Physics Final Review – Part I

Mr. Menin

KINEMATICS

Concepts

1. Which quantity must remain constant for the 6 equations of motion to work?
2. Be able to sketch a position vs. time graph for each of the following situations:
   a) Car goes at constant velocity to the right, then stops for a while, then constant velocity left.
   b) Two cars going right. Car A is faster than B. Both at constant velocity.
   c) Car going to the right. Speeding up.
   d) A superball bouncing.
3. In Massachusetts, the acceleration of an object in free fall is 9.81 m/s^2 down when what 3 things are true about an object? _____ _____ _____
4. Tell the SI unit for each: displacement time velocity acceleration mass force
5. (B-question) Starting with the equations of motion, prove that the path a projectile follows is a parabola.

Problems

6. A driver hits the brakes and accelerates at $-3.8\ m/s^2$ for 2.9 seconds until he rolls to a stop. How fast was he going before he hit the brakes?
7. How long does it take to go 100.0 m if you start at 5.0 m/s and accelerate at 2.0 m/s^2?
8. A ball is thrown upward with a velocity of 25.0 m/s.
   a) How fast is it going 1.0 second later?
   b) How high does it go above its starting point?
   c) How long does it take to go up and come back down to the thrower's hand?
9. Add a) 3.0 [E] + 5.2 [E] b) 3.0 [N] + 5.2 [S] c) 3.0 [N] + 5.2 [E]
10. You go 64 miles North, and then 79 miles [39° E of N]. What is your displacement?
11. 73 mi [N] + 73 mi [W] + 31 mi [N] + 117 mi [E] =
12. A boat heads due west, straight across a river with a 5.0 km/hr current north. The boat would normally travel 11 km/hr. What is the actual velocity (speed and direction) of the boat?
13. A pilot wants to fly East. Her plane would normally go 180 mph in still air. There is, however, a wind blowing 75 mph toward the South. a) How fast will the plane actually go? b) Exactly what direction should the plane's heading be?
14. A dart is shot horizontally from a height of 2.0 m. It lands 14 m away on the floor.
   a) What is its muzzle velocity? (Assume air resistance is too small to matter.)
   b) Convert this to mph using 1 m/s = 2.24 mph)
15. (B-question) A speeder going 50.0 m/s passes a stationary cop car, which instantly begins to accelerate at 3.0 m/s^2. How long does it take the cop to catch up with the speeder?
16. (B-question) A golf ball is launched at a 28° angle above the horizontal with a speed of 47 m/s.
   a) How high is it when it is above a tree 150 m away?
   b) (New question.) At the highest point in its flight, what is "given"?
   c) So how high is it at its highest point?
17. (A-question) A car going 44 m/s (about 100 mph) passes a police car pulling on to the highway at 9.0 m/s. The cop instantly accelerates at 2.6 m/s^2. The cop's top speed is 53 m/s. How long does it take the cop to catch the speeder? How far do they travel during this time?

Physics Final Review

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DYNAMICS
A. FORCE AND NEWTON'S LAWS

Concepts

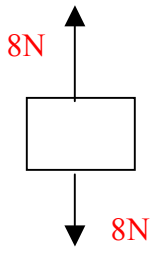
18. Mr. Menin's mass is 80 kg on earth. What is his mass on the moon, where g = 1.6? What is his mass in empty space, where g = 0?
19. What is "weight"? How is it different from mass? Why are they often confused?
20. A space ship in empty space accelerates until it is going 10,000 mph. There are no planets nearby and no forces acting on the spaceship. The captain wants to cruise at a steady 10,000 mph speed in a straight line. Can she shut the engines off?
    a) yes, the ship will go 10,000 mph straight ahead b) no, the ship will stop
    c) no, the ship will slow down d) yes, but the ship will speed up

For the next 2 questions, point out what's wrong **by naming the force** that the speaker is overlooking.

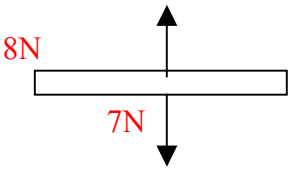
21. "Newton's 1st law is wrong. If you kick a book across the floor it slides to a stop. That proves that things with no force on them do stop. They don't just keep going." What should you say?
22. "The moon goes in a circle around the earth. That proves that objects with no force on them don't go in a straight line." What should you say?
23. Sketch a plane. Draw arrows showing the 4 forces on it. Put the correct name by each.
24. The plane is going straight ahead at a steady 500 mph.
    i) What is the net force on it? _____
    ii) Which forces must be equal to each other? (2 answers)
25. As the plane flies, it burns up gasoline.
    i) So the mass of the plane is a) decreasing b) staying steady c) increasing
    ii) So which **force** is getting smaller? _____
    iii) To keep the plane at a steady speed in a straight line, which other force must be reduced to balance everything? _____
26. For the given "action force" give the corresponding "reaction force."
    A car's tires push backward on the road with a force of 1500 N.
27. A very large tractor-trailer truck collides with a small car. The force that the large truck exerts on the small car is _____ the force the small car exerts on the big truck.
    a) smaller than b) the same as c) greater than d) not enough information

For the next 2 questions, use the 3rd law to explain why each object moves.

28. Why does a helicopter go up?
29. Why does a swimmer move forward?
30. Here's an object with 2 forces on it.
    i) Could it be remaining stationary?
    ii) Could it be moving?
    iii) Could it be moving to the right?
    iv) To the left?
    v) Up?
    vi) If it is moving, what can you say about its motion?



31. Here's an object with 2 forces on it.
    i) Could it be remaining stationary?
    ii) Could it be moving?
    iii) If it is moving, what can you say about its motion?



Problems

32. Calculate the force of gravity between a 3.0 kg brick and a planet with a mass of 4.0×10^{25} kg and a radius of 4.0×10^{6} m.

33. What is "g" on the planet in the previous problem?

34. A 12.0 kg brick is sitting on a sidewalk. What is the normal force on it? (Strength and direction.)

35. The same 12.0 kg brick is sitting on a sidewalk, but you are trying unsuccessfully to lift it, exerting an upward force of 63 N on the brick. What is the normal force on it? (Strength and direction.)

36. A block is sliding across a surface. The weight force on the block is 32 N. The friction force is 58 N. What is the coefficient of friction?

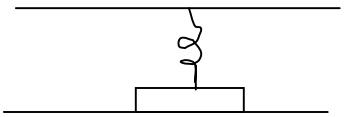
37. Compared to other coefficients of friction you have seen, were the surfaces in the previous problem slippery, medium, or sticky?

38. A 1.52 kg fish is hanging from a spring. The spring stretches just .113 m (11.3 cm). What is the spring constant for this spring?

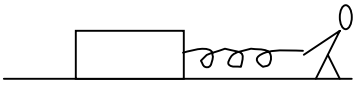
39. You are designing a car. Its mass will be 1500 kg. Your boss wants it to accelerate at 2.8 m/s^2. How much force must the engine provide? (Ignore friction.)

40. A 1500 kg car accelerates from 15 m/s to 28 m/s in 7.0 seconds. You know that the force of friction is 1300 N. What force is the engine generating?

41. (B-question) A spring is holding a 2.0 kg block down as shown. The spring constant is 85 N/m. The spring is compressed .13 m. What is the normal force on the block?

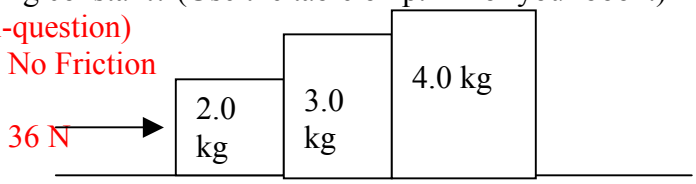


42. (B-question) How much thrust force is needed to accelerate a 1.5 kg toy rocket at 13 m/s^2 at lift-off?



43. (A-question) A person is dragging a 35 kg steel block across a steel floor at constant velocity. He is pulling it with a spring (don't ask me why). The spring is stretched 1.2 m. What is the spring constant? (Use the table on p.144 of your book.)

44. (A-question)



a) What is the acceleration of the whole system?

b) What is the net force on each block?

c) Draw a complete force diagram for each block. Label each force and give the numerical values for the horizontal forces.

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DYNAMICS
B. WORK, POWER, ENERGY, & MOMENTUM

Concepts

45. Indicate the type(s) of energy present or the energy transformation:
A) Car a. Sitting still b. Starts moving, speeding up c. Brakes to a stop
d. Goes uphill (constant velocity) e. Brakes to a stop
B) Toy Rocket a. Sitting on the launch pad b. You ignite the engine & it goes up
c. The engine quits & it keeps climbing, slower d. At the highest point it stops
e. It is falling down f. It hits the ground and stops

46. From a physics standpoint, an airbag reduces the amount of injury by increasing **TWO** different quantities. What are they and how does each relate to the risk of injury?

47. Tell whether each collision is "perfectly inelastic" (I) or "partial elastic" (E):
a) One beach ball bounces off another
b) Cue ball hits 8 ball. Cue ball stops. 8 ball goes.
c) Tractor trailer truck hits bug which sticks to windshield.
d) Ty Law intercepts a pass.

Problems

48. You lift a 45 kg mass from the ground to eye level (1.6 m) in 3.2 seconds. a) How much work did you do? b) How much power did you exert?

49. How long does it take an 85 hp motor to lift 4900 lbs. 52 feet?

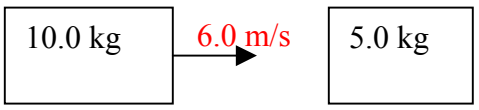
50. A frictionless 450 kg roller coaster starts at the top of a 24 m hill.
a) how fast is it going at the bottom of the hill?
b) how fast is it going at the top of the next hill, which is 15 m high?

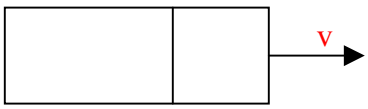
51. The same roller coaster starts at the top of the same hill, but this time there is friction and 52,000 J of the initial energy are converted into heat on the way down. What is the coaster's speed at the bottom?

52. A 130 kg astronaut in space is moving at 1.10 m/s away from his ship. His thruster exerts a fixed force of 15 N and it does **not** noticeably affect his mass to use it. How long should he fire it if he wants to wind up going toward his ship at **.**50 m/s?

53. Use the conservation of momentum to find the value of the variable in each diagram.

a)





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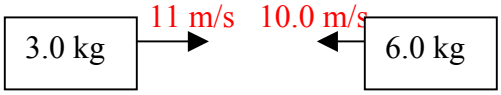

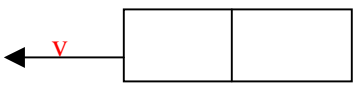

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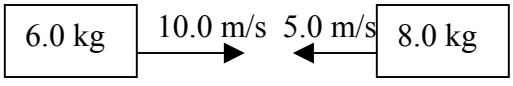

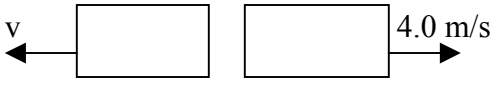

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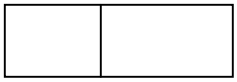

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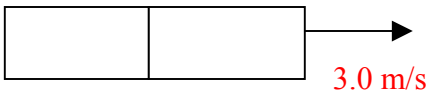

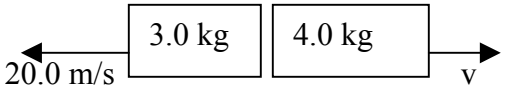

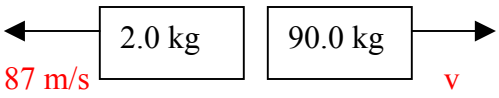

54. A 2300 kg truck going 31 m/s smashes into an 1100 kg parked car.
    a) What is the velocity of the combined mass immediately after the collision?
    b) How much kinetic energy was "lost"?
    c) What happened to that kinetic energy?

55. (B-question) A 28 g bullet going 750 m/s hits and sticks in a 2.0 kg block. The coefficient of friction between the block and the floor is 2.2. How far does the block slide?

56. (B-question) A 3.00 kg pendulum rises .186 m when a 7.51 g bullet is fired into it. How fast was the bullet going?

57. (A-question) A 160 kg elevator must be able to move at a constant speed of 1.5 m/s carrying a maximum load of ten 85 kg passengers. What power rating (**in hp**) must the motor have if the gears (wheel & axle) are 79% efficient and the cable/pulley set-up is 48% efficient?

58. (A-question) A 6.0 kg ball going 10.0 m/s hits a stationary 2.0 kg ball. A **perfectly elastic** collision occurs. How fast is the 6.0 kg ball going after the collision? (Hint: Write the conservation equations for momentum and kinetic energy and solve them.)

59. (A-question) You are an accident investigator. A 2100 kg truck hit a parked 1300 kg car. Skid marks show that the combined mass went about 45 m. You measure the coefficient of friction to be about 1.4. The driver says he was going the speed limit (45 mph). How fast was he really going? Convert your answer to mph using 1 m/s = 2.24 mph.