Multiple Choice: Kinematics

1. B. Object B has a greater net displacement which is determined by the area
2. D. There is no object with a constant slope
3. A. The total displacement in object A is 0
4. B. The areas must be equal, therefore it must be between 1-2
5. C. $x = v_0 t_1 + v_0 t + \frac{1}{2}at^2 = 36$
6. C. $x = v_0 t \rightarrow 2d = 2v_o t$
7. D. Velocity constantly decreases, acceleration remains negative and constant.
8. D. Points P and R have equal velocity because they are at the same height, and must be greater than the highest point Q
9. D. Acceleration is just gravity, which is pointing down
10. D. $v = \frac{D}{t}$
11. A. The area is less than car X, therefore it's displacement is less and car Y is ahead of car X
12. B. Car Y is at car X's location, because car Y has a higher velocity, it will be passing car X.
13. D. As speed increases at a constant rate, the distance will increase in a parabolic manner
14. D. The northern force has increased, and the easteren force has turned to west. Therefore, the force applied must be northwest.
15. D. Vertical velocity is always 0 at the peak, horizontal velocity and vertical acceleration will be constant throughout all points.
16. D. An increase in velocity will cause a parabolic increase, a constant velocity will give a linear increase, a decrease in velocity will cause a parabolic decrease
17. C. The block travels around 10 meters in $\sqrt{2}$ seconds.
18. A. The graph should consist of two main parts, a part where position increases at a constant rate and a part where it decreases at constant rate.
19. D. The acceleration of the plastic balls not being uniform is the most likely reason. The other options are all wrong/impossible.
20. C. All other options will be shorter than 0-45 degrees

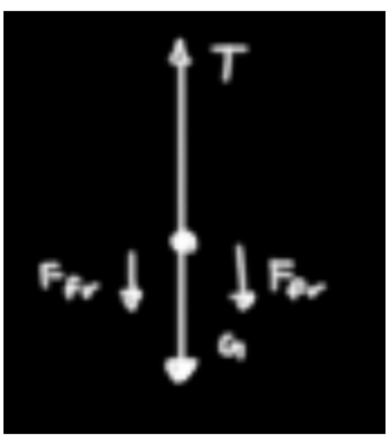
Multiple Choice: Linear Dynamics

1. C. T_2 supports more of the weight
2. D. Gravity goes straight down, force pulls it back, and normal force is perpendicular to the ramp
3. D. The force pushing the block down is calculated from $sin\theta \times mg = 10N$. However, the block accelerates at 2, which means that $F_G - F_F = \Sigma F$. Therefore, F_F must equal 6.
4. D. The tension is equal to the force on the 1kg block, which is ⅓ of F
5. B. If velocity increases, then air resistance increases, which causes a decrease
6. B. The force takes some of the normal force.
7. D. At the bottom, the tension is only 100 N, as it only supports the block. At the top, it will be 150, as it needs to support the block under and the weight of itself.
8. D. The work is divided by two and cosine
9. A. $\frac{Bg}{A+B} = \frac{mg}{4m} = \frac{g}{4}$
10. B. The magnitude of normal force must be multiplied by $cos\theta$
11. A. The vector sum must equal 0, as it is moving in translational equilibrium. D. If all forces are 0, then it must be moving at a constant speed.

12. D. Constant momentum means velocity does not change at all.
13. A. Solve for mass of the object, which is 3kg. The maximum amount of force that can be applied is 20N, so using $F = ma$, solve for acceleration
14. C. Solve for T_L in
    $500 + 125 = T_L + 250$
15. A. The tension on the left is greater, which means that more of the weight is focused towards that side
16. A. The cart can be already moving left and speeding up towards the left. D. The cart can also be moving right while slowing down.
17. C. The forces do not add up, as it is the same thing as pulling on a wall
18. A. The object is accelerating at a constant rate, which causes a parabola for velocity
19. B. The horizontal component needs to be canceled out, and then vertical component is added
20. D. The total spring constant is $0.5\frac{N}{m}$, which means the sum of k_1 and k_2 must equal $0.5\frac{N}{m}$

Free Response: Dynamics

1. A.



B.
$T = (400)(10) + 200 + (400)(2) = 50$
C.
$Mg - 4200 = (400 + M)a$
$M = 625$

Multiple Choice: Torque

1. B. The distance the object should be hung away from the object is 4 centimeters away. Because the meterstick's pivot is at the 40 cm mark, therefore the answer must be 36
2. A. The equation that represents the forces is
   $(300)(30) + 20x = (200)(40)$Solve for x
3. C. A perpendicular force with the greatest distance from the pivot point produces the max torque
4. D. This is because if the torque is 4 times larger than the other side, that means there that the block must be 20cm away from the end, which means that it can either be 20cm or 80cm
5. D. The weight of the bar is equal to the torque produced by the 45 gram weight, but 0.5 meter mark. Solve for x in
   $(45)(42.5 - 20) = (50 - 42.5)x$
6. B. Either double the left side or subtract Fd from the right side
7. B. The total torque produced by the weight is $50Nm$. Therefore, when a $50kg$person walks on the board, they can walk for 1 meter
8. C. The net torque exerted on the right side is $2.5lNm$. Therefore the torque by the fish and the $3.5kg$weight must equal $2.5lNm$
9. D. At point D, the torques produced at each point are $24L$, L being the distance for each section
10. C. The equation can be represented by $Mg(cos(60)R + Rx) = 2MgR$

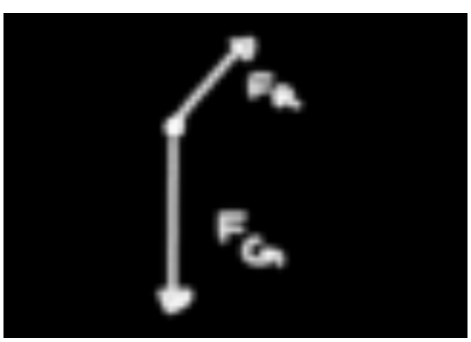
Multiple Choice: Work Energy

1. B. Equation is derived from $\frac{1}{2}mv^2 = \frac{1}{2}kA^2$, solve for v

2. A. The constant velocity means 0 net force. This means that the magnitude of the pulling force is equal
3. D. 0 net displacement means work done is 0
4. A. The total displacement will be $L(1 - cos\theta)$, therefore using $U_G = mg\Delta y$, the equation is $U_G = mgL(1 - cos\theta)$
5. A. Solve for F in $FD = \frac{1}{2}mV^2$
6. C. Kinetic energy is max at the center, which means where kinetic energy is 0, potential energy must be max
7. D. Solve for D with $\frac{1}{2}mv^2 = FD$, which gives us $D = \frac{mv^2}{2F}$, if mass increases, then displacement must be proportional.
8. D. Solve for D with $\frac{1}{2}mv^2 = FD$, which gives us $D = \frac{mv^2}{2F}$, if velocity increases, then displacement increases proportional to the square
9. B. If the ball is halfway, then it has half the original kinetic energy, as the other half went into potential energy. Therefore, for kinetic energy to be half, velocity must be $\frac{1}{\sqrt{2}}$smaller
10. A. The ball still has kinetic energy as it is still moving horizontally

Free Response: Work Power Energy

1. A.



B.

$mgLsin\theta = \frac{1}{2}mv^2$

$v = \sqrt{2gLsin\theta}$

C.

$m\frac{v^2}{r} + mgsin\theta$

$\frac{m2gLsin\theta}{L} + mgsin\theta$

$2mgsin\theta + mgsin\theta = 3mgsin\theta$

Multiple Choice: Momentum and Impulse

1. D. If $F\Delta t = mv$, force and velocity remain constant, if mass increases, time must increase proportionally
2. D. Using momentum and energy, this can be solved. $\frac{1}{2}(M + m)(\frac{mv}{M+m})^2 = \frac{1}{2}kx^2$, solve for x
3. C. Because velocity is proportional to the square when compared to momentum
4. D. The net momentum is 0
5. A. The momentum equation can be represented by $(75)(6) + (100)(8) = (100 + 75)v$, and solve for v
6. C. The momentum of the system can be represented by $(5000)(4) = (5000 + 8000)v$, and solve for v
7. A. Energy remains constant throughout the whole experiment.
8. B. Force exerted on the spring is equal, this is because of newton's third law
9. B. The change in momentum is equal to $(0.5)(6) - (0.5)(-4)$
10. B. The momentum of the system can be represented by $(2)(1) = (2 + 3)v$, so solve for v. Because we set the initial velocity as 1, v will be proportional to 1