1/6)g
(b) (3/8)g
(c) (1/8)g
(d) (1/2)g
(e) (5/8)g

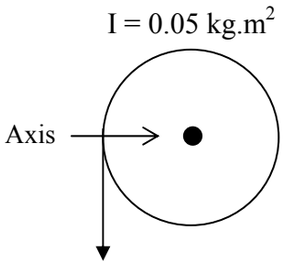
17. A merry-go-round of radius R = 2.0 m has a moment of inertia I = 250 kg · m^2, and is rotating at 10 rad/s. A child whose mass is 25 kg and initially at rest jumps onto the edge of the merry-go-round. The new angular speed (in rad/s) of the merry-go-round is approximately

(a) 10 (b) 9.2 (c) 8.5 (d) 7.1 (e) 6.4

18. A 3.0 kg object moving in the positive *x* direction has a one-dimensional elastic collision with a 5.0 kg object initially at rest. After the collision the 5.0 kg object has a velocity of 6.0 m/s in the positive *x* direction. What was the initial speed of the 3.0 kg object?

(a) 6.0 m/s (b) 7.0 m/s (c) 4.5 m/s (d) 8.0 m/s (e) 5.5 m/s

19. A cylinder of radius 0.15 m, has a rotational inertial of 0.05 kg.m^2 (around the axis of the cylinder, about which it can rotate). A massless, inextensible string is wound around the cylinder, as show below:



If the string is pulled with a force F = 5N, what is the angular acceleration of the cylinder about the axis of rotation (in rads/s^2 assuming the string does not slip on the cylinder.

(a) 7.5 (b) 15 (c) 10 (d) 12.5 (e) 9.0

20. A 2.0 kg block is initially at rest on the positive *x*-axis 2.0 m from the origin. It is acted on by a constant force $\vec{F} = (4.0\hat{i} - 4.0\hat{j})N$. After this force has acted for 3 s, what is the angular momentum of the block (in kg.m^2/s) about the origin?

(a) $+192\hat{k}$ (b) $-96\hat{k}$ (c) $-240\hat{k}$ (d) $-24\hat{k}$ (e) $-48\hat{k}$

21. Two discs, A and B, rotate about a common axis. Disc A has a rotational inertia (moment of inertia) of 10 kg.m^2 and Disc B 8 kg.m^2. Initially disc A is rotating at 20 rads/s while disc B is stationary. Disc B is then dropped onto disc A, so that they both end up rotating at a common angular speed. What is the rotational kinetic energy (in J) lost in this completely inelastic collision?

(a) zero (b) 2000 (c) 1111 (d) 889 (e) 1555

22.

Two galaxies, A and B, are both moving away from observers on Earth along the same line (the $\hat{i}$ direction). Earth observers measure the velocity of galaxy A as $(0.8c)\hat{i}$ and of galaxy B as $(0.7c)\hat{i}$. The velocity of galaxy B as measured by observers in galaxy A is:

(a) $(-0.1c)\hat{i}$ (b) $(0.1c)\hat{i}$ (c) $(-0.06c)\hat{i}$ (d) $(-0.23c)\hat{i}$ (e) $(0.23c)\hat{i}$

23. A meter stick moves in the direction of its length in a laboratory. According to measurements taken by observers at rest in the laboratory, the stick has a length of 0.45 m. The speed at which the stick moves relative to the observers in the laboratory is:

(a) 0.80c (b) 0.89c (c) 0.91c (d) 0.85c (e) 0.95c

24. The speed of a subatomic particle is measured by a set of observers to be 0.95c. These same observers also measure the lifetime of this particle – the time it takes to decay – to be 6.4 μs. What is the lifetime of the particle measured by observers at rest with respect to the particle?

(a) 20.5μs (b) 6.4μs (c) 0.62μs (d) 2.0μs (e) 1.4μs

25. A galactic miner observes two explosions simultaneously at $t = 0$, the first located at the origin ($x = 0$) on planet A in his reference frame, and the second on planet B located at $x = 10^6$ m. A mining inspector, moving at speed $v = 0.35c$ in the positive x-direction, measures the time interval (difference) between these two explosions as (1 ms = 10^{-3}s).

(a) 9.5 ms (b) 8.9 ms (c) 0.9 ms (d) 1.25 ms (e) zero

THE END