INSTRUCTIONS:

This exam contains **20 multiple-choice questions plus 1 extra credit question**, each worth **3 points**. Choose one answer only for each question. Choose the best answer to each question. Answer all questions.

**Allowed material:** Before turning over this page, put away all materials except for pens, pencils, erasers, rulers and your calculator. There is a formula sheet attached at the end of the exam. **Other copies of the formula sheet are not allowed.**

**Calculator:** In general, any calculator, including calculators that perform graphing, is permitted. Electronic devices that can store large amounts of text, data or equations (like laptops, e-book readers, smart phones) are NOT permitted. Devices (including calculators and smart watches) with WiFi technology are NOT permitted. If you are unsure if your calculator is allowed for the exam, ask your TA.

**How to fill in the bubble sheet:**

- Use a number 2 pencil. Do NOT use ink. If you did not bring a pencil, ask for one.
- You will continue to use the same bubble sheet you already used for Exam 1.
- **Bubble answers 43-63 on the bubble sheet for this exam.**

Only, if for some reason you are starting a new bubble sheet, write and fill in the bubbles corresponding to:

- Your last name, middle initial, and first name.
- ★★ **Your ID number (the middle 9 digits on your ISU card)** ★★
- Special codes K to L are your recitation section. Always use two digits (e.g. 01, 09, 11, 13).

Please turn over your bubble sheet when you are not writing on it.

If you need to change any entry, you must completely erase your previous entry. Also, circle your answers on this exam. Before handing in your exam, be sure that your answers on your bubble sheet are what you intend them to be. You may also copy down your answers on a piece of paper to take with you and compare with the posted answers. You may use the table at the end of the exam for this.

When you are finished with the exam, place all exam materials, including the bubble sheet, and the exam itself, in your folder and return the folder to your recitation instructor.

No cell phone calls allowed. Either turn off your cell phone or leave it at home. Anyone answering a cell phone must hand in their work; their exam is over.

**Best of luck,**

*Dr. Soeren Prell*
43. A piece of metal rests in a toy wood boat floating in water in a bathtub. If the metal is removed from the boat, and kept out of the water, what happens to the water level in the tub?

A) It does not change.
B) It goes up.
C) It goes down.
D) It is impossible to determine without knowing the density of the metal.
E) It is impossible to determine without knowing the weight of the metal.

44. A container consists of two vertical cylindrical columns of different diameter connected by a horizontal section. The open faces of the two columns are closed by very light plates that can move up and down without friction. The tube diameter at A is 35.0 cm and at B it is 10.2 cm. This container is filled with oil of density 0.820 g/cm³. If a 125 kg object is placed on the larger plate at A, how much mass should be placed on the smaller plate at B to balance it?

A) 10.6 kg
B) 1470 kg
C) 125 kg
D) 64.9 kg
E) 342 kg

45. A wood block floats in water with ¾ of its volume above the surface of the water. What is the ratio of the density of the wood block to that of water?

A) 1/4
B) 1/3
C) 4/3
D) 3/4
E) 1/2
46. Water flows through a 0.25-cm radius pipe connected to a 0.5-cm radius pipe. Compared to the speed of the water $v$ in the 0.25-cm radius pipe, the speed in the 0.5-cm radius pipe is:

A) $1/4 \, v$
B) $1/2 \, v$
C) $v$
D) $2 \, v$
E) $4 \, v$

47. A pressurized cylindrical tank, 5.0 m in diameter, contains water that emerges from the pipe at point C with a speed of 13 m/s as shown in the figure. Point A is 10 m above point B and point C is 3.0 m above point B. The area of the pipe at point B is 0.080 m$^2$ and the pipe narrows to an area of 0.040 m$^2$ at point C. Assume that the water is an ideal fluid. The density of water is 1000 kg/m$^3$. The mass flow rate in the pipe is closest to

A) 310 kg/s
B) 360 kg/s
C) 420 kg/s
D) 520 kg/s
E) 470 kg/s

48. A mass on a spring undergoes Simple Harmonic Motion. When the mass passes through the equilibrium position, which of the following statements about it are true?

A) Its speed is zero.
B) Its acceleration is maximum.
C) Its total mechanical energy is zero.
D) Its elastic potential energy is maximum.
E) Its kinetic energy is a maximum.
49. Air is being blown from the left through a horizontal pipe with varying diameter and open right end. At locations with maximum diameter and minimum diameter small holes are drilled into the top of the pipe and Ping-Pong balls are put into the upward airflow. Which picture shows qualitatively the correct height of the Ping-Pong balls?

A) 

B) 

C) 

D) 

E) 

50. Consider two simple pendulums, A and B. Pendulum B is nine times as long as pendulum A. Pendulum B is also four times as heavy as pendulum A. The period of pendulum A is $T_A$. What is the period of pendulum B?

A) $3 \ T_A$
B) $9 \ T_A$
C) $3/2 \ T_A$
D) $1/2 \ T_A$
E) $9/4 \ T_A$
51. A mass on a spring undergoes Simple Harmonic Motion. Shown in the figure is the potential elastic energy of the spring \((U)\) and the kinetic energy of the mass \((K)\) versus time. What is the period of this oscillation?

A) 0.5 s  
B) 1.0 s  
C) 2.0 s  
D) 3.0 s  
E) 4.0 s

52. A fisherman fishing from a pier observes that the float on his line bobs up and down, taking 2.4 s to move from its highest point to its lowest point. He also estimates that the distance between adjacent wave crests is 48 m. What is the speed of the waves going past the pier?

A) 20 m/s  
B) 4.8 m/s  
C) 1.0 m/s  
D) 10 m/s  
E) 120 m/s

53. A wire that is 1.0 m long with a mass of 0.090 kg is under a tension of 710 N. When a transverse wave travels on the wire, its wavelength is 0.10 m and its amplitude is 6.5 mm. What is the frequency of this wave?

A) 1200 Hz  
B) 1000 Hz  
C) 920 Hz  
D) 1500 Hz  
E) 890 Hz
54. A 10 cm long tube has one open end and one closed end. Blowing over the open end produces a sound with the fundamental wavelength of

A) 2.5 cm  
B) 5.0 cm  
C) 10 cm  
D) 20 cm  
E) 40 cm

55. A sound of 40 decibels is

A) 10 times as intense as a sound of 20 decibels  
B) 1000 times as intense as a sound of 20 decibels  
C) four times as intense as a sound of 20 decibels  
D) twice as intense as a sound of 20 decibels  
E) 100 times as intense as a sound of 20 decibels.

56. A whistle produces a sound of frequency of 1.00 kHz. If a listener moves with a speed of 30 m/s away from the whistle, what frequency does this person hear if the sound speed is 340 m/s?

A) 912 Hz  
B) 919 Hz  
C) 1000 Hz  
D) 1088 Hz  
E) 1097 Hz
57. Two speakers emit a sound of the same frequency. In the picture, the condensations [C] and rarefactions [R] of the sound waves are indicated. At which points (1 – 6) do the sound waves interfere destructively?

A) 1 and 3  
B) 4 and 5  
C) 2 and 6  
D) 1, 2 and 3  
E) Only 6

58. At their closest approach, Venus and Earth are $4.20 \times 10^{10}$ m apart. The mass of Venus is $4.87 \times 10^{24}$ kg and the mass of Earth is $5.97 \times 10^{24}$ kg. What is the magnitude of the gravitational force exerted by Venus on Earth at that point?

A) $6.30 \times 10^{20}$ N  
B) $5.43 \times 10^{26}$ N  
C) $4.62 \times 10^{28}$ N  
D) $1.10 \times 10^{18}$ N  
E) $1.72 \times 10^{19}$ N

59. The captain of a spaceship orbiting planet X discovers that to remain in orbit at 410 km from the planet's center, she needs to maintain a speed of 68 m/s. What is the mass of planet X?

A) $2.8 \times 10^{16}$ kg  
B) $2.8 \times 10^{19}$ kg  
C) $4.2 \times 10^{17}$ kg  
D) $4.2 \times 10^{14}$ kg  
E) $6.7 \times 10^{18}$ kg
60. Neptune orbits the Sun at a distance of 2.795 billion miles. The gravitational force by the Sun on Neptune is F. The force by Neptune on the Sun is …

A) smaller than F, because Neptune is so far away from the Sun.
B) smaller than F, because Neptune is much lighter than the Sun.
C) equal to F.
D) larger than F, because Neptune is moving around the Sun.
E) larger than F, because of the presence of the other planets.

61. Two hoops, hoop A and hoop B, roll down a high incline. Hoop A has radius $R$ and mass $M$ and hoop B has radius $2R$ and mass $8M$. They start together from rest at the top of the incline. Hoop A reaches speed $v$ at the bottom of the incline. The speed of hoop B at the bottom of the incline is

A) $2v$
B) $v$
C) $\sqrt{2}v$
D) $0.5v$
E) $\sqrt{3}v$

62. A solid uniform cylinder is rolling without slipping. What fraction of its kinetic energy is rotational?

A) $\frac{3}{4}$
B) $\frac{1}{2}$
C) $\frac{1}{4}$
D) $\frac{2}{3}$
E) $\frac{1}{3}$
63. A 24.5-kg child is standing on the outer edge of a horizontal merry-go-round that has a moment of inertia of 989 kg m^2 about a vertical axis through its center and a radius of 2.40 m. The entire system (including the child) is initially rotating with an angular velocity of 0.180 rad/s. Find the angular velocity if the child moves to a new position 1.10 m from the center of the merry-go-round.

A) 0.20 rad/s  
B) 0.86 rad/s  
C) 3.1 rad/s  
D) 8.2 rad/s  
E) 11 rad/s
Physics 111 Exam 3 - KEY

43  53  63
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45  55
46  56
47  57
48  58
49  59
50  60
51  61
52  62