

- An electric refrigerator transfer heat from the cold cooling coils to the warm surroundings. Does this violate the second law of thermodynamics? why? (5%)
- Draw a Wheatstone bridge and derive the relationship between the resistances when the bridge is balanced. (5%)
- A 5.0 kg block and a 10 kg block are placed on a smooth table and connected by a spring. The 10 kg block is then pushed east by a horizontal force of 60 N.
 - Find the acceleration of the center of mass of the two blocks. (10%)
 - What is the velocity of the center of mass after 2.0 sec have elapsed? At this time the 10 kg block has a velocity of 6.0 meters/sec east. What is the velocity of the 5.0 kg block? (10%)
- An object is 250 mm from a diverging lens of 150 mm focal length. A converging lens of focal length 100 mm is 50 mm beyond the diverging lens(Fig.1). Find the position of the final image. (20%)
- A "needle-free" hypodermic injection procedure makes use of the fact that a sufficiently high-speed small diameter liquid jet can penetrate several layers of human tissue. Velocities higher than the velocity of sound are obtained by some types of hypodermic jet injection devices, although for injection the velocity need not necessarily be that high. Now suppose the time required for a 0.10 cm^3 injection is 0.20 sec. What is the average velocity of the jet? Assume the cross-sectional area of the jet is $1.5 \times 10^{-8} \text{ m}^2$. (15%)
- Fig.2 shows the setup commonly used for intravenous infusions.(in this aspect of medical practice. Pressures are usually expressed in mm H_2O rather than in mm Hg. For example, a pressure of 50 mm H_2O means that the pressure is that exerted by a column of water 50 mm high.)
 - How high above the needle must the intravenous fluid level be in order that, at the needle, the net pressure(intravenous fluid pressure minus venous pressure, that is, minus the opposing pressure of 80 mm H_2O of the blood in the veins) is 700 mm H_2O ? Assume the fluid being used for "intravenous feeding" is simply water. (10%)
 - Show whether the height calculated in (a) is significantly different from the height that would be determined if, instead of water, the fluid were the commonly used 5% Dextrose solution. (This means that each 100 milliliters of water

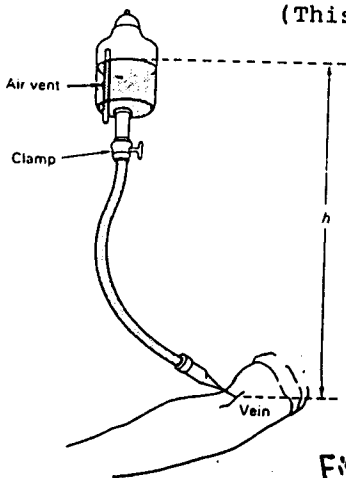


Fig.2

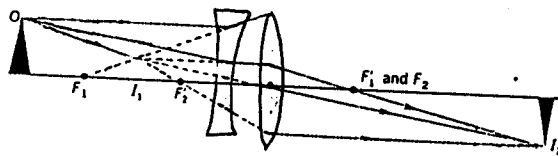


Fig.1

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contains 5 gm of dextrose; the combined volume of the water and the dextrose is itself 100 milliliters to a good approximation.) (10%)

7. A $60\ \Omega$ resistor is connected in series with a $0.25\ \text{H}$ inductor, a $50\ \mu\text{F}$ capacitor, and an ac generator delivering $110\ \text{V(rms)}$ at 60 cycles. Find
(a) the electron current in the circuit, and (5%)
(b) the power. (10%)