New Jersey Science League
FIRST YEAR PHYSICS
JANUARY, 2004

Directions: For each question or statement fill in the appropriate space on the answer sheet. Use the letter preceding the word, phrase, or quantity which best completes or answers the question. Each of the 25 questions is worth 4 points. Use: $g = 9.8\ m/s^2$ $\rho_{water} = 1.00\ g/cm^3$

1. An object is floating on a clear mountain lake with 30% of its volume above the water surface. The density of water is 1.00 g/cm^3. The density of the object is about

   a. 1 g/cm^3 b. 0.7 g/cm^3 c. 0.3 g/cm^3 d. 0.1 g/cm^3
   e. Can't determine without knowing the mass of the object.

2. Two vectors have magnitudes of 8 and 12 units. When added, the magnitude of the sum
   a. is 20 units b. is 4 units c. is larger than 20 units d. is less than 4 units
   e. could be anything from 4 to 20 units.

3. Some physical quantity is calculated by use of $R = 3\pi c(a^2 + b^2)$ where a, b, and c are lengths. What is(are) the unit(s) of R?
   a. m b. m^2 c. m^3 d. $3\pi m$ e. m^{-1}

4. An object starts from rest and is uniformly accelerated in a straight line. During the 1st second, it travels a distance of 5 meters. How far will it travel during the *second* second?
   a. 5m b. 10m c. 15m d. 20m e. 25m

5. Two cars are approaching each other on a long straight road in Kansas. One is traveling 45 km/hr West and the other at 55 km/hr East. They are originally separated by 150 km. How long does it take them to meet side-by-side, hopefully in two different lanes?
   a. 1 hr b. 1.5 hr c. 2 hr d. 3 hr e. 2/3 hr

6. A fisherman whose boat can travel at 6 m/s in still water wishes to get directly across a river that has a current of 3 m/s. At what angle relative to the shoreline should he point the boat in order to make it directly across in one straight-line path?
   a. 0° b. 30° c. 40° d. 60° e. 90°

7. If you drive west at 20 km/hr then drive east at 40 km/hr, your average speed for the trip is
   a. 10 km/hr b. 20 km/hr c. 30 km/hr d. 40 km/hr
   e. Cannot be determined with the information provided.

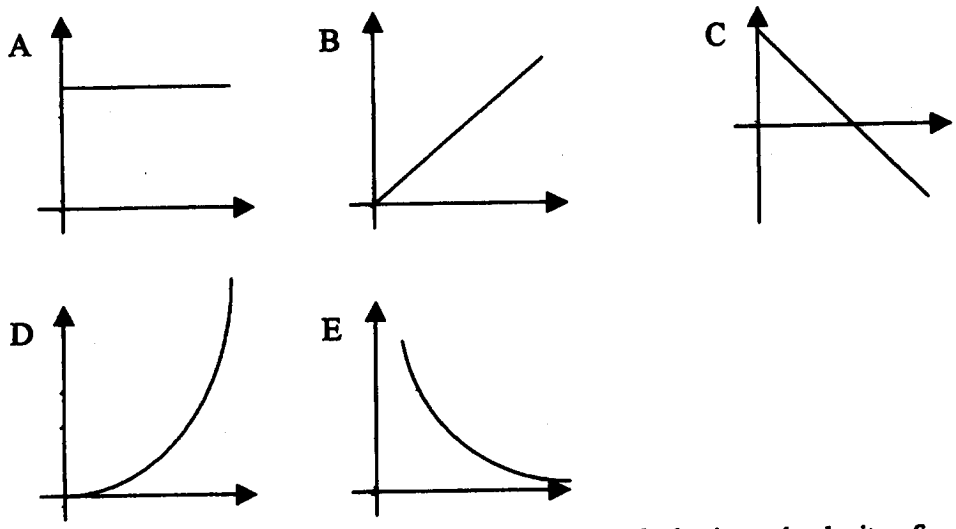
8. A package of supplies intended for a group of stranded Physics students is dropped from a plane. One second later, another package is dropped. Neglecting air resistance, the distance between the falling packages while both are still in the air will
   a. increase b. decrease c. be constant d. depend on their weights
   e. Cannot be determined.

9. A mass is resting on a shallow (a very small angle to the horizontal) inclined plane. You have identified these forces involved; $F_{//}$ (parallel force), $F_{\perp}$ (Perpendicular force), F_N (Normal force), F_f (friction force), and mg (weight). As the angle of incline is slowly increased, which of these forces will increase?
   a. $F_{//}$ b. $F_{\perp}$ c. F_N d. All of them. e. None of them

10. Florence, of weight 480 N, stands on a bathroom scale while riding in an elevator. What does the scale read as she and the elevator accelerate upward at 4 m/s^2?

a. Zero b. 480 N c. 676 N d. 884 N e. 196 N

Use the following set of graphs to answer Questions #11-13.



11. Ignoring air resistance, which graph would represent the horizontal velocity of a projectile vs. time?

a. A b. B c. C d. D e. E

12. Ignoring air resistance, which graph would represent the vertical velocity of a projectile vs. time?

a. A b. B c. C d. D e. E

13. Which graph represents the vertical force acting on a projectile?

a. A b. B c. C d. D e. E

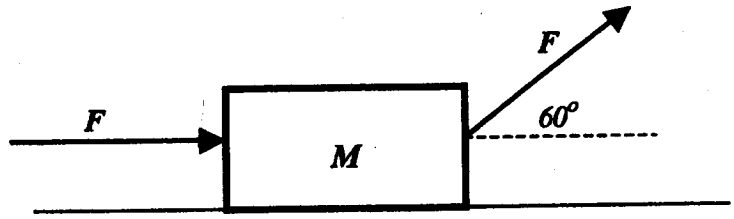
14. If it requires a force of magnitude F to throw a baseball with some initial velocity v_o here on earth, what force would be required to do the same on the surface of the moon where the acceleration of gravity is one-sixth that of earth's?

a. Zero b. $\frac{F}{6}$ c. $\frac{F}{2}$ d. F e. $6F$

15. A 50 N fish is hanging from two identical spring scales hanging vertically in series. The scales which are of negligible mass are arranged with one scale attached directly to the bottom of the other. What are the readings on the scales?

a. Each scale reads 25 N.
b. Each scale reads 50 N.
c. The top scale reads 50 N and the bottom scale reads zero.
d. The bottom scale reads 50 N and the top scale reads zero.
e. Each scale will show unequal readings greater than zero but less than 50 N, but the sum of the two readings is 50 N.

Use the following information and diagram to answer Questions #16-18. $F = 20$ N and $M = 5.0$ kg.



16. If the horizontal surface shown on which the block slides is frictionless, what is the magnitude of the resulting acceleration of the block?

a. 4 m/s^2 b. 6 m/s^2 c. 7 m/s^2 d. 8 m/s^2 e. zero

17. What is the Normal force between the block and surface?

a. Zero b. 49 N c. 39 N d. 32 N e. 29N

18. If there is indeed friction where the coefficient of friction is 0.3, what is the resulting acceleration of the block?

a. Zero b. 4 m/s^2 c. 5 m/s^2 d. 6 m/s^2 e. 7 m/s^2

19. Engineers have designed looping roller coasters to be "fail-safe". If the car of mass M is just barely to maintain contact with the rails as it passes the top of a loop of radius R, what is the minimum value for it's speed at that time?

a. $2Mrg$ b. $\sqrt{2Mrg}$ c. $\sqrt{2rg}$ d. $\sqrt{rg}$ e. Mrg

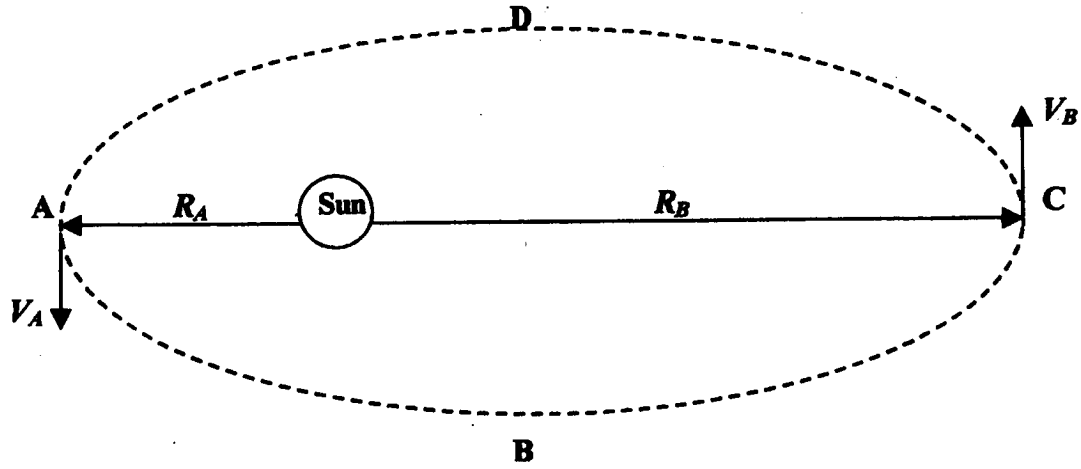
20. Recently a planet was discovered orbiting a star similar to our own sun in the far away Andromeda Galaxy system. Its mass is four times that of earths, but orbits with the same orbital radius as earth, R. What is the orbital period of this planet compared to the earth's period, T?

a. $4T$ b. $2T$ c. T d. $T/2$ e. $T/4$

21. A 100 g mass is hung from a vertical spring and causes a stretch of 4 cm. If another 100 g were added, the potential energy in the spring would be

a. half as much. b. the same. c. twice as much. d. 3 times as much e. 4 times as much.

Use the following diagram to answer Questions #22-24. The diagram shows an exaggerated view of the earth's elliptic orbit about the sun.



22. At which point of earth's path is its orbital speed the greatest?

a. A b. B c. C d. D e. All the same

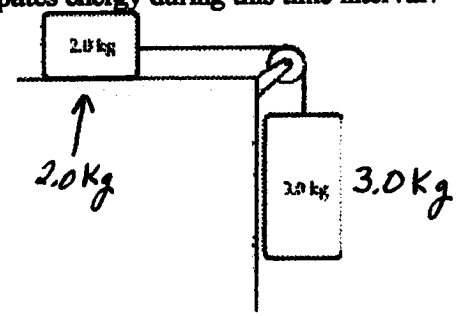
23. At which point of earth's path is its gravitational potential energy relative to the sun the greatest?

a. A b. B c. C d. D e. All the same

24. In terms of R_A, R_B, and G, the Universal Gravitational Constant, what is the ratio $\frac{V_A}{V_B}$? (Where V_A is the velocity at point A and V_B is the velocity at point B.)

a. $\frac{R_A}{R_B}$ b. $\sqrt{\frac{R_A}{R_B}}$ c. $G\sqrt{\frac{R_A}{R_B}}$ d. $\sqrt{\frac{R_B}{R_A}}$ e. $\frac{R_B}{R_A}$

25. As shown in the figure, a 2 kg mass on the table and a 3 kg mass hanging from the massless pulley are released from rest. After the 3.0-kg mass has fallen 1.5 m, it is moving with a speed of 3.8 m/s. What is the rate at which the frictional force dissipates energy during this time interval?



a. 6 W b. 8 W c. 10W d. 12W e. 14W

NEW JERSEY SCIENCE LEAGUE
FIRST-YEAR PHYSICS EXAM
JANUARY 2004
ANSWERS

1. B	**14. D**
2. E	**15. B**
3. C	**16. B**
4. C	**17. D**
5. B	**18. B**
6. D	**19. D**
7. E	**20. C**
8. A	**21. E**
9. A	**22. A**
10.C	**23. C**
11. A	**24. D**
12. C	**25. C**
13. A	

PHYSICS 1 For algebra based physics and calculus based physics.

JANUARY: scalars, vectors, kinematics, projectiles, mass, density, Newton's laws, forces(mechanical, gravitational, frictional, centripetal), work, energy(potential, kinetic), and its conservation, power.

FEBRUARY: impulse, linear momentum and its conservation, elastic and inelastic collisions, angular measure and motion, the concept of angular momentum and its conservation, equilibrium of forces and torques, simple machines, plus previous topics

MARCH: temperature, thermal equilibrium, linear expansion and contraction, specific heat, calorimetry, modes of energy transfer, thermodynamic laws, simple harmonic motion, wave propagation, standing waves, sound, plus previous topics

APRIL: electrical charges and forces, coulombs law, voltage sources and resistances, series/parallel networks, electricity and magnetism, light, index of refraction, color, optics, lenses, mirrors, interference phenomena, plus previous topics.

TESTING DATES FOR THE NEW JERSEY SCIENCE LEAGUE

THURSDAY, JANUARY 8, 2004; THURSDAY, FEBRUARY 12, 2004;

THURSDAY, MARCH 11, 2004; Thursday April 8, 2004