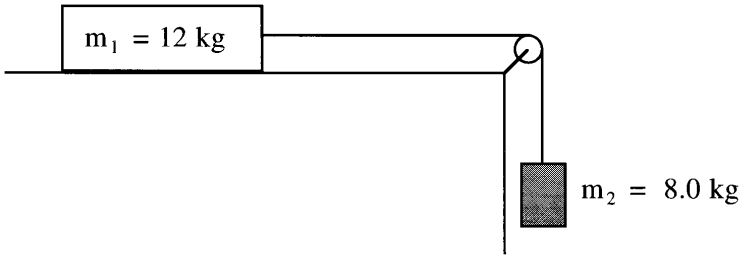
Course Final Review Name_____

Instructions:

Using a pencil, answer the following questions on a separate piece of paper. The assignment is marked, based on effort, completeness, neatness, and accuracy. Do your best!

2D Forces:

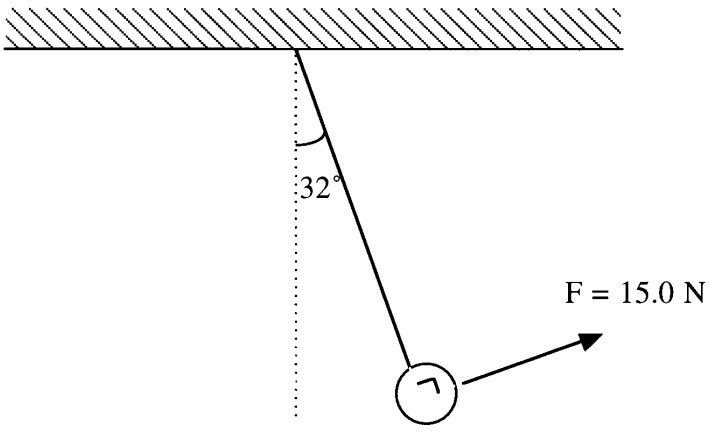
1. Two objects are connected by a light string, as in the below diagram. The horizontal surfaces and the pulley are frictionless.



   a. At what rate will the 12 kg mass accelerate? *(ans: 3.9 m/s²)*

   b. What is the tension in the connecting string? *(ans: 47 N)*

2. A 15.0 N force is used to hold a mass on a string at an angle of 32° from the vertical, as in the below diagram.



   What is the mass? *(ans: 2.9 kg)*

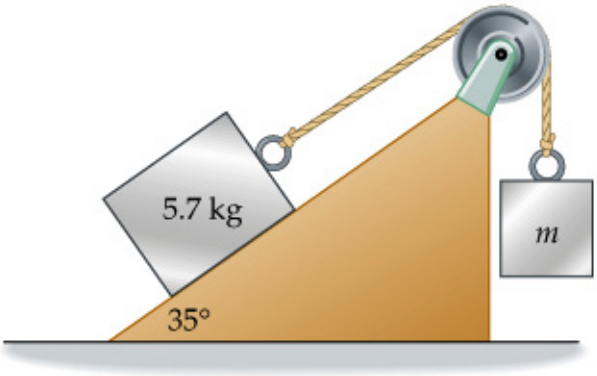
3. Before stepping onto an escalator an 80 kg person's vertical velocity is zero. During the first step, however, they accelerate upwards at 2.5 m/s^2 for 0.3s. During that time, what is their sensation of their weight? Express your answer in both Newtons as well as their *equivalent mass* on Earth, in kg. *Tip: start by making a freebody diagram for the person! (ans: 100 kg, weight = 984 N)*

4. An athlete is training using a 60 kg weighted sled. She is pushing down on the sled with a force of 750 N, at an angle of 15° above the horizontal.

   a. Given that she is able to keep the sled moving at a constant velocity, determine the coefficient of kinetic friction between the sled and the ground. *(Ans: 0.926)*

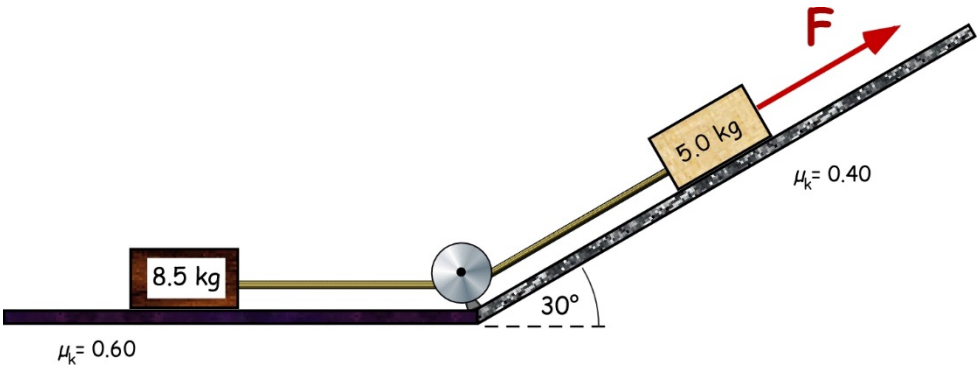
   b. An alternative workout involves pulling the same sled with a rope inclined at 15° above the horizontal. How much force would be required to keep the 60 kg sled moving at a constant velocity in this situation? (ans: *452 N)*

5. Find the minimum value for the mass *m* that would just begin to accelerate the 5.7 kg block up the hill. (μ_s = 0.75, μ_k = 0.35). *(ans: 6.77 kg)*



6. Find the tension in the connecting rope above once the blocks have moved 30 cm. (*ans: 56.4 N)*

7. Two blocks made of different materials are connected by a rope passing over a frictionless pulley, as shown. Calculate the force of tension in the connecting rope when the 5.0 kg block is accelerating up the incline at 2.5 m/s^2. *(ans: 71.2 N)*



8. Determine the applied force **F** that would accelerate 5.0 kg block above up the incline at 2.5 m/s^2 *(ans: 125.2 N)*

Work, Energy and Power:

9. The force of gravity on a box of apples is 98.0 N. How much work will you do
   (a) if you lift the box from the floor to a height of 1.2 m?

   (b) if you carry the box horizontally a distance of 2.0 m?

10. The force of gravity on a box is 100.0 N. The coefficient of friction between the floor and the box is 0.250. How much work is done when the box is pushed along the floor, at a steady speed, for a distance of 15.0 m?

11. How much energy is consumed by a 100.0 W light bulb, if it is 'left on' for 12.0 h?

12. A motor does 25 MJ (megajoules) of work in one hour.
    (a) What is the power rating of the motor?

    (b) How many horsepower is this motor, if 1 HP = 750 W?

13. Discuss the scientific accuracy of this statement:
    "I used a ramp to get my motorbike up on my truck, and the ramp saved me a lot of work!"

14. A pendulum bob is moving 1.8 m/s at the bottom of its swing. To what height above the bottom of the swing will the bob travel?

15. The initial speed of a golf ball, struck with a driver by professional golfer Tiger Woods, has been measured to be 285 km/h. From what vertical height would you have to drop a golf ball, if it is to reach this same speed as it hits the ground? Assume that air friction can be ignored.

16. A skier has 60 kJ of **gravitational potential energy** when at the top of the hill. Assuming no friction, how much kinetic energy does she have when she is one-third of the way down the hill?

17. The head of a golf club imparts a certain amount of kinetic energy to the ball upon impact. Let this be E_k. If the golfer lightens the mass of the club head by 1/3, and increases the club head speed so that it is 3 times it previous speed, how much kinetic energy will be imparted to the ball now?

18. A steel rod is at a temperature of 25°C. To what Celsius temperature must you raise it, in order to double its Kelvin temperature?

19. A certain metal has a specific heat capacity of 420 J/kg/C°, while water has a specific heat capacity of 4200 J/kg/C°. A kilogram of the metal and a kilogram of water are both at a temperature of 98°C. If both are allowed to cool to 18°C, which will give off more heat to the atmosphere, and how much more will it release?

20. What is the efficiency of a 1500 W kettle if it supplies heat at the rate of 1400 W to the water in it?

21. A 1200 W kettle warms 800.0 g of water from 20°C to 99°C in 4.0 min. How efficient is the kettle?

22. If 24 kJ of energy will warm 0.600 kg of a metal from 20° up to 220°C, what is the **specific heat capacity** of the metal?

23. A golfer wishes to hit his drives further by increasing the kinetic energy of the golf club when it strikes the ball. Which would have the greater effect on the energy transferred to the ball by the driver — doubling the mass of the club head or doubling the speed of the club head? Explain.

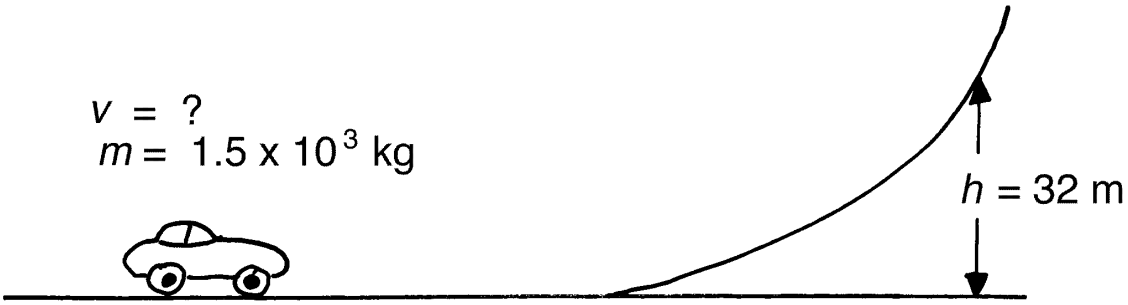
24. How much work must be done to increase the speed of a 12 kg bicycle ridden by a 68 kg rider from 8.2 m/s to 12.7 m/s?

25. A vehicle moving with a speed of 90 km/h (25 m/s) loses its brakes but sees a 'runaway' hill near the highway. If the driver steers his vehicle into the runaway hill, how far up the hill (vertically) will the vehicle travel before it comes to a stop? (Ignore friction.) If friction is taken into account, will the vertical distance the vehicle moves be less or greater than the 'ideal' distance you just solved for, neglecting friction? Explain.

26. How long will it take a 6.0×10^3 W motor to lift a 5.0×10^3 kg load through a height of 2.5 m? *(ans: 20 s)*

27. The force of gravity on a wooden crate is 500.0 N. If it requires 1.5×10^3 J of work to push the crate at steady speed along the floor for a distance of 5.0 m, what is the coefficient of friction between the floor and the crate? *(ans: $\mu = 0.60$)*

28. A car loses its brakes while travelling along a highway, so the driver aims it up the hill of a runaway lane, as in the below diagram.



If the car comes to a stop when it reaches a vertical height of 32 m, what is the minimum speed it must have had when it entered the runaway lane? *(ans: 25 m/s)*

29. A conveyor belt lifts 60 pieces of luggage, averaging 25 kg each, 3.0 m up to the baggage compartment of an aircraft. If this work is done in 49 s, what is the power rating of the conveyor? *(ans: 9.0 x 10^2 W)*

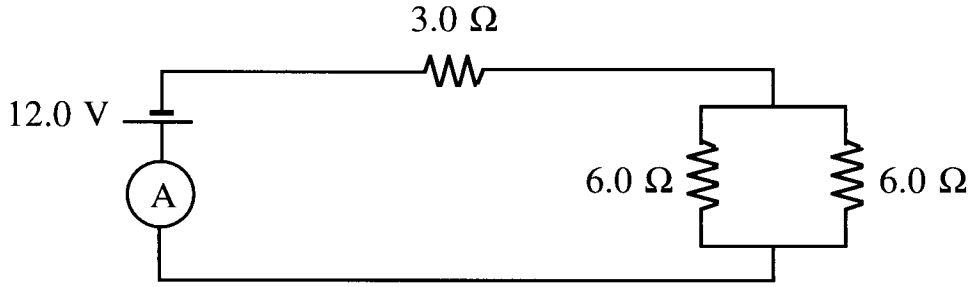
30. Bubba runs up the stairs, elevating his 102 kg body a vertical distance of 2.29 meters in a time of 1.32 seconds at a constant speed.

    a. Determine the work done by Bubba in climbing the stair case. *(ans:* 2.30 x 10^3 J*)*

    b. Determine the power generated by Bubba. *(ans: 1.73 x 10^3 W)*

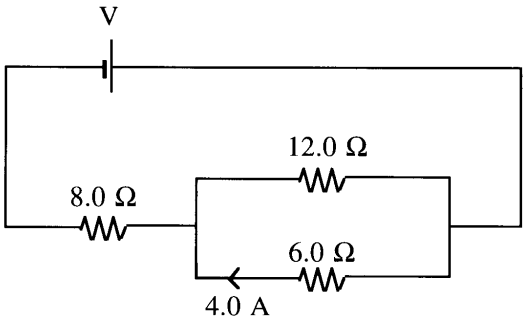
Electricity:

31. What is the current in the ammeter **A** shown below?



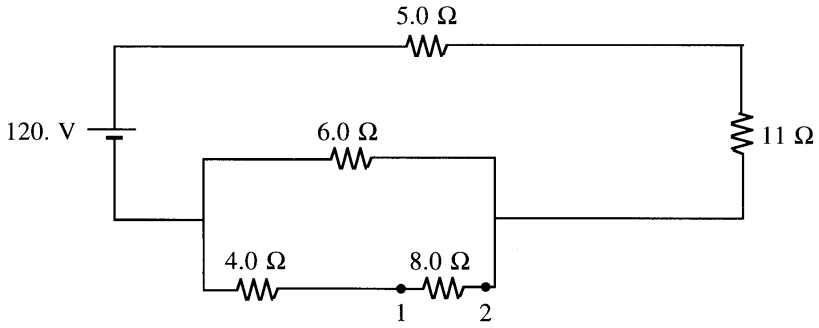
(ans: 2.0A)

32. What is the voltage *V* of the power supply shown below?



(ans: 72V)

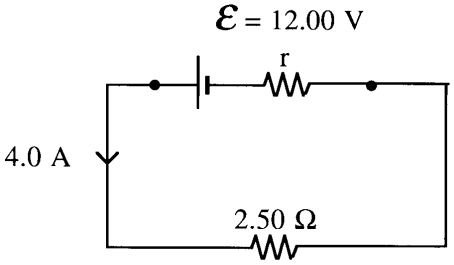
33. Consider the circuit shown below;



a. What is the voltage across the 8.0 Ω resistor (between 1 and 2)? *(ans: 16V)*

b. How much power is dissipated in the 5.0 Ω resistor? *(ans: 180W)*

34. What is the internal resistance of the battery shown below?



(ans: 0.50 Ω)

35. A flashlight contains a battery of two cells in series, with a bulb of resistance 12.0 Ω. The internal resistance of each cell is 0.260 Ω. If the potential difference across the bulb is 2.88 V, what is the EMF of *each* cell? *(ans: 1.5V)*

36. A 1500 W kettle is connected to a 110 V source. What is the resistance of the kettle element? *(ans: 8.1 Ω)*

37. A power station delivers 500 kW of power to a village through lines with a total resistance of 5.00 Ω. The input voltage is 400,000 V. If the input voltage was reduced to 10,000 V, by what factor would the power wasted as heat in the lines be multiplied? *(ans: 1600 times as much wasted power)*

38. What is the efficiency of a transmission line if 20.0 A, input at 120 V, delivers 2.0×10^3 W of power? *(ans: 83%)*

Waves:

39. Explain, with the help of a sketch, what each of these terms means with respect to waves:
    (a) crest;
    (b) trough;
    (c) wavelength;
    (d) frequency;
    (e) amplitude.

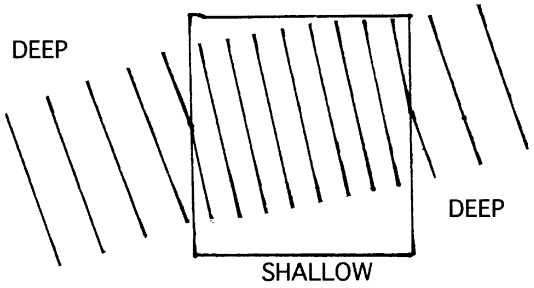
40. If the speed of sound is 330 m/s, what wavelength does a sound of frequency 512 Hz have?

41. Alternating current in power lines produces electromagnetic waves of frequency 60 Hz that travel outward at the speed of light, which is 3.0×10^8 m/s. What is the wavelength of these waves?

42. An observer counts 36 waves arriving at the shore of a beach, in a time of 3.00 min.
    (a) What is the **frequency** of the waves?

    (b) What is the **period** of the waves?

43. The diagram below shows water waves in a wave tank moving from deep water into shallow water, then back into deep water.



    a. What property of waves does this model illustrate?

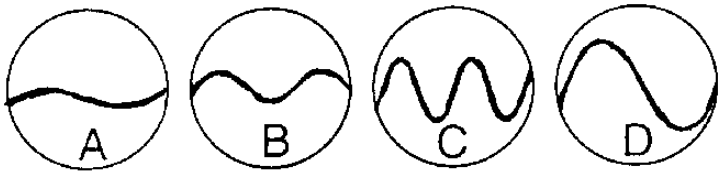
    b. What measurable property of the waves does not change as the waves move from one medium into another?

    c. According to the diagram, what can you conclude happens to the waves when they enter the shallow water?

44. What is the Doppler Effect? What causes it?

45. On a calm, quiet day, you watch a golfer swing a golf club on a tee 520 m away. There is a delay of 1.55 s before you hear the sound of the club hitting the ball. What is the speed of sound according to this data?

46. The drawings below show what four different pure tones look like on an oscilloscope screen.



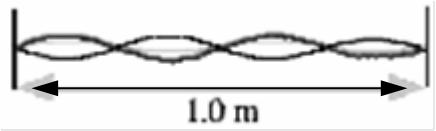
a. Which of the four pure tones had the **loudest** sound?

b. Which of the four pure tones had the **highest pitch**?

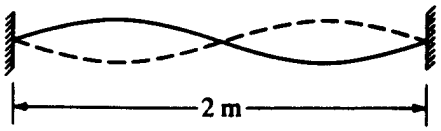
47. What is the name given to a point on a vibrating string at which the displacement is always zero? What is the name given to a point at which the displacement is always maximum?

48. What is the longest possible wavelength, λ, for a standing wave in terms of the string length, L? Assume the string is fixed on both ends.

49. The standing wave pattern diagrammed to the right is produced in a string fixed at both ends. The speed of waves in the string is 2 m/s. What is the frequency of the standing wave pattern?



50. A standing wave of frequency 5 hertz is set up on a string 2 meters long with nodes at both ends and in the center, as shown below.



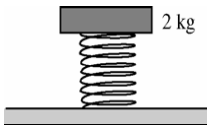
a. What is the speed at which waves propagate on the string?

b. What is the fundamental frequency of vibration of the string?

51. A simple pendulum of mass m and length L has a period of oscillation T at angular amplitude $\theta = 5°$ measured from its equilibrium position. If the amplitude is changed to 10° and everything else remains constant. What is the new period of the pendulum? Explain (use equation).

52. A simple pendulum has a period of 2 s for small amplitude oscillations. The length of the pendulum is most nearly what?

53. A platform of mass 2 kg is supported by a spring of negligible mass as shown. The platform oscillates with a period of 3 s when the platform is pushed down and released. What must be the mass of a block that when placed on the platform doubles the period of oscillation to 6 s?



Kinematics and Dynamics Review:

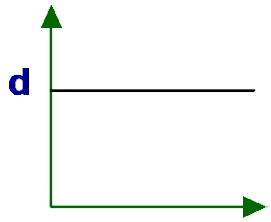
54. A caterpillar travels across the length of a 2.00 m porch in 6.5 minutes. What is the average speed of the caterpillar?

55. A cross-country race car driver sets out on a 1 hour, 100 km race. At the halfway marker (50 km), the pit crew radios that the car had averaged a speed of only 80 km/h.
    a. How long did it take the driver to travel the first 50 km?

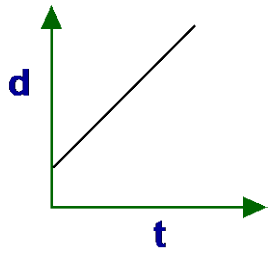
    b. How fast must the driver drive over the remaining distance in order to average 100 km/h for the entire race ?

56. Match the graphs below. Match the appropriate displacement-time graph with the corresponding velocity-time graph drawn below. Note: Some v-t graphs may be used more than once, or not at all

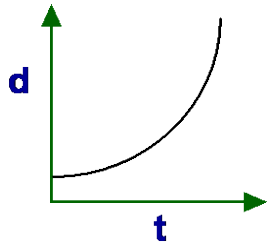
a.



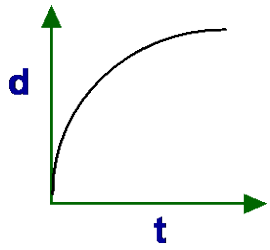
b.



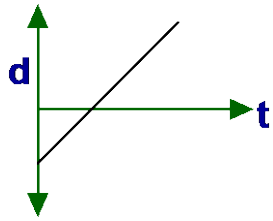
c.



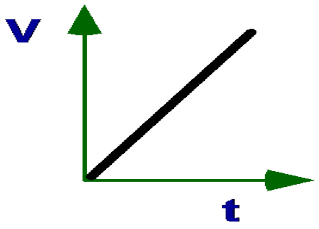
d.



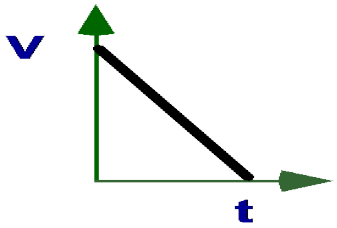
e.



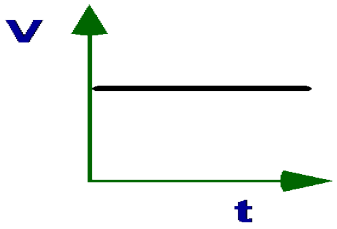
1.



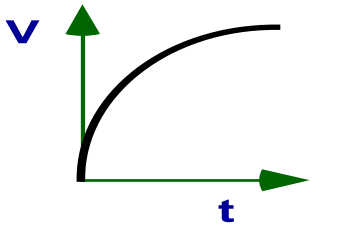
2.



3.



4.



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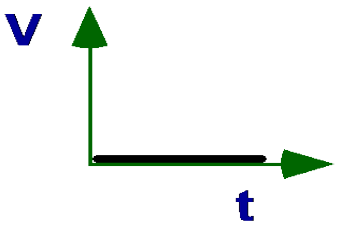


57. When a jet airliner lands on a runway it accelerates at -1.9 m/s^2 for 55 s until it stops. How fast was the plane moving when it touched down on the runway?

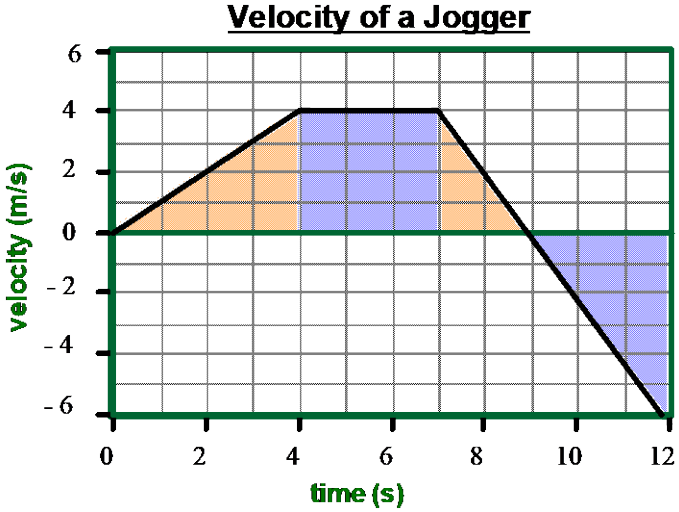
58. A team of students competing in the 'Egg Drop' competition at the Physics Olympics at UBC, drop their egg from a ledge, three floors above the ground.

    a. If it takes the egg 2.4 seconds to reach the ground, calculate the height of the ledge in meters.

    b. How fast was the egg traveling the instant before it hit the ground?

    c. The students had planned to protect the egg by dropping it into a garbage can filled with confetti, 0.85 m deep. Assuming that the egg stopped just as it reached the bottom of the can, calculate the rate of deceleration of the egg.

59. The velocity of a jogger is plotted over a 12 second duration and the v-t graph is plotted below:



    a. Determine the total displacement of the jogger for these 12 seconds.

    b. Construct a d-t graph that will represent the jogger's motion.

60. A tragic accident occurred on the Sea-to-Sky highway: a car passed over the edge of the road, over a cliff and into the ocean. The police measured that the horizontal distance from the ocean to the highway to be 110m, and that the road was 60 m above the ocean. Use these measurements to determine if the car was travelling over the posted 80 km/hr speed limit at the time of the accident.

61. Isaac is attempting to cross a river in a kayak. The river flows due east at 1.9 m/s. Isaac points the kayak due north and paddles at 2.4 m/s (relative to the water). The river is 38 m wide at this location.

    a. Determine the resultant velocity of the boat - both magnitude and direction.

    b. Determine the time for Glenda and Harold to cross the river.

    c. How far downstream will the boat be when Glenda and Harold reach the opposite shore?

62. An Astronaut has a mass of 86 kg. Determine the mass and the weight of this astronaut on the moon where the gravitational field is one-sixth that of the Earth.

63. A physics teacher jumps out of an airplane without a parachute. Seconds later his 82.5-kg body experiences 118 N of air resistance. Determine his acceleration at this instant in time. Begin by drawing a free body diagram and determine the net force.

64. Maty is attempting to drag her 32.6-kg Shepard across the wooden floor by applying a horizontal force. What force must she apply to move the dog with a constant speed of 0.95 m/s? The coefficient of friction between the dog and the floor is 0.72.

65. A 20 kg block rests on a frictionless table. A cord attached to the block extends horizontally to a pulley at the edge of the table. A 10 kg mass hangs at the end of the cord.

    a. Clearly draw and label the force vectors acting on each object.

    b. Calculate the acceleration of the block and mass.

    c. Calculate the tension in the cord.

ANSWERS:

2D Forces:

1-8 (answers appear after question)

9. a) 1.2 x 10^2 J, b) 0J

Work, Energy, and Power:

10. 375 J
11. 4.32 x 10^6 J
12. (a) 6.9 x 10^3 W, (b) 9.3 HP
13. The ramp reduces effort force at the expense of effort distance, which increases. The ramp does *not* save you work!
14. 0.17 m (or 17 cm)
15. 320 m
16. 20 kJ
17. $3E_k$
18. 323°C
19. Water gives off 10 times as much heat.
20. Efficiency = 93%
21. Efficiency = 92%
22. 200 J/kg/C°
23. $E_k = \frac{1}{2}mv^2$, Doubling mass will double kinetic energy, but doubling speed will *quadruple* kinetic energy.
24. 3.8 x 10^3 J
25. Without considering friction, $\frac{1}{2}mv^2 = mgh$.

$$h = \frac{v^2}{2g} = \frac{(25\text{ m/s})^2}{2(9.8\text{ m/s}^2)} = 32\text{ m}$$

With friction, the vertical height will be less.

26. 20 s
27. 0.6
28. 25 m/s
29. *9.0 x 10^2 W*
30. *2.30 x 10^3 J, 1.73 x 10^3 W*

Electricty:

31 – 38 (answers appear after question)

Waves:

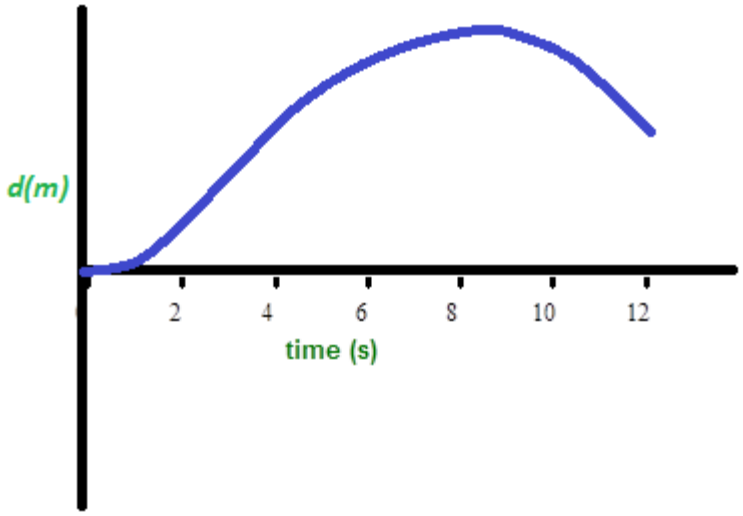
39. diagram
40. 0.645 m
41. 5.0 x 10^6 m, or 5000 km!
42. (a) 0.20 Hz, (b) 5.0 s
43. (a) refraction, (b) frequency, (c) Wave speed is reduced by about one half.

44. change in frequency of a wave caused by a source moving in relation to the receiver
45. 335 m/s
46. (a) D, (b) C
47. Node, antinode
48. $\lambda_{max} = 2L$
49. 4 Hz
50. 10 m/s, 2.5 Hz
51. Remains at T. Small amplitudes do not affect period
52. 1.0m
53. 8kg total, therefore 6 kg of additional mass

Kinematics and Dynamics Review:

54. $v_{avg.} = 5.13 \times 10^{-3}$ m/s
55. a. t = 0.625 h, b. v = 133 km/h
56. a-5, b-3, c-1, d-2, e-3
57. v = 104.5 m/s
58. a. d = 28.2 m, b. v = -23.5 m/s, c. a = +325 m/s^2
59. a. Total Area = 10 m

    b.



60. 113 km/h
61. a. 3.1 m/s, 38° east of north, b. 16s, c. 30m
62. mass = 86kg, weight = 140N
63. 8.37m/s^2 down
64. 230N
65. a. refer to tutorials, b. 3.27 m/s^2, c. 65.3N