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 22-42 on the bubble sheet for this exam.

If you did not take the first exam, 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
22. In the figure, a 10-lb weight is suspended from two spring scales, each of which has negligible weight. Which one of the following statements about the readings in the scales is true?

A) Each scale will show a reading between one and 10 lb, such that the sum of the two is 10 lb. However, exact readings cannot be determined without more information.
B) The top scale will read zero, the lower scale will read 10 lb.
C) Each scale will read 5 lb.
D) The lower scale will read zero, the top scale will read 10 lb.
E) None of these is true.

23. A person who normally weighs 700 N is riding in an elevator that is moving upward but slowing down at a steady rate. If this person is standing on a bathroom scale inside the elevator, what would the scale read?

A) 700 N
B) More than 700 N
C) Less than 700 N
D) Between 350 N and 700 N.
E) Not enough information given to answer the question.
24. Two blocks, A and B, are being pulled to the right along a horizontal surface by a horizontal 100-N pull, as shown in the figure. Both of them are moving together at a constant velocity of 2.0 m/s to the right, and both weigh the same. Which of the figures below shows a correct free-body diagram of the horizontal forces acting on the lower block, B?

A) ![Diagram A](image1)
B) ![Diagram B](image2)
C) ![Diagram C](image3)
D) ![Diagram D](image4)
E) None of these diagrams is correct.

25. The coefficients of static and kinetic friction between a 3.0-kg box and a horizontal desktop are 0.40 and 0.30, respectively. What is the force of friction on the box when a 15-N horizontal push is applied to the box?

A) 6.0 N  
B) 4.5 N  
C) 8.8 N  
D) 12 N  
E) 15 N
26. The figure shows a 100-kg block being released from rest from a height of 1.0 m. It then takes 0.53 s for it to reach the floor. What is the mass \( m \) of the block on the left? There is no friction or mass in the pulley, and the connecting rope is very light.

A) 14 kg  
B) 16 kg  
C) 11 kg  
D) 13 kg  
E) 7.0 kg

27. The graphs shown show the magnitude \( F \) of the force exerted by a spring as a function of the distance \( x \) the spring has been compressed. For which one of the graphs does the spring obey Hooke's law?

A) Graph a)  
B) Graph b)  
C) Graph c)  
D) Graph d)  
E) Graph e)
28. Two astronauts, of masses 60 kg and 80 kg, are initially right next to each other and at rest in outer space. They suddenly push each other apart. What is their separation after the heavier astronaut has moved 12 m?

A) 28 m  
B) 45 m  
C) 24 m  
D) 16 m  
E) 21 m

29. The total momentum of an isolated system is conserved

A) if only conservative forces do work.  
B) if only non-conservative forces do work.  
C) if only internal forces act on the system.  
D) if only external forces act on the system.  
E) only if no forces act on the system.

30. A 2.0-kg ball is moving with a constant speed of 5.0 m/s in a horizontal circle whose diameter is 1.0 m. What is the magnitude of the net force on the ball?

A) 20 N  
B) 0 N  
C) 100 N  
D) 40 N  
E) 50 N
31. The curved section of a horizontal highway is a circular unbanked arc of radius 740 m. If the coefficient of static friction between this roadway and typical tires is 0.40, what would be the maximum driving speed for a 850-kg car to navigate this horizontal curved section of highway?

A) 48 m/s  
B) 46 m/s  
C) 54 m/s  
D) 50 m/s  
E) 52 m/s

32. In the figure, determine the character of the collision. The masses of the blocks, and the velocities before and after, are shown. The collision is

A) elastic.  
B) inelastic, but not completely inelastic.  
C) completely inelastic.  
D) characterized by an increase in kinetic energy.  
E) not possible because momentum is not conserved.

33. A bicycle has wheels that are 60 cm in diameter. What is the angular speed of these wheels when it is moving at 4.0 m/s?

A) 1.2 rad/s²  
B) 4.8 rad/s²  
C) 13 rad/s²  
D) 0.36 rad/s²  
E) 7.6 rad/s²
34. A 12-kg rock falls from a vertical cliff that is 4.0 m tall and experiences no significant air resistance as it falls. At what speed will its gravitational potential energy (relative to the base of the cliff) be equal to its kinetic energy?

A) 6.3 m/s  
B) 13 m/s  
C) 3.1 m/s  
D) 4.4 m/s  
E) 8.9 m/s

35. A small 1.4-N stone slides down a frictionless bowl, starting from rest at the rim. The bowl itself is a hemisphere of radius 75 cm. Just as the stone reaches the bottom of the bowl, how hard is the bowl pushing on it?

A) 1.4 N  
B) 0.7 N  
C) 2.8 N  
D) 5.6 N  
E) 4.2 N

36. An ideal spring stretches by 21.0 cm when a 135-N object is hung from it. If instead you hang a fish from this spring, what is the weight of a fish that would stretch the spring by 31.0 cm?

A) 91 N  
B) 199 N  
C) 145 N  
D) 279 N  
E) 185 N
37. You slam on the brakes of your car in a panic, and skid a certain distance on a straight level road. If you had been traveling twice as fast, what distance would the car have skidded, under the same conditions?

A) It would have skidded half as far.
B) It would have skidded 4 times farther.
C) It would have skidded 1.4 times farther.
D) It would have skidded twice as far.
E) It is impossible to tell from the information given.

38. You and your friend, who weighs the same as you, want to go to the top of the Eiffel Tower. Your friend takes the elevator straight up. You decide to walk up the spiral stairway, taking longer to do so. Compare the gravitational potential energy of you and your friend, after you both reach the top.

A) It is impossible to tell, since the times you both took are unknown.
B) Your friend’s gravitational potential energy is greater than yours, because he got to the top faster.
C) Your gravitational potential energy is greater than that of your friend, because you traveled a greater distance in getting to the top.
D) It is impossible to tell, since the distances you both traveled are unknown.
E) Both of you have the same amount of gravitational potential energy at the top.

39. What is the minimum energy needed to change the speed of a 1600-kg sport utility vehicle from 15.0 m/s to 40.0 m/s?

A) 40.0 J
B) 20.0 J
C) 1.10 MJ
D) 10.0 kJ
E) 0.960 MJ
40. A 5-kg ball collides inelastically head-on with a 10-kg ball, which is initially stationary. Which of the following statements is true?

A) The magnitude of the change of velocity the 5-kg ball experiences is greater than that of the 10-kg ball.
B) Both balls lose all their momentum since the collision is inelastic.
C) The magnitude of the change of velocity the 5-kg ball experiences is equal to that of the 10-kg ball.
D) The magnitude of the change of velocity the 5-kg ball experiences is less than that of the 10-kg ball.
E) The total momentum is reversed in the collision.

41. When an object moves in uniform circular motion, the acceleration is

A) directed toward the center of its circular path.
B) in the opposite direction of its velocity vector.
C) directed away from the center of its circular path.
D) zero.
E) in the same direction as its velocity vector.

42. A heavy stone and a light stone are released from rest in such away that they both have the same amount of gravitational potential energy just as they are released. Air resistance is negligibly small. Which of the following statements about these stones are correct?

A) The stones must have been released from the same height.
B) The stones both have the same speed just as they reach the ground.
C) Just as it reaches the ground, the heavy stone is traveling faster than the light stone.
D) The heavy stone has a larger kinetic energy than the light stone just as they reach the ground.
E) The initial height of the light stone is greater than the initial height of the heavy stone.