Name:

ID:

There is a sheet of useful formulae and some conversion factors at the end. Circle your answers clearly. All problems are 2.5 points. Maximum score is 100. There are a total of 40 problems.

1. The product of 10^{9} and 10^{-6} is
   a. 10 b. 1000 c. 0.1 d. 100

2. Write down the three base units of SI unit system:

3. The number of square centimeters in a square inch is
   a. 6.45 b. 0.16 c. 2.54 d. 0.39

4. The volume in m^3 of a cylinder with radius 1.3 cm and height 0.5 m is
   a. 2.7 b. 2.7×10^{-1} c. 2.7×10^{-4} d. 2.7×10^{-3}

5. A man runs the 100 yd dash in 15 s. His speed in meters per second is
   a. 0.61 m/s b. 6.1 m/s c. 6.096 m/s d. 61 m/s

6. Assuming the Earth is a sphere of radius 6.4×10^{3} km and has mass 6.0×10^{24} kg, its density in SI units is
   a. 5.5×10^{12} b. 5.5×10^{3} c. 1.2×10^{16} d. 3.5×10^{8}

7. The density of gold is 19.3 gm/cm^3. In SI units it is
   a. $1.93\times10^{6}\ \mathrm{kg/m^3}$ b. $1.93\times10^{4}\ \mathrm{kg/m^3}$
   c. $1.93\times10^{9}\ \mathrm{kg/m^3}$ d. $1.93\times10^{-3}\ \mathrm{kg/m^3}$

8. The radius of a hydrogen atom in its ground state is approximately 5.0×10^{-11} m. If one Angstrom = 10^{-10} m, then the radius of the hydrogen atom in Angstroms is
   a. 5 b. 0.5 c. 50 d. 0.05

9. According to Einstein, $E = mc^2$ for an object with mass m (c is the speed of light). The units of E are
   a. kg m/s b. kg m^2/s^2 c. kg^2m d. kg/m

10. An object is thrown straight upward from the edge of a cliff which is 20 m high. The object rises 15 m and then falls to the base of the cliff. Choosing the positive x to be up, the rock's displacement is:
    a. 20 m b. -15 m c. -20 m d. 55 m

11. For which **two** of the following functions specifying positions x as a function of time t is the velocity in the negative x direction?
    a. $x=-15t^{-2}+20$ b. $x=18t^{3}-5$
    c. $x=7t^{-2}+20$ d. $x=-10t+5$

12. An object moves along the negative x direction with increasing speed. The sign of its acceleration is:
    a. positive b. negative c. Undeterminable

13. A plot of an object's velocity v as a function of time is a straight line with positive slope which crosses the t axis at some time. Which of the following statements is NOT true?
    a. the acceleration is constant
    b. the object changes direction of motion
    c. the object is instantaneously at rest at some instant
    d. the object never changes direction of motion

14. An object moves with initial velocity equal to 10 m/s. How long must it accelerate at a constant acceleration of 2 m/s^2 before its average velocity is equal to three times its initial velocity?
    a. 20 s b. 25 s c. 15 s d. 10 s

15. Photographs are taken of a falling object at equal time intervals. The distance between the neighboring positions of the object will be
    a. the same b. bigger with time
    c. smaller with time d. Undeterminable

16. Two objects are thrown off a cliff. One is thrown directly up, the other directly down. The ball thrown upward hits the ground
    a. at the same speed as the one thrown downward
    b. faster than the one thrown downward
    c. slower than the one thrown downward
    d. cannot determine

17. A ball is thrown straight up. It reaches a maximum height and then descends. As it descends
    a. its velocity and acceleration both point down.
    b. its velocity and acceleration point in opposite directions.
    c. its velocity and acceleration both point up.
    d. None of the above

18. A ball is thrown straight up with a speed of 10 m/s from a cliff of height 15 m. Its speed when it reaches the ground is
    a. 17.1 m/s b. 19.9 m/s c. 29.9 m/s d.9.9 m/s

19. Vector A has a magnitude of 5 and makes an angle of 30° with the x axis. Vector B has a magnitude of 10 and makes an angle of 60° with the x axis. The magnitude of the resultant vector of the addition of these two vectors is
    a. 14.6 b. 15 c. 12.3 d. 8

20. When a vector **B** is subtracted from the vector given by $A_X = 3$, $A_Y = 4$, the resulting vector points in the positive x direction and has magnitude equal to that of **A**. The magnitude of **B** is
    a. 4.2 b. 6.1 c. 0 d. 5

21-23] A projectile was launched at an unknown angle with respect to horizontal. Answer the following series of questions.

21. What is the acceleration in this motion?

22. Which of the following statements is true for a projectile launched at l?
    a. Its speed is constant.
    b. Its horizontal speed decreases
    c. The acceleration and velocity vectors are always anti-parallel.
    d. Its vertical component of velocity changes sign.

23. The projectile will have maximum range for a given initial speed if it's launched at an angle of
    a. 30° b. 45° c. 60° d. 75°

24. Which of the following statements is true for two balls thrown in the air at different angles with the horizontal?
    a. the ball making the steeper angle spends more time in the air
    b. the ball making the shallower angle spends more time in the air
    c. the time of flight depends on the initial speed given each ball.
    d. none of the above

25. You are on a merry-go-round of diameter 10 m revolving at 0.1 rev/s. The magnitude of your centripetal acceleration is:
    a. 4 m/s^2 b. 0.08 m/s^2 c. 0.04 m/s^2 d. 8 m/s^2

26. Which of the following statements is true for a particle in uniform circular motion?
    a. Its velocity and acceleration vectors are always parallel
    b. Its velocity and acceleration vectors are always perpendicular.
    c. Its acceleration vector is constant.
    d. Its velocity vector is constant.

27. Which of the following is not an inertial frame of reference?
    a. a car moving at constant velocity
    b. a rotating merry-go-round
    c. an inclined plane
    d. a plane flying at constant velocity

28. A box sits on a table. You can reduce the normal force of the table on the box by
    a. exerting an upward force on the box b. exerting a downward force on the box
    c. no means; it is constant d. none of the above

29. A person stands on a scale in a free falling elevator. The reading on the scale is
    a. zero b. the person's true weight
    c. more than the person's true weight d. less than the person's weight, but not zero

30. Which of the following statements is true for a pair of forces obeying Newton's Third Law?
    a. they are parallel to each other in the same direction
    b. they are perpendicular to each other
    c. they act on the same object
    d. they act on different objects

31. A car collides with a truck. The force exerted by the truck on the car is
    a. greater than the force exerted by the car on the truck
    b. less than the force exerted by the car on the truck
    c. the same as the force exerted by the car on the truck
    d. not necessarily related to the force exerted by the car on the truck.

This space is deliberately left blank. The exam problems continue on the next page. Be sure to complete them, too!

[32-36] A 5 kg block slides down a frictionless plane inclined at 30° with the horizontal.

32. What are the forces acting on this block?

33. What is the direction of the gravitational force exerted on this block?
    a. Along the incline toward the bottom
    b. Down toward the center of the earth
    c. Along the incline toward the top
    d. Cannot determine with the given information

34. Draw a free-body diagram of this motion.

35. Write down the two force equations on x and y direction.

36. What is the acceleration of the block?

37. You first apply a horizontal force to drag a box across a floor. If instead you apply a force of the same magnitude but an angle above the horizontal, does the force of kinetic friction
    a. become greater
    b. become smaller
    c. remain the same
    d. none of the above

38. A block is placed on a plane inclined at angle θ and remains stationary. From this observation what can we conclude? μ_k is a constant of kinetic friction, and μ_s is a constant of static friction.
    a. $\mu_k > \tan\theta$
    b. $\mu_k < \tan\theta$
    c. $\mu_s < \tan\theta$
    d. $\mu_s > \tan\theta$

39. A block is placed on an inclined plane where it is held at rest by friction. A force is then applied parallel to the plane pointing up the plane. Which of the following statements is true?
    a. As the magnitude of the applied force increases, the frictional force never changes direction.
    b. As the magnitude of the applied force increases, the frictional force goes from pointing down to pointing up the plane.
    c. As the magnitude of the applied force increases, the frictional force goes from pointing up to pointing down the plane.
    d. The force of static friction always equals in magnitude the applied force.

40. A block of mass 2 kg is attached to a string that will break if the tension exceeds 500 N. If the block is whirled in a horizontal circle of radius 0.5 m, its maximum speed will be
    a. 2.2 m/s
    b. 11 m/s
    c. 25 m/s
    d. 125 m/s

Useful Formula

Some conversion factors: 1 in = 2.54 cm; 1yd = 0.91 m

Volume of a sphere with radius r: $V = \frac{4\pi}{3} r^3$

Volume of a cylinder with radius r and height h: $V = \pi r^2 h$

Rule of derivatives: $\frac{d\left(at^n + b\right)}{dt} = nat^{n-1} + 0$

Some 1-dimensional Kinematic formulae:

$v_f = v_i + at$

$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2$; $y_f = y_i + v_{yi}t + \frac{1}{2}a_y t^2$

$v_f^2 = v_i^2 + 2a\left(x_f - x_i\right)$

One revolution per second for a circular motion with radius r is equivalent to the linear speed in a circular motion: $v = 2\pi r$ m/s

Centripetal acceleration: $a_r = \frac{v^2}{r}$

Newton's 2nd law of motion: $\sum F_x = ma_x$; $\sum F_y = ma_y$

Magnitude of the gravitational acceleration is $g = 9.8 m/s^2$.

The solutions for a 2-dimensional equation:

$$ax^2 + bx + c = 0$$

are:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$