Name (print): ________________________________

(Last) (First)

WSU ID Number (9 digit): ________________________________

Please circle your quiz section:

Monday 11:45 AM (K. Dhindsa)
Tuesday 10:40 AM (J. Huang)
Wednesday 11:45 AM (K. Dhindsa)
Thursday 10:40 AM (J. Huang)

Instructions:

1) Print your name and ID number at the top. Indicate on the scantron sheet which exam you have (A or B) by marking either “A” or “B” in a blank area near the top center of the scantron sheet.

2) Keep the cover of exam CLOSED until the exam has started!

3) Using a pencil, fill out the answer sheet boxes and bubbles with your name and identification number (include leading 0’s in ID number) before starting the exam (you do not need to include date of birth, grade, sex, etc.).

4) You will have 50 minutes to do the exam.

5) The scantron sheet will not be returned. You will get back the exam itself from your quiz instructor. An exam key will be posted on Blackboard/lecture website.

6) You may use a non-graphing calculator. No other electronic devices may be used. Cellphones, PDAs, etc., cannot be used as a calculator.

7) When you are finished with the exam, please bring your student ID, the answer sheet and the exam to the instructor.

8) You are NOT to use notes or books during the exam, or to communicate with another student, or to look at another student’s exam. Any violation can result in a grade of “zero” for this exam or a failing grade for this course.

All questions carry the same weight.
1. A “secret payload” of the first commercial space capsule, Space X Dragon, launched to the low Earth orbit on December 8, 2010, was a 12 kg wheel of Le Brouere cheese. What was the weight of that cheese wheel in orbit? You might find the following information useful: \( G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2 \), the mass of the Earth is \( 5.97 \times 10^{24} \text{ kg} \) and the radius of the Earth is \( 6.37 \times 10^6 \text{ m} \).

A. 118 N  
B. 107 N  
C. 12 kg  
D. 118 kg  
E. 0 N

2. A 5.0-g bullet leaves the muzzle of a rifle with a speed of 320 m/s. What total force (assumed constant) is exerted on the bullet while it is traveling down the 1-m-long barrel of the rifle? Assume that the bullet is travelling with constant acceleration and starts with zero initial velocity.

A. \( 2.56 \times 10^5 \text{ N} \)  
B. 256 N  
C. 1600 N  
D. 16 N  
E. Impossible to determine with provided data

3. A 40 kg box is sliding down a ramp angled at 15° down from the horizontal. The box is accelerating at 1.5 m/s\(^2\) down the ramp. Ignoring air resistance, what is the force of friction between the box and the ramp?

A. 101.5 N  
B. 60.0 N  
C. 161.5 N  
D. 392 N  
E. 41.5 N

4. Two blocks are connected by a lightweight, flexible string over a massless frictionless pulley. If one block has a mass \( m_2 = 15 \text{ kg} \) and the other a mass \( m_1 = 10 \text{ kg} \), find the acceleration of \( m_1 \), the 10 kg mass.

A. 2.0 m/s\(^2\) upwards  
B. 9.8 m/s\(^2\) upwards  
C. 4.9 m/s\(^2\) downwards  
D. 6.5 m/s\(^2\) downwards  
E. 3.3 m/s\(^2\) upwards
5. A space station is moving in a circular orbit around the Earth. It makes one revolution in 90 minutes. How high above the Earth's surface is the space station? The mass of the Earth is \(5.97 \times 10^{24}\) kg and the radius of the Earth is \(6.37 \times 10^6\) m.

A. 1000 km
B. 6370 km
C. 280 km
D. 16300 km
E. 10 km

6. The rotor is an amusement park ride where people stand against the inside of a cylinder. Once the cylinder is spinning fast enough, the floor drops out. The cylinder has a radius of 3.3 m. If the cylinder is to have a frequency of 0.50 Hz, what should be the minimum coefficient of friction, such that the people don’t fall out?

A. \(\mu = 0.2\)
B. \(\mu = 0.1\)
C. \(\mu = 0.4\)
D. \(\mu = 0.3\)
E. \(\mu = 0.5\)

7. A soccer ball of diameter 31 cm rolls without slipping at a linear speed of 2.8 m/s. Through how many complete revolutions has the soccer ball turned as it moves a linear distance of 18 m?

A. 0 revolutions
B. 180 revolutions
C. 18 revolutions
D. 3 revolutions
E. Impossible to determine with provided data

8. A space station is shaped like a ring and rotates to simulate gravity. If the radius of the space station is 120 m, at what frequency must it rotate so that it simulates Earth’s gravity? Hint: the apparent weight of the astronauts on the station must be same as their weight on Earth. Recall that 1 Hz = 1 s\(^{-1}\).

A. 0.045 Hz
B. 120 Hz
C. 1 Hz
D. 1500 Hz
E. None of the above
9. An 8000 kg satellite is launched from the surface of the earth, and injected into a circular orbit at an altitude of 100 km above the surface of the earth. What is the gravitational potential energy of the satellite in the circular orbit? You might find this information useful: \( M_{\text{Earth}} = 5.97 \cdot 10^{24} \text{ kg} \), \( R_{\text{Earth}} = 6.37 \cdot 10^{6} \text{ m} \).

A. \( 5.01 \cdot 10^{11} \text{ J} \)
B. \( 4.92 \cdot 10^{11} \text{ J} \)
C. \( 4.75 \cdot 10^{11} \text{ J} \)
D. \( 4.02 \cdot 10^{11} \text{ J} \)
E. \( 3.85 \cdot 10^{11} \text{ J} \)

10. An ideal spring has a spring constant \( k = 20.0 \text{ N/m} \). What is the amount of work that must be done to stretch the spring 40 cm from its relaxed length?

A. \( 400 \text{ J} \)
B. \( 4 \text{ J} \)
C. \( 1.6 \text{ J} \)
D. \( 800 \text{ J} \)
E. \( -800 \text{ J} \)

11. A large crate is pulled along a horizontal path at a constant speed by a cable that is inclined at an angle of 20° with respect to the horizontal. The tension in the cable is \( 2.4 \times 10^{3} \text{ N} \). The power the cable supplies is \( 1.0 \times 10^{3} \text{ W} \). How far will the crate move in 10 seconds?

A. \( 2.2 \text{ m} \)
B. \( 4.4 \text{ m} \)
C. \( 12 \text{ m} \)
D. \( 4.2 \text{ m} \)
E. \( 0.44 \text{ m} \)

12. A potato sack of mass 20 kg, slides down a frictionless ramp of length 3.0 m inclined at an angle \( \theta \) with respect to the horizontal. If the potato sack starts from rest, and at the edge of the ramp its speed is 5.0 m/s, what is the angle \( \theta \)?

F. \( 22^\circ \)
G. \( 65^\circ \)
H. \( 30^\circ \)
I. \( 25^\circ \)
J. None of the above
13. A 75.0 kg skier slides down a 75.0 m high slope without friction. The velocity of the skier at the bottom of the slope is

A. 38.3 m/s.
B. 29.7 m/s.
C. 20.6 m/s.
D. 40.5 m/s.
E. 50.0 m/s.

14. A constant force is applied for the same duration of time on two objects. The mass of one object is twice as large as the other object. Which of the following is true?

A. Both objects will have the same momentum change, but the object with the larger mass will have the larger velocity change.
B. Both objects will have the same momentum change, but the object with the smaller mass will have the larger velocity change.
C. Both objects will have the same velocity change, but the object with the smaller mass will have the larger momentum change.
D. Both objects will have the same velocity change, but the object with the larger mass will have the larger momentum change.
E. None of the above.

15. A 1700 kg car travels at 20 m/s WEST and collides with a 2000 kg car traveling EAST. The collision is completely inelastic and they both come to rest. What is the velocity of the 2000 kg car?

A. 17 m/s WEST
B. 14 m/s EAST
C. 17 m/s EAST
D. 14 m/s WEST
E. 12 m/s EAST
Possibly useful equations:

Physical Constants
• \( g = 9.80 \frac{m}{s^2} \) (always down!)
• \( G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg} \cdot \text{s}^2 \)

Chapter 1
- Surface area of a sphere: \( S = 4\pi r^2 \) (r is a radius)
- Surface area of a cube: \( S = 6a^2 \) (a is a side)
- Volume of a sphere: \( V = \frac{4}{3} \pi r^3 \)
- Volume of a cube: \( V = a^3 \)
- Quadratic equation: \( ax^2 + bx + c = 0 \); solution: \( x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \)

Chapter 2
- Displacement (change in position): \( \Delta \vec{r} = \vec{r}_f - \vec{r}_i \)
- Average velocity: \( \vec{v}_{av} = \frac{\Delta \vec{r}}{\Delta t} \); average acceleration: \( \vec{a}_{av} = \frac{\Delta \vec{v}}{\Delta t} \)
- Constant acceleration equations:
  \[
  \begin{align*}
  \Delta v_x &= v_{fx} - v_{ix} = a_x \Delta t \\
  \Delta x &= x_f - x_i = \frac{1}{2} (v_{fx} + v_{ix}) \Delta t \\
  \Delta x &= v_{ix} \Delta t + \frac{1}{2} a_x \left( \Delta t \right)^2 \\
  v_{fx}^2 - v_{ix}^2 &= 2a_x \Delta x
  \end{align*}
  \]

Chapter 3
- Two-dimensional motion
  \[
  \sin \theta = \frac{\text{opposite}}{\text{hypotenuse}} \quad \cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} \quad \tan \theta = \frac{\text{opposite}}{\text{adjacent}}
  \]
  Right triangle: \( a^2 + b^2 = c^2 \)

Chapter 4
- Force and Newton’s Laws of Motion
  - Newton’s 2\textsuperscript{nd} Law: \( \vec{a} = \sum \frac{\vec{F}}{m} \) or \( \sum \vec{F} = m\vec{a} \)
  - The magnitude of the gravitational force: \( F = \frac{Gm_1m_2}{r^2} \)
  - Weight: \( W = mg \)
  - Static friction: \( f_s \leq \mu_s N \)
  - Kinetic friction: \( f_k = \mu_k N \)
Chapter 5  
- Circular Motion
  - Angular displacement: $\theta_f - \theta_i$; average angular velocity $\bar{\omega}_{av} = \frac{\Delta \theta}{\Delta t}$
  - $s = r\theta$, 1 complete circle = 1 revolution = $2\pi$ radians; $f = \frac{1}{T}$, $\omega = 2\pi f$
  - To relate linear to angular quantities: $v = r\omega$
  - Acceleration in uniform circular motion: $a_r = \frac{v^2}{r} = \omega^2 r$
    
    $\Delta \omega = \omega_f - \omega_i = \alpha \Delta t$
    $\Delta \theta = \frac{1}{2}(\omega_f + \omega_i) \Delta t$
    $\Delta \theta = \omega_i \Delta t + \frac{1}{2} \alpha \Delta t^2$
    $\omega_f^2 - \omega_i^2 = 2\alpha \Delta \theta$
    $\sum F_r = m a_r = m \frac{v^2}{r}$

Chapter 6  
- Work and Energy
  - Work: $W = F \Delta r \cos \theta$ (If $F$ and $r$ are along the x-axis then $W = F \Delta x$).
  - Translational kinetic energy: $K_{trans} = \frac{1}{2}mv^2$.
  - The Work-Kinetic Energy Theorem: $W_{total} = \Delta K$
  - The gravitational potential energy close to earth: $U_{grav} = mg \gamma$
  - Gravitational potential energy everywhere: $U_{grav} = -\frac{Gm_1 m_2}{r}$
  - The potential energy associated with a spring: $U_{spring} = \frac{1}{2}kx^2$.
  - The force required to pull on a spring: $F_{spring} = -kx$
  - Conservation of energy: $E_{initial} = E_{final}$.
  - Power: $P = \frac{\Delta E}{\Delta t} = Fv \cos \theta$

Chapter 7  
- Momentum, Impulse and Conservation of Momentum
  - Linear momentum: $\vec{p} = m\vec{v}$ (add as vectors)
  - Conservation of momentum: $\sum \vec{p}_{initial} = \sum \vec{p}_{final}$
  - Impulse: $\Delta \vec{p} = \sum \vec{F} \Delta t$

Conversion factors:  
- $1 \text{ m} = 39.37 \text{ inches}; \quad 1 \text{ km} = 1000 \text{ m} = 100,000 \text{ cm}$
- $1 \text{ mi} = 1.609 \text{ km}; \quad 1 \text{ kg} = 2.20 \text{ lb}$