Name:

ID: Answer Keys

There is a sheet of useful formulae and some conversion factors at the end. Circle your answers clearly. All problems are 2 points except a few marked with their own scores. Maximum score is 100. There are a total of 46 problems. Procedures must be shown in free style problems for full credit.

1. The number of significant figures in the number 0.0005930 is
   a. 4 b. 5
   c. 6 d. 7

2. The area of a rectangle which is 4.5 cm by 3.25 cm is correctly given by
   a. 14.625 b. 14.63
   c. 14.6 **d. 15**

3. The length of a car is given as 6.5 m. The percent uncertainty in this measurement is
   a. 2% b. 20%
   c. 1% d. 10%

4. A sheet of paper is measured to be 20.0 cm by 40.12 cm. Its area is correctly given in SI unit by **(No answer. Everyone gets the point.)**
   a. 800 cm^2 b. 802.4 cm^2
   c. 8.00 m^2 d. 0.800 m^2

5. Two hundred fifty six grams is equivalent to
   a. 2.56 kg **b. 0.256 kg**
   c. 0.0256 kg d. 0.00256 kg

6. Newton's Law of Universal Gravitation states that the force between two masses m_1 and m_2, separated by a distance r is given by $F = Gm_1m_2/r^2$. Force has dimensions kg m/s^2. The units of the gravitational constant G are
   a. none, G is dimensionless b. kg m/s^2
   c. m^2/kg^2 **d. $m^3/(kg\ s^2)$**

7. A student runs back and forth on a track five times covering a total distance of 500 m. Her displacement is:
   a. 2500m b. 500 m
   c. 100 m **d. 0 m**

8. A person runs from home to the store and back again, a total distance of 1.5 mi. It took him 10 minutes on the way to the store. He spent 20 minutes in the store. On the way back home, he met his friend and talk to him a while. So the return trip took him 20 minutes. What is his average velocity through the trip.
   a. 1.8 mi/hr b. 3 mi/hr **c. 0 mi/hr**
   d. cannot be determined since he stopped on the way back.

9. The plot of y vs. x for an object's motion is a parabola. The acceleration of the object is
   a. zero **b. constant**
   c. variable d. cannot be determined

10-15] A car starts from rest and accelerates at 5 m/s^2 for 10 s to positive x-axis. It travels at constant speed for 40 s and then slows down at a rate of 1 m/s^2 to full stop. Answer the following questions. The procedure must be accompanied with the answers. You will not get full credit by just writing down the answers.

10. What is the velocity after completing the first 10s of the motion? [3 points]

Ans] $v_f = v_i + at = 0 + 5 \cdot 10 = 50 m/s$

11. What is the distance covered during the first 10s of the motion? [3 points]

Ans] $x_f - x_i = v_i t + \frac{1}{2} a t^2 = 0 + \frac{5 \cdot 10^2}{2} = 250 m$

12. How long does it take for the car to come to full stop through the final segment of the motion? [3 points]

$v_i = 50 m/s; \quad v_f = 0 m/s$

Ans] $v_f = v_i + at$

$$t = \frac{v_f - v_i}{a} = \frac{-50}{-1.0} = 50 \text{sec}$$

13. What is the average velocity of the motion? [3 points]

Ans] Displacement in the three segments are

$$x_1 = 250 m$$

$$x_2 = v_i t + \frac{1}{2} a t^2 = 50 \cdot 40 = 2000 m$$

$$x_3 = v_i t + \frac{1}{2} a t^2 = 50 \cdot 50 - \frac{1}{2} \cdot 1.0 \cdot (50)^2 = 1250$$

$$x = x_1 + x_2 + x_3 = 250 + 2000 + 1250 = 3500 m$$

$$\bar{v} = \frac{x}{t} = \frac{3500}{10 + 40 + 50} = \frac{3500}{100} = 35 m/s$$

14. What is the total distance covered by the motion? [3 points]

Ans] From the above: 3500m

15. What is the displacement through the motion? [3 points]

Ans] From the above: 3500m since the motion was along the positive x axis.

16. A ball is thrown downward from a cliff with a speed of 15 m/s. After 10 s, its velocity will be:

a. 98 m/s
b. 113 m/s
c. 0 m/s
d. 9.8 m/s

17. Two objects are thrown off a cliff with the same speed. One is thrown directly up, the other directly down. The ball thrown upward hits the ground
    a. faster than the one thrown downward
    b. slower than the one thrown downward
    c. at the same speed as the one thrown downward
    d. Cannot be determined since the acceleration is not known

18. A ball is thrown upward with an initial velocity of 5.2 m/s. How long will it take to reach its maximum height?
    a. 1.06 s
    b. 0.53 s
    c. 1.59 s
    d. Cannot be determined without acceleration

19. A ball is thrown straight up with non-zero velocity on top of Mt. Himalaya. What is the direction of the acceleration throughout the ball's motion?
    a. The direction initially points upward then slowly turns around to point down as the ball descends.
    b. The acceleration always points upward.
    c. The acceleration always points downward.
    d. The direction cannot be determined since the exact value of the initial velocity is not known.

20. A nickel and feather are dropped simultaneously in a nitrogen-filled tube. The net acceleration of the feather is
    a. greater than that of the nickel
    b. less than that of the nickel
    c. the same as that of the nickel
    d. cannot be determined since they do not move in a nitrogen-filled tube

21. Vector A has an x component of X and a y component of Y. The angle A makes with the x axis is
    a. 53.1^o
    b. 36.9^o
    c. cos(X/Y)
    d. $\tan^{-1}(Y/X)$

22. Three vectors are given by: $A_X = 2$, $A_Y = 10$, $B_X = 9$, $B_Y = 12$, $C_X = 4$, $C_Y = 15$. What is the magnitude of the vector **A+B-C**?
    a. 9.9
    b. 10.4
    c. -9.5
    d. 3.0

23. You walk 10 m due south and then turn and walk 5 m in a direction 45^o north of east. Your total displacement is **(No answer. Everyone gets the point.)**
    a. 14 m
    b. 135.4 m
    c. 73.7 m
    d. 64.6 m

24. The magnitude of the **addition** between the two unit vectors **i** and **j** is
    a. 2
    b. 0
    c. 1.4
    d. 0.7

25-27] A projectile was launched at an unknown angle with respect to horizontal. Answer the following series of questions.

25. What is the acceleration in this motion?
    Gravitational Acceleration or 9.8m/s^2 or -9.8m/s^2

26. 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.

27. 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°

28. 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

29. You are on a merry-go-round of diameter 10 m revolving at 0.1 rev/s. The magnitude of your centripetal acceleration is: **(No answer. Everyone gets the points.)**
a. 4 m/s^2 b. 0.08 m/s^2 c. 0.04 m/s^2 d. 8 m/s^2

30. 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.

31. 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

32. 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

33. 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

34. 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 act on the same object
c. they are perpendicular to each other **d. they act on different objects**

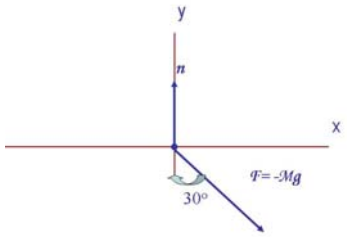
35. A car collides with a truck. The force exerted by the truck on the car is
a. greater than the force exerted by the car on the truck
b. less than the force exerted by the car on the truck
c. the same as the force exerted by the car on the truck
d. not necessarily related to the force exerted by the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

[36-40] A 10 kg block slides down a frictionless plane inclined at 15° with respect to the horizontal plane.
36. What are the forces acting on this block? Give their names not their sizes.

Ans] Gravitational force
Normal force

37. 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

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



39. Write down the two force equations on x and y direction. [2 points each, totaling 4 points]

$\sum F_x = mg\sin 15^\circ = ma$; $\sum F_y = n - mg\cos 15^\circ = 0$

40. What is the acceleration of the block?

Ans) From the first equation above, one can obtain
$ma = mg\sin 15^\circ$ **canceling mass m on either side, the acceleration is**
$a = g\sin 15^\circ = 9.8\sin 15^\circ = 2.5 m/s^2$ **downward, along the incline.**

41. 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

42. 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.** $\mu_s > \tan\theta$

43. 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 changes direction and magnitude.
    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.

44. 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

45-46] Write down the followings:
45. Three base units of SI unit system

Ans] Length: m, Time: sec, Mass: kg

46. The unit of work expressed in base units

Ans] Joule=kg m^2/s^2

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:

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