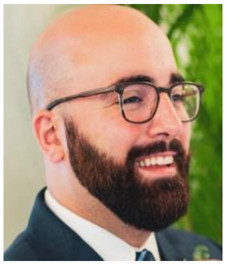

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Physics

Learning Packet Overview
Hello there! During these unprecedented times we wanted to make sure that you were provided with an opportunity to continue to practice and refine your physics knowledge. Why? It's simple really – physics is the study of the way the world around us works and it's fascinating!! Physics will also prepare you for your future science classes, and it is our goal to make sure you are as prepared for next year as possible. So, with this in mind, we created this learning packet for you and here is what you need to know: • This learning packet is a review of all material learned in units 1 – 6. There is no new content in this packet. • Links will be provided throughout the packet to help you. These will be links to optional readings and videos for you to reference if you are stuck at any point in time. • You should work on this packet for approximately 25-30 minutes per day without distractions. Doing so will ensure you will be able to complete the entire packet by Friday, April 3rd. • You should show all of your work! Why? Because points are awarded on AP tests for showing all of your work (and they will take off points for not showing all work). Also, it is easier to find and fix a mistake if you show all your work. • If you are stuck <u>and have already watched videos and completed the readings</u> feel free to call or text us for additional help between the times of 10am and 2 pm. Work hard, have fun, and stay safe. Let us know if you need any support! -Mr. Resavy and Ms. Garrett

Necessary Materials
• Your calculator set to degree mode. (Don't have it? Click here.) • Formula sheet (Don't have it? We added it to this packet 😊) • Any notes that you have from class (Don't have them? That's okay. We are providing links to supplemental material)

How students will be successful in Physics	How caregivers can help students be successful
Students will be successful if they: • Attempt all problems and show all work. • Watch the linked videos and read the linked readings. • Reach out to Mr. Resavy or Ms. Garrett if help is needed.	Caregivers can help students be successful by: • Ensuring students are working in a distraction free zone. • Check in to see if students are using the linked videos and readings to help them.

Formula Sheet

Unit Conversions

Distances	**Times**	**Weights/Masses**
1 foot = **12** inches	1 minute = **60** second	1 kilogram = **2.2** pounds
1 yard = **3** feet	1 hour = **60** minutes	1 pound = **16** ounces
1 mile = **5280** feet	1 day = **24** hours	1 ton = **2000** pounds
1 mile = **1.61** kilometers	1 year = **365** days	
1 mile = **1760** yards	1 year = **52** weeks	
1 meter = **3.281** feet	1 week = **7** days	

Kinematics Equations **(1 Dimension)**

Constant Velocity Equation

$$v = \frac{d}{t} = \frac{\Delta d}{\Delta t} = \frac{d_f - d_i}{t_f - t_i}$$

$$d = v * t$$

Acceleration Equations (Changing Vel.)

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

$$\vec{d}_f = \vec{d}_i + \frac{\vec{v}_i + \vec{v}_f}{2} * t$$

$$\vec{v}_f = \vec{v}_i + \vec{a} * t$$

$$\vec{d}_f = \vec{d}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$

$$\vec{v}_f^2 = \vec{v}_i^2 + 2\vec{a}(\vec{d}_f - \vec{d}_i)$$

2 Dimensional Motion ($V_o = V_i$)

Horizontal Motion

$V_{xf} = V_{xo} + a\,(t)$	(a = constant)
$d_x = V_{xo}(t) + ½\, a\,(t^2)$	(a = constant)
$V_{xf}^2 = V_{xo}^2 + 2a\,(d_x)$	(a = constant)
$d_x = V_x(t)$	($a = 0\ m/s^2$)

Vertical Motion

$V_{yf} = Vy_o + g\,(t)$	($g = -9.81\ m/s^2$)
$d_y = V_{yo}(t) + ½\, g\,(t^2)$	($g = -9.81\ m/s^2$)
$V_{yf}^2 = V_{yo}^2 + 2g\,(d_y)$	($g = -9.81\ m/s^2$)

Note that d_x and d_y represent *displacement not distance*, and none of these equations are valid unless acceleration is constant.

Force Equations

$F_{net} = m * a$ → $a = \frac{F_{net}}{m}$ $F_g = mg$ $F_f = \mu F_N$ → $\mu = \frac{F_f}{F_N}$

F_{net} is also the sum of all forces in a given direction

Momentum Equations

Momentum & Conservation of Momentum

Momentum of 1 object → $p = mv$

Total momentum of a 2 object system→ $p_{before} = p_{after}$ → $m_1 v_1 + m_2 v_2 = m_1 v_{1f} + m_2 v_{2f}$

Impulse = Change in Momentum

Impulse = $F * t = \Delta p$ $\Delta p = m\Delta v = m(v_f - v_i)$ $\Delta p_1 = -\Delta p_2$

Work, Power, & Energy Equations

WORK Equations

$W = F * d$ (Force here must be parallel to the displacement, so F_x when there's an angle)

$W = \Delta ME = ME_f - ME_i$ $W = P * t$

ENERGY Equations

$KE = \frac{1}{2} mv^2$ $PE_g = mgh$ $PE_{sp} = \frac{1}{2} kx^2$

Conservation of Energy Equations

$ME = PE + KE$

When no friction present → $ME_i = ME_f$ When friction present → $ME_i - W = ME_f$

SPRING Equations

$F_{sp} = kx$ → $k = \frac{F_{sp}}{x}$ $PE_{sp} = \frac{1}{2} kx^2$

POWER Equations

$P = \frac{W}{t}$ $P = F * v$

Circular Motion

Tangential Speed and Centripetal Force

$v_t = r * \omega$

$F_c = \frac{m * v_t^2}{r}$

Torque:

$T = F * r$

Angular Momentum

L = m*v_t*r

Waves:

Wave speed = frequency * Wavelength

Newton's Law of Universal Gravitation

$F = \frac{G(m_1 * m_2)}{d^2}, G = 6.67 * 10^{-11}$

Electricity:

Coulomb's Law

$F = \frac{K(q_1 * q_2)}{d^2}, K = 9.0 * 10^9$

Ohm's Law

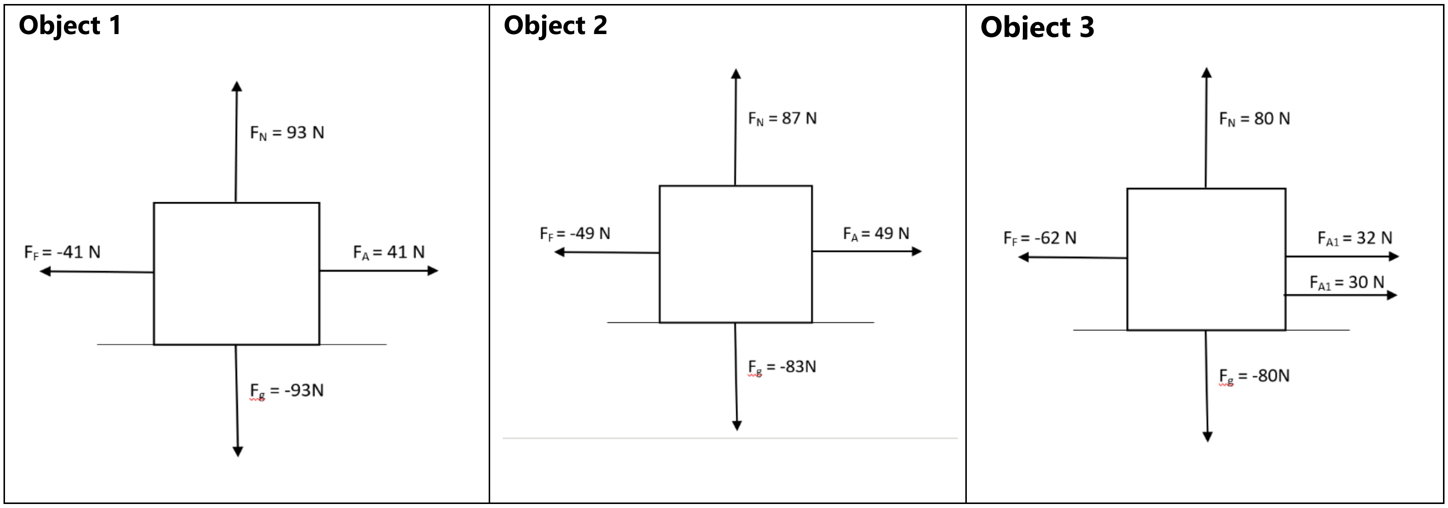
$I = \frac{V}{R}$

Coefficients of Friction		
Materials	Static Friction	Kinetic Friction
Steel on steel	0.74	0.57
Aluminum on steel	0.61	0.47
Wood on brick	0.60	0.45
Copper on steel	0.53	0.36
Rubber on concrete	1.0	0.80
Wood on wood	0.45	0.20
Glass on glass	0.94	0.40
Waxed wood on wet snow	0.14	0.10
Waxed wood on dry snow	--	0.040
Metal on metal (lubricated)	0.15	0.060
Ice on ice	0.10	0.030
Teflon on teflon	0.040	0.040
Synovial Joints in humans	0.010	0.0030
Rubber on Asphalt	0.85	0.67
Rubber on Ice		0.15
Oak on Oak	0.62	0.48
Leather on Oak	0.61	0.52

Unit 1 Material: Newton's First Law of Motion

Use the following information for questions 1-7.

The diagrams represent the forces acting on three different objects.



1. Which object(s) are in equilibrium? Explain how you know.

2. Calculate the net force acting on each object.

Object 1 (m = 10 kg) is at rest, object 2 (m = 12 kg) is moving, and object 3 (m = 11 kg) is also moving.

3. Which object has the least amount of inertia? Explain how you know.

4. Which object is in static equilibrium? Explain how you know.

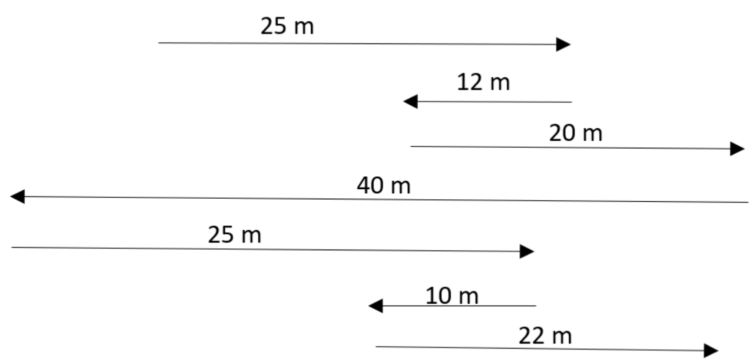
5. Which object is in dynamic equilibrium? Explain how you know.

6. Which object is accelerating? Explain how you know.

7. Calculate the acceleration of each object.

Use the following information for questions 8 – 13.

The diagram below represents the motion of a student walking across a field. The entire trip takes the student 100 seconds. (Check out this link, or this link, or this video you are stuck!)



8. Calculate the student's total distance traveled.

9. Calculate the student's displacement.

10. Calculate the student's average speed.

11. Calculate the student's average velocity.

12. Predict what would happen to velocity if time was cut in half. Justify your response mathematically.

13. Predict what would happen to speed if the time was doubled. Justify your response mathematically.

<u>Unit 2 Material</u>: Newton's Second Law of Motion

Use the following scenario for questions 14 – 16.

A car driving at 10 m/s accelerates to 18 m/s in 8.0 seconds.

14. Is the car in equilibrium? Explain how you know.

15. What is the net force acting on the car?

16. Calculate the cart's acceleration.

Use the following scenario for questions 17-19.

A cart (m = 2.0 kg) has an initial velocity of 0.5 m/s accelerates at a rate of 0.75 m/s^2 for 12 seconds.

17. Is the cart in equilibrium? Explain how you know.

18. Calculate the net force acting on the cart.

19. Calculate the cart's final velocity.

Use the following scenario for questions 20-23.

A 3.5 kg rock is dropped from a height of 5.0 meters. (Stuck? Check out this link, this video, and this video).

20. What is the initial (starting) velocity of the rock?

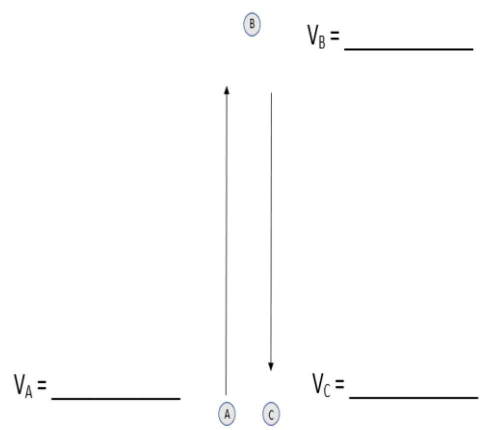
21. Is the rock in equilibrium as it falls through the air? Explain how you know.

22. Calculate the time it takes for the rock to hit the ground.

23. Calculate the rock's final velocity right before it hits the ground.

Use the following scenario for questions 24 – 29.

A baseball with a mass of 1.5 kg is thrown vertically into the air at a velocity of 4.0 m/s.



24. What is the velocity of the ball when it reaches its maximum height (position B)?

25. Complete the diagram to the right.

26. Calculate the time it takes for the ball to reach its maximum height.

27. Calculate the time it takes for the ball to travel from its maximum height back to its starting position.

28. Calculate the total time that the ball spends in the air.

29. Calculate the maximum height achieved by the ball. (Stuck? Watch this video starting at minute 35)

Use the following scenario for questions 30-35.

A 5.0 kg rock is launched vertically into the air at a velocity of 7.5 m/s.

30. At what rate is the object accelerating?

31. Calculate the time it takes for the rock to reach its maximum height.

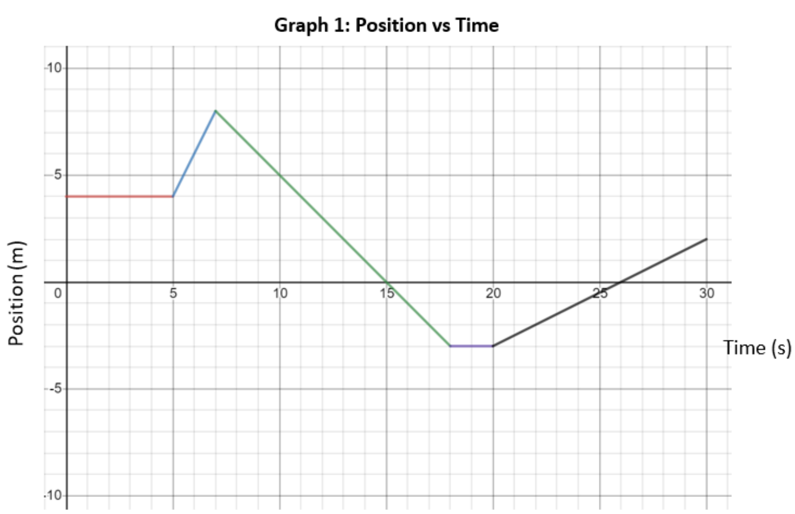
32. Calculate the time it takes for the rock to travel from its maximum height to its starting position.

33. Calculate the total time that the rock spends in the air.

34. Calculate the maximum height achieved by the rock.

35. Larry claims that the rock will have a displacement of 0 meters when it returns to its starting position. Is Larry correct? Explain why or why not.

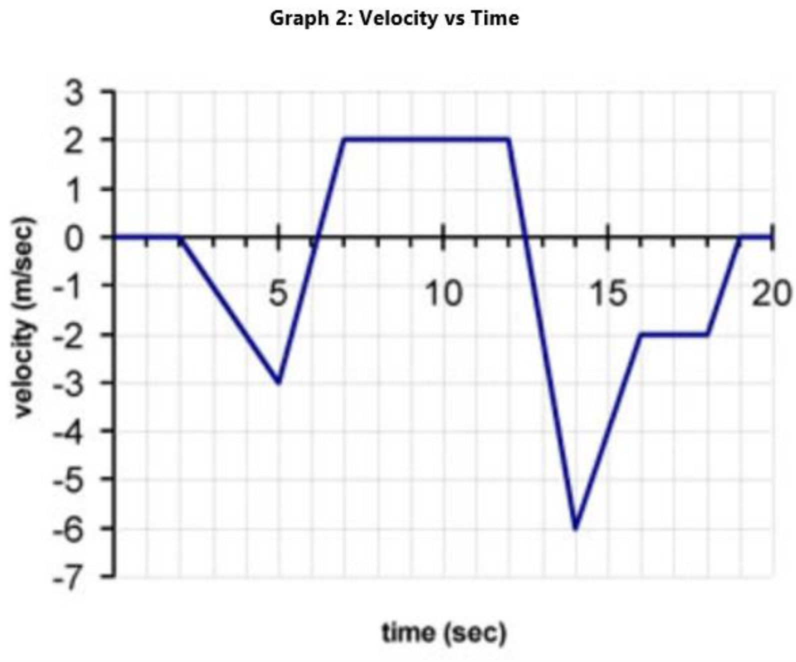
Use the graph below to answer questions 36 and 37.

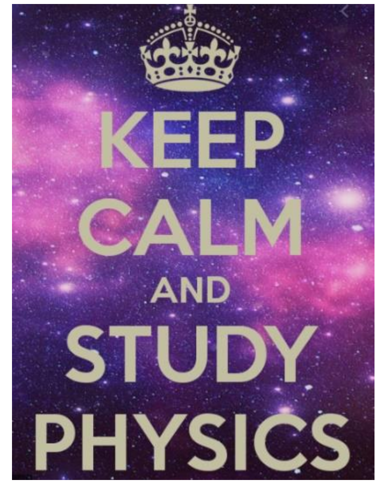


36. Annotate the graph to show where the object is in static equilibrium.

37. Calculate the velocity of the object between times 7 and 15 seconds. (Hint: Velocity is the average rate of change of position over time.)

Use the graph below to answer questions 37-41.





38. Annotate the graph to show the one time where the graph is in static equilibrium.

39. Annotate the graph to show the two segments where the object is in dynamic equilibrium.

40. Calculate the object's rate of acceleration between times 2 and 5 seconds.

41. Calculate the object's final displacement between times 2 and 5 seconds. (Follow the steps below.)

Step 1: Complete this list	Step 2: Pick a formula and solve!
a = vi = vf = di = df = ? t = (Hint: time is **not** 5 seconds)	

Unit 3 Material: Newton's Third Law of Motion

Use the following information for questions 42 – 45

A 10 kg cart is traveling at a velocity of 3 m/s when it hits a wall.

42. Which object, the cart or the wall, experienced more force during the collision? Explain how you know.

43. Calculate the cart's momentum.

44. Beth claims that the cart's momentum can be destroyed. Is Beth correct? (Reference the law of conservation of momentum.)

Use the following information for questions 45 – 55.

Cart 1 (m = 12 kg) is traveling at a velocity of +1.5 m/s when it collides elastically with cart 2 (m = 15 kg). Cart 2 had a velocity of 1.0 m/s before the collision. After the collision, cart 1 has a new velocity of 0.5 m/s. (Here is a helpful resource!)

45. What does it mean for objects to collide elastically?

46. What does it mean for objects to collide inelastically?

47. Calculate the momentum of cart 1 before the collision.

48. Calculate the momentum of cart 2 before the collision.

49. Calculate the total momentum before the collision.

50. What is the total momentum after the collision?

51. Calculate the momentum of cart 1 after the collision.

52. How much momentum does cart 2 have after the collision? Justify your response mathematically.

53. Calculate the velocity of cart 2 after the collision. (Use cart 2's final momentum from question 52 and the momentum formula p=mv).

54. Knowing that impulse is the same as change in momentum…
    a. Calculate cart 1's impulse.

    b. Calculate cart 2's impulse.

    c. Explain how these two calculations support the law of conservation of energy.

55. The collision lasts for 0.55 seconds. Calculate the force experienced by each force during the collision. (Force is impulse over time.)

Force experienced by cart 1:	**Force experienced by cart 2:**

Use the following information for questions 56-60.

Cart X (m = 20 kg) is traveling at a velocity of 3.0 m/s when it collides inelastically with cart Y (m = 16 kg). The collision takes 0.60 seconds.

56. What does it mean for the cart to collide inelastically?

57. Calculate the total momentum before the crash.

58. Calculate the total momentum after the crash.

59. Calculate the velocity of both carts after the crash.

60. Calculate the force experienced by cart X during the collision.

Use the following information for questions 61 – 63.

A 19.5 kg wood box is sliding across a wood surface. The box is experiencing an applied force of +73 Newtons.

61. Draw a free-body diagram to show all forces acting on the box. Be sure to include the magnitudes of each force. (This object is NOT inclined. There are four forces acting on the box).

62. Calculate the net force acting on the box.

63. Calculate the box's acceleration?

<u>Unit 4 Material</u>: Uniform Circular Motion and Newton's Law of Universal Gravitation (One more link!)

Use the following information for questions 64 – 67.

A mouse-trap car of mass 12.0 kg is attached to a CD with radius of 0.12 meters. The car has a rotational speed of 0.54 m/s.

64. Calculate the tangential velocity.

65. Calculate the centripetal force acting on the car.

66. Calculate the car's centripetal acceleration. (Hint: Centripetal force is the net force)

67. Predict the new centripetal acceleration if radius was cut in half.

Use the following information for questions 68 – 69.

A particle (m = 0.23 kg) attached to a string of length 1.7 meters is given an initial tangential velocity of 6 m/s. The string is attached to a peg, and, as the particle rotates about the peg, the string winds around the peg.

68. Calculate the particles angular momentum. (L = m*v*r)

69. What is the length of the string that is not yet wound around the peg when the particle is traveling at a tangential velocity of 17.5 m/s?

Use the following information for question 70.

A particle (m = 0.45 kg) attached to a string of length 2.0 meters is given an initial tangential velocity of 7 m/s. The string is attached to a peg, and, as the particle rotates about the peg, the string winds around the peg.

70. Calculate the length of the string that is not yet wound around the peg when the particle is traveling at a tangential velocity of 21 m/s.

71. Use Newton's Law of Universal Gravitation to complete the table below. (See page 4 of this packet for the formula.)

Object 1	Mass (kg)	Object 2	Mass (kg)	Separation Distance (m)	Force of Gravity (N)
Football Player	100 kg	Earth	5.98×10^{24}	6.38×10^{6} (on surface)	
Ballerina	40 kg	Earth	5.98×10^{24}	6.38×10^{6} (on surface)	
Physics Student	70 kg	Earth	5.98×10^{24}	6.60×10^{6} (low-height Orbit)	
Physics Student	70 kg	Physics Student	70 kg	1.0	
Physics Student	70 kg	Physics Student	70 kg	0.2	
Physics Student	70 kg	Physics Book	1.0 kg	1.0	
Physics Student	70 kg	Moon	7.34×10^{22}	1.71×10^{6} (on surface)	
Physics Student	70 kg	Jupiter	1.901×10^{27}	6.98×10^{7} (on surface	

Unit 5 Material: Projectile Motion

Use the following information for questions 72 – 77.

A soccer ball is kicked at a 30-degree angle above the ground with an initial velocity of 4.5 m/s.

72. Draw a diagram to represent the motion of the ball.

73. Calculate the magnitudes of each component vector (Vx and Vy).

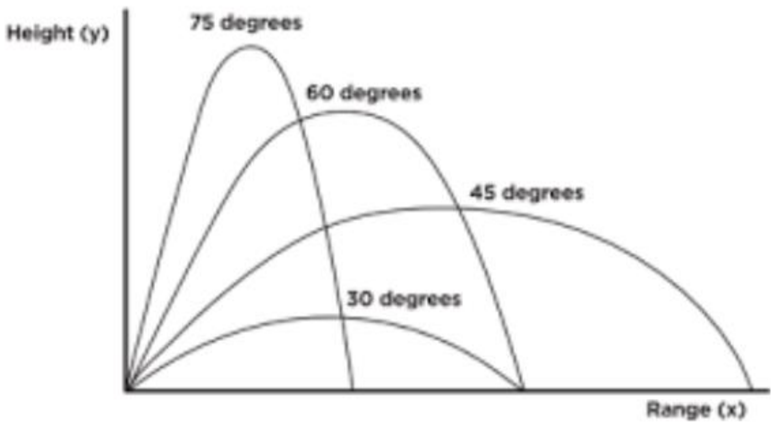
74. Calculate the time it takes for the ball to reach its maximum height.

75. Calculate the total amount of time that the ball is in the air.

76. Calculate the ball’s maximum height (dy).

77. Calculate the ball’s horizontal range (dx).

Use the diagram below to answer questions 78-81.



78. Which angle results in the largest horizontal range?

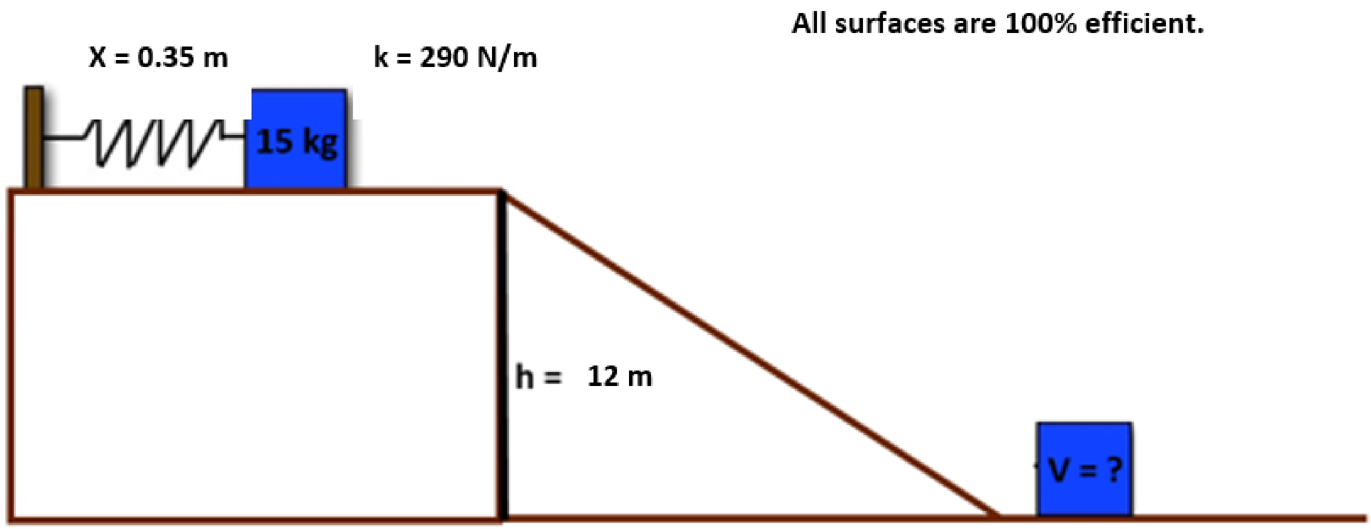
79. Explain what happens to the maximum height of the object as the angle of launch increases.

80. Explain what happens to the amount of time the projectile spends in the air as the launch angle increases.

81. What happens to the horizontal range as the launch angle increases?

<u>**Unit 6 Material**</u>: Conservation of Energy

Use the diagram below to answer questions 82 and 83.



82. Complete the table to show all types of energy experienced by the box at the **top** of the ramp.

Elastic Potential Energy (J)	Gravitational Potential Energy (J)	Kinetic Energy (J)	Heat (J)

83. Complete the table to show all types of energy experienced by the box at the **bottom** of the ramp.

Elastic Potential Energy (J)	Gravitational Potential Energy (J)	Kinetic Energy (J)	Heat (J)

Use the following information for questions 84 – 88.

A crate with a mass of 30 kilograms slides to the right 15 meters while experiencing a rightward applied force of 200 newtons and a leftward force of friction that is three fourths the magnitude of the applied force.

84. Toby claims that the crate is moving at a constant velocity, whereas Sam claims that the crate is accelerating. Who is correct?

    ______Toby is correct ______Sam is correct

    Justify your response in one or two sentences.

85. Calculate the work done by the applied force.

86. Calculate the work done by friction.

87. Calculate the net amount of work done on the crate.

88. It takes 3.5 seconds for the crate to travel the 15 meters. Calculate the power required to move the crate.

Use the following information to answer questions 89 – 93.

A 40 kg aluminum box is on a horizontal steel surface. The box starts at rest.

89. Draw a free-body diagram to represent all forces acting on the box. Be sure to label and calculate the magnitude of each force. (Hint: There are only two forces and there is no angle.)

The surface is inclined to 52-degrees?

90. Did the parallel component (Fgx) of weight increase, decrease, or remain the same?

91. Did the perpendicular component (Fgy) of weight increase, decrease, or remain the same?

92. Draw a new free-body diagram to represent all forces acting on the box. Be sure to include the magnitude of each force. (Hint: this is the diagram for an inclined plane).

The box travels a distance of 5.0 meters across the steel surface.

93. Calculate the velocity of the box after traveling this distance.

Use the following information to answer questions 94 – 99.

A 21 kg wood box is sliding down a wood inclined plane with a slope that is 9.5 meters in length. The surface is inclined at a 27-degree angle. The inclined plane has a height of 4.31 meters. (Here is one more helpful link.)

94. Calculate the normal force.

95. Calculate the force of friction

96. Calculate the net force.

97. Calculate the acceleration.

98. Calculate the velocity at the bottom of the plane.

99. What was the box’s gravitational potential energy at the top of the plane?

And finally, we arrive at question #100. We are proud of you for persevering this far! You should be proud of yourself for giving your best effort and for answering every question. You are almost done! You got this!

100. A 41 kg wood box is sliding on a wood surface that is inclined at a 55-degree angle above the horizontal. The surface is 5 meters long and the box had an initial velocity of 0 m/s. **Calculate the efficiency of the inclined plane.**