

PHYSICS 149

FINAL EXAM

April 30, 2002

Name: _____ ID#: _____

This is a closed book exam. Print and encode your name, student ID number, and recitation number on the answer sheet. Answers to all the questions are to be recorded on the answer sheet. There are 20 multiple choice questions for a total of 200 points. Do not do the problems in the order in which they are given. Do the easy problems first. There is only one correct answer to each question. No penalty for a wrong answer. However, all credit for a question will be lost if more than one choice is marked for that question. You may use your crib sheet and calculator. Fill out the op-scan card gradually, as soon as you finish a problem. Do not wait filling out the op-scan card during the last hectic five minutes!

USEFUL CONSTANT:

$$g = 9.81 \text{ (m/s}^2\text{)}$$

$$G = 6.67 \times 10^{-11} \text{ (N} \cdot \text{m}^2\text{/kg}^2\text{)}$$

1. (10 points) Which one of the following quantities is a vector quantity?

- (A) the age of the earth
- (B) the mass of a football
- (C) the earth's pull on your body
- (D) the temperature of an iron bar
- (E) the number of people attending a baseball game

2. (10 points) A car starts from rest and accelerates at a constant rate in a straight line. In the first second the car covers a distance of 2.0 meters. How fast will the car be moving at the end of the second second?

- (A) 4.0 m/s
- (B) 16 m/s
- (C) 2.0 m/s
- (D) 32 m/s
- (E) 8.0 m/s

3. (10 points) A tennis ball is shot vertically upward from the surface of an atmosphere-free planet with an initial speed of 20.0 m/s. One second later, the ball has an instantaneous velocity in the upward direction of 15.0 m/s.

What is the magnitude of the acceleration due to gravity on the surface of this planet?

- (A) 5.0 m/s²
- (B) 9.8 m/s²
- (C) 12 m/s²
- (D) 15 m/s²
- (E) 24 m/s²

4. (10 points) A small boat travels 80.0 km north and then travels 60.0 km east in 1.0 hour.

What is the boat's average speed during the one-hour trip?

- (A) 20 km/h
- (B) 100 km/h
- (C) 140 km/h
- (D) 280 km/h
- (E) 10 000 km/h

5. (10 points) A cannonball is aimed 30.0° above the horizontal and is fired with an initial speed of 125 m/s at ground level. How far away from the cannon will the cannonball hit the ground?

- (A) 125 m
- (B) 138 m
- (C) 695 m
- (D) 1040 m
- (E) 1380 m

6. (10 points) Two cars A and B approach each other at an intersection. Car A is traveling south at 20 m/s, while car B is traveling east at 17 m/s. What is the velocity of car A as described by the passengers in car B?

- (A) 37 m/s, eastward
- (B) 26 m/s, 40° south of east
- (C) 26 m/s, 50° south of east
- (D) 26 m/s, 50° south of west
- (E) 26 m/s, 40° south of west

7. (10 points) A 2.0-N rock slides on a frictionless inclined plane. Which one of the following statements is true concerning the normal force that the plane exerts on the rock?

- (A) () The normal force is zero newtons.
- (B) () The normal force is 2.0 N.
- (C) () The normal force is greater than 2.0 N.
- (D) () It increases as the angle of inclination, θ , is increased.
- (E) () The normal force is less than 2.0 N, but greater than zero newtons.

8 (10 points) At a playground, a child slides down a slide that makes a 42° angle with the horizontal direction. The coefficient of kinetic friction for the child sliding on the slide is 0.20. What is the magnitude of her acceleration during her sliding?

- (A) 4.6 m/s^2
- (B) 5.1 m/s^2
- (C) 5.4 m/s^2
- (D) 6.3 m/s^2
- (E) 9.8 m/s^2

9. (10 points) Callisto and Io are two of Jupiter's moons. The distance from Callisto to the center of Jupiter is approximately 4.5 times as far as that of Io. How does Callisto's orbital period, T_C , compare to that of Io, T_I ?

(A) $T_C = 4.5 T_I$

(B) $T_C = 21 T_I$

(C) $T_C = 9.5 T_I$

(D) $T_C = 0.2 T_I$

(E) $T_C = 2.7 T_I$

10. (10 points) An airplane flying at 115 m/s due east makes a gradual turn following a circular path to fly south. The turn takes 15 seconds to complete.

What is the radius of the curve that the plane follows in making the turn?

- (A) 280 m
- (B) 350 m
- (C) 830 m
- (D) 1100 m
- (E) 1600 m

11. (10 points) A concrete block is pulled 7.0 m across a frictionless surface by means of a rope. The tension in the rope is 40 N; and the net work done on the block is 247 J. What angle does the rope make with the horizontal?

- (A) () 28°
(B) () 41°
(C) () 47°
(D) () 62°
(E) () 88°

12. (10 points) Larry's gravitational potential energy is 1870 J as he sits 2.20 m above the ground in a sky diving airplane. What is Larry's gravitational potential energy when he begins to jump from the airplane at an altitude of 923 m?

- (A) $7.85 \times 10^5 \text{ J}$
- (B) $1.87 \times 10^3 \text{ J}$
- (C) $3.29 \times 10^4 \text{ J}$
- (D) $9.36 \times 10^2 \text{ J}$
- (E) $4.22 \times 10^6 \text{ J}$

13. (10 points) Complete the following statement: A force that acts on an object is said to be conservative if

- (A) it obeys Newton's law of motion.
- (B) it results in a change in the object's kinetic energy.
- (C) it always acts in the direction of motion of the object.
- (D) the work it does on the object is independent of the path of the motion.
- (E) the work it does on the object is equal to the increase in the object's kinetic energy.

14. (10 points) A 0.065-kg tennis ball moving to the right with a speed of 15 m/s is struck by a tennis racket, causing it to move to the left with a speed of 15 m/s. If the ball remains in contact with the racquet for 0.020 s, what is the magnitude of the average force experienced by the ball?

- (A) zero newtons
- (B) 98 N
- (C) 160 N
- (D) 1.6×10^5 N
- (E) 9.8×10^4 N

15. (10 points) A stone of mass 2 kg falls 100 meters near the surface of the earth. It strikes the ground without any rebound thereby making a perfectly inelastic collision with the earth. Approximately how much kinetic energy is transferred to the earth in this process?

- (A) zero joules
- (B) 200 J
- (C) 2000 J
- (D) 10 000 J
- (E) 20 000 J

16. (10 points) Complete the following statement: Momentum will be conserved in a two-body collision *only if*

- (A) () both bodies come to rest.
- (B) () the collision is perfectly elastic.
- (C) () the kinetic energy of the system is conserved.
- (D) () the net external force acting on the two-body system is zero.
- (E) () the internal forces of the two body system cancel in action-reaction pairs.

17. (10 points) A wheel with a 0.10-m radius is rotating at 35 rev/s. It then slows uniformly to 15 rev/s over a 3.0-s interval. What is the angular acceleration of a point on the wheel?

- (A) () -2.0 rev/s^2
- (B) () 0.67 rev/s^2
- (C) () -6.7 rev/s^2
- (D) () 42 rev/s^2
- (E) () -17 rev/s^2

18. (10 points) A wheel, originally rotating at 126 rad/s undergoes a constant angular deceleration of 5.00 rad/s^2 . What is its angular speed after it has turned through an angle of 628 radians?

- (A) () 15 rad/s
- (B) () 19 rad/s
- (C) () 98 rad/s
- (D) () 121 rad/s
- (E) () 150 rad/s

19. (10 points) A circular disk of radius 0.010 m rotates with a constant angular speed of 5.0 rev/s. What is the acceleration of a point on the edge of the disk?

- (A) () 0.31 m/s²
- (B) () 1.6 m/s²
- (C) () 9.9 m/s²
- (D) () 2500 m/s²
- (E) () zero m/s²

20. (10 points) A long thin rod of length $2L$ rotates with a constant angular acceleration of 10 rad/s^2 about an axis that is perpendicular to the rod and passes through its center.

What is the ratio of the tangential acceleration of a point on the end of the rod to that of a point a distance $L/2$ from the end of the rod?

- (A) () 1:1
- (B) () 1:2
- (C) () 2:1
- (D) () 4:1
- (E) () 1:4