**Answer all questions on the answer sheet!** This test consists of 40 multiple choice questions. Questions are on both sides of the paper.

1. Mathematics is used in science because
   (A) with math we can prove scientific laws
   (B) mathematics allow us to quantify physical measurements
   (C) students don't like mathematics
   (D) scientist are smart

2. A mathematical function
   (A) is normally represented as an equation
   (B) can be visualized as a graph
   (C) is a rule that tells us how to get one quantity if we know another quantity
   (D) all of the above

3. A vector is
   (A) a quantity with direction and magnitude
   (B) also known as a scalar
   (C) a quantity with only magnitude
   (D) something which has no physical meaning.

4. Which graph corresponds to a stone dropped from rest near the surface of the earth.
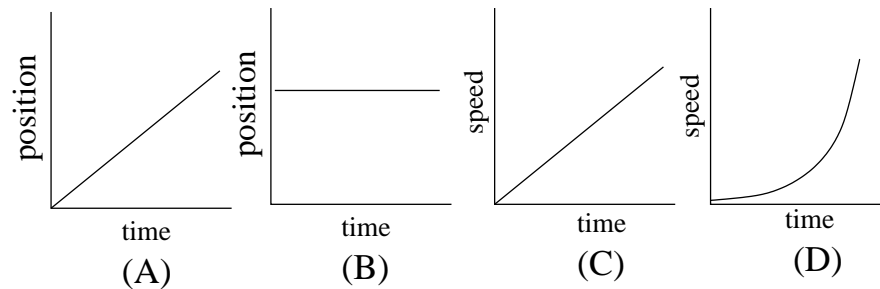
5. The SI (metric) unit of acceleration is
   (A) kg m^2/s^2
   (B) m/s
   (C) m/s^2
   (D) kg m/s^2

6. The velocity of an object:
   (A) is the same as the object's speed
   (B) is constant if the object moves in a circle
   (c) depends on the object's mass
   (D) is determined by the object's speed and direction

7. The value of the average velocity for any round trip is equal to
   (A) zero.
   (B) total distance traveled divided by total trip time.
   (C) the final acceleration multiplied by trip time
   (D) the person's speed halfway through the path.

8. Suppose you have a car traveling down the road at constant speed and not changing direction. It is experiencing gravity, wind resistance and frictional forces from the road. What can be said about the car's acceleration?
   (A) It is not accelerating because gravity holds it down.
   (B) It accelerating because the motor is running, propelling the car forward.
   (C) It is not accelerating because it has constant velocity.
   (D) It is accelerating because there are forces acting on it.

9. To cause a 25 kg object to experience an acceleration of 2 m/s^2 the net force that needs to be applied to the object is
   (A) 50 N
   (B) 5 N
   (C) 100 N
   (D) 10 N

10. Suppose a tree branch falls down to the ground with constant acceleration and takes 2 seconds to hit the ground. Which of the following statements regarding the path of the branch is true?
    (A) It covers the same distance during the first second as it does during the last second.
    (B) It covers more distance during the last second.
    (C) It covers less distance during the last second.
    (D) Its acceleration is increasing during the time it falls

11. If a rocket accelerates from rest at a rate of 50 m/s^2 for 10 seconds, the distance traveled during this time is
    (A) 250 m
    (B) 500 m
    (C) 2500 m
    (D) 5000 m

12. A projectile is thrown directly upward and caught again. At the top of its path
    (A) its horizontal velocity changes
    (B) its acceleration changes
    (C) it stops accelerating
    (D) its vertical velocity is zero

13. Mass
    (A) is a measure of inertia
    (B) is the same as weight.
    (C) is proportional to the square of the acceleration if the total force is fixed.
    (D) is measured in Newtons

14. Suppose you go from the earth to a planet where the acceleration of gravity is 3 m/s². On the new planet your mass will
    (A) be 1/3 its value on Earth
    (B) not change
    (C) be 9 times its value on Earth
    (D) be 3/10 its value on Earth

15. Two forces of 2 Newtons each are applied to an object with a mass of 4 kg. The angle between the forces is 90°. What is the magnitude of the acceleration of the object.
    (A) 1 m/s²
    (B) $\frac{1}{2}$ m/s²
    (C) $\frac{\sqrt{2}}{2}$ m/s²
    (D) $\sqrt{2}$ m/s²

16. An object is in mechanical equilibrium when
    (A) only one force acts on the object
    (B) it has constant acceleration
    (C) the net force on the object is zero
    (D) acted on by a constant force

17. A car traveling at 100 km/hr strikes a bug and the bug splatters on the windshield. The force of impact
    (A) is greater on the bug
    (B) is greater on the car
    (C) is the same on the bug and the car
    (D) is different for the bug and car and depending on the ratio of their masses

18. Which physical quantity is not a vector.
    (A) momentum
    (B) mass
    (C) velocity
    (D) acceleration

19. A 1000 kg automobile is traveling at 10 m/s. The kinetic energy of the automobile is
    (A) 10^3 J
    (B) 5 x 10^3 J
    (C) 10^4 J
    (D) 5 x 10^4 J

20. An object that has kinetic energy must be
    (A) moving
    (B) at an elevated position
    (C) at rest
    (D) none of the above

21. You push on a box with a force of 20 N and the box moves a distance of 8 m. The amount of work you have done on the box is
(A) 20 J
(B) 160 J
(C) 320 J
(D) 0 J

22. A spinning Frisbee is thrown between two persons in a park. The motion of the Frisbee is
(A) purely translational.
(B) neither rotational nor translational.
(C) rotational and translational.
(D) purely rotational.

23. A water tower is often used to provide water pressure for a building. How much energy is required to pump 1000 kg of water to a tank that is 50 meters above the pump?
(A) 4.9 x 10^4 Joules
(B) 9.8 x 10^4 Joules
(C) 4.9 x 10^5 Joules
(D) 9.8 x 10^5 Joules

24. The energy unit 'Joule' is equivalent to
(A) kg m^2/s
(B) kg m^2/s^2
(C) kg m^2/s^3
(D) kg^2 m^2/s

25. Suppose you push horizontally on the wall of a building. For you to do work on the wall, which of the following need to happen?
(A) The wall moves away from you
(B) The wall lifts up
(C) The wall moves sideways
(D) Nothing, you always do work when you push on something.

26. Momentum is:
(A) a measure of an objects energy
(B) conserved because of time reversal symmetry
(C) mass times velocity
(D) one half an objects mass times its velocity squared

27. Suppose you are riding a bicycle. If you want to waste as little energy as possible while the bike is in motion, what type of friction should exist between the bike's tires and the road?
(A) none
(B) static
(C) as much as possible
(D) kinetic (sliding)

28. Impulse (force·Δt) is equal to
    (A) the change in kinetic energy
    (B) the change in momentum
    (C) the momentum
    (D) the acceleration

29. Power is
    (A)The amount of heat generated when a job is done.
    (B)The rate at which energy is used, stored, dissipated, etc.
    (C)The amount of energy used multiplied by time.
    (D)The amount of energy used to do a particular job.

30. A hair dryer is rated at a power of 1000 watts. How much electrical energy does the
    dryer use in 20 seconds
    (A) 1,000 Joules
    (B) 2,000 Joules
    (C) 20,000 Joules
    (D) 50,000 Joules

31. Rotational symmetry is the underlying reason for
    (A) momentum conservation
    (B) Newton's $2nd$ law
    (C) energy conservation
    (D) angular momentum conservation

32. Torque can best be described as
    (A) rotation in radians
    (B) angular momentum
    (C) angular force
    (D) a push or a pull

33. Two children are on a seesaw in the park. One child has a weight of 200 N and is
    1.5 meter from the pivot. The other child has a weight of 300 N. If the seesaw is in
    rotational equilibrium, the second child should be how far from the pivot
    (A) 0.50 m
    (B) 0.75 m
    (C) 1.00 m
    (D) 1.25 m

34. For momentum to be conserved in a system it must
    (A) experience a dissipative forces like drag.
    (B) not be connected to a motor.
    (C) experience no net external force.
    (D) be weightless

35. When a figure skater pulls in their arms during a spin,
    (A) they change their angular momentum and increase their speed
    (B) they change their 'rotational mass' and increase their angular speed
    (C) they change their angular momentum and decrease their speed
    (D) they change their 'rotational mass' and decrease their angular speed

36. Suppose the moon's angular velocity is halved. By what factor will its rotational kinetic energy change?
    (A) It will decrease to $\frac{1}{4}$ its original value
    (B) It will decrease to $\frac{1}{2}$ its original value
    (C) It will double
    (D) It will quadruple

37. The coefficient of restitution for a particular ball is 0.45. If the ball hits a surface traveling at 100 m/s its rebound speed will be
    (A) 90 m/s
    (B) 75 m/s
    (C) 45 m/s
    (D) 25 m/s

38. A boy swings a .5 kg rock around his head on a cord in a circular path. The circular path has a radius of 1.0 m and the speed of the rock is 2 m/s. What is the centripetal force on the rock
    (A) 1.0 N
    (B) 1.5 N
    (C) 2.0 N
    (D) 2.5 N

39. You are riding an amusement park ride where you are strapped to the inside of a giant metal wheel that is rotating quite rapidly. Your acceleration is
    (A) Zero
    (B) Straight up
    (C) Straight down
    (D) Toward the center

40. You go through a loop in a roller coaster at constant speed. Where is your apparent weight a minimum?
    (A) Halfway up, going up
    (B) Halfway up, going down
    (C) At the top
    (D) At the bottom