Examples of problems and Essay Topics that could appear in 1033C Exams.

In answering the problems it is not enough to have the correct answer, you must wrote 2 or 2 lines of text explaining the physics reasoning of your solution. For essays you can bring a PC to class or just write longhand.

1. On the Earth where the acceleration due to gravity g=10 m/s^2, a small pebble dropped from a height (unknown) reaches the ground in 4 seconds. The same pebble is transported to planet Vulcan where g= 2.5 m/s^2. How long does it take the pebble to hit the ground on Vulcan when dropped from the same height? [8 s.]
   General physics equation for constant acceleration $X=(1/2)at^2$
   X is same on Earth and planet Vulcan. Thus $X(earth) =(1/2)gt_E^2 = X(Vulcan) = (1/2)\, G_V t_V^2$
   So $t_V^2 = t_E^2\, g_e/G_V = 16x10/2.5 = 64$ and t_V=8 s.

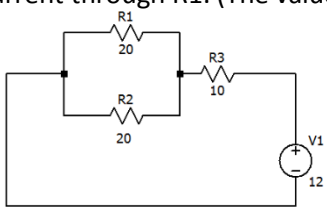
2. Two rockets ships are on a collision course. Each ship has a mass of 1000 tons and is moving at 100 m/s. When they collide the two ships fuse at the point of collision. State the final speed of the fused ships, and write down the law that you used. [0 m/s]
   General principle in this problem is conservation of momentum. Initially each ship has the opposite momentum, therefore initially total momentum = 0. Thus total final meomentum must be zero.

3. The force between two electrically charged cylinders is 2 newtons when they are 1 meter apart. What is the force when they are 50 centimeters apart? [8 N.]
   The physics law to use is Coulomb's law $F=KQ_1Q_2/R^2$. K is a constant, Q_1 and Q_2 are the charges and R the separation. K, Q1 and Q2 are kept constant, thus $F_2/F_1=(R_1/R_2)^2 = 4$, or F_2 =8N.

4. Helium gas is stored in a strong steel cylinder. If the pressure at 300 K is 200 bar, what is the pressure if it is heated to 450K? [300 bar]
   Need to use the ideal gas law, PV=nRT, or P proportional to T as long as T is in Kelvin. Thus $P_2=P_1 \times (T_2/T_1) =P_1 \times (450/300) = 1.5 \times P_1 = 300$ bar.
   Warning. You could get a problem where the temperatures are in Centigrade and you need to convert to Kelvin.

5. Jane who has a mass of 150 kg sits in a canoe that has a mass if 75 kg. Jane jumps out of the canoe with velocity of 2m/s. What is the recoil velocity of the canoe? [-4m/s]
   This is a conservation of momentum problem. Initially nothing is moving and so total momentum initially zero. Thus momentum after must be zero. Momentum of Jane is 300 kg m/s. Thus momentum of canoe is -300 kg m/s, and since mass is 75 kg, velocity of canoe is -4 m/s.

6. A 12 volt battery is connected across the circuit of resistances shown in the figure. Calculate the current through R1. (The values of the resistances is in ohms.) [0.3 A]



R_1 and R_2 in parallel are equal to 10 Ω, therefore total resistance in circuit is 20 Ω.
Current is I = 6/20 = 0.3 Ω.

7. A rocket ship of mass 100,000 kg is traveling at 50m/s. It burns 2000 kg of fuel that is converted to hot gas and ejected at 1000 m/s. What is the velocity of the rocket after the burn? [71 m/s]
   This is about conservation of momentum. Initial momentum = 100,000 x 50 = 5 10^6 kg m/s.
   P of burnt fuel = -2000 x 1000 = -2 10^6 kg m/s. Thus final momentum of rocket = +7 10^6 kg m/s.
   (Sum of final momentum of fuel and that of rocket must = + 5 10^6 kg m/s.)
   P final (rocket) =7 10^6 = m x V_F and V_F = 71 m/s.

8. A car driving at 10 m/s passes a stationary police vehicle. At the moment of passing, the police vehicle accelerates at 2 m/s^2. When does the police car catch up with the car? [10 s.]
   This is about accelerated motion. For the car, the distance traveled X = Vt. For the police vehicle the distance traveled X = (1/2) a t^2. The distances are the same when they meet. Thus Vt =(1/2) at^2, or V =(1/2)at, or 10=(1/2) 2 t, and t = 10 s.

Write an essay on one of the following topics (1.5 pages maximum):

9. The importance of symmetries in Physics. (see posted lecture notes)
10. The contributions of Isaac Newton to Physics (or mathematics). (lecture notes and https://en.wikipedia.org/wiki/Isaac_Newton)
11. The importance of friction in everyday life. (see posted lecture notes)
12. Is the concept of relativity important for an accurate GPS? (see posted lecture notes)

For the following essay topics diagrams need to be drawn to clarify the texts you write (one page maximum).

13. Explain in words how Eratosthenes measured the diameter of the Earth. (see posted lecture notes)
14. Discuss the major contribution of Augustin de Coulomb to understanding electricity. (lecture notes and https://en.wikipedia.org/wiki/Coulomb%27s_law)
15. Describe how thunderclouds become electrically charged. (see posted lecture notes)