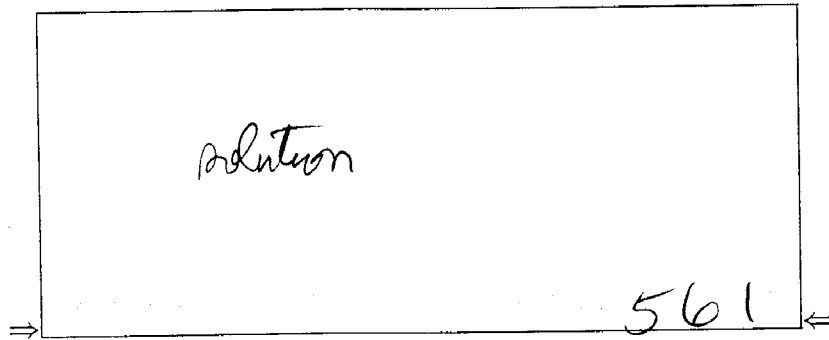


Physics 123 - Analytical Physics
SECOND COMMON HOUR EXAM
Monday, November 10, 2008
Professor R.A. Bartynski

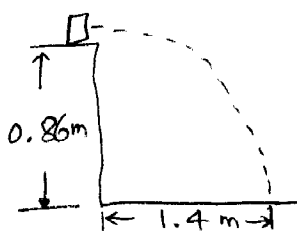


Your name sticker with **exam code**. **SIGN HERE:**

1. The exam will last from 9:40 - 11:00 p.m. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts..
2. In the section labeled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit RUID Number.
4. Enter 123 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and one 8.5 x 11 inch sheet (both sides) with formulas and notes.
7. There are 15 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. **At the end of the exam, hand in the answer sheet and the cover page.** Retain this question paper for future reference and study.
8. When you are asked to open the exam, make sure that your copy contains all 15 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.
10. If needed, the acceleration due to gravity on earth may be take as $g = 9.81 \text{ m/s}^2$.

1. An empty beer mug slides off a bar 0.86 m high and strikes the floor 1.4 m from the base. With what speed did the mug leave the counter?

- a) 3.33 m/s
 b) 1.86 m/s
 c) 2.26 m/s
 d) 5.11 m/s
 e) 1.64 m/s



$$\Delta y = \frac{1}{2} g t^2 = 0.86$$

$$t = \sqrt{2 \times 0.86 / 9.81}$$

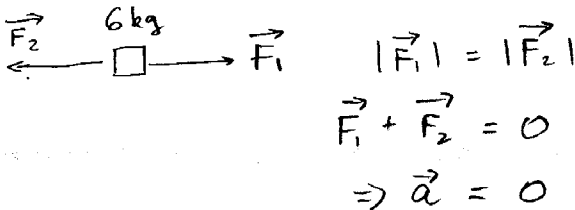
$$= 0.418$$

$$v_x t = 1.4$$

$$v_x = (1.4) / 0.418 = 3.33 \frac{m}{s}$$

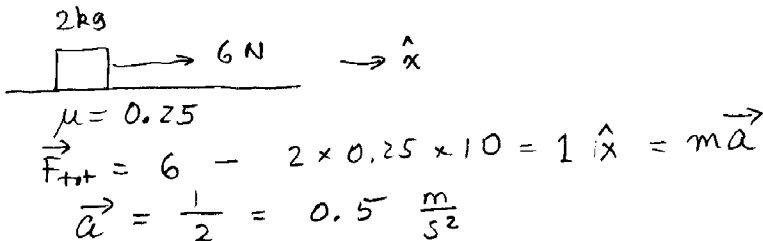
2. Two forces act on a body of mass 6 kg. \vec{F}_1 has a magnitude of 12 N, and acts to the right. \vec{F}_2 has a magnitude of 12 N and acts to the left. The acceleration of the mass is:

- a) 0 m/s²
 b) 2 m/s²
 c) 12 m/s²
 d) 4 m/s²
 e) 72 m/s²



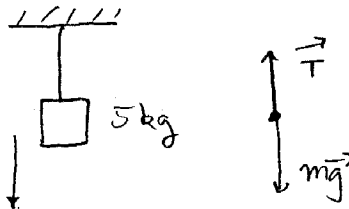
3. A mass of 2 kg is in contact with a horizontal plane and is moving horizontally due to an external horizontal force of 6 N. The coefficient of kinetic friction between the mass and the plane is 0.25. What is the magnitude of the acceleration of the mass? Assume $g = 10 \text{ m/s}^2$.

- a) 0.5 m/s²
 b) 20 m/s²
 c) 1.0 m/s²
 d) 60 m/s²
 e) 3.0 m/s²



4. A 5.0 kg object is suspended by a string from the ceiling of an elevator that is accelerating downward at 2.6 m/s^2 . What is the tension in the string?

- a) 49 N
 b) 36 N
 c) 62 N
 d) 13 N
 e) 52 N



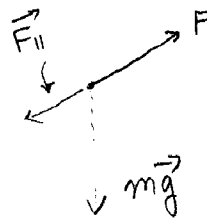
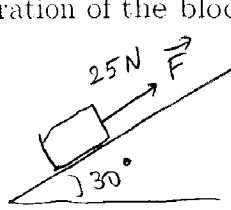
$$m\vec{g} + \vec{T} = m\vec{a}$$

$$5 \times 9.81 - T = 5 \cdot (2.6)$$

$$T = 5(9.8 - 2.6) = 36 \text{ N}$$

5. A block of mass 3 kg is pulled up a frictionless 30° incline by an applied force of 25 N in the direction parallel to the incline. What is the magnitude of the resulting acceleration of the block?

- a) 4.6 m/s^2
 b) 2.3 m/s^2
 c) 4.9 m/s^2
 d) 2.9 m/s^2
 e) 3.4 m/s^2



$$|\vec{F}_{\parallel}| = mg \sin 30^\circ = 3 \text{ kg} \cdot 10 \frac{\text{m}}{\text{s}^2} \sin 30^\circ$$

$$|\vec{F}_{\text{tot}}| = |\vec{F} + \vec{F}_{\parallel}| = 25 - mg \sin 30^\circ$$

$$= 10 \text{ N} = ma$$

$$a = \frac{10}{3} \approx 3.4 \frac{\text{m}}{\text{s}^2}$$

6. When a spring is stretched an external agent to a distance of 5.0 m from its equilibrium position, the restoring force (the force exerted by the spring) is 10 N. What is the amount of work that is done by the external agent in stretching the spring to 5.0 m?

- a) 50 J
 b) 500 J
 c) 25 J
 d) 0 J
 e) 250 J

$$F = -kx = 10 \text{ N} \Rightarrow k = 2 \frac{\text{N}}{\text{m}}$$

$$W = \int_0^5 F dx = \frac{1}{2} kx^2 \Big|_0^5 = \frac{1}{2} \times 2 \times 25 = 25 \text{ J}$$

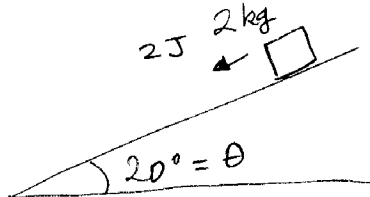
7. On a snowy October afternoon, you take a walk with your dog Newton, pulling an empty sled behind you. You pull the sled for 100m at a constant speed of 3 m/s by applying a force F_1 at an angle of 30° above the horizontal. You then tie Newton to the sled, and he pulls it for 200m at a constant speed of 6 m/s by applying a force F_2 that is directed along the horizontal. Which of the following is a true statement?

- a) [The total work done on the sled when Newton is pulling] is twice the work you do while pulling $= (F_1 \cos 30^\circ) \times 100 \text{ m} \neq 0$
- b) [The total work done on the sled when you are pulling] is $1/4$ of the work Newton does while pulling $= F_2 \times 200 \text{ m} \neq 0$
- c) [The total work done on the sled when Newton is pulling] is the same as [the total work done on the sled while you are pulling] $= 0$
- d) The work done by friction is larger in magnitude when you are pulling than when Newton is pulling. $\text{net } W = 0 \Rightarrow F_{\text{tot}} = 0 \Rightarrow F_{\text{you}} = -F_{\text{friction}}$
- e) None of the forces acting on the sled do work.

For example, you do work on sled,
 friction does work on sled,
 etc.

8. A 2.0 kg block is moves down a plane that makes an angle of 20° with the horizontal with an initial kinetic energy of 2.0 J. If the coefficient of kinetic friction between the block and the plane is 0.40, how far will the block slide along the plane before coming to rest? Assume $g = 10 \text{ m/s}^2$.

- a) 3.0 m
 b) 1.8 m
 c) 0.30 m
 d) 1.0 m
 e) 1.3 m



$$KE_i = 2.0 \text{ J} = \frac{1}{2} m v_i^2$$

$$v_i = \sqrt{\frac{4}{2}} = 1.41 \text{ m/s}$$

$$F = -\mu mg \cos \theta + mg \sin \theta$$

$$= -0.4 \times 20 \times 0.94 + 20 \times 0.34$$

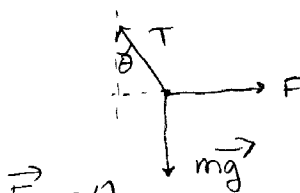
$$= -7.52 + 6.84 = -0.68$$

$$a = \frac{F}{m} = -0.34 \quad 0 = v_i^2 + 2a \Delta x$$

$$\Delta x = \frac{2}{2 \cdot 0.34} = 2.9 \text{ m}$$

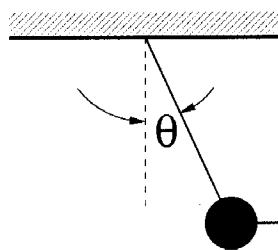
9. A pendulum bob that weighs 1 N is held at an unknown angle θ from the vertical by a 2 N horizontal force F as shown. The tension in the string supporting the pendulum bob is:

- a) $\cos \theta$ N
 b) $2 / \cos \theta$ N
 c) 2.2 N
 d) 1 N
 e) 10 N



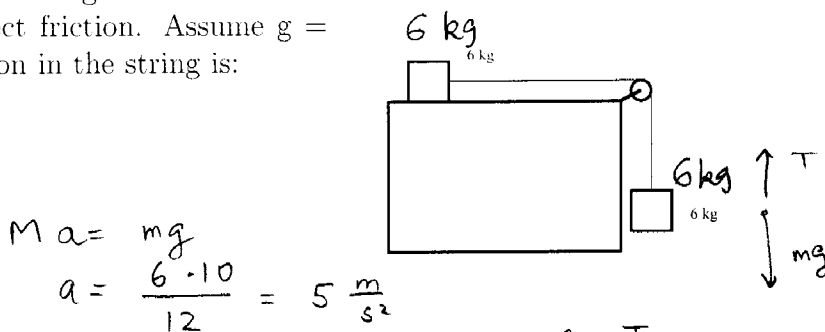
$$\Rightarrow \begin{aligned} T \sin \theta &= F = 2 \\ T \cos \theta &= mg \end{aligned} \Rightarrow \tan \theta = \frac{2}{1} \Rightarrow \theta = 63.4^\circ$$

$$T = \frac{2}{\sin \theta} = 2.2 \text{ N}$$



10. Two blocks of 6 kg each are connected by a string that passes over a massless pulley as shown and are moving with a constant acceleration. Neglect friction. Assume $g = 10 \text{ m/s}^2$. The tension in the string is:

- a) 60 N
 b) 120 N
 c) 20 N
 d) 0 N
 e) 30 N



$$M a = mg$$

$$a = \frac{6 \cdot 10}{12} = 5 \frac{\text{m}}{\text{s}^2}$$

$$mg - T = ma$$

$$m(g - a) = T$$

$$6(10 - 5) = T$$

$$30 \text{ N} = T$$

11. An object is constrained by a cord to move in a circular path of radius 0.5 m on a horizontal frictionless surface. The cord will break if its tension exceeds 16 N. The maximum kinetic energy of the object is:

- a) 4 J
 b) 8 J
 c) 16 J
 d) 32 J
 e) 64 J

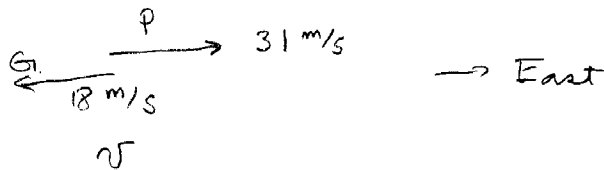
$$T = \frac{mv^2}{R} =$$

$$mv_{\max}^2 = T_{\max} R = 16 \cdot 0.5 = 8$$

$$K.E. \max = \frac{1}{2} mv_{\max}^2 = 4 \text{ J}$$

12. Peter is driving east in the right lane of a highway at a speed of 31 m/s. George is in the left lane and driving west at 18 m/s. What is Peter's speed, in m/s, relative to George?

- a) 49 West
 b) 13 West
 c) 49 East
 d) 31 East
 e) 13 East



13. A biology book lies on top of a physics book which lies on top of a horizontal table as shown. Which of the following is a Newtonian action-reaction force pair?

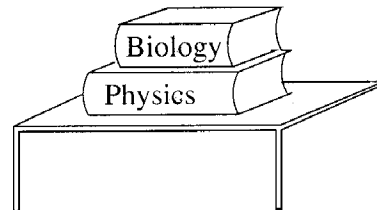
- a) The weight of the biology and physics books and the normal upward force of the table on the books.
 b) The weight of the biology book and the normal upward force of the physics book on the biology book.
 c) The downward force of the physics book on the table and the upward normal force of the physics book on the biology book.
 d) The upward force of the physics book on the biology book and the downward force of the biology book on the physics book.
 e) The weight of the physics book and the weight of the biology book, assuming they both have the same mass.

gravity force books \rightarrow earth }
 normal force table \rightarrow books } NOT pair

" " NOT pair

physics book \rightarrow table }
 physics book \rightarrow biology book } pair

pair



phys. book \rightarrow earth }
 bio. book \rightarrow earth } NOT pair

14. A block of 1.0 kg mass is pulled from rest on a frictionless horizontal surface by a constant force applied in the direction of motion. After the force applied over a distance of 12 m, the speed of the block is 2.0 m/s. What is the magnitude of the applied force?

- a) 6 N
- b) 0.17 N
- c) 1.0 N
- d) 10 N
- e) 0.085 N

$$\Delta KE = W = Fd$$

$$\Delta KE = \frac{1}{2} m v^2 = \frac{1}{2} \cdot 1 \cdot 4 = 2 \text{ J} = F \cdot \frac{d}{12}$$

$$F = \frac{2}{12} = \frac{1}{6} \text{ N} = 0.17 \text{ N}$$

15. A sign is suspended from a wall by a horizontal bar attached the side of the sign nearest the wall and cable attached to the other side, as shown in the figure. Which of the following force should NOT be included in the free body diagram of the sign?

- a) The tension in the cable.
- b) The force of the sign on the bar.
- c) The force of gravity on the sign.
- d) The force of the bar on the sign.
- e) All of these forces should be included.

