1982B1. The first meters of a 100-meter dash are covered in 2 seconds by a sprinter who starts from rest and accelerates with a constant acceleration. The remaining 90 meters are run with the same velocity the sprinter had after 2 seconds.

a. Determine the sprinter’s constant acceleration during the first 2 seconds.
b. Determine the sprinters velocity after 2 seconds have elapsed.
c. Determine the total time needed to run the full 100 meters.
d. On the axes provided below, draw the displacement vs time curve for the sprinter.
Question 1

1. Conceptually explain what is happening during the time interval 0-4 s taking into account position, distance, displacement, velocity, and acceleration.

2. Conceptually explain what is happening during the time interval 4-6 s taking into account position, distance, displacement, velocity, and acceleration.

3. Where on the graph is the acceleration "0"?

5. If you were sketching an acceleration vs time or a displacement vs time graph, how many lines must you have?

6. If the slope on a velocity vs time graph is constant, how will the lines on the acceleration vs time graph look?

7. Sketch the acceleration vs time graph.
**Question 2**
A particle starts from rest from the top of an inclined plane and slides down with constant acceleration. The inclined plane is 2.00 m long, and it takes 3.00 seconds for the particle to reach the bottom.

Find (a) the acceleration (b) its speed at the bottom of the incline (c) the time it takes the particle the middle of the incline (d) its speed at the midpoint. (ans: 0.44 m/s², 1.32 m/s, 2.13 s, 0.93 m/s)

**Question 3**
A car travels 2000 meters north then 3500 m, 60 degrees W of N. Find the magnitude and direction of the car's displacement. Include a vector diagram. (ans: 85.8 degrees N of W)

**Question 4**
A bomber flies horizontally with a speed of 275 m/s at an altitude of 3000 m.

a) What is the initial "y" velocity (V oy) of an object if it starts off horizontally? (ans: 0 m/s)

b) In the formula, x = v ox t + 1/2at², what is the acceleration in the x direction? (ans: 0 m/s²)

c) Solve for the time the projectile is in the air. (ans: 24.7 s)

d) Solve for the "x" displacement. (ans: 6792.5 m)
**Question 5**
A skier leaves the ramp of an elevated 35-degree ski jump with a velocity of 10 m/s. How long is he in the air? What is his maximum height? How far away does he land? (ans: 1.2 s, 1.68 m, 9.84 m)

**Question 6**
A 15-kg box is pushed at a **constant speed**, with friction, horizontally by a rope with tension of 55 N.

a) Draw a force diagram. Solve for all of the forces. What is the value of the coefficient of kinetic friction? (ans: 0.37)

b) Suppose the 15-kg box is now placed on a 25-degree incline and the 55 N force is applied downward parallel to the incline. Draw a force diagram. Solve for all of the forces. What is the new value of the coefficient of kinetic friction? (ans: 0.88)

**1981B1.** A 10-kilogram block is pushed along a rough horizontal surface by a constant horizontal force $F$ as shown above. At time $t = 0$, the velocity $v$ of the block is 6.0 meters per second in the same direction as the force. The coefficient of sliding friction is 0.2. Assume $g = 10$ meters per second squared.

a. Calculate the force $F$ necessary to keep the velocity constant.

The force is now changed to a larger constant value $F'$. The block accelerates so that its kinetic energy increases by 60 joules while it slides a distance of 4.0 meters.

b. Calculate the force $F'$.

c. Calculate the acceleration of the block.
Question 7

A wooden block of mass 9-kg accelerates down an incline sloped at 20 degree. The block starts from rest and is located 5.0 m from the bottom of the incline.

a) Determine the acceleration of the block if the coefficient of kinetic friction is 0.33. (ans: 0.31 m/s²)

b) Determine the velocity of the block at the bottom of the incline. (ans: v = 1.76 m/s)

Question 8

M₁ = 4 kg and M₂ = 6 kg are connected over a frictionless pulley. Friction is present on the surface.

a) Draw a force diagram for M₁ and M₂.

b) M₂ starts from rest and moves a total displacement of 1.75 meters in 2.5 seconds. What is the acceleration of M₂? Is this value the same for M₁? Explain. (ans: 0.56 m/s², yes.)

c) Determine the coefficient of kinetic friction for M₁. (ans: 1.36)
A 10-kilogram block rests initially on a table as shown in cases I and II above. The coefficient of sliding friction between the block and the table is 0.2. The block is connected to a cord of negligible mass, which hangs over a massless frictionless pulley. In case I a force of 50 newtons is applied to the cord. In case II an object of mass 5 kilograms is hung on the bottom of the cord. Use g = 10 meters per second squared.

a. Calculate the acceleration of the 10-kilogram block in case I.

b. On the diagrams below, draw and label all the forces acting on each block in case II.

c. Calculate the acceleration of the 10-kilogram block in case II.
**Question 9**
A person swings a 0.65 kg rock in an old fashion slingshot around in a vertical circle. The length of the slingshot is 0.85 m. If the person swings the rock around once in 0.55 seconds, determine:

a) The slingshot’s speed. (ans: 9.71 m/s)
b) The slingshot’s tension when the rock is at the bottom of the swing. (ans: 78.5 N)
c) The slingshot’s tension when the rock is at the highest point of the swing. (ans: 65.7 N)
d) Suppose the same person swung the rock around horizontally at an angle of 20 degrees below the horizontal. Draw a force diagram. Solve for tension, radius, and velocity. (ans: 18.6 N, 0.8 m, 2.8 m/s)

**Question 10**
A man pushes down on a lawnmower with a force of 50 N at 55 degrees above the horizontal along the +x direction.

a) If the displacement is 6 m, how much work does the man do on the lawnmower? (ans: 172.1 J)
b) If the lawnmower starts from rest, how fast is it moving at the end of the 6 m if its mass is 100 kg? (ans: 1.85 m/s)

**Question 11**
A crane pulls a 250 kg box 35 m upward with a constant speed in 5.5 seconds. What is the power generated during this time? (ans: 15,590.9 W)

Suppose the crane in the problem has a giant 500 kg ball at the end of a 15 m cable. The ball makes a 25-degree angle with respect to the vertical. Determine the initial height of the ball and the velocity of the ball at the bottom of the swing. (ans: h = 1.4 m, v = 5.24 m/s)
1979B1. From the top of a cliff 80 meters high, a ball of mass 0.4 kilogram is launched horizontally with a velocity of 30 meters per second at time $t = 0$ as shown above. The potential energy of the ball is zero at the bottom of the cliff. Use $g = 10$ meters per second squared.

a. Calculate the potential, kinetic, and total energies of the ball at time $t = 0$.

b. On the axes below, sketch and label graphs of the potential, kinetic, and total energies of the ball as functions of the distance fallen from the top of the cliff.

c. On the axes below sketch and label the kinetic and potential energies of the ball as functions of time until the ball hits the cliff.
**Question 12**

A 675 kg car traveling at 15 m/s strikes another car at rest.

a) What is the velocity of the second car (525 kg) if the 1st car comes to rest? What type of collision is this? Is kinetic energy conserved? (ans: 19.3 m/s)

b) If the two cars stick together what will be their final velocity? What type of collisions is this? Is kinetic energy conserved? (ans: 8.44 m/s)

A loaded cannon with ball has a mass of 250 kg. What is the velocity of a 5 kg ball if the cannon moves backwards at 0.5 m/s? (ans: -20 m/s)

A 145 kg linebacker moving at 1.5 m/s to the west strikes a 165 Kg running back who momentarily stops before the collision. The linebacker moves at 32 degrees N of W after the collision and the running back moves at 66 degrees S of W.

a) Sketch the situation.

b) Determine the final velocity of both football players. (ans: $v_1 = 13.83$ m/s, $v_2 = 7.06$ m/s)

**1976B2.**

A bullet of mass $m$ and velocity $v_0$ is fired toward a block of mass 4$m$. The block is initially at rest on a frictionless horizontal surface. The bullet penetrates the block and emerges with a velocity of $\frac{v_0}{3}$.

(a) Determine the final speed of the block.

(b) Determine the loss in kinetic energy of the bullet.

(c) Determine the gain in the kinetic energy of the block.
**Question 13**

3 metal spheres have charges of (sphere 1=) –12 C, (sphere 2=) +4 C and (sphere 3=) +3 C. Sphere 1 touches sphere 2. What is the new charge on each sphere?

Sphere 2 now touches sphere 3. What is the new charge on each sphere?

If Sphere 1 is now placed at +y = 3 cm, sphere 2 at the origin, and sphere 3 at x= -2. Calculate the magnitude and direction of the NET electrostatic force on the particle at the origin. (*Use the NEW charges after the above interactions*). (ans: 20.77 N, 1.31°)

Calculate the electric potential energy for the system of charges. (ans: J)

Remove charge 2 from the origin. Calculate the magnitude and direction of the electric field at the origin due to Spheres 1 and 3. (ans: 4.16 x 10^7 N/C, 1.3°)

Remove charge 2 from the origin. Calculate the NET potential at the origin due to Spheres 1 and 3. (ans: - 1.33 x 10^6 V)

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**1978B3.** A uniform electric field E is established between two capacitor plates, each of area A, which are separated by a distance s as shown above.

(a) What is the electric potential difference V between the plates?
(b) Specify the sign of the charge on each plate.
1981B3. A small conducting sphere of mass $5 \times 10^{-3}$ kilogram, attached to a string of length 0.2 meter, is at rest in a uniform electric field $E$, directed horizontally to the right as shown above. There is a charge of $5 \times 10^{-6}$ coulomb on the sphere. The string makes an angle of $30^\circ$ with the vertical. Assume $g = 10$ meters per second squared.

a. In the space below, draw and label all the forces acting on the sphere.

b. Calculate the tension in the string and the magnitude of the electric field.

c. The string now breaks. Describe the subsequent motion of the sphere and sketch on the following diagram the path of the sphere while in the electric field.
1987B2. Object I, shown above, has a charge of $+3 \times 10^{-6}$ coulomb and a mass of 0.0025 kilogram.
a. What is the electric potential at point P, 0.30 meter from object I?

Object II, of the same mass as object I, but having a charge of $+1 \times 10^{-6}$ coulomb, is brought from infinity to point P, as shown above.
b. How much work must be done to bring the object II from infinity to point P?
c. What is the magnitude of the electric force between the two objects when they are 0.30 meter apart?
d. What are the magnitude and direction of the electric field at the point midway between the two objects?

The two objects are then released simultaneously and move apart due to the electric force between them. No other forces act on the objects.
e. What is the speed of object I when the objects are very far apart?
In the circuit shown above, the current delivered by the 9-volt battery of internal resistance 1 ohm is 3 amperes. The power dissipated in R₂ is 12 watts.

(a) Determine the reading of voltmeter V in the diagram.
(b) Determine the resistance of R₂.
(c) Determine the resistance of R₁.