# Semester 2 Final Exam Review Answers


A truck with mass 1600 kg collides with a car with mass 800 kg at rest. They stick together and continue to move to the right.

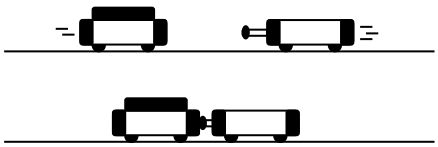
1. What is the total momentum of the system **before** the collision?
   *14400 kgm/s*

2. What happens to the total momentum of the system **after** the collision?
   *total momentum before = total momentum after  that's the law!*

3. What is the velocity of the pair after the collision
   *6 m/s*

4. Compare the force of the truck on the car to the car on the truck during the collision.
   *F truck on car = F car on truck  N3LFP*

A 1.0 kg low-friction non-plunger cart is moving toward a 0.50 kg low-friction plunger. The carts collide and the spring is compressed and the carts momentarily come to a stop as shown.



5. How do the accelerations of each of the carts compare?
   *The acceleration of the smaller mass cart is greater*

6. How do the changes in momentum Δp of the carts compare?
   *The changes in momentum of each of the carts are equal and opposite*

7. Why is it safer for a pole-vaulter fall onto a puffy mat than onto the ground?
   *The puffy increases the stopping time thereby decreasing the stopping force*

8. Is it possible for a bullet and a baseball to have the same momentum?
   *Yes if the baseball is going slow and the bullet is going fast or they are both not moving ☺*

9. Why do you think medieval catapults had very long flinging arms?
   *Longer arms means that the force applied lasts for more time giving the projectiles a larger change in velocity*

A Human Cannon Ball is a carnival trick where a person is launched from a giant cannon. Suppose that the person has a mass of 80 kg and the cannon a mass of 800 kg. When the daredevil is launched…

10. Which exerts more force, the cannon on the man or the man on the cannon?
    *They exert equal forces on each other  N3LFP*

11. Based on mass which will have larger change in velocity the cannon or man?
    *The man will move forward faster than the cannon moves backward because he has less mass*

12. If the cannon applies an average force of 1000 N to the man for 0.50 seconds, at what speed does the man leave the cannon?
    *6.25 m/s*

13. Why is it that objects float?
*Objects float if the upward force by the water is equal to the downward force by the earth.*

14. How is the density of an object related to its ability to float in a fluid?
*If the density of the object is less than the density of the surrounding fluid the object will float.*

A sample of mineral oil has a mass of 8 g and a volume of 10 ml. A piece of Styrofoam density of 0.60 g/cm$^3$.

15. Calculate the density of the mineral oil.
*Density of mineral oil = 0.80 g/ml = 0.80 g/cm$^3$*

*16.* Styrofoam will float in mineral oil. What percent of the Styrofoam remains under the oil?
*75% under the surface*

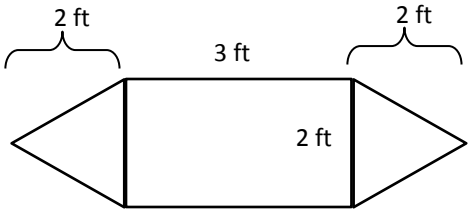
An aluminum foil boat of mass is constructed in the form of an open topped cube with individual side lengths of 4 cm. You place 5 nickels, each with a mass of 5 g, into the boat so that it sinks halfway into the water.

17. Calculate the volume of water displaced by the boat?
*32 cm$^3$*

18. What mass, in grams, can the above volume of displaced water support?
*32 g*

19. What is the total mass of the boat?
*7 g*

A cardboard boat is to be constructed so that the bottom of the boat has the dimensions shown at the right and straight sides. Rower #1 weighs 140 pounds, the boat weighs 10 pounds and the gear weighs 2 pounds. The water line is 6 inches up from the bottom of the boat.

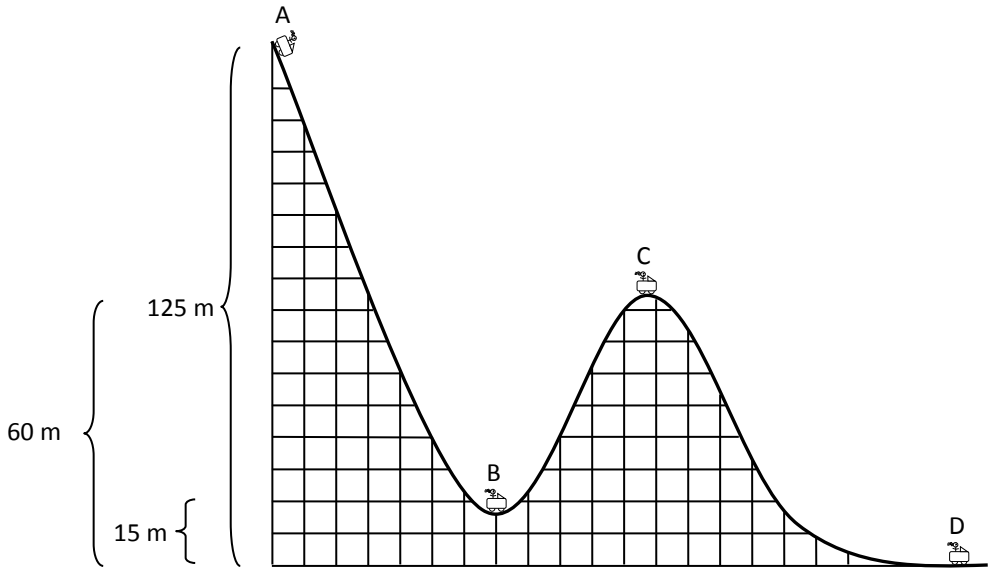



20. How much weight can one cubic foot displaced of water support?
*62.4 pounds*

21. Calculate the volume of water displaced by the boat.
*5 ft$^3$*

22. What is the weight of rower #2?
*160 pounds*

Pictured below is a new roller coaster. A physics student riding and the coaster car have a combined mass of 200 kg. The car is at rest at point A and there is no braking at point D. Assume no friction between the coaster car and the track.




23. Rank the total energy from least to greatest.
*The total amount of energy stays the same the whole time*

24. Rank the gravitational energy from least to greatest.
*D B C A*

25. Rank the kinetic energy from least to greatest.
*A C B D*

26. Rank the speed of the cart from least to greatest.
*A C B D*

27. What happens to the energy as the cart rolls from A to B?
*Some of the gravitational energy is converted to kinetic energy*

28. Determine the student's gravitational energy at point A.
*250000 J*

29. Determine the student's kinetic energy at point A.
*0 J (it is stopped)*

30. At point B, her height is only 15 m. Determine her gravitational energy and kinetic energies at point B.
*Gravitational Energy = 30000 J Kinetic Energy = 220000 J*

31. At point D the coaster is on the ground and still moving. How fast is it going at Point D?
*50 m/s*

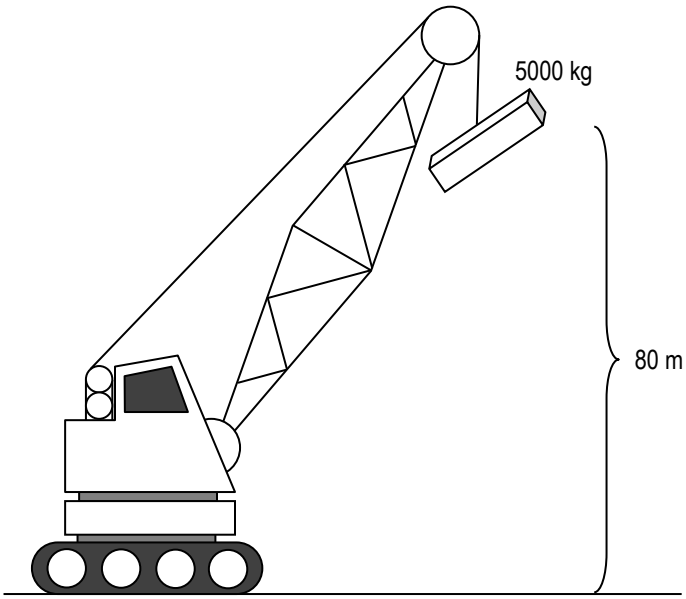
On a real rollercoaster friction (both from the track and the air) are very present.

32. Draw pie charts for a real rollercoaster as it moves from points A to B to C to D?
*G → K + G +T → G + K +T → K + T*

33. Assume that between points A and D the roller coaster lost 20% of its total energy. The speed of the roller coaster at point D would be?

*44.7 m/s*

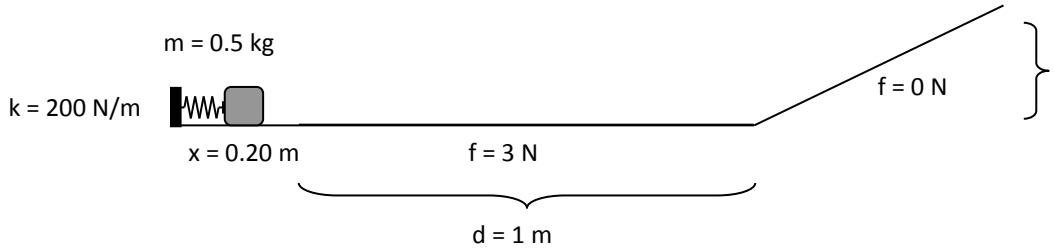
**A crane lifts a steel girder of mass 5000 kg to a height of 80 meters.**




34. Did the crane do work on the girder? How do you know?
*Yes – the crane lifts the girder giving it gravitational energy. Work is the transfer of energy and the motor transfers electrical energy to gravitational energy*

35. How much work was done by the crane's motor?
*4000000 J*

36. If the motor pulls the girder up in one minute seconds what is the power output of the motor?
*66667 Watts*




A 0.50 kg block that was being pushed against a spring is released from rest. The spring pushes the block which slides along a rough surface and then up a frictionless ramp and comes to a stop near the top of the ramp.

37. What happens to the total energy of the system as the block is pushed off of the spring; slides over the rough surface and then up the hill?
*The total energy of the system stays constant*

38. What is the speed of the block just after it leaves the spring?
*4 m/s*

39. What is the speed of the block as it leaves the rough surface?
*2 m/s*

40. To what vertical height does the block go?
*0.2 m*

41. What is the force that you would have to apply to hold the block against the spring?
*40 N*

42. Write one sentence that describes the spring constant.
*For every additional 1 meter you compress the spring you would need to apply an additional 200 N of force*

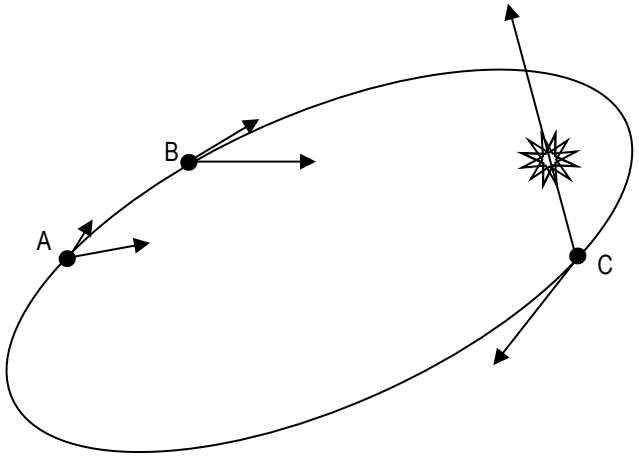
43. As the moon orbits the Earth, how many forces are on the moon (ignore any forces by the sun)?
*Just one, the Earth pulling the moon inward*

44. In which directions do the velocity and acceleration arrows point?
*The velocity is tangent to the circular path and the acceleration is inward toward the Earth.*

45. If the distance between the moon and the Earth were changed to half of the original distance, the force of gravity on the moon would be about…
*Four times of what it was*

46. Which force is bigger the Earth on the Sun or the Sun on the Earth?
*F Earth on moon = F moon on Earth*

At the right is a picture of a comet moving in an elliptical orbit around a star. Assume that the comet moves from A to B to C.




47. At which of the locations in the orbit at the right is the force on the comet the greatest? The least? How do you know?
*F is the greatest at C and the least at A. The closer it is the greater the force.*

48. At which of the locations in the orbit at the right is the comet moving the fastest? The slowest? How do you know?
*The comet is the fastest at C and slowest at A. The closer it is the faster it is going.*

49. Draw an arrow at each position that shows the force on the comet by the star?

50. Draw an arrow at each position that shows the velocity of the comet?

Mercury is the closest planet to the sun. It has a mass of $3.30 \times 10^{23}$ kg and a radius of $2.44 \times 10^{6}$ meters.

51. What is the acceleration due to gravity on Mercury?
*3.7 m/s/s*

52. What would be the gravitational force between a 200 kg astronaut and Mercury if he were standing on the surface?
*740 N*

A water bug is sitting on the surface of a pond when a frog jumps in and disturbs the water. The bug makes 20 bobs up and down in 25 seconds and reaches a maximum height of 0.30 meters above still water. With his handy-dandy meter stick, he measures the length between crests of the wave to be 4 meters. After a few seconds, the height of the waves is only 0.10 meters.

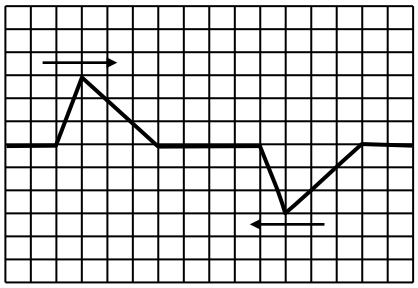
53. What is the period of the waves?
    *1.25 seconds/wave*

54. What is the frequency of the waves?
    0.8 waves/second

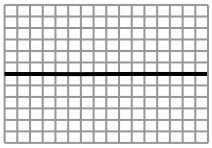
55. What is the speed of the waves in the water?
    *3.2 m/s*

56. What happens to the speed of the wave as the amplitude becomes smaller?
    *Nothing – the speed of the waves is determined by the water.*

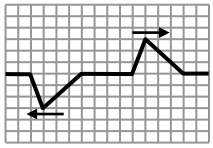
Two wave pulses approach each other from opposite ends of a spring as shown.



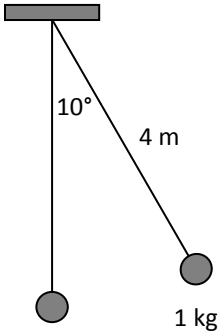
57. Draw what the spring looks like when the two pulses are interacting?



58. Draw what the spring looks like after the pulses have passed through each other?



Some physics students set up a pendulum in the classroom as shown.

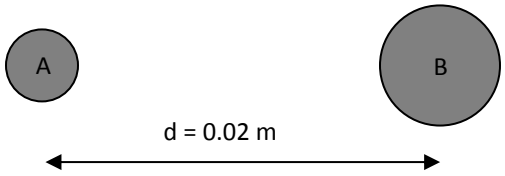



59. How much time would it take this pendulum to complete one full swing?
    *4 seconds*

60. How would halving the mass of the ball AND doubling the initial displacement angle affect the period of the pendulum?
    *The period would stay the same.*

61. What would you have to do to the length of the pendulum to get the period to decrease by a factor of 2?
    *You would have to decrease the length by a factor of 4.*

Two charged metal spheres A and B are separated by a distance of 0.02 meters. Sphere A has a charge of $+7.0 \times 10^{-7}$ C and sphere B has a charge of $+5.0 \times 10^{-7}$ C. In addition, sphere B has twice the surface area as sphere A.




62. How will the spheres move if released?
*They will move away from each other.*

63. Which supplies more force, A on B or B on A?
*N3LFP*

64. Calculate the force of A on B.
*7.875 N*

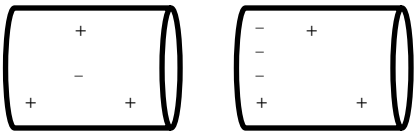
65. How much charge will B have if the objects are touched together then separated to the original positions?
*$8 \times 10^{-7}$ C – charge distribution is based on surface area*

66. What happens to the force of A on B when the distance between the charged objects is doubled?
*The force will decrease by a factor of 4.*

An aluminum can was made positive charged by a fun fly stick. The charged can is then moved toward a neutral aluminum can.

67. How did the charged can get charged?
*The fun fly stick is very positive and pulled some of the electrons from the can.*

68. Draw the charge distribution on the neutral can?



69. If the neutral can were free to move, how would it move?
*Toward the charged can*

70. If the cans touched how would they move?
*They would repel because they would both be positively charged.*