SAINT JOSEPH'S PREPARATORY SCHOOL
PHYSICS TEST QUESTIONS.....T P FITZPATRICK
Final Exam Sample Problems
Waves and Sound

1. What is the wavelength of radio waves whose frequency is 100.3 MHz? Radio waves travel at the speed of light. Be careful of the correct metric unit prefix.
2. What is the frequency of a photon whose wavelength is 6350 Å (635 nm)?
3. At 0.00° C, sound travels at 331.0 m/s. What is the frequency of a sound whose wavelength is 2.00 m at 0.00° C?
4. The sound of an explosion is heard 7.25 s after the explosion is seen. If the temperature of the air is 21.0° C, How far from the observer did the explosion take place?
5. A student shouts in a canyon. 8.00 s after the shout, the student hears an echo from one of the walls. Assuming that the speed of sound is 336 m/s, how far is the wall from the student?
6. The frequency produced by a certain tuning fork is 440.0 Hz. What is the wavelength of this sound in air when the temperature is 25.0° C?
7. The frequency produced by a certain tuning fork is 540.0 Hz. What is the wavelength of this sound in air when the temperature is 30.0° C?
8. Two strings are played together and produce beats with a frequency of 4 Hz. If the frequency of one string is raised to 305 Hz and the resulting beat frequency is 6 Hz, what is the frequency of the other string?
9. A police car pursuing a perpetrator sounds a siren at 305 Hz. The police car is moving north at 38.0 m/s and the other car is moving north at 36.0 m/s. What frequency is heard by the bad guy if the speed of sound in air is 345 m/s?
10. Two cars are approaching each other. Each car has a speed of 12.5 m/s relative to the ground. What frequency is heard by the second car if the first car sounds a horn at 256 Hz? The temperature of the air is 10.0° C.
11. What frequency is heard by a stationary observer from a horn sounding at 528 Hz if the horn is on a train moving away from the observer at 25.0 m/s. The temperature of the air is 23.5° C.
12. A sound wave in air has a frequency of 262 Hz and travels with a speed of 343 m/s. How far apart are the wave crests (compressions)?
13. (*a*) AM radio signals have frequencies between 550 kHz and 1600 kHz (kilohertz) and travel with a speed of 3.00×10^8 m/s. What is the range of wavelengths of these signals? On FM, the frequencies range from 88.0 MHz to 108 MHz (megahertz) and travel at the same speed; what is the range of their wavelengths?
14. A cord of mass 0.65 kg is stretched between two supports 28 m apart. If the tension in the cord is 150 N, how long will it take a pulse to travel from one support to the other?
15. A ski gondola is connected to the top of a hill by a steel cable of length 620 m and diameter 1.5 cm. As the gondola comes to the end of its run, it bumps into the terminal and sends a wave pulse along the cable. It is observed that it took 16 s for the pulse to return. (a) What is the speed of the pulse? (b) What is the tension in the cable?

16. P and S waves from an earthquake travel at different speeds, and this difference helps in locating the earthquake "epicenter" (where the disturbance took place). (a) Assuming typical speeds of 8.5 km/s and 5.5 km/s for P and S waves, respectively, how far away did the earthquake occur if a particular seismic station detects the arrival of these two types of waves 2.0 min apart? (b) Is one seismic station sufficient to determine the position of the epicenter? Explain.

17. An earthquake-produced surface wave can be approximated by a sinusoidal transverse wave. Assuming a frequency of 0.50 Hz (typical of earthquakes, which actually include a mixture of frequencies), what amplitude is needed so that objects begin to leave contact with the ground? [Hint: Set the acceleration $a > g$]

18. A fisherman notices that wave crests pass the bow of his anchored boat every 3.0 s. He measures the distance between two crests to be 6.5 m. How fast are the waves traveling?

Electrostatics

19. What is the electric field associated with a +2.55 C charge 36.0 m North of it?

20. What charge would cause a +2.5 μC charge to experience an attractive force of 2.25 N when placed 15.0 cm away?

21. What is the electric field at the origin caused by 5.25×10^{12} electrons placed on the axis 25.0 cm in the positive *y* direction from the origin?

22. A styrofoam peanut has a mass of 5.00 g. If there is an electric field near the earth's surface equal to 150 N/C directed downward, what charge placed on the peanut will result in "levitation"?

23. What is the force of electrostatic repulsion between two protons separated by a distance to 15.4 cm? What is the force of gravitational attraction between them?

Simple Harmonic Motion

24. A 4.00 kg mass is hung from a spring whose constant is 145 N/m. When the system undergoes simple harmonic motion, what is the period of vibration? If the mass is replaced by one whose mass is 1.00 kg, what will the period become?

25. A 1.25 kg mass is hung from a spring and is observed to undergo 25.0 vibrations in exactly 21.0 s. What is the spring constant?

26. A 1250 kg car has a suspension whose overall spring constant is 3160 N/m. Without shock absorbers, what would be the period of oscillation whenever the car hits a bump?

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27. If a particle undergoes SHM with amplitude 0.18 m, what is the total distance it travels in one period?

28. An elastic cord is 65 cm long when a weight of 75 N hangs from it but is 85 cm long when a weight of 180 N hangs from it. What is the "spring" constant, *k* of this elastic cord?

29. The springs of a 1500-kg car compress 5.0 mm when its 68-kg driver gets into the driver's seat. If the car goes over a bump, what will be the frequency of vibrations?

30. A fisherman's scale stretches 3.6 cm when a 2.7-kg fish hangs from it. (*a*) What is the spring stiffness constant and (*b*) what will be the amplitude and frequency of vibration if the fish is pulled down 2.5 cm more and released so that it vibrates up and down?

31. An elastic cord vibrates with a frequency of 3.0 Hz when a mass of 0.60 kg is hung from it. What is its frequency if only 0.38 kg hangs from it?

32. Construct a Table indicating the position *x* of the mass in Fig. 11–2 at times $t = 0, \frac{1}{4}T, \frac{1}{2}T, \frac{3}{4}T, T,$ and $\frac{5}{4}T,$ where *T* is the period of oscillation. On a graph of *x* vs. *t*, plot these six points. Now connect these points with a smooth curve. Based on these simple considerations, does your curve resemble that of a cosine or sine wave (Fig. 11–8a or 11–9)?

33. A small fly of mass 0.25 g is caught in a spider's web. The web vibrates predominately with a frequency of 4.0 Hz. (*a*) What is the value of the effective spring stiffness constant *k* for the web? (*b*) At what frequency would you expect the web to vibrate if an insect of mass 0.50 g were trapped?

34. A mass *m* at the end of a spring vibrates with a frequency of 0.88 Hz. When an additional 680-g mass is added to *m*, the frequency is 0.60 Hz. What is the value of *m*?

35. A 0.60-kg mass at the end of a spring vibrates 3.0 times per second with an amplitude of 0.13 m. Determine (*a*) the velocity when it passes the equilibrium point, (*b*) the velocity when it is 0.10 m from equilibrium, (*c*) the total energy of the system, and (*d*) the equation describing the motion of the mass, assuming that *x* was a maximum at $t = 0.$

36. At what displacement from equilibrium is the speed of a SHO half the maximum value?

37. A mass attached to the end of a spring is stretched a distance x_0 from equilibrium and released. At what distance from equilibrium will it have acceleration equal to half its maximum acceleration?

38. A mass of 2.62 kg stretches a vertical spring 0.315 m. If the spring is stretched an additional 0.130 m and released, how long does it take to reach the (new) equilibrium position again?

39. An object with mass 3.0 kg is attached to a spring with spring stiffness constant $k = 280\ \text{N/m}$ and is executing simple harmonic motion. When the object is 0.020 m from its equilibrium position, it is moving with a speed of $0.55\ \text{m/s}$. (*a*) Calculate the amplitude of the motion. (*b*) Calculate the maximum velocity attained by the object. [*Hint*: Use conservation of energy.]

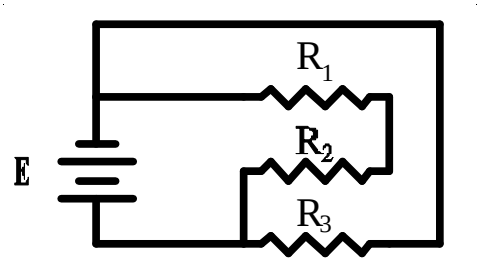
40. It takes a force of 80.0 N to compress the spring of a toy popgun 0.200 m to "load" a 0.180-kg ball. With what speed will the ball leave the gun?

41. A mass sitting on a horizontal, frictionless surface is attached to one end of a spring; the other end is fixed to a wall. 3.0 J of work is required to compress the spring by 0.12 m. If the mass is released from rest with the spring compressed, the mass experiences a maximum acceleration of $15\ \text{m/s}^2$. Find the value of (*a*) the spring stiffness constant and (*b*) the mass.

Simple and Complex Resistance Circuits

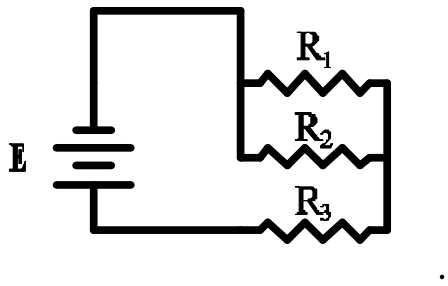
42. Fill in the chart for the circuit shown.

	V (v)	I (A)	R (Ω)	P (w)
1			18	
2			30	
3			96	
T	480			



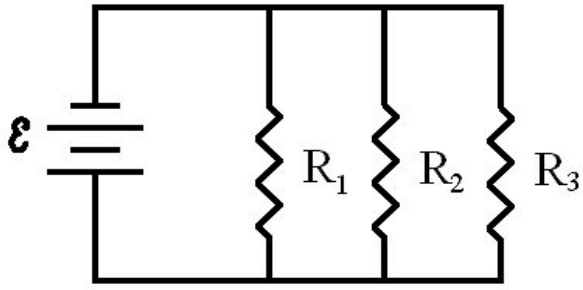
43. Fill in the chart for the circuit shown.

	V (v)	I (A)	R (Ω)	P (w)
1			120	
2			40	
3			60	
T	240			



44. Fill in the chart:

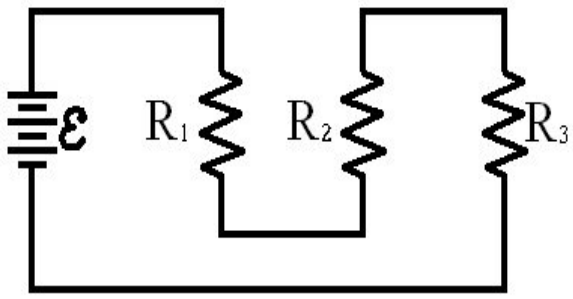
	V (v)	I (A)	R (Ω)	P (w)
1			1000	
2			2000	
3			4700	
T	270			



Use decimal values. No fractions or constants!

45. Fill in the chart:

	V (v)	I (A)	R (Ω)	P (w)
1			450	
2			800	
3			250	
T	300			



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SHM

46. A 4.00 kg mass is hung from a spring whose constant is 145 N/m. When the system undergoes simple harmonic motion, what is the period of vibration? If the mass is replaced by one whose mass is 1.00 kg, what will the period become?

47. A 1.25 kg mass is hung from a spring and is observed to undergo 25.0 vibrations in exactly 21.0 s. What is the spring constant?

48. A 1250 kg car has a suspension whose overall spring constant is 3160 N/m. Without shock absorbers, what would be the period of oscillation whenever the car hits a bump?

49. If a particle undergoes SHM with amplitude 0.18 m, what is the total distance it travels in one period?

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55. A small fly of mass 0.25 g is caught in a spider's web. The web vibrates predominately with a frequency of 4.0 Hz. (*a*) What is the value of the effective spring stiffness constant *k* for the web? (*b*) At what frequency would you expect the web to vibrate if an insect of mass 0.50 g were trapped?

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61. An object with mass 3.0 kg is attached to a spring with spring stiffness constant $k = 280\ \text{N/m}$ and is executing simple harmonic motion. When the object is 0.020 m from its equilibrium position, it is moving with a speed of $0.55\ \text{m/s}.$ (*a*) Calculate the amplitude of the motion. (*b*) Calculate the maximum velocity attained by the object. [*Hint*: Use conservation of energy.]

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63. A mass sitting on a horizontal, frictionless surface is attached to one end of a spring; the other end is fixed to a wall. 3.0 J of work is required to compress the spring by 0.12 m. If the mass is released from rest with the spring compressed, the mass experiences a maximum acceleration of $15\ \text{m/s}^2$. Find the value of (*a*) the spring stiffness constant and (*b*) the mass.

64. A 0.60-kg mass vibrates according to the equation $x = 0.45\cos 6.40t,$ where *x* is in meters and *t* is in seconds. Determine (*a*) the amplitude, (*b*) the frequency, (*c*) the total energy, and (*d*) the kinetic energy and potential energies when $x = 0.30\ \text{m}.$

65. At what displacement from equilibrium is the energy of a SHO half KE and half PE?

66. If one vibration has 7.0 times the energy of a second, but their frequencies and masses are the same, what is the ratio of their amplitudes?

67. A 2.00-kg pumpkin oscillates from a vertically hanging light spring once every 0.65 s. (*a*) Write down the equation giving the pumpkin's position y $(+\text{upward})$ as a function of time t, assuming it started by being compressed 18 cm from the equilibrium position (where $y = 0$), and released. (*b*) How long will it take to get to the equilibrium position for the first time? (*c*) What will be the pumpkin's maximum speed? (*d*) What will be its maximum acceleration, and where will that first be attained?

68. A block of mass m is supported by two identical parallel vertical springs, each with spring stiffness constant k (Fig. 11–49). What will be the frequency of vibration?

69. A 300-g mass vibrates according to the equation $x = 0.38 \sin 6.50t$, where x is in meters and t is in seconds. Determine (*a*) the amplitude, (*b*) the frequency, (*c*) the period, (*d*) the total energy, and (*e*) the KE and PE when x is 9.0 cm. (*f*) Draw a careful graph of x vs. t showing the correct amplitude and period.

70. Figure 11–50 shows two examples of SHM, labeled A and B. For each, what is (*a*) the amplitude, (*b*) the frequency, and (*c*) the period? (*d*) Write the equations for both A and B in the form of a sine or cosine.

71. At $t = 0$, a 755-g mass at rest on the end of a horizontal spring $(k = 124\ \text{N/m})$ is struck by a hammer, which gives the mass an initial speed of $2.96\ \text{m/s}$. Determine (*a*) the period and frequency of the motion, (*b*) the amplitude, (*c*) the maximum acceleration, (*d*) the position as a function of time, and (*e*) the total energy.

72. A vertical spring with spring stiffness constant $305\ \text{N/m}$ vibrates with an amplitude of 28.0 cm when 0.260 kg hangs from it. The mass passes through the equilibrium point $(x = 0)$ with positive velocity at $t = 0$. (*a*) What equation describes this motion as a function of time? (*b*) At what times will the spring have its maximum and minimum extensions?

73. A 25.0-g bullet strikes a 0.600-kg block attached to a fixed horizontal spring whose spring stiffness constant is $7.70 \times 10^3\ \text{N/m}$. The block is set into vibration with an amplitude of 21.5 cm. What was the speed of the bullet before impact if the bullet and block move together after impact?

74. A bungee jumper with mass 65.0 kg jumps from a high bridge. After reaching his lowest point, he oscillates up and down, hitting a low point eight more times in 38.0 s. He finally comes to rest 25.0 m below the level of the bridge. Calculate the spring stiffness constant and the unstretched length of the bungee cord.

Electromagnetism

75. Two parallel straight wires are 1.50 m apart. Each wire carries 2.00 A of current in the same direction. What is the resultant magnetic induction produced by both wires at a point midway between them? What is the magnetic induction at a point 0.250 m from one of the wires?

76. Two parallel straight wires are 1.70 m apart. The wires each carry 2.00 A of current but in opposite directions. What is the resultant magnetic induction produced by both wires at a point midway between them? What is the magnetic induction at a point 0.450 m from one of the wires?

77. Two parallel straight wires are 2.00 m apart. One carries a current of 1.50 A and the other a current of 3.50 A. If the two currents are in the same direction, how far from the first wire (1.50 A) is the point where the magnetic induction is zero?

78. What current flowing in a circular loop of radius 1.25 m will produce a magnetic induction of 6.25 Wb/m^2 at the loop's center?

79. What is the magnetic induction at the center of a circular loop of wire carrying a current of 2.45 A and having a radius of 0.160 m? What induction would result if the radius of the loop were doubled and the current was maintained at 2.45 A?

80. At what distance from a wire carrying 15.0 A of current is the magnetic induction equal to 5.00×10^5 Wb/m^2?

81. What current is required to produce a flux density of 2.50×10^{-5} Wb/m^2 at a distance of 0.125 m from the wire?

82. What is the magnetic induction at a point 3.00 m from a wire carrying a current of 1.25 A?

83. A wire 1.00 m long carrying a current of 12.0 A is at right angles to a magnetic field of 0.250 Wb/m^2. What is the magnitude of the force exerted on the wire by the magnetic field?

84. A current-bearing wire 25.0 cm long is at right angles to a magnetic field of 0.100 Wb/m^2 and experiences a force of 0.455 N. What is the current in the wire?

85. A horizontal length of wire 1.25 m long weighs 0.455 N. When placed at right angles to a magnetic field and a current of 15.0 A is passed through it, the magnetic field exerts and upward force on the wire that just supports its weight. What must be the strength of the magnetic field?

86. A current of 15.0 A is passed through a horizontal wire 40.0 m long at a place where the downward component of the earth's magnetic field is 5.50×10^{-5} Wb/m^2. What force will be exerted on the wire by this component of the Earth's magnetic field?

87. Each of two long parallel conductors carries a current of 4.75 A. The currents are in the same direction. What force per meter do the conductors exert upon each other when the distance between them is 0.0250 m? Do the conductors attract or repel each other?

88. A beam of electrons moving at 2.0×10^8 m/s is at right angles to a uniform magnetic field of 4.25 Wb/m^2. What force acts on each electron in the beam? What is the radius of the circle produced by this force?

89. A proton moves at right angles to a magnetic field of 1.75 Wb/m^2 in a circular path of radius 0.455 m. What is the speed of the proton?

Spherical Mirrors and Lenses

90. A spherical, convex mirror has an object in front of it at a distance *f*/2 from the mirror. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

91. A spherical, concave mirror has an object in front of it at a distance of *f*/2 from the mirror. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

92. A spherical, concave mirror has an object in front of it at a distance of 2*f* from the mirror. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

93. A spherical, concave lens has an object in front of it at a distance of 2*f* from the lens. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

94. A spherical, convex lens has an object in front of it at a distance of 2*f* from the lens. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

95. A spherical, convex lens has an object in front of it at a distance of 3*f* from the lens. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.

96. A spherical, convex lens has an object in front of it at a distance of *f*/2 from the lens. Describe the image (real/virtual, up side down/right side up, Magnification.) Calculate the location of the image and the magnification. Draw a ray diagram that describes the image.