Review of the whole semester

Each of the following slides shows some of the major themes we talked about, followed by a multiple choice question

Position, average and instantaneous velocity, speed, acceleration

- I. Which concept describes what's going on if a car is going faster and faster?
 - a) Acceleration
 - b) Speed
 - c) Instantaneous velocity
- II. Which of the following is NOT an example of accelerated motion?
 - a) If a car slows down
 - b) If a car turns a corner at constant speed
 - c) If a car's instantaneous velocity is equal to its average velocity
- III. What is the average velocity of a car that is first going 20 m/s for 50 s and then 30 m/s for another 150 s?
 - a) 30 m/s
 - b) 27.5 m/s
 - c) 25 m/s

Position, average and instantaneous velocity, speed, acceleration

- I. Which concept describes what's going on if a car is going faster and faster?
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[(20m/s x 50s + 30m/s x 150s) / (50s + 150s)]

c) 25 m/s

Force, Newton's 3 Laws

- IV. Which forces act on a heavy crate sitting at rest on a slightly inclined ramp? List ALL that apply
 - a) Gravity
 - b) Static friction
 - c) Kinetic friction
 - d) Normal Force
- V. An electron and a proton (2000 times heavier) experience each others electrostatic attraction. Which statements are true? List ALL that apply
 - a) The force on the electron is 2000x larger than that on the proton
 - b) The electron's acceleration is 2000x larger than the proton's
 - c) If the proton had twice the charge, the force on BOTH would increase
- VI. What can we conclude if we observe an object that is moving with constant velocity?
 - a) That no force is acting on it
 - b) That a force **must** be acting in the direction of its motion
 - c) That all forces acting on it must add up to zero (vectorially)

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 - a) The force on the electron is 2000x larger than that on the proton
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Momentum

- VII. A firecracker explodes in midair, instantaneously at rest. 40% of its mass fly to the right with 30 m/s velocity. What is the velocity of the remaining 60%
 - a) 30 m/s
 - b) Can't tell
 - c) 20 m/s
 - d) 20 m/s
- VIII. An electron and a proton start moving (from rest) under their mutual attraction. When they collide, they form a hydrogen atom. Which of the following statements is true?
 - a) The collision is elastic
 - b) The atom will be at rest
 - c) Some form of energy has to be given off by the atom when it is formed
- IX. A 10,000 kg train car is moving with velocity 10 m/s along a straight, level track without being pulled or pushed. All of a sudden, a load of 40,000 kg of coal is dumped into the car from an overhead chute. What is its new velocity?
 - a) 2 m/s
 - b) 5 m/s
 - c) 0 m/s (it comes to a complete stop)

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 - a) 30 m/s
 - b) Can't tell
 - c) 20 m/s
 - d) -20 m/s (momentum is conserved: 0.4m*30m/s + 0.6m*(-20m/s) = 0)
- VIII. An electron and a proton start moving (from rest) under their mutual attraction. When they collide, they form a hydrogen atom. Which of the following statements is true?
 - a) The collision is elastic
 - b) The atom will be at rest \checkmark (because everything was at rest initially)
 - c) Some form of energy has to be given off by the atom when it is formed \checkmark
- IX. A 10,000 kg train car is moving with velocity 10 m/s along a straight, level track without being pulled or pushed. All of a sudden, a load of 40,000 kg of coal is dumped into the car from an overhead chute. What is its new velocity?
 - a) 2 m/s \checkmark (momentum is conserved: 10,000kg*10m/s = 50,000kg*2m/s)
 - b) 5 m/s
 - c) 0 m/s

Energy

- X. A 1 g speck of dust is moving from a point where it has a potential energy of $U_{pot} = 1.2 \cdot 10^{-4}$ J to a point where it has $U_{pot} = 1.0 \cdot 10^{-4}$ J. What is its velocity if it started out at rest?
 - a) 20 m/s
 - b) Can't tell
 - c) 0.02 m/s
 - d) 0.2 m/s
- XI. If the same speck falls from a height of 30 m to a height of 10 m in Earth's gravitation, by how much does its kinetic energy increase?
 - a) By 20 J
 - b) By 0.2 J
 - c) By 0.02 J
- XII. Two cannons fire simultaneously straight up into the air. Cannon 2 has double the muzzle velocity of cannon 1. Which of the following statements is correct? (Possibly more than one!)
 - a) Cannonball 2 spends twice the amount of time in the air as cannonball 1
 - b) Cannonball 2 reaches twice the maximum height as cannonball 1
 - c) Cannonball 2 hits the ground with twice the speed of cannonball 1

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d) 0.2 m/s $V\Delta U_{pot} = -2.10^{-5} \text{J} \rightarrow \Delta T_{kin} = +2.10^{-5} \text{J} = 1/2 \times 0.001 \text{kg} \times (0.2 \text{m/s})^2$

- XI. If the same speck falls from a height of 30 m to a height of 10 m in Earth's gravitation, by how much does its kinetic energy increase?
 - a) By 20 J

b) By 0.2 J
$$\bigvee [mg\Delta h = 0.001 \text{kg} \times 10 \text{ m/s}^2 \times (-20 \text{m}), \Delta \text{K.E.} = -\Delta U_{\text{pot}}]$$

- c) By 0.02 J
- XII. Two cannons fire simultaneously straight up into the air. Cannon 2 has double the muzzle velocity of cannon 1. Which of the following statements is correct? (Possibly more than one!)
 - a) Cannonball 2 spends twice the amount of time in the air as cannonball 1 $\bigvee (\Delta t = v_0/g)$
 - b) Cannonball 2 reaches twice the maximum height as cannonball 1 ($mgh = 1/2mv_0^2 \Rightarrow 4x$)
 - c) Cannonball 2 hits the ground with twice the speed of cannonball $1 \bigvee$

Rotational motion

- XIII. A long rod has 2 weights close to its center and is rotating with constant ω when suddenly the weights shake loose and move to the ends of the rod. Which of the following statements is NOT true?
 - a) The moment of inertia increases
 - b) The angular momentum increases
 - c) The angular velocity ω decreases
 - d) The kinetic energy decreases
- XIV. Two cars are rounding a 90-degree bend in the street. The one on the inner lane (50 m radius) has velocity 15 m/s, and the one on the outer lane (60 m radius) has velocity 18 m/s. Which one will complete the 90 degree bend first?
 - a) The inner one
 - b) The outer one
 - c) It's a tie
- XV. In the situation above, which car experiences the larger centripetal acceleration?
 - a) The inner one
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 - c) Both the same

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 - b) The angular momentum increases **(**(mom. of inertia increases and ang. mom. is constant)
 - c) The angular velocity ω decreases
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 - a) The inner one
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 - c) It's a tie [Both have angular velocity $\omega = v/R = 0.3$ rad/s]
- XV. In the situation above, which car experiences the larger centripetal acceleration?
 - a) The inner one
 - b) The outer one \checkmark [$a_{centr} = R\omega^2$]
 - c) Both the same

Gravity and Ballistics

- XVI. Moon has 1/81 the mass of Earth. Where on the path from Earth to Moon would a spaceship be in gravitational equilibrium?
 - a) In the middle
 - b) 9 times closer to Moon than to Earth
 - c) 81 times closer to Moon than to Earth
 - d) $6561 = 81^2$ times closer to Moon than to Earth
- XVII. Are all planets on circular paths with sun at the center?
 - a) Yes
 - b) No
- XVIII. An airplane is traveling horizontally at 10,000 m height with 200 m/s velocity. A helicopter is right underneath, at 2500 m height and moving in the same direction with 100 m/s velocity. Both drop a sack of potatoes at exactly the same time. Which statement below is true?
 - a) Both sacks hit the ground at the same spot.
 - b) The airplane's sack hits the ground 2x further from the drop point than the helicopter's
 - c) The airplane's sack hits the ground 4x further from the drop point than the helicopter's
 - d) The airplane's sack hits the ground 8x further from the drop point than the helicopter's

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b)

- No 🧹 [they are elliptical]
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[4x the height = 2x the drop time] x [twice the horizontal velocity] = 4x the distance

 $[F = GMm/R^2]$

Electrostatics

- XIX. A 1 mg speck of dust carrying $-1 \mu C$ of charge is moving from an electrical potential of 100 V to 120 V. By how much does its potential energy change?
 - a) By 20 J
 - b) Not enough information given
 - c) By $2 \cdot 10^{-5} J$
 - d) By -2·10-5J
- XX. A 1 μ C charge is suspended to the left of both a 2.5 μ C charge and a -10 μ C charge. It is twice closer to the 2.5 μ C charge than the -10 μ C charge. Which way does the electrostatic force on the 1 μ C charge point?
 - a) There is no **net** electostatic force on this charge
 - b) Towards the left, away from both other charges
 - c) Towards the right, towards both other charges
- XXI. A grounded, conducting sphere (zero potential) is held up right next to the terminal of a van de Graaf generator, which is at -10,000V. What is the net charge of the sphere?
 - a) Zero
 - b) Positive
 - c) negative

Electrostatics

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 - a) By 20 J
 - b) Not enough information given
 - By 2.10-5J c)
 - By -2.10^{-5} J \checkmark ($\Delta U_{\text{pot}} = q^* \Delta V = -10^{-6} \text{ C}^* 20 \text{ V}$) d)
- A 1 μ C charge is suspended to the left of both a 2.5 μ C charge and a -10 μ C charge. XX. It is twice closer to the 2.5 μ C charge than the -10 μ C charge. Which way does the electrostatic force on the 1µC charge point?
 - There is no **net** electostatic force on this charge \checkmark [$F = kq Q_1/R^2 + kq(-4Q_1)/4R^2$] a)

- Towards the left, away from both other charges b)
- Towards the right, towards both other charges c)
- XXI. A grounded, conducting sphere (zero potential) is held up right next to the terminal of a van de Graaf generator, which is at -10,000V. What is the net charge of the sphere?
 - Zero a)
 - Positive [/ induction pushes negative charge away and into the ground] b)
 - c) negative

Currents and Circuits

- XXII. Your Christmas light chain suddenly goes out because a single light bulb in the chain burned out. What do you conclude?
 - a) The light bulbs are all in parallel
 - b) The light bulbs are all in series
 - c) The fuse must have blown
 - d) Either c) or b)
- XXIII. 3 light bulbs in series are connected to a battery. The first one is brighter than the other two. What do you conclude?
 - a) That's because it is closer to the "+" terminal of the battery
 - b) This must mean it has a larger resistance than the others
 - c) This must mean it has a smaller resistance than the others
 - d) More current must be flowing through it than through the others
- XXIV. You have 2 light bulbs and 1 battery. You can either arrange the two bulbs in series with the battery, or set up a parallel circuit. How much more TOTAL light output (both bulbs combined) would you get in the second case?
 - a) The same
 - b) Twice as much
 - c) 4x
 - d) 8x

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 - d) Either c) or b) **V** (actually b is the most likely scenario)
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 - b) This must mean it has a larger resistance than the others $V[P = \Delta V^*I = (R^*I)^*I]$
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 - b) Twice as much

4x \checkmark [$P = \Delta V^*I$; for series both ΔV and I are 1/2 as for parallel]

d) 8x

c)

Magnetism

- XXV. To test whether magnetic forces follow the $1/r^2$ law for isolated poles, your friend proposes to saw a permanent dipole magnet in half and then measure the force between the two halves at various distances. Would this work?
 - a) Yes
 - b) No
- XXVI. The captain of a ship orders: "Course directly towards the North Pole". The first mate replies: "Magnetic or geographic?" How far are those two apart?
 - a) They are exactly at the same spot
 - b) On the order of 1000 km or so
 - c) Nearly 20,000 km
- XXVII. A proton and an electron are moving independently in a homogeneous magnetic field (perpendicular to the field direction). The electron moves 1836 times faster than the proton. Which statements are true?
 - a) They both move along straight lines
 - b) They both move on circles with the same radius
 - c) It takes them the same amount of time to complete one circle
 - d) Neither gains or loses kinetic energy

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 - a) Yes

b)

No 🖌

- (because you can not isolate poles that way)
- XXVI. The captain of a ship orders: "Course directly towards the North Pole". The first mate replies: "Magnetic or geographic?" How far are those two apart?
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 - a) They both move along straight lines
 - b) They both move on circles with the same radius $\bigvee [R=mv/qB]$
 - c) It takes them the same amount of time to complete one circle $[\omega = eB/m]$
 - d) Neither gains or loses kinetic energy