UNIVERSITY OF MANITOBA

December 15, 2015 FINAL EXAMINATION
(6:00 pm – 9:00 pm)

COURSE NO.: PHYS 1050 TIME: 3 hours

EXAMINATION: Physics 1: Mechanics EXAMINERS: C.-M. Hu, F. Lin, J. Sirker

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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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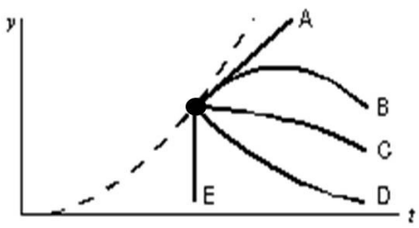
speeds up

1. At time $t = 0$ a car has a velocity of 16 m/s. It ~~slows down~~ with an acceleration given by $a = 0.50t$, in m/s^2 for t in seconds. At the end of 2.0 s it has traveled:

   A) 0 B) 12 m C) 14 m D) 34 m E) 33 m

2. An elevator is moving upward with constant acceleration. The dashed curve shows the position y of the ceiling of the elevator as a function of the time t. At the instant indicated by the dot, a bolt breaks loose and drops from the ceiling. Which curve best represents the position of the bolt as a function of time?



   A) A B) B C) C D) D E) E

3. A heavy ball falls freely, starting from rest. Between the third and fourth second of its fall it travels a distance of:

   A) 4.9 m B) 9.8 m C) 29.4 m D) 34.3 m E) 39.8 m

4. Two vectors lie with their tails at the same point. When the angle between them is increased by 30° their scalar product has the same magnitude but changes from positive to negative. The original angle between them was:

   A) 0° B) 65° C) 75° D) 85° E) 90°

5. The value of $\hat{i} \cdot \left(\hat{j} \times \hat{k} \right)$ is:

   A) 0 B) +1 C) –1 D) 3 E) $\sqrt{3}$

6. An object has a velocity of (5.4 m/s) $\hat{\imath}$ – (4.8 m/s) $\hat{\jmath}$. Over a period of 2 s, its velocity changes to (1.7 m/s) $\hat{\imath}$ + (5.9 m/s) $\hat{\jmath}$. What is its acceleration (assumed to be constant)?

   A) –(3.7 m/s) $\hat{\imath}$ + (11 m/s) $\hat{\jmath}$
   B) –(1.9 m/s) $\hat{\imath}$ + (5.4 m/s) $\hat{\jmath}$
   C) (3.7 m/s) $\hat{\imath}$ + (11 m/s) $\hat{\jmath}$
   D) (1.9 m/s) $\hat{\imath}$ + (5.4 m/s) $\hat{\jmath}$
   E) –(2.8 m/s) $\hat{\imath}$ + (1.1 m/s) $\hat{\jmath}$

correction: unit in the answers should be m/s^2

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7. Identical guns fire identical bullets horizontally at the same speed from the same height above level planes, one on the Earth and one on the Moon. Which of the following three statements is/are true?
I. The horizontal distance traveled by the bullet is greater for the Moon.
II. The flight time is less for the bullet on the Earth.
III. The velocities of the bullets at impact are the same.

A) III only B) I and II only C) I and III only D) II and III only E) I, II, III

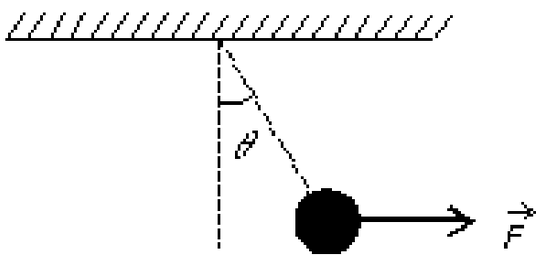
8. For a biological sample in a 0.5m radius centrifuge (*you might have seen a real centrifuge machine in the research lab tour offered to the PHYS1050 students back in Nov.*) to have a centripetal acceleration of 25g its speed must be:

A) 11 m/s B) 16 m/s C) 50 m/s D) 122 m/s E) 245 m/s

9. A ferry boat is sailing at 12 km/h 30° west of south with respect to a river that is flowing at 6.0 km/h to the east. As observed from the shore, the ferry boat is sailing:

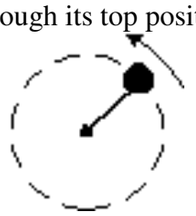
A) 30° east of south
B) due north
C) 30° west of south
D) 45° east of north
E) due south

10. A 2-N object is held at an angle θ from the vertical by a 3-N horizontal force F as shown. The object does not move. The tension in the string supporting the object is:



A) 2 N B) 3.6 N C) 5 N D) 3 N E) $\sqrt{5}$ N

11. The ball shown has a mass of 1 kg and is being swung in a vertical circle at the end of a 1.2-m string. How slowly can the ball go through its top position without having the string go slack?



A) 0.8 m/s B) 1.7 m/s C) 2.5 m/s D) 3.4 m/s E) 9.8 m/s

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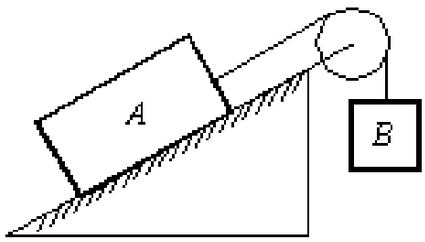
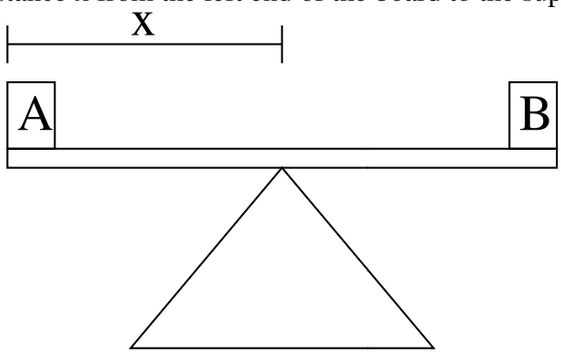
12. Block A, with a mass of 4 kg, rests on a 30° incline. The coefficient of static friction is 0.2 and the coefficient of kinetic friction 0.1. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 3.0 kg, is attached to the other end of the string. The acceleration of B is:



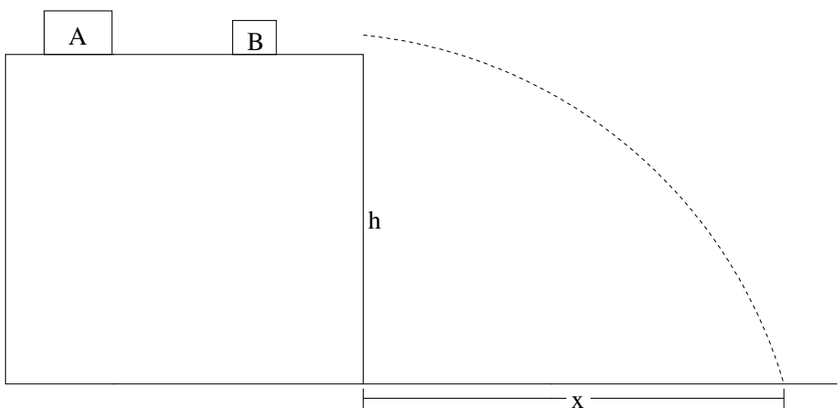
A) 0.92 m/s^2, down
B) 0.92 m/s^2, up
C) 1.4 m/s^2, up
D) 1.4 m/s^2, down
E) 0 m/s^2

13. Two masses, A and B, are placed on the edges of a rectangular board which is 6 m long and has a mass of 20 kg which is homogeneously distributed. The board is supported as shown in the figure such that an unstable equilibrium is achieved. If the mass of A is 12 kg and the mass of B 16 kg, how large is the distance x from the left end of the board to the support point?



A) 3 m B) 3.25 m C) 3.4 m D) 3.75 m E) 4 m

14. Block A, mass 5 kg, and block B, mass 1 kg, are sitting on a frictionless surface h=6 m above the ground. Block A is moving to the right with an initial velocity v=20 m/s. An elastic collision between the two blocks takes place. What is distance x where block B will hit the ground?



A) 11.4 m B) 20 m C) 33.3 m D) 36.9 m E) 2.9 m

15. An ideal spring is hung vertically from the ceiling. When a 6.0-kg mass hangs at rest from it, the spring is extended 10 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the force, the work done by the spring is:

A) –8.8 J B) +8.8 J C) –3.6 J D) +3.6 J E) –1.0 J

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16. An 11-kg object is moving at 30 km/h. It must be brought to a stop in 12 s. What is the required average power?

A) 412.5 W B) 41 W C) 382 W D) 4950 W E) 32 W

17. Two objects, A with mass m_A=0.25 kg and B with mass m_B=1.25 kg, are held at rest on a horizontal frictionless surface and a spring is compressed between them. Immediately after the spring is released, A has a kinetic energy of 22 J and B has a kinetic energy of:

A) 110 J B) 5.5 J C) 11 J D) 4.4 J E) 19.4 J

18. 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 magnitude is:

A) 0.016 N·m B) 0.18 N·m C) 0.57 N·m D) 2.1 N·m E) 13.2 N·m

19. 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. When the speed of the heavier block is 2.0 m/s the kinetic energy of the pulley is:

A) 0.15 J B) 0.30 J C) 1.0 J D) 10 J E) 20 J

20. A disk has a rotational inertia of 6.0 kg · m^2 and a constant angular acceleration of 2.0 rad/s^2 . If it starts from rest the work done during the first 5.0 s by the net torque acting on it is:

A) 0 B) 30 J C) 60 J D) 300 J E) 600 J

21. The position of a 2.0-kg block is given by $\vec{r}(t)=0.5\cos(\omega t)\hat{\imath} + 0.5\sin(\omega t)\,\hat{\jmath} + 0.75\hat{k}$ with ω=12 rad/s. What is its angular momentum at t=4s in kg·m^2/s?

A) $2.9\hat{\imath} + 3.5\hat{\jmath} + 3\hat{k}$ B) $9.2\hat{\imath} - 7.7\hat{\jmath}$ C) $6.0\hat{k}$ D) $-5.8\hat{\imath} + 8.2\hat{\jmath} + 6\hat{k}$ E) $5.8\hat{\imath} + 6.9\hat{\jmath} + 6\hat{k}$

22. A playground merry-go-round has a radius of 2.0 m and a rotational inertia of 600 kg · m^2. It is initially spinning at 0.80 rad/s when a 20-kg child starts crawling 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) 0.71 rad/s C) 0.80 rad/s D) 0.89 rad/s E) 1.1 rad/s

23. A graduate student discovers that an elementary particle produced in his experiment travels 0.250 mm through the lab at a speed of 0.950c before it decays (becomes another particle). What is the lifetime of the particle measured in its rest frame (proper lifetime).

A) 8.77×10^{-13} s B) 7.99×10^{-13} s C) 2.74×10^{-13} s D) 2.24×10^{-13} s E) 2.81×10^{-12} s

24. Spaceship S1 is moving away from us at a speed of 0.5c. Spaceship 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) 0.5c B) 0.8c C) 0.9c D) 1.0c E) 1.25c

25. If the kinetic energy of a particle is equal to twice of its rest energy then its speed must be:

A) 0.94c B) 0.87c C) 0.50c D) c E) unknown unless its mass is given

THE END