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.
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
1. Convert a speed of 4.50 km/h to units of ft/min. (3.28 ft = 1 m)

A) 246 ft/min
B) 886 ft/min
C) 165 ft/min
D) 82.3 ft/min
E) 0.246 ft/min

2. The speed of a wave pulse on a string depends only on the tension in the string, $F$, and the mass per unit length of the string, $\mu$. Tension has SI units of $\text{kg m} / \text{s}^2$ and the mass per unit length has SI units of $\text{kg} / \text{m}$. What combination of $F$ and $\mu$ can the speed of the wave be proportional to?

A) $F / \mu$
B) $\sqrt{\mu F}$
C) $\mu / F$
D) $\sqrt{\mu / F}$
E) $\sqrt{F / \mu}$

3. What must be your average speed in order to travel 350 kilometers in 5.15 hours along a straight line?

A) 67.2 km/h
B) 68.0 km/h
C) 69.4 km/h
D) 66.7 km/h
E) 68.8 km/h
4. A cart with an initial velocity of 5.0 m/s to the right experiences a constant acceleration of 2.0 m/s\(^2\) to the right. What is the cart's displacement during the first 6.0 s of this motion?

A) 10 m  
B) 80 m  
C) 66 m  
D) 55 m  
E) 102 m

5. A rock from a volcanic eruption is launched straight up into the air with no appreciable air resistance. Which one of the following statements about this rock while it is in the air is correct?

A) On the way up, its acceleration is downward and its velocity is upward, and at the highest point both its velocity and acceleration are zero.  
B) Throughout the motion, the acceleration is downward, and the velocity is always in the same direction as the acceleration.  
C) On the way down, both its velocity and acceleration are downward, and at the highest point both its velocity and acceleration are zero.  
D) The acceleration is downward at all points in the motion except that is zero at the highest point.  
E) None of the above.

6. If a net force accelerates a 4.5-kg tool at 40 m/s\(^2\), what acceleration would that same net force give to an 18-kg tool?

A) 160 m/s\(^2\)  
B) 32 m/s\(^2\)  
C) 180 m/s\(^2\)  
D) 9.8 m/s\(^2\)  
E) 10 m/s\(^2\)
7. The motion of a particle is described in the velocity vs. time graph shown in the figure.

Over the nine-second interval shown, we can say that the speed of the particle

A) increases and then decreases.
B) only decreases.
C) decreases and then increases.
D) remains constant.
E) only increases.

8. You walk 33 m to the North, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?

A) 75 m
B) 68 m
C) 39 m
D) 35 m
E) 78 m

9. A boat, whose speed in still water is 8.0 m/s, crosses a river with a current of 6.0 m/s. If the boat heads perpendicular to the current, what is the magnitude of the velocity of the boat relative to an observer standing on the shore as it crosses the river?

A) 10.0 m/s
B) 5.3 m/s
C) 6.0 m/s
D) 8.0 m/s
E) 7.4 m/s
10. An athlete competing in the long jump leaves the ground with a speed of 9.14 m/s at an angle of 55° with the horizontal. What is the length of the athlete's jump if air resistance is of no significance?

A) 6.5 m  
B) 7.2 m  
C) 7.8 m  
D) 8.0 m  
E) 8.4 m

11. Alice and Bill each kick a ball off the ground. Alice kicks her ball at an angle of 30° over the horizontal. Bill’s kicks his ball at an angle of 60° over the horizontal. Both balls reach the same maximum height. Ignore air resistance. Which ball has the larger range?

A) Alice’s ball.  
B) Bill’s ball.  
C) Both balls have the same range.  
D) There’s not enough information to answer the question.  
E) It’s not possible that both balls reach the same height, if their launch angles differ.

12. A student adds two displacement vectors that have the magnitudes of 32.0 m and 4.0 m. What is one possible answer for the magnitude of the resultant vector?

A) 24.0 m  
B) 26.3 m  
C) 27.8 m  
D) 28.2 m  
E) None of the above.
13. A small sports car and a large SUV are at a stoplight. The sports car has a mass equal to half that of the SUV, and the SUV can produce a maximum accelerating force equal to twice that of the car. When the light turns green, both drivers push their accelerators to the floor at the same time. The acceleration of the SUV is _____________ the acceleration of the sports car.

A) 2 times larger than
B) 4 times larger than
C) half of
D) a quarter of
E) the same as

14. A person who normally weighs 700 N is riding in a rather swift elevator that is moving at a constant speed of 9.8 m/s. If this person is standing on a bathroom scale inside the elevator, what would the scale read?

A) Always less than 700 N
B) Always more than 700 N
C) 700 N
D) More than 700 N, if the elevator is going down and less than 700 N, if the elevator is going up.
E) Less than 700 N, if the elevator is going down and more than 700 N, if the elevator is going up.

15. Three forces, $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$, act on an object of mass 2.0 kg, as shown in the free-body diagram. The magnitudes of the forces are: $F_1 = 80.0$ N, $F_2 = 60.0$ N, and $F_3 = 40.0$ N. The acceleration of the object has a magnitude of

A) 17.7 m/s²
B) 23.7 m/s²
C) 10.0 m/s²
D) 90.0 m/s²
E) 29.0 m/s²
16. An astronaut weighs 99 N on the Moon, where the acceleration of gravity is 1.62 m/s². How much does she weigh on Earth?

A) 16 N  
B) 99 N  
C) 600 N  
D) 61 N  
E) 440 N

17. Two boxes rest initially on a frictionless surface. A force with magnitude $F$ pushes on box 1 with mass $M_1$ from the left as shown in the picture. Box 1 pushes against box 2, which has a mass $M_2$. As a result, both boxes accelerate to the right with acceleration $a$. The magnitude of the net force on box 1 is ....

A) less than $F$.  
B) greater than $F$.  
C) equal to $F$.  
D) less than $M_1a$.  
E) equal to $(M_1 + M_2) a$.

18. The components of vectors $\mathbf{B}$ and $\mathbf{C}$ are given as follows:

\[ B_x = 9.2 \quad C_x = 4.5 \]
\[ B_y = 6.1 \quad C_y = 4.3 \]

The angle between vectors $\mathbf{B}$ and $\mathbf{C}$ is closest to

A) 10°  
B) 77°  
C) 170°  
D) 103°  
E) 84°
19. Superman holds two ropes. On one rope a tractor is pulling to the left and on the other rope an elephant is pulling to the right. Which of the following force pairs is a Newton’s 3rd law action reaction pair?

A) The force on superman by the left rope and the force on superman by the right rope.
B) The force by the tractor on the left rope and the force of the elephant on the right rope.
C) The force by superman on the right rope and the force by the elephant on the right rope.
D) The force by the tractor on the left rope and the force by the left rope on the tractor.
E) The weight of the tractor and the weight of the elephant.

20. An object slides on a level floor. It slows and comes to a stop with a constant acceleration of magnitude 2.4 m/s². What is the coefficient of kinetic friction between the object and the floor?

A) 0.24
B) 0.48
C) 0.12
D) 0.06
E) It is impossible to determine without knowing the mass of the object.

21. An object is moving with constant non-zero velocity. Which of the following statements about it must be true?

A) The net force on the object is zero.
B) A constant net force is applied to it perpendicular to the direction of motion.
C) A constant net force is applied to it in the direction of motion.
D) A constant net force is applied to it in the direction opposite of motion.
E) Its acceleration is in the same direction as it velocity.
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|13 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|14 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|15 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|16 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|17 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|18 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|19 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|20 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|21 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |