UNIVERSITY OF MANITOBA

December 11, 2010
(6:00 pm – 9:00 pm)

FINAL EXAMINATION

COURSE NO.: PHYS 1050

TIME: 3 hours

EXAMINATION: Physics 1: Mechanics

EXAMINERS: C-M. Hu, F. Lin, 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.

---

1. The angle between the vector $\vec{A} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{B} = \hat{i} - \hat{j} + \hat{k}$ is:

   (a) 180° (b) 90° (c) 71° (d) 55° (e) 109°

2. A particle of mass $m = 0.1$ kg is subject to an external force $\vec{F}$ such that its position vector $\vec{r}(t)$ (in m) is given by:

$$\vec{r}(t) = t^4\hat{i} + t^3\hat{j} + t^2\hat{k}$$

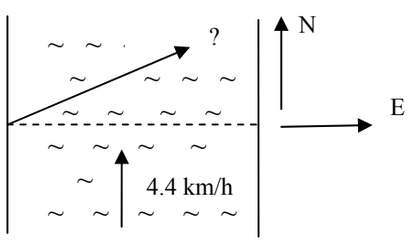
   where t is in s. The power P (in watts) delivered to this particle by the force $\vec{F}$ at time $t = 2$ s is:

   (a) 24.5 (b) 49.5 (c) 51.4 (d) 169.2 (e) 188.0

3. A particle leaves the origin at time $t = 0$ with an initial velocity (in m/s) $\vec{v}_0 = 5.0\vec{j}$. It is subjected to a constant acceleration (in m/s^2) $\vec{a} = 3.1\hat{i} - 2.4\hat{j}$. The speed of this particle (in m/s) when it reaches its maximum (positive) y co-ordinate is:

   (a) 0 (b) 9.8 (c) 2.1 (d) 6.5 (e) 3.1

4. A ferry boat can sail at 12 km/h in still water. If it sails 30° N of E with respect to a river flowing at 4.4 km/h N, as observed from the shore the boat is moving

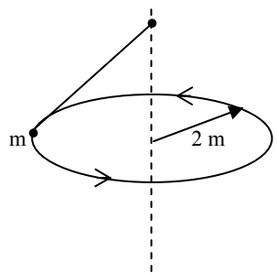


   (a) due N (b) 45° E of N (c) 30° E of N (d) 68° E of N (e) 22° E of N

5. A projectile launched over a level surface, reaches a maximum height of 150 m. If the range of this projectile is 280 m then the angle, ϕ_0, at which the projectile is launched is:

   (a) 25° (b) 55° (c) 79° (d) 65° (e) 45°

6. A mass $m = 0.15$ kg is attached to a massless string and rotates at constant speed $v = 4$ m/s in a horizontal circle of radius 2 m. The tension T (in N) in the string is:



(a) 1.1 (b) 1.9 (c) 2.4 (d) 3.3 (e) 4.9

7. An object, moving in a straight line, has a velocity of 5.0 m/s at time $t = 0$. From $t = 0$ to $t = 5$ s its acceleration is 2.5 m/s^2, while from $t = 5$ to $t = 11$ s its acceleration is - 0.1 m/s^2. Over the time interval $t = 5$ s to $t = 11$ s its average velocity is:

(a) 15.0 m/s (b) 12.5 m/s (c) 17.2 m/s (d) 14.5 m/s (e) 8.8 m/s

8. A thrower releases a javelin at a height h above level ground with a speed of 40 m/s at 40° above the horizontal. If the javelin hits the ground 5.35 s later, then the height h (in m) at which the javelin is released is:

(a) 1.8 (b) 2.4 (c) 2.9 (d) 2.7 (e) 2.2

9. A car moves horizontally with a constant acceleration of 3 m/s^2. A ball is suspended by a string from the ceiling of the car; the ball does not swing, being at rest with respect to the car. What angle does the string make with the vertical?

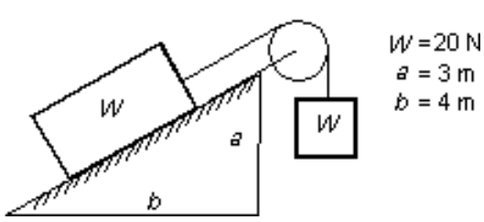
(a) 17° (b) 35° (c) 52° (d) 73°
(e) Cannot be found without knowing the length of the string

10. A block is placed on a rough wooden plane. It is found that when the plane is tilted 30° to the horizontal, the block will slide down at constant speed. The coefficient of kinetic friction of the block with the plane is:

(a) 0.500 (b) 0.577 (c) 1.73 (d) 0.866 (e) 4.90

11. The system shown remains at rest. The force of friction on the upper block is:

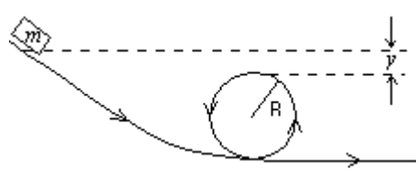
(a) 4 N (b) 8 N (c) 12 N
(d) 16 N (e) 20 N



12. A man pushes an 80-N crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. His force is parallel to the slope. If the speed of the crate decreases at a rate of 1.5 m/s^2, then the work done by the man is:

(a) –200 J (b) 61 J (c) 140 J (d) 200 J (e) 260 J

13. A small object of mass *m* starts at rest at the position shown and slides along the frictionless loop-the-loop track of radius *R*. What is the smallest value of *y* such that the object will slide without losing contact with the track?



(a) *R*/4 (b) *R*/2 (c) *R* (d) 2*R* (e) zero

14. A 700-N man jumps out of a window into a fire net 10 m below. The net stretches 2 m before bringing the man to rest and tossing him back into the air. The maximum potential energy stored in the net, compared to its unstretched potential energy, is:

(a) 300 J (b) 710 J (c) 850 J (d) 7000 J (e) 8400 J

15. A 3.00-g bullet traveling horizontally at 400 m/s hits a 3.00-kg wooden block, which is initially at rest on a smooth horizontal table. The bullet buries itself in the block without passing through. The speed of the block after the collision is:

(a) 1.33 m/s (b) 0.40 m/s (c) 12.0 m/s (d) 40.0 m/s (e) 160 m/s

16. Blocks A and B are moving toward each other. A has a mass of 2.0 kg and a velocity of 50 m/s, while B has a mass of 4.0 kg and a velocity of –25 m/s. They suffer a completely inelastic collision. The kinetic energy lost during the collision is:

(a) 0 (b) 1250 J (c) 3750 J (d) 5000 J (e) 5600 J

17. Block A, with a mass of 2 kg, is moving with a speed of 1.0 m/s while block B, with a mass of 9 kg, is moving in the opposite direction with a speed of 4 m/s. The center of mass of the two block-system is moving with the velocity of:

(a) 3.1 m/s in the same direction as A
(b) 3.1 m/s in the same direction as B
(c) 3.5 m/s in the same direction as A
(d) 3.5 m/s in the same direction as B
(e) 5.0 m/s in the same direction as A

18. A pulley with a radius of 3.0 cm and a rotational inertia of 4.5×10^{-3} kg·m^2 is suspended from the ceiling. A rope passes over it with a 2.0-kg block attached to one end and a 4.0-kg block attached to the other. The rope does not slip on the pulley. At any instant after the blocks start moving, the object with the greatest kinetic energy is:

(a) the heavier block
(b) the lighter block
(c) the pulley
(d) either block (the two blocks have the same kinetic energy)
(e) none (all three objects have the same kinetic energy)

19. A certain wheel has a rotational inertia of 12 kg·m^2. As it turns through 5.0 revolutions its angular velocity increases from 5.0 rad/s to 6.0 rad/s. If the net torque is constant its value is:

(a) 0.016 N ·m (b) 0.18 N ·m (c) 0.57 N ·m (d) 2.1 N ·m (e) 3.6 N ·m

20. A 2.0-kg block travels around a 0.50-m radius circle with an angular velocity of 12 rad/s. The magnitude of its angular momentum about the center of the circle is:

(a) 6 kg·m^2/s (b) 12 kg·m^2/s (c) 48 kg·m^2/s (d) 72 kg·m^2/s (e) 576 kg·m^2/s

21. A 2.0-kg block starts from rest on the positive x axis 3.0m from the origin and thereafter has an acceleration given by $\vec{a} = (4.0m/s^2)\hat{i} - (3.0m/s^2)\hat{j}$. At the end of 2.0 s its angular momentum about the origin is:

(a) 0 (b) (−36 kg·m^2/s) $\hat{k}$ (c) (+48 kg·m^2/s) $\hat{k}$ (d) (−96 kg·m^2/s) $\hat{k}$
(e) (+96 kg·m^2/s) $\hat{k}$

22. A playground merry-go-round has a radius of 3.0m and a rotational inertia of 600 kg·m^2. It is initially spinning at 0.80 rad/s when a 20-kg child crawls from the center to the rim. When the child reaches the rim the angular velocity of the merry-go-round is:

(a) 0.62 rad/s (b) 0.73 rad/s (c) 0.80 rad/s (d) 0.89 rad/s (e) 1.1 rad/s

23. An observer notices that a moving clock runs slow by a factor of exactly 10. The speed of the clock is:

(a) 0.100c (b) 0.0100c (c) 0.990c (d) 0.900c (e) 0.995c

24. A certain automobile is 6m long if at rest. If it is measured to be 4/5 as long, its speed is:

(a) 0.1c (b) 0.3c (c) 0.6c (d) 0.8c (e) > 0.95c

25. Star S1 is moving away from us at a speed of 0.8c. Star S2 is moving away from us in the opposite direction at a speed of 0.5c. The speed of S1 as measured by an observer on S2 is:

(a) 0.21c (b) 0.5c (c) 0.93c (d) 1.3c (e) 2.17c

THE END