**UNIVERSITY OF MANITOBA**

December 12, 2016 FINAL EXAMINATION
(6:00 pm – 9:00 pm)



COURSE NO.: PHYS 1050 (A02) TIME: 3 hours

EXAMINATION: Physics 1: Mechanics EXAMINERS: J. Bland

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All questions are of equal value. Answer all 25 questions. No marks are subtracted for wrong answers.

Record all answers on the bubble 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. **<u>DO NOT start your student number with 00</u>**.

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1. This graph shows the position of a particle as a function of time. What is its average speed between $t$ = 2s and $t$ = 9s?


(a) 1.7 m/s (b) 8.6 m/s (c) 12 m/s
(d) -12 m/s (e) Need additional information.

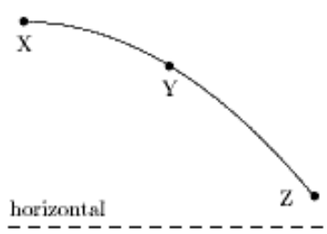
2. The two vectors $(3\text{ m})\,\hat{i} - (7\text{ m})\,\hat{j}$ and $(2\text{ m})\,\hat{i} + (3\text{ m})\,\hat{j} - (2\text{ m})\,\hat{k}$ define a plane. Which of the following vectors is perpendicular to the plane?

(a) $(14\text{ m})\,\hat{i} + (6\text{ m})\,\hat{j} + (23\text{ m})\,\hat{k}$
(b) $(-14\text{ m})\,\hat{i} + (6\text{ m})\,\hat{j} + (23\text{ m})\,\hat{k}$
(c) $(14\text{ m})\,\hat{i} - (6\text{ m})\,\hat{j} + (23\text{ m})\,\hat{k}$
(d) $(14\text{ m})\,\hat{i} + (6\text{ m})\,\hat{j} - (23\text{ m})\,\hat{k}$
(e) $(14\text{ m})\,\hat{i} + (6\text{ m})\,\hat{j}$

3. An object has a velocity of $(5.4\text{ m/s})\,\hat{i} - (4.8\text{ m/s})\,\hat{j}$. Over a period of 1.3 s, its velocity changes to $(1.7\text{ m/s})\,\hat{i} + (5.9\text{ m/s})\,\hat{j}$. What is its acceleration?

(a) $-(3.7\text{ m/s}^2)\,\hat{i} + (11\text{ m/s}^2)\,\hat{j}$
(b) $-(2.8\text{ m/s}^2)\,\hat{i} + (8.2\text{ m/s}^2)\,\hat{j}$
(c) $(3.7\text{ m/s}^2)\,\hat{i} + (11\text{ m/s}^2)\,\hat{j}$
(d) $(2.8\text{ m/s}^2)\,\hat{i} + (8.2\text{ m/s}^2)\,\hat{j}$
(e) $-(2.8\text{ m/s}^2)\,\hat{i} + (1.1\text{ m/s}^2)\,\hat{j}$

4. A stone is thrown horizontally and follows the path XYZ shown. Neglecting air resistance, the direction of the acceleration of the stone at point Y is:




(a) ↓ (b) → (c) ↘
(d) ↙ (e) ↗

5. A large cannon is fired from ground level over level ground at an angle of 60° above the horizontal. The initial speed is 980 m/s. Neglecting air resistance, the projectile will travel what horizontal distance before striking the ground?

(a) 4.3 km (b) 8.5 km (c) 43 km (d) 85 km (e) 170 km

6. A Ferris wheel with a radius of 8.0m makes 1 revolution every 10 s. When he is at the top, essentially a diameter above the ground, he releases a ball. How far from the point on the ground directly under the release point does the ball land?

(a) 0 m (b) 1.0 m (c) 8.0 m (d) 16 m (e) 9.1 m

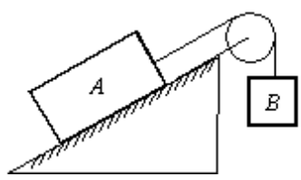
7. A motor boat can travel at 10 km/h in still water. A river flows at 5 km/h west. A boater wishes to cross from the south bank to a point directly opposite on the north bank. At what angle must the boat be headed?

(a) 27° E of N (b) 30° E of N (c) 45° E of N
(d) 60° E of N (e) depends on the width of the river

8. A 5.0-kg crate is resting on a horizontal plank. The coefficient of static friction is 0.50 and the coefficient of kinetic friction is 0.40. After one end of the plank is raised so the plank makes an angle of 25° with the horizontal, the force of friction is:

(a) 0 N (b) 20 N (c) 21 N (d) 22 N (e) 44 N

9. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. The largest mass $m_B$, of block B, attached to the dangling end, for which A begins to slide down the incline, is:

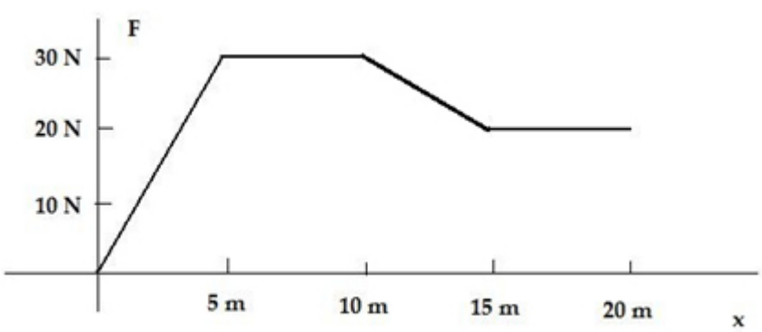



(a) 2.5 kg (b) 3.5 kg (c) 5.9 kg (d) 9.0 kg (e) 10.5 kg

10. At time $t$ = 0, a 2-kg particle has a velocity of (4 m/s) $\hat{i}$ – (3 m/s) $\hat{j}$. At $t$ = 3 s its velocity is (2 m/s) $\hat{i}$ + (3 m/s) $\hat{j}$. During this time the work done on the particle was:

(a) 4 J (b) –4 J (c) –12 J (d) –40 J (e) (4 J) $\hat{i}$ + (36 J) $\hat{j}$

11. The plot shows the force on an object as it moves from $x$ = 0 m to $x$ = 20 m. How much work is done on the object?

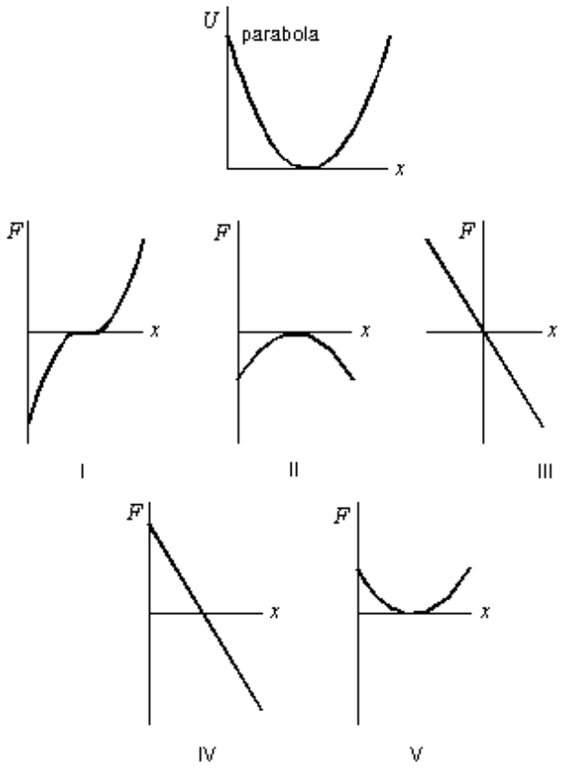



(a) 40 J (b) 90 J (c) 200 J (d) 450 J (e) 750 J

12. A small object of mass *m*, on the end of a light cord, is held horizontally at a distance *r* from a fixed support as shown. The object is then released. What is the tension in the cord when the object is at the lowest point of its swing?


(a) mg/2 (b) mg (c) 2 mg (d) mgr (e) 3 mg

13. The first graph shows the potential energy $U(x)$ for a particle moving on the $x$ axis. Which of the following five graphs correctly gives the force $F$ exerted on the particle?




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

14. A stationary mass $m$ = 1.3 kg is hanging from a spring of spring constant $k$ = 1200 N/m. You raise the mass a distance of 10 cm above its equilibrium position in a time of 1.4 s. What was the average power expended?

(a) 0.93 W (b) 4.3 W (c) 5.2 W (d) 8.6 W (e) 10.2 W

15. Block A, with a mass of 4.0 kg, is moving with a speed of 2.0 m/s while block B, with a mass of 8.0 kg, is moving in the opposite direction with a speed of 3.0 m/s. The momentum of the center of mass of the two-block system is:

(a) 16 kg m/s in the same direction as A
(b) 16 kg m/s in the same direction as B
(c) 32 kg m/s in the same direction as A
(d) 12 kg m/s in the same direction as B
(e) 60 kg m/s in the same direction as A

16. A 75-kg man is riding in a 30-kg cart at 2.0 m/s. He jumps off in such a way as to land on the ground with no horizontal velocity. The resulting change in speed of the cart is:

(a) 0 m/s faster (b) 2.0 m/s faster (c) 3.0 m/s faster
(d) 7.0 m/s faster (e) 5.0 m/s faster

17. Blocks A and B are moving toward each other. A has a mass of 1.0 kg and a velocity of 50 m/s, while B has a mass of 2.0 kg and a velocity of –25 m/s. They suffer a completely inelastic collision. The kinetic energy lost during the collision is:

(a) 0 J (b) 1250 J (c) 1875 J (d) 5000 J (e) 5600 J

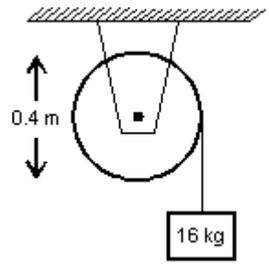
18. A pulley with a radius of 3.0 cm and a rotational inertia of $4.5 \times 10^{-3}$ kg·m$^2$ is suspended from the ceiling. A rope passes over it with a 2.0-kg block attached to one end and a 4.0-kg block attached to the other. The rope does not slip on the pulley. When the velocity of the heavier block is 2.0 m/s the total kinetic energy of the pulley and blocks is:

(a) 2.0 J (b) 12 J (c) 14 J (d) 22 J (e) 28 J

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

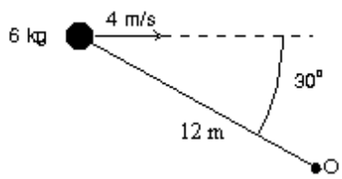
(a) 0.015 N·m (b) 0.18 N·m (c) 0.57 N·m
(d) 13 N·m (e) 2.1 N·m

20. A 16 kg block is attached to a cord that is wrapped around the rim of a flywheel of diameter 0.40 m and hangs vertically, as shown. The rotational inertia of the flywheel is 0.50 kg·m$^2$. When the block is released and the cord unwinds, the acceleration of the block is (expressed as times of gravitational acceleration *g*):



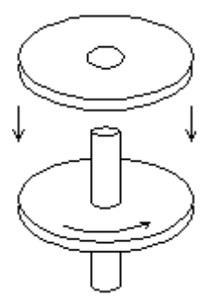

(a) 0.15 g (b) 0.56 g (c) 0.84 g
(d) 1.0 g (e) 1.3 g

21. A 6.0-kg particle moves to the right at 4.0 m/s as shown. The magnitude of its angular momentum about the point O is:




(a) 0 kg·m$^2$/s (b) 288 kg·m$^2$/s
(c) 144 kg·m$^2$/s (d) 24 kg·m$^2$/s
(e) 249 kg·m$^2$/s

22. A wheel, with rotational inertia 2*I*, mounted on a vertical shaft with negligible rotational inertia, is rotating with angular speed $\omega_0$. A non-rotating wheel with rotational inertia *I* is suddenly dropped onto the same shaft as shown. The collision is completely inelastic. The resultant combination of the two wheels and shaft will rotate at:



(a) $\omega_0$ /2 (b) 2$\omega_0$ (c) 2$\omega_0$ /3
(d) $\omega_0$ /3 (e) $\omega_0$ /4

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

(a) 0.21c (b) 0.50c (c) 0.93c (d) 1.3c (e) 2.2c

24. Two events occur 100 m apart with an intervening time interval of 0.37 μs. The speed of a clock that measures the proper time between the events is:

(a) 0 *c* (b) 0.45*c* (c) 0.56*c* (d) 1.8*c* (e) 0.90*c*

25. An event occurs at $x$ = 500 m, $t$ = 1.0 μs in one frame of reference. Another frame is moving at 0.90*c* in the positive $x$ direction. The origins coincide at $t$ = 0 and clocks in the second frame are zeroed when the origins coincide. The coordinate and time of the event in the second frame is:

(a) 500 m, 0.90 μs (b) 1700 m, 5.5 μs (c) 740 m, 2.4 μs
(d) 530 m, –1.1 μs (e) 590 m, –1.4 μs

**THE END**