Physics 31A Midterm (150pts)
Fall 2002

1. (3) If we represent the dimensions of mass, length, and time by *M*, *L*, and *T*, respectively, then the dimensions of impulse are (a) [ML/T] (b) [ML^2/T^2] (c) [ML/T^2] (d) [LT/M] (e) none of these.

2. (3) A firecracker explodes in midair. Considering all the fragments upon explosion (a) the total KE remains constant (b) the total momentum decreases (c) the total KE decreases (d) the total momentum remains constant (e) none of these.

3. (3) A 75.0-kg astronaut wearing a 25.0-kg spacesuit while floating in space fires a little gas jet that shoots out a blast of 10.0 g of gas at 100 m/s. He in turn (a) moves in the opposite direction at 100 m/s (b) moves in the opposite direction at 10.0 m/s (c) moves in the opposite direction at 1.00 m/s (d) moves in the opposite direction at 0.100 m/s (e) none of these.

4. (3) A garbage truck crashes head-on into a Volkswagen and the two come to rest in a cloud of flies. Which experiences the greater impact force? (a) the truck (b) the Volkswagen (c) both experience the same force (d) not enough information given (e) none of these.

5. (3) In analyzing the condition of rotational equilibrium, one takes the sum of the torques about an axis (a) which must pass through the body's *c.g.* (b) through which the line-of-action of all the forces must pass (c) passing through the center of the body (d) located anywhere (e) none of these.

6. (3) A flying saucer in a TV show banks and just blocks out the disk of the Moon (which subtends an angle of 0.009 rad) when a nearby radar device determines its range to be 10km away. How big was the craft? (a) 9 m (b) 0.09 km (c) 0.9 km (d) 0.9 m (e) none of these.

7. (3) For the net force acting on a body to result in purely linear motion (a) it must be zero (b) it must pass through the *c.m.* (c) it must be less than the weight of the body (d) it must not pass through the *c.m.* (e) none of these.

8. (3) A solid cylinder, a solid sphere, and a hoop all of the same mass but different radii, roll without sliding down an inclined plane. The body that gets to the bottom first will invariably be (a) the hoop (b) the sphere (c) the cylinder (d) they all arrive together (e) not enough information.

9. (3) How high above the Earth's surface must a 1.0-kg mass be for it to have a *gravitational*-PE of 1.0 J with respect to that surface? (a) 9.8 m (b) 1.0 m (c) 0.10 m (d) 0.01m (e) 32 m.

10. (3) Mars has a mass of 0.107 4M and is at a mean distance form the sun that is 1.52 times larger than that of earth. By comparison to the gravitational force exerted on Mars by our world, the force exerted on Earth by Mars is (a) 0.107 4 times smaller (b) 0.107 4 times larger (c) the same (d) 1.52 times less (e) none of these.

11. (3) The acceleration due to gravity, as measured by a spring-balance determination of the weight of an object ($F_w = mg$), varies from place to place on Earth because (a) the mass changes (b) *g* is affected by the rotation of the planet only (c) *g* depends on the shape of the planet only (d) *g* depends on both the rotation and shape of the planet (e) none of these.

12. (3) The average speed of a coconut during a 2-s fall from a tree, starting at rest, is (a) 19.6 m/s (b) 9.8 m/s² (c) 39.2 m/s (d) 9.8 m/s (e) none of these.

13. (3) If *L* stands for length, *T* for time, and *M* for mass, the dimension of force are (a) [ML^2] (b) [ML/T] (c) [ML/T^2] (d) [LT/M] (e) none of above

14. (3) Two forces, each of 100 N acting at a point such that they are 120º apart, are equivalent to a single force of (a) 100N (b) zero (c) 200N (d) 86.6N (e) none of these.

15. (3) A vector 10 units long pointing northeast is added to a vector 24 units long pointing northwest. The magnitude of the resultant is (a) 26 units (b) 14 units (c) 34 units (d) 0 units (e) not enough information.

16. (3) On a distance – time graph, the slope at any point is (a) the distance traveled (b) the time elapsed (c) the instantaneous speed (d) the average speed (e) none of these.

17. (12) A railroad flatcar having a mass of 10,000 kg is coasting along at 20 m/s. As it passes under a bridge, 10 men (having an average mass of 90 kg) drop straight down onto the car. What is its speed as it emerges with its new passengers from beneath the bridge?

18. (12) A 90-kg signal relay floating in space is struck by a 1000-g meteoroid. The latter embeds itself in the craft, and the two sail away at 5.0 m/s. What was the initial speed of the meteoroid?

19. (12) A cylindrical wheel is rotating with a constant angular acceleration of 4.0 rad/s^2. At the instant it reaches an angular speed of 2.0 rad/s, a point on its rim experiences a total acceleration of 8.0 m/s^2. What is the radius of the wheel?

20. (12) A chimp sitting on a yellow unicycle with a wheel diameter of 20 in. is pedaling away at 100 rpm. How fast does it travel? Give the answer in SI units.

21. (12) The kid pulls a loaded wagon having a total mass of 100kg. He applies a constant force of 100N along the handle at 30.0º. Ignoring friction, compute the horizontal force on the wagon and the resulting acceleration.

22. (12) A baseball recoiling from a bat soars into the air at an angle of 40.0º above the ground traveling at 45.7m/sec. Assuming it is caught at the same height at which it is hit, derive the range equation. Calculate the ball's theoretical range.

23. (12) The displacement of a cart, being acted upon by a constant force supplied via a small rocket, is $\mathbf{s} = (100\text{ m})\,\mathbf{i}$. If the force is $\mathbf{F} = (12.0\text{ N})\,\mathbf{i} + (73.2\text{ N})\,\mathbf{j} + (16.9\text{ N})\,\mathbf{k}$, how much work is done by the rocket?

24. (12) Gold has a density of 19.3×10^3 kg/m^3. How big would a solid gold sphere have to be if the acceleration due to gravity at its surface was to be 9.81 m/s^2? Check your answer against the radius of the Earth, which has a mean density of 5.5×10^3 kg/m^3.