Physics 107: Ideas of Modern Physics

Exam 1
Feb. 14, 2006

Name______________________________________________________
ID #_________________________               Section #______________

On the Scantron sheet,
1) Fill in your name
2) Fill in your student ID # (not your social security #)
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Fundamental constants:  
g = accel. of gravity on Earth = 10 m/s^2
G = gravitational constant = 6.7x10^{-11} N-m^2/kg^2
1. B

2. The term 'net force' most accurately describes:
   
   A. the quantity that changes the velocity of an object
   B. the quantity that causes displacement
   C. the quantity that keeps an object moving
   D. the inertia of an object
   E. the mass of an object

3. The gravitational force on a 1 kg apple near the earth's surface is
   
   A. 5 N
   B. 0.5 N
   C. 1 N
   D. 0 N
   E. 10 N

4. A Ferrari F50 can accelerate from 0 to 27 m/s (60 mph) in 3.8 sec. What is the average acceleration in terms of \(\text{g}\), the acceleration of gravity (e.g. 20 m/s/s = 2 g) ?
   
   A. 1.3 \(\text{g}\)
   B. 1.11 \(\text{g}\)
   C. 0.7 \(\text{g}\)
   D. 0.5 \(\text{g}\)
   E. need to know mass

5. On Earth, I throw a 1 kg ball upwards with a force of 100 N. At its maximum height (before it falls back down) its acceleration is
   
   A. upward
   B. downward
   C. changing quickly
   D. not defined
   E. zero
6. Fred car drives through traffic in a city, with exactly 20 minutes to get to an appointment. He has to stop at several lights, and then speeds up to pass some cars. His average speed was only 15 miles/hour. Fred just barely makes it to his appointment. How far away was the appointment?

A. 5 miles  
B. 3 miles  
C. 2 miles  
D. 1 mile  
E. 15 miles

7. A baseball is thrown at 40 m/s. A batter swings, and hits the ball. It flies away at 50 m/s in the opposite direction. What was the average force applied by the bat during the 0.001 second in which it contacted the 0.15 kg ball?

A. 7,500 N  
B. 2500 N  
C. 1000 N  
D. 500 N  
E. 13,500 N

8. What property of an object is constant during the application of a constant net force?

A. velocity  
B. acceleration  
C. momentum  
D. all of the above  
E. none of the above

9. Which of the following best describes the idea of ‘conservation of momentum’

A. Momentum cannot be negative  
B. Momentum can be transferred, but does not disappear  
C. The momentum of an object can never decrease  
D. The momentum of an object can never change  
E. Momentum should not be wasted
10. An 50 kg astronaut and her ship are at rest with respect to each other in outer space. She returns to the ship by quickly shooting six .44 magnum bullets (0.0167 kg each) in a direction away from the ship. The bullets leave the pistol at 500 m/s. At what speed does she approach her ship?

A. 5 m/s  
B. 2 m/s  
C. 1 m/s  
D. 0.5 m/s  
E. 10 m/s

11. I push a 10 kg box along the floor so that it moves in a straight line at a constant velocity of 2 m/s. The total net force on the box is

A. 20 N  
B. 10 N  
C. 5 N  
D. 0 N  
E. 50 N

12. Joe (a 100 kg astronaut) and Jane (a 50 kg astronaut) are mining asteroids in space. Both have identical thrusters that provide 100 N of thrust for exactly 2 seconds. Both use up their thrusters to start moving toward the next asteroid. Compare the speeds of Joe and Jane as they coast after their thrusters are used up. Assume that their masses do not change as the thrusters are used up.

A. \( speed_{\text{Joe}} = (speed_{\text{Jane}}) \times \sqrt{2} \)  
B. \( speed_{\text{Joe}} = (speed_{\text{Jane}}) / 2 \)  
C. \( speed_{\text{Joe}} = (speed_{\text{Jane}}) \times 2 \)  
D. \( speed_{\text{Joe}} = speed_{\text{Jane}} \)  
E. \( speed_{\text{Joe}} = (speed_{\text{Jane}}) / \sqrt{2} \)

13. Jetpack Man has a mass of 100 kg and uses his jet pack thrusters to hover 5 meters above the Earth’s surface. He suddenly cuts off his thrusters and starts falling. Approximately what constant thrust (force) must he apply over the last 0.1 meters (distance) of his fall to touch down at zero speed?

A. 50,000 N  
B. 5,000 N  
C. 2,500 N  
D. 1000 N  
E. 100,000 N
14. An 80 kg man dives from a 10 meter high-dive. Ignoring air resistance, about how fast is he moving when he hits the water?

A. 10 m/s
B. 7 m/s
C. 5 m/s
D. 1 m/s
E. 14 m/s

15. An astronaut is in freefall two earth radii away from the center of the earth. How does his acceleration toward the earth compare to his acceleration falling off a ladder when he is cleaning his gutters on earth?

A. Two times smaller
B. Same
C. Two times bigger
D. Four times bigger
E. Four times smaller

16. An object is moving to the right in a straight line at a constant speed. Which one of the following statements best describes forces acting on it?

A. Just one force is acting on the object.
B. The net force acting on the object is to the right.
C. A larger number of forces are acting on the object to the right than to the left.
D. No forces are acting on the object.
E. No net force is acting on the object.

17. Assume that 1 horse puts out 1 horsepower, and that 1 horsepower = 750 watts. How long would it take a horse to pull his 75 kg rider out of a 5 meter deep well?

A. 5.0 seconds
B. 3.4 seconds
C. 2.0 seconds
D. 1.0 second
E. 7.1 seconds
18. Hoover dam produces electrical power from water dropping a vertical distance of 200 meters. This water flows at a rate 20,000 gal/sec (=750,000 kg/s). Assuming that energy of the falling water is converted entirely to electrical power, what is the power output of the dam? (1 mega-watt = 1,000,000 watts)

A. 1500 mega-watts  
B. 750 mega-watts  
C. 150 mega-watts  
D. 7.5 mega-watts  
E. 3000 mega-watts

19. I push a 10 kg box along the floor at constant speed a distance of 5 meters by applying a constant force of 2 Newtons. How much work did I do?

A. 50 Joules  
B. 20 Joules  
C. 10 Joules  
D. 0 Joules  
E. 100 Joules

20. You lift bricks one at a time onto a table. After a while, you begin to lift them slower and slower. As you slow down, how does the energy you put into each brick, and the power you put into each brick, compare to when you started?

A. Energy greater, power greater  
B. Energy less, power same  
C. Energy same, power less  
D. Energy same, power same  
E. Energy less, power less

21. A pendulum swings back and forth. At the top of the swing,

A. potential energy smaller, kinetic energy greater than at bottom.  
B. potential energy greater, kinetic energy smaller than at bottom.  
C. both potential energy and kinetic energy smaller than at bottom.  
D. both potential energy and kinetic energy greater than at bottom.  
E. potential energy and kinetic energy same as at bottom.