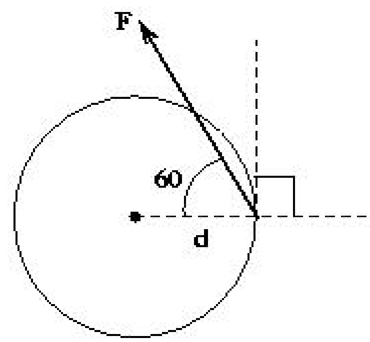
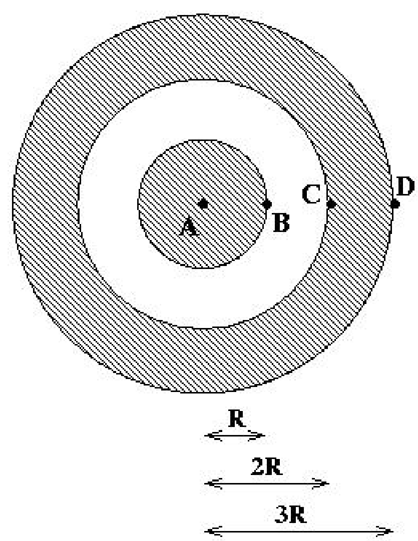
**ATTENTION: All Division I students, <u>STOP HERE</u>. Your last answer should be number 40. Numbers 41-50 should remain blank for Division I students.**
**All Division II students, continue to question 50.**

41. For the diagram shown, what is the magnitude of the torque from the applied force as measured from the center of the disk?



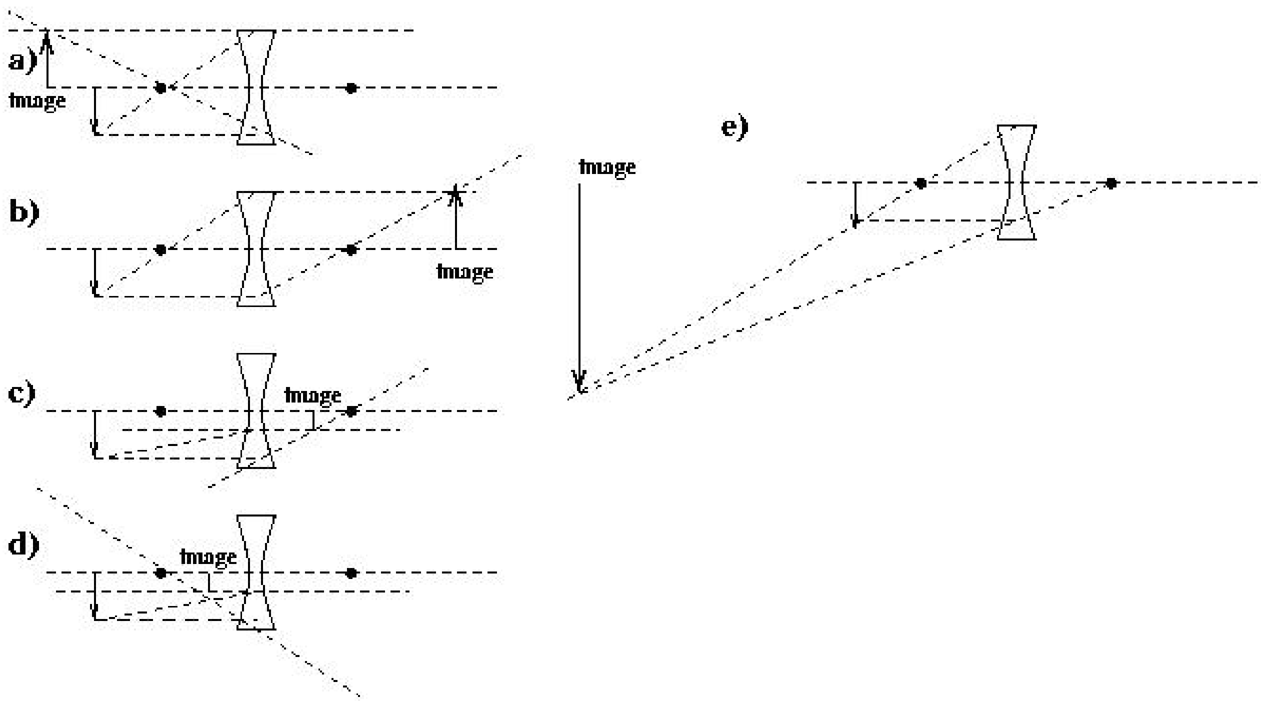

(a) $Fd\sin 30^0$
(b) $Fd\tan 30^0$
(c) $Fd\sin 90^0$
(d) $Fd\sin 120^0$
(e) $Fd\cos 120^0$

42. A solid spherical conductor has charge $+Q$ and radius $R$. It is surrounded by a solid spherical shell with charge $-Q$, inner radius $2R$, and outer radius $3R$. Which of the following statements is true for the labeled points in the diagram? Assume these objects are isolated in space and that the electric potential is zero as the distance from the spheres approaches infinity. Point A is at the center of the inner sphere, Point B is located at $r = R + \delta$, Point D is located at $r = 3R + \delta$ and Point C is located at $r = 2R - \delta$ where $\delta$ is an infinitesimal amount and all distances are from the center of the inner sphere.




(a) The electric potential has a maximum magnitude at C and the electric field has a maximum magnitude at A.
(b) The electric potential has a maximum magnitude at D and the electric field has a maximum magnitude at B.
(c) The electric potential at A is zero and the electric field has a maximum magnitude at D.
(d) The electric potential at A is zero and the electric field has a maximum magnitude at B.
(e) Both the electric potential and electric field achieve a maximum magnitude at B.

43. Which of the following best represents the ray diagram construction for finding the image formed for the virtual object shown? The solid dots on either side of the lens locate the equal magnitude foci of the lens.




44. A person vibrates the end of a string sending transverse waves down the string. If the person then doubles the rate at which he vibrates the string, the speed of the waves

(a) doubles and the wavelength is unchanged
(b) doubles and the wavelength doubled
(c) doubles while the wavelength is halved
(d) is unchanged while the wavelength is doubled
(e) is unchanged while the wavelength is halved.

45. If the temperature of a material doubles on the Kelvin scale, by how much does the time-rate at which energy is radiated from the material change?

(a) It is unchanged
(b) It is doubled
(c) It is 4 times greater
(d) It is 8 times greater
(e) It is 16 times greater

46. An ideal gas undergoes a reversible isothermal expansion at $T$ = 300 K. The total change in entropy of the gas is 2.5 J/K. How much work was done by the environment on the gas during this process?

(a) -750 J
(b) -120 J
(c) 120 J
(d) 750 J
(e) More information is required to answer this question.

47. Two spaceships travel along paths that are at right angles to each other. Each ship travels at 0.60*c* where *c* is the speed of light in a vacuum according to a stationary observer. If one of the ships turns on a green laser and aims it at a right angle to the direction of its travel, with what speed does the other speed record the speed of the green light?

(a) 0.40 *c*
(b) 0.85 *c*
(c) 1.00 *c*
(d) 1.17 *c*
(e) More information is required about the direction that the light is traveling in order to answer the question.

48. How fast must an observer move so that a stationary object appears to be one-half of its proper length?

(a) 0.50 c
(b) 0.67 c
(c) 0.75 c
(d) 0.87 c
(e) 0.93 c

49. The ratio $\lambda_1/\lambda_2$ of the deBroglie wavelengths of two non-relativistic particles with masses $m_1$ and $m_2$ and the same kinetic energy, is equal to

(a) $m_2/m_1$ (b) $m_1/m_2$ (c) $\sqrt{m_2/m_1}$ (d) $\sqrt{m_1/m_2}$ (e) 1

50. A gas undergoes radioactive decay with time constant $\tau$. A sample of 10000 particles is put into a container. After one time constant has passed, the experimenter places another 10000 particles into the original container. How much time passes from the addition of the particles until the container of gas reaches 10000 total particles again?

(a) $(0.313)\,\tau$ (b) $(0.500)\,\tau$ (c) $(0.693)\,\tau$ (d) $\tau$ (e) $2\tau$