

**PHY 111/121 Practice Test***University of Southern Maine*

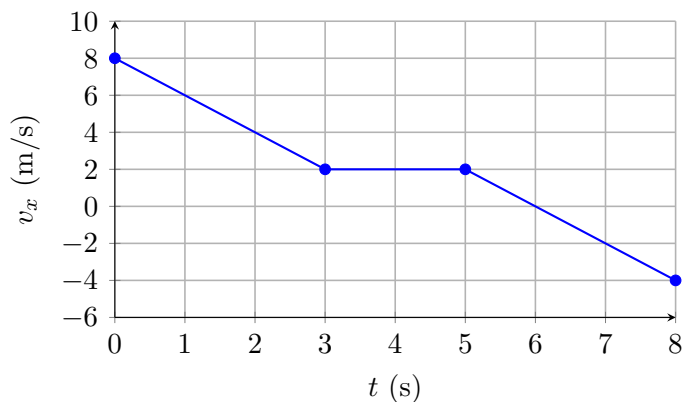
Name: \_\_\_\_\_ Date: \_\_\_\_\_

**Total:** 116 points**Time suggested:** 75 minutes

Question:	1	2	3	4	5	6	7	8	9	10	11	Total
Points:	12	10	12	4	4	4	4	16	18	18	14	116
Score:												

## Part I — Conceptual Questions

1. The velocity-versus-time graph below describes the motion of a car along a straight road. Positive  $x$  is to the right. 6



Answer the following, giving brief justification for each.

- (a) During which time interval(s) is the car's *speed* increasing? 2

- (b) During which time interval(s) is the acceleration *negative*? 2

- (c) At approximately what time does the car momentarily stop? How do you read this from the graph? 2

2. A textbook sits at rest on a table. A student claims: “*The normal force from the table on the book and the gravitational force of the Earth on the book are a Newton’s Third-Law action–reaction pair, because they are equal in magnitude and opposite in direction.*”

5

(a) Explain clearly why the student’s reasoning is **incorrect**. What is actually wrong with calling these two forces a Third-Law pair?

3

(b) Identify the true Newton’s Third-Law partner of the gravitational force that Earth exerts on the book, and state the object on which it acts.

2

3. A hockey puck slides across a perfectly frictionless frozen lake for a long distance.

6

(a) A student says: “*The puck must have a force pushing it forward, otherwise it would slow down and stop.*” Identify the error in this reasoning and explain, using Newton’s First Law, what actually keeps the puck moving.

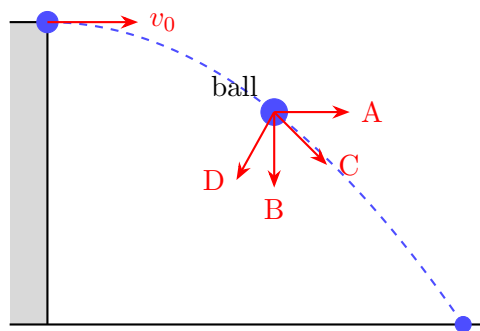
3

(b) Sketch a free-body diagram of the puck while it is sliding on the frictionless ice. Label every force, give its approximate direction, and explain why no horizontal force is needed.

3

**Part II — Multiple Choice**

4. Vector  $\vec{A}$  has magnitude 5.0 m directed at  $37^\circ$  above the positive  $x$ -axis, and vector  $\vec{B}$  has magnitude 3.0 m directed along the negative  $x$ -axis. The  $x$ -component of  $\vec{A} + \vec{B}$  is most nearly: 4
- A. 7.0 m  
B. 1.0 m  
C. -1.0 m  
D. 4.0 m
5. A ball is thrown horizontally from the top of a cliff. At the instant shown in the figure below, which arrow *best* represents the direction of the ball's **acceleration**? 4



- A. Arrow A (horizontal, in direction of motion)  
B. Arrow B (straight down)  
C. Arrow C (diagonally down-right)  
D. Arrow D (opposite to velocity)
6. An object starts from rest and accelerates uniformly. After traveling 40.0 m, its speed is 20.0 m/s. What is the magnitude of its acceleration? 4
- A.  $2.50 \text{ m/s}^2$   
B.  $5.00 \text{ m/s}^2$   
C.  $10.0 \text{ m/s}^2$   
D.  $0.500 \text{ m/s}^2$
7. A 4.0 kg box is pushed along a frictionless horizontal surface by a net horizontal force of 12 N. After 3.0 s (starting from rest), the box's speed is: 4
- A. 3.0 m/s  
B. 6.0 m/s  
C. 9.0 m/s  
D. 36 m/s

**Part III — Challenging Problems**

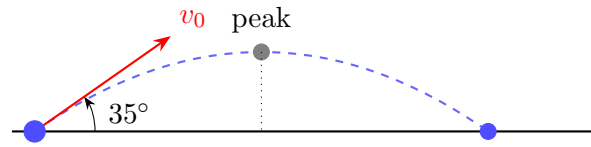
8. A car is traveling at  $30.0 \text{ m/s}$  when the driver sees an obstacle and applies the brakes. The car first travels  $0.60 \text{ s}$  at constant speed (reaction time), and then decelerates uniformly at  $8.0 \text{ m/s}^2$  until it stops. 8

(a) How far does the car travel during the reaction time? 2

(b) How far does the car travel *while braking*? (Use kinematics.) 3

(c) The obstacle was  $75 \text{ m}$  away when the driver first saw it. Does the car stop in time? By how much margin (distance), or how far past the obstacle does it travel? 3

9. A soccer ball is kicked from the ground at 20.0 m/s at an angle of  $35^\circ$  above the horizontal. Ignore air resistance; take  $g = 9.80 \text{ m/s}^2$ . 9



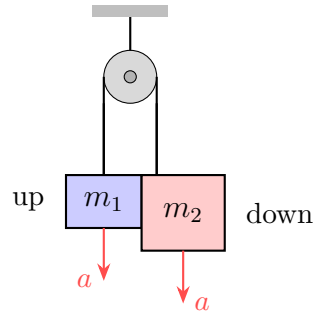
- (a) Find the initial  $x$ - and  $y$ -components of velocity. 2

- (b) Find the time of flight (total time in the air). 3

- (c) Find the horizontal range. 2

- (d) Find the maximum height reached by the ball. 2

10. Two blocks are connected by a light string over a frictionless, massless pulley (an Atwood machine). Block 1 has mass  $m_1 = 3.0$  kg and Block 2 has mass  $m_2 = 5.0$  kg. The blocks are released from rest. 8

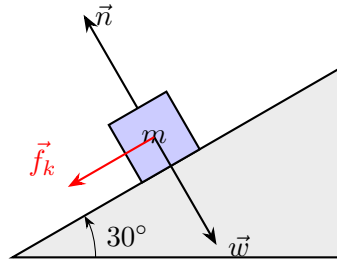


- (a) Draw a separate free-body diagram for each block. Then apply Newton's second law to each block (taking the direction of motion as positive for each) and write the two equations of motion. 4

- (b) Solve the system of equations to find the acceleration  $a$  of the blocks. 2

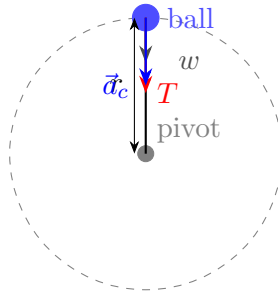
- (c) Find the tension  $T$  in the string. 2

11. A 5.0 kg block is placed on an incline that makes an angle of  $30^\circ$  with the horizontal. The coefficient of kinetic friction between the block and the incline is  $\mu_k = 0.20$ . The block is given a brief push up the ramp and then released. 9



- (a) Draw a free-body diagram of the block (in a tilted coordinate system aligned with the ramp) *while it is sliding up*. Label all forces. 2
- (b) Apply Newton's second law along and perpendicular to the ramp to find the block's acceleration while it is sliding *up* the incline. (Use  $g = 9.80 \text{ m/s}^2$ .) 4
- (c) Would the magnitude of the acceleration be larger, smaller, or the same if the block were sliding *down* the ramp instead of up? Justify your answer both conceptually and with a brief calculation. 3

12. A 0.40 kg ball on a 0.80 m string swings in a vertical circle. At the **top** of the circle the ball's speed is 4.0 m/s. 7



- (a) Using Newton's second law in the radial direction, find the tension in the string at the top of the circle. Clearly indicate your sign convention. 3

- (b) What is the *minimum* speed the ball must have at the top so that the string remains taut? What is the string tension at that minimum speed? 2

- (c) If the ball's speed at the top were doubled (to 8.0 m/s), by what factor would the centripetal acceleration change? 2

**Selected Answers / Key Facts**

**Q3 (b)**  $\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$

**Q4 (b)**  $A_x + B_x = 5.0 \cos 37 - 3.0 \approx 4.0 - 3.0 = 1.0 \text{ m}$

**Q5 (b)** Acceleration is always straight down (gravity only).

**Q6 (c)**  $a = F/m = 3.0 \text{ m/s}^2$ ;  $v = at = 9.0 \text{ m/s}$

**Q7**  $d_{\text{react}} = 18 \text{ m}$ ;  $d_{\text{brake}} = 56.25 \text{ m}$ ; total = 74.25 m; car stops with  $\approx 0.75 \text{ m}$  to spare.

**Q8**  $v_{0x} \approx 16.4 \text{ m/s}$ ,  $v_{0y} \approx 11.5 \text{ m/s}$ ;  $t_{\text{flight}} \approx 2.34 \text{ s}$ ; range  $\approx 38.3 \text{ m}$ ;  $h_{\text{max}} \approx 6.74 \text{ m}$ .

**Q9**  $a_{\text{up}} \approx 6.6 \text{ m/s}^2$  (down the ramp);  $a_{\text{down}} \approx 3.2 \text{ m/s}^2$  (down the ramp) — smaller, because friction reverses direction.**Q10**  $T = m(v^2/r - g) \approx 4.8 \text{ N}$ ;  $v_{\text{min}} = \sqrt{gr} \approx 2.8 \text{ m/s}$ ,  $T_{\text{min}} = 0$ ; doubling  $v$  quadruples  $a_c$ .