Instructor: Ihas/Biswas

PHYSICS DEPARTMENT

PHY 2053 Final Exam, 120 minutes December 13, 2008

Name (print, last first): ___________________________ Signature: ___________________________

On my honor, I have neither given nor received unauthorized aid on this examination.

DIRECTIONS

(1) Code your test number (THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE) on your answer sheet using lines 76–80. Write your test number down and take it with you. Code your name on your answer sheet. Code your UFID number on your answer sheet.

(2) Print your name on this sheet and sign it also.

(3) You may do scratch work anywhere on this exam. Circle your answers on the test form. At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.

(4) Fill in the circles of your intended answers completely on the answer sheet, using a #2 pencil or blue or black ink. Do not make any stray marks or some answers may be counted as incorrect.

(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.

(6) Hand in the answer sheet separately, showing your UFID.

\[
\begin{align*}
g & = 9.80 \text{ m/s}^2 \\
R_{\text{earth}} & = 6.37 \times 10^6 \text{m} \\
G & = 6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2 \\
\rho_{\text{water}} & = 1000 \text{kg/m}^3 \\
M_{\text{earth}} & = 5.98 \times 10^{24} \text{kg} \\
I_{\text{disk}} & = \frac{1}{2}MR^2 \\
P_{\text{atm}} & = 1.013 \times 10^5 \text{Pa}
\end{align*}
\]

All ropes, strings, and cables are massless.

1. A person takes a trip, driving with a constant speed of 99.5 km/h except for a 21.0 min rest stop. If the person’s average speed is 61.3 km/h, how far does the person travel?

   (1) 55.9 km   (2) 119 km   (3) 90.3 km   (4) 45.2 km   (5) 181 km

2. A person takes a trip, driving with a constant speed of 94.0 km/h except for a 20.0 min rest stop. If the person’s average speed is 74.4 km/h, how far does the person travel?

   (1) 119 km   (2) 55.9 km   (3) 90.3 km   (4) 45.2 km   (5) 181 km

3. A person takes a trip, driving with a constant speed of 93.0 km/h except for a 22.0 min rest stop. If the person’s average speed is 67.5 km/h, how far does the person travel?

   (1) 90.3 km   (2) 55.9 km   (3) 119 km   (4) 45.2 km   (5) 181 km

4. A brick is thrown upward from the top of a building at an angle of 30° to the horizontal and with an initial speed of 16 m/s. If the brick is in flight for 2.7 s before it drops to the bottom of the building, how tall is the building?

   (1) 14.1 m   (2) 26.4 m   (3) 39.7 m   (4) 10.0 m   (5) 52.8 m

5. A brick is thrown upward from the top of a building at an angle of 15° to the horizontal and with an initial speed of 10 m/s. If the brick is in flight for 2.6 s before it drops to the bottom of the building, how tall is the building?

   (1) 26.4 m   (2) 14.1 m   (3) 39.7 m   (4) 10.0 m   (5) 52.8 m

6. A brick is thrown upward from the top of a building at an angle of 15° to the horizontal and with an initial speed of 16 m/s. If the brick is in flight for 3.3 s before it drops to the bottom of the building, how tall is the building?

   (1) 39.7 m   (2) 26.4 m   (3) 14.1 m   (4) 10.0 m   (5) 52.8 m
7. Find the tension in the left wire that supports the 90.0 N weight \( w \) when \( \theta \) is 39\(^\circ\) in the figure.

(1) 71.5 N  (2) 99.7 N  (3) 59.8 N  (4) 30.0 N  (5) 160 N

8. Find the tension in the left wire that supports the 120 N weight \( w \) when \( \theta \) is 37\(^\circ\) in the figure.

(1) 99.7 N  (2) 71.5 N  (3) 59.8 N  (4) 30.0 N  (5) 160 N

9. Find the tension in the left wire that supports the 80.0 N weight \( w \) when \( \theta \) is 42\(^\circ\) in the figure.

(1) 59.8 N  (2) 99.7 N  (3) 71.5 N  (4) 30.0 N  (5) 160 N

10. Two packing crates of masses \( m_1 = 10.0 \) kg and \( m_2 = 6.50 \) kg are connected by a string that passes over a frictionless pulley as shown in the figure. The 6.50 kg crate lies on a smooth incline of angle \( \theta = 39.0^\circ \). Find the acceleration of the 6.50 kg crate.

(1) 3.51 m/s\(^2\) (up the incline)  
(2) 5.00 m/s\(^2\) (up the incline)  
(3) 2.84 m/s\(^2\) (up the incline)  
(4) 1.42 m/s\(^2\) (up the incline)  
(5) 7.02 m/s\(^2\) (up the incline)

11. Two packing crates of masses \( m_1 = 10.0 \) kg and \( m_2 = 4.00 \) kg are connected by a string that passes over a frictionless pulley as shown in the figure. The 4.00 kg crate lies on a smooth incline of angle \( \theta = 43.0^\circ \). Find the acceleration of the 4.00 kg crate.

(1) 5.09 m/s\(^2\) (up the incline)  
(2) 3.51 m/s\(^2\) (up the incline)  
(3) 2.84 m/s\(^2\) (up the incline)  
(4) 1.42 m/s\(^2\) (up the incline)  
(5) 7.02 m/s\(^2\) (up the incline)
12. Two packing crates of masses $m_1 = 10.0 \text{ kg}$ and $m_2 = 7.50 \text{ kg}$ are connected by a string that passes over a frictionless pulley as shown in the figure. The 7.50 kg crate lies on a smooth incline of angle $\theta = 41.0^\circ$. Find the acceleration of the 7.50 kg crate.

(1) 2.84 m/s$^2$ (up the incline)
(2) 5.09 m/s$^2$ (up the incline)
(3) 3.51 m/s$^2$ (up the incline)
(4) 1.42 m/s$^2$ (up the incline)
(5) 7.02 m/s$^2$ (up the incline)

13. A 7.00 g bullet is fired into a 1.50 kg ballistic pendulum. The bullet emerges from the block with a speed of 200 m/s, and the block rises to a maximum height of 9.00 cm. Find the initial speed of the bullet.

(1) 485 m/s (2) 504 m/s (3) 542 m/s (4) 271 m/s (5) 1000 m/s

14. A 7.00 g bullet is fired into a 1.50 kg ballistic pendulum. The bullet emerges from the block with a speed of 200 m/s, and the block rises to a maximum height of 10.3 cm. Find the initial speed of the bullet.

(1) 504 m/s (2) 485 m/s (3) 542 m/s (4) 271 m/s (5) 1000 m/s

15. A 7.00 g bullet is fired into a 1.50 kg ballistic pendulum. The bullet emerges from the block with a speed of 200 m/s, and the block rises to a maximum height of 13.0 cm. Find the initial speed of the bullet.

(1) 542 m/s (2) 504 m/s (3) 485 m/s (4) 271 m/s (5) 1000 m/s

16. A certain light truck can go around a flat curve having a radius of 150 m with a maximum speed of 27.0 m/s. With what maximum speed can it go around a curve having a radius of 76.5 m? (Assume the same coefficient of friction for both curves.)

(1) 19.3 m/s (2) 24.0 m/s (3) 27.8 m/s (4) 13.9 m/s (5) 38.6 m/s

17. A certain light truck can go around a flat curve having a radius of 150 m with a maximum speed of 35.5 m/s. With what maximum speed can it go around a curve having a radius of 68.5 m? (Assume the same coefficient of friction for both curves.)

(1) 24.0 m/s (2) 19.3 m/s (3) 27.8 m/s (4) 13.9 m/s (5) 38.6 m/s

18. A certain light truck can go around a flat curve having a radius of 150 m with a maximum speed of 36.5 m/s. With what maximum speed can it go around a curve having a radius of 87.0 m? (Assume the same coefficient of friction for both curves.)

(1) 27.8 m/s (2) 24.0 m/s (3) 19.3 m/s (4) 13.9 m/s (5) 38.6 m/s

19. A thin spherical shell of mass 0.350 kg and diameter 0.240 m is filled with alcohol ($\rho = 806 \text{ kg/m}^3$). It is then released from rest at the bottom of a pool of water. Find the acceleration of the alcohol filled shell as it rises toward the surface of the water.

(1) 1.67 m/s$^2$ (2) 0.659 m/s$^2$ (3) 0.311 m/s$^2$ (4) 0.150 m/s$^2$ (5) 1.92 m/s$^2$
20. A thin spherical shell of mass 0.400 kg and diameter 0.180 m is filled with alcohol (\(\rho = 806 \text{ kg/m}^3\)). It is then released from rest at the bottom of a pool of water. Find the acceleration of the alcohol filled shell as it rises toward the surface of the water.

\[
\begin{array}{c}
\text{(1) 0.659 m/s}^2 \\
\text{(2) 1.67 m/s}^2 \\
\text{(3) 0.311 m/s}^2 \\
\text{(4) 0.150 m/s}^2 \\
\text{(5) 1.92 m/s}^2 \\
\end{array}
\]

21. A thin spherical shell of mass 0.350 kg and diameter 0.160 m is filled with alcohol (\(\rho = 806 \text{ kg/m}^3\)). It is then released from rest at the bottom of a pool of water. Find the acceleration of the alcohol filled shell as it rises toward the surface of the water.

\[
\begin{array}{c}
\text{(1) 0.311 m/s}^2 \\
\text{(2) 0.659 m/s}^2 \\
\text{(3) 1.67 m/s}^2 \\
\text{(4) 0.150 m/s}^2 \\
\text{(5) 1.92 m/s}^2 \\
\end{array}
\]

22. The heels on a pair of women’s shoes have radii of 0.48 cm at the bottom. If 32% of the weight of a woman weighing 530 N is supported by each heel, find the stress on each heel.

\[
\begin{array}{c}
\text{(1) } 2.34 \times 10^6 \text{ Pa} \\
\text{(2) } 1.70 \times 10^6 \text{ Pa} \\
\text{(3) } 1.27 \times 10^6 \text{ Pa} \\
\text{(4) } 2.90 \times 10^6 \text{ Pa} \\
\text{(5) } 3.40 \times 10^6 \text{ Pa} \\
\end{array}
\]

23. The heels on a pair of women’s shoes have radii of 0.58 cm at the bottom. If 30% of the weight of a woman weighing 600 N is supported by each heel, find the stress on each heel.

\[
\begin{array}{c}
\text{(1) } 1.70 \times 10^6 \text{ Pa} \\
\text{(2) } 2.34 \times 10^6 \text{ Pa} \\
\text{(3) } 1.27 \times 10^6 \text{ Pa} \\
\text{(4) } 2.90 \times 10^6 \text{ Pa} \\
\text{(5) } 3.40 \times 10^6 \text{ Pa} \\
\end{array}
\]

24. The heels on a pair of women’s shoes have radii of 0.60 cm at the bottom. If 30% of the weight of a woman weighing 480 N is supported by each heel, find the stress on each heel.

\[
\begin{array}{c}
\text{(1) } 1.27 \times 10^6 \text{ Pa} \\
\text{(2) } 1.70 \times 10^6 \text{ Pa} \\
\text{(3) } 2.34 \times 10^6 \text{ Pa} \\
\text{(4) } 2.90 \times 10^6 \text{ Pa} \\
\text{(5) } 3.40 \times 10^6 \text{ Pa} \\
\end{array}
\]

25. For safety in climbing, a mountaineer uses a nylon rope that is 55 m long and 11.0 mm in diameter. When supporting a 94 kg climber, the rope elongates 1.4 m. Find its Young’s modulus.

\[
\begin{array}{c}
\text{(1) } 3.81 \times 10^8 \text{ Pa} \\
\text{(2) } 4.80 \times 10^8 \text{ Pa} \\
\text{(3) } 8.18 \times 10^8 \text{ Pa} \\
\text{(4) } 9.60 \times 10^8 \text{ Pa} \\
\text{(5) } 1.90 \times 10^8 \text{ Pa} \\
\end{array}
\]

26. For safety in climbing, a mountaineer uses a nylon rope that is 55 m long and 10.0 mm in diameter. When supporting a 84 kg climber, the rope elongates 1.2 m. Find its Young’s modulus.

\[
\begin{array}{c}
\text{(1) } 4.80 \times 10^8 \text{ Pa} \\
\text{(2) } 3.81 \times 10^8 \text{ Pa} \\
\text{(3) } 8.18 \times 10^8 \text{ Pa} \\
\text{(4) } 9.60 \times 10^8 \text{ Pa} \\
\text{(5) } 1.90 \times 10^8 \text{ Pa} \\
\end{array}
\]

27. For safety in climbing, a mountaineer uses a nylon rope that is 65 m long and 9.0 mm in diameter. When supporting a 98 kg climber, the rope elongates 1.2 m. Find its Young’s modulus.

\[
\begin{array}{c}
\text{(1) } 8.18 \times 10^8 \text{ Pa} \\
\text{(2) } 4.80 \times 10^8 \text{ Pa} \\
\text{(3) } 3.81 \times 10^8 \text{ Pa} \\
\text{(4) } 9.60 \times 10^8 \text{ Pa} \\
\text{(5) } 1.90 \times 10^8 \text{Pa} \\
\end{array}
\]

28. The pulley in Atwood’s Machine has a moment of inertia of 3.0 kg·m² and a radius of 0.50 m. The cable supporting the masses \(m_1\) and \(m_2\) does not slip, and the axle is frictionless. If \(m_1 = 1.6\) kg and \(m_2 = 4.8\) kg, find the tension in the part of the cable supporting \(m_1\).

\[
\begin{array}{c}
\text{(1) 18.4 N} \\
\text{(2) 21.9 N} \\
\text{(3) 32.4 N} \\
\text{(4) 9.2 N} \\
\text{(5) 43.8 N} \\
\end{array}
\]
29. The pulley in Atwood’s Machine has a moment of inertia of 4.0 kg·m$^2$ and a radius of 0.50 m. The cable supporting the masses $m_1$ and $m_2$ does not slip, and the axle is frictionless. If $m_1 = 1.9$ kg and $m_2 = 6.2$ kg, find the tension in the part of the cable supporting $m_1$.

(1) 21.9 N (2) 18.4 N (3) 32.4 N (4) 9.2 N (5) 43.8 N

30. The pulley in Atwood’s Machine has a moment of inertia of 7.0 kg·m$^2$ and a radius of 0.50 m. The cable supporting the masses $m_1$ and $m_2$ does not slip, and the axle is frictionless. If $m_1 = 3.0$ kg and $m_2 = 6.8$ kg, find the tension in the part of the cable supporting $m_1$.

(1) 32.4 N (2) 21.9 N (3) 18.4 N (4) 9.2 N (5) 43.8 N

31. A particular satellite was placed in a circular orbit about 258 km above the surface of the Earth. Determine the orbital speed of the satellite.

(1) 7,750 m/s (2) 3,880 m/s (3) 1,600 m/s (4) 9,800 m/s (5) 6,370 m/s

32. A container is filled to a depth of 25.0 cm with water. On top of the water floats a 32.0 cm thick layer of oil with density 700 kg/m$^3$. What is the absolute pressure at the bottom of the container?

(1) $1.06 \times 10^5$ Pa (2) $5.00 \times 10^4$ Pa (3) $2.1 \times 10^5$ Pa (4) $4.2 \times 10^5$ Pa (5) $8.05 \times 10^5$ Pa

33. Two cars on a road move toward one another. Car 1 has a speed of 100 km/h, car 2 a speed of 60.0 km/h. Car 2 blows its horn, emitting a frequency of 500 Hz. What is the frequency heard by the driver in car 1? (Assume the speed of sound is 345 m/s.)

(1) 568 Hz (2) 517 Hz (3) 483 Hz (4) 500 Hz (5) 340 Hz

34. If a person can jump a maximum horizontal distance (by using a 45° projection angle) of 2.40 m on Earth, what would be his maximum range on the Moon, where the free-fall acceleration is $g/6$?

(1) 14.4 m (2) 17.3 m (3) 4.80 m (4) 7.20 m (5) 24.4 m

35. A jet of water squirts out horizontally from a hole at the bottom of the tank (see figure). If the hole has a diameter of 3.70 mm, what is the height, $h$, of the water level in the tank? Assume the diameter of the tank is much larger than the hole diameter.

(1) 9.00 cm (2) 30.0 cm (3) 18.0 cm (4) 3.70 cm (5) 60.0 cm

36. The position of a 0.64-kg mass undergoing simple harmonic motion is given by $x = (0.160 m) \cos(\pi t/16)$. What is its period of oscillation?

(1) 32 s (2) 100 s (3) 16 s (4) 8.0 s (5) 64 s
37. Two disks collide by one dropping on the other, as in the figure. Initially, \( I_1 \) is spinning at angular velocity \( \omega_0 \), and \( I_2 \) is not spinning. After the collision, they both spin at the same angular velocity \( \omega \). In this collision, what is conserved?

(1) Only angular momentum
(2) Both angular momentum and rotational kinetic energy
(3) Only rotational kinetic energy
(4) Only linear kinetic energy
(5) No other answer is correct

38. A harmonic wave is traveling along a rope. It is observed that the oscillator that generates the wave completes 38.0 vibrations in 25.0 s. Also, a given maximum travels 428 cm along the rope in 10.0 s. What is the wavelength?

(1) 28.2 cm  (2) 428 cm  (3) 282 cm  (4) 11.3 cm  (5) 60.1 cm

39. A 2000-kg ore car rolls (from rest) 50.0 m down a frictionless 10.0° incline. If there is a horizontal spring at the end of the incline, what spring constant is required to stop the ore car in a distance of 70.0 cm?

(1) \( 6.95 \times 10^5 \) N/m  (2) \( 4.86 \times 10^5 \) N/m  (3) \( 9.80 \times 10^5 \) N/m  (4) \( 1.96 \times 10^6 \) N/m  (5) \( 1.96 \times 10^5 \) N/m

40. A ventilation fan with a moment of inertia of 0.034 kg·m² has a net torque of 0.11 N·m applied to it. If it starts from rest, what kinetic energy will it have 8.0 s later?

(1) 11 J  (2) 17 J  (3) 31 J  (4) 6.6 J  (5) 8.0 J
1 \quad \frac{\Delta x}{\Delta t} = \frac{U_{\text{inst}}}{t_{\text{stop}}}, \quad \frac{\Delta x}{\Delta t + t_{\text{stop}}} = U_{\text{av}}

\Rightarrow \Delta t = \frac{\Delta x}{U_{\text{inst}}}

\Rightarrow \frac{\Delta x}{U_{\text{inst}}} + t_{\text{stop}} = U_{\text{av}}

\Rightarrow \Delta x = \frac{U_{\text{av}} \Delta x + U_{\text{av}} t_{\text{stop}}}{U_{\text{inst}}}

\Rightarrow \Delta x (1 - \frac{U_{\text{av}}}{U_{\text{inst}}}) = U_{\text{av}} t_{\text{stop}}

\Rightarrow \Delta x = \frac{U_{\text{av}} t_{\text{stop}}}{1 - \frac{U_{\text{av}}}{U_{\text{inst}}}}

\text{for:}

U_{\text{av}} = 61.3 \text{ km/h}, \quad t_{\text{stop}} = 21.0 \text{ min}, \quad U_{\text{inst}} = 99.5 \text{ km/h}

\Delta x = 55.9 \text{ km}

U_{\text{av}} = 74.4 \text{ km/h}, \quad t_{\text{stop}} = 20.0 \text{ min}, \quad U_{\text{inst}} = 94.0 \text{ km/h}

\Delta x = 119 \text{ km}

U_{\text{av}} = 67.5 \text{ km/h}, \quad t_{\text{stop}} = 22.0 \text{ min}, \quad U_{\text{inst}} = 93.0 \text{ km/h}

\Delta x = 90.3 \text{ km}

\Delta y = -h, \quad \text{vo}_y = v_0 \sin \theta, \quad a = -9.8 \text{ m/s}^2

-h = v_0 \sin \theta t - 4.9 t^2

\text{for } v_0 = 16 \text{ m/s}, \quad \theta = 30^\circ, \quad t = 2.7 \text{ s}

\Rightarrow h = 14.1 \text{ m}
\[v_0 = 10 \text{ m/s}, \quad \theta = 15^\circ, \quad t = 2.6 \text{ s} \]
\[h = 26.4 \text{ m}\]

\[v_0 = 16 \text{ m/s}, \quad \theta = 15^\circ, \quad t = 3.3 \text{ s} \]
\[h = 39.7 \text{ m}\]

\[2T \sin \theta = \omega^2 \]
\[\Rightarrow T = \frac{\omega^2}{2 \sin \theta}\]

\(\text{If } \omega = 90 \text{ N}, \quad \theta = 39^\circ, \text{ then } T = 71.5 \text{ N}\)

\(\text{If } \omega = 120 \text{ N}, \quad \theta = 37^\circ, \text{ then } T = 99.7 \text{ N}\)

\(\text{If } \omega = 80 \text{ N}, \quad \theta = 42^\circ, \text{ then } T = 59.8 \text{ N}\)
\[ T - m_2 g \sin \theta = m_2 a \]

\[ T - m_1 g = -m_1 a \]

\[ m_1 g - m_2 g \sin \theta = (m_2 + m_1) a \]

\[ a = \frac{m_1 g - m_2 g \sin \theta}{m_2 + m_1} \]

1. If \( m_1 = 10 \text{ kg}, \ m_2 = 6.5 \text{ kg}, \ \theta = 39^\circ \)
   \[ a = 3.51 \text{ m/s}^2 \]

2. If \( m_1 = 10 \text{ kg}, \ m_2 = 4.00 \text{ kg}, \ \theta = 43^\circ \)
   \[ a = 5.09 \text{ m/s}^2 \]

3. If \( m_1 = 10 \text{ kg}, \ m_2 = 7.5 \text{ kg}, \ \theta = 41^\circ \)
   \[ a = 2.34 \text{ m/s}^2 \]
\( \implies m_1u_{1i} + 0 = m_1u_{1f} + m_2u_{2f} \)

\[ \implies 0.007u_i = 0.007 \times 200 + 1.5u_{2f} \]

\[ \implies u_{2f} = \frac{0.007u_i - 1.4}{1.5} \]

\[ \frac{1}{2} m_2 u_{2f}^2 = m_2 gh \]

\[ \implies u_{2f} = \sqrt{2gh} \]

\[ \implies 0.007u_i - 1.4 = \frac{\sqrt{2gh}}{1.5} \]

\[ \implies u_{1i} = \frac{1.5\sqrt{2gh} + 1.4}{0.007} \]

\[ \text{if } h = 9 \text{ cm, } u_{1i} = 4.85 \text{ m/s} \]

\[ \text{if } h = 10.3 \text{ cm, } u_{1i} = 5.04 \text{ m/s} \]

\[ \text{if } h = 13 \text{ cm, } u_{1i} = 5.42 \text{ m/s} \]
\[ F_c = \frac{m u_1^2}{r_1} = \frac{m u_2^2}{r_2} \]

\[ \Rightarrow \frac{u_1^2}{r_1} = \frac{u_2^2}{r_2} \Rightarrow u_2 = \sqrt{\frac{r_2}{r_1}} u_1 \]

\[ r_1 = 150 \text{ m}, \quad r_2 = 76.5 \text{ m}, \quad u_1 = 27 \text{ m/s} \]

\[ u_2 = 19.3 \text{ m/s} \]

\[ r_1 = 150 \text{ m}, \quad r_2 = 68.5 \text{ m}, \quad u_1 = 35.5 \text{ m/s} \]

\[ u_2 = 24.0 \text{ m/s} \]

\[ r_1 = 150 \text{ m}, \quad r_2 = 87.0 \text{ m}, \quad u_1 = 36.5 \text{ m/s} \]

\[ u_2 = 27.3 \text{ m/s} \]

\[ F_B - m_1 g - m_{acg} g = (m_1 + m_{acg}) a \]

\[ \text{Booster} \quad \text{Vacuum} \quad g - (m_1 + m_{acg}) g = (m_1 + m_{acg}) a \]

Submerged \( \Rightarrow \) \( V_{	ext{vacuum}} = V_{\text{shell}} \)

\[ \Rightarrow \text{Booster} \quad \frac{V_{\text{shell}} g - (m_1 + m_{acg} V_{\text{shell}}) g}{(m_1 + m_{acg} V_{\text{shell}})} = a \]

\[ V_{\text{shell}} = \frac{4}{3} \pi \frac{d^3}{3} \]
\[ m_1 = 0.35 \text{ kg}, \ d = 0.24 \text{ m} \]
\[ a = 1.67 \text{ m/s}^2 \]
\[ m_1 = 0.4 \text{ kg}, \ d = 0.18 \text{ m} \]
\[ a = 0.659 \text{ m/s}^2 \]
\[ m_1 = 0.35 \text{ kg}, \ d = 0.16 \text{ m} \]
\[ a = 0.311 \text{ m/s}^2 \]

\[ F = \frac{xW}{100} \]

\[ P = \frac{xW}{100 \pi R^2} \]

- \( x = 32, \ W = 530 \text{ N}, \ R = 0.48 \text{ cm} \)
  \[ P = 2.34 \times 10^6 \text{ Pa} \]
- \( x = 30, \ W = 600 \text{ N}, \ R = 0.58 \text{ cm} \)
  \[ P = 1.70 \times 10^6 \text{ Pa} \]
- \( x = 30, \ W = 480 \text{ N}, \ R = 0.60 \text{ cm} \)
  \[ P = 1.27 \times 10^6 \text{ Pa} \]

\[ y = \frac{F/A}{\Delta L/L} = \frac{mg/(ka^2/4)}{\Delta L/L} \]

- \( m = 94 \text{ kg}, \ d = 11 \text{ mm}, \ \Delta L = 1.4 \text{ m}, \ L = 55 \text{ m} \)
  \[ y = 3.81 \times 10^8 \text{ Pa} \]
- \( m = 84 \text{ kg}, \ d = 10 \text{ mm}, \ \Delta L = 1.2 \text{ m}, \ L = 55 \text{ m} \)
  \[ y = 4.8 \times 10^8 \text{ Pa} \]
- \( m = 98 \text{ kg}, \ d = 9 \text{ mm}, \ \Delta L = 1.2 \text{ m}, \ L = 65 \text{ m} \)
  \[ y = 8.18 \times 10^8 \text{ Pa} \]
\[ T_1 = m_1 (g + a) \]
\[ T_2 = m_2 (g - a) \]
\[ m_1 (g + a) R - m_2 (g - a) R = -\frac{Ia}{R^2} \]
\[ (m_1 + m_2) a + \frac{Ia}{R^2} = (m_2 - m_1) g \]
\[ a = \frac{(m_2 - m_1) g}{(m_1 + m_2 + \frac{I}{R^2})} \]
\[ T_1 = m_1 \left[ g + \frac{(m_2 - m_1) g}{(m_1 + m_2 + \frac{I}{R^2})} \right] \]

For: \( m_1 = 1.6 \text{ kg}, \ m_2 = 4.8 \text{ kg}, \ I = 3 \text{ kg m}^2, \ R = 0.5 \text{ m} \)
\[ T_1 = 18.4 \text{ N} \]

For: \( m_1 = 1.9 \text{ kg}, \ m_2 = 6.2 \text{ kg}, \ I = 4 \text{ kg m}^2, \ R = 0.5 \text{ m} \)
\[ T_1 = 21.9 \text{ N} \]

For: \( m_1 = 3.0 \text{ kg}, \ m_2 = 6.8 \text{ kg}, \ I = 7 \text{ kg m}^2, \ R = 0.5 \text{ m} \)
\[ T_1 = 32.4 \text{ N} \]
\[
\frac{GMv^2}{(RE + r)^2} = \frac{\gamma h u^2}{RE + r} \quad \Rightarrow \quad u = \sqrt{\frac{GM}{RE + r}}
\]

\[r = 258000 \, \text{m} \]
\[RE = 6.37 \times 10^6 \, \text{m} \]
\[ME = 5.98 \times 10^{24} \, \text{kg} \]

\[\Rightarrow \quad 7757 \, \text{m/s} \]

12. \[P = P_{atm} + \rho_0 gh \omega + \rho_{oil} gh_{oil} \]
\[= 1.013 \times 10^5 + 1000 \times 9.8 \times 0.25 \]
\[+ 700 \times 9.8 \times 0.32 \]

\[= 1.06 \times 10^5 \, \text{Pa} \]

13. \[f_0 = f_s \left( \frac{U + U_0}{U - U_0} \right) \]

\[\Rightarrow f_0 = 500 \left( \frac{345 + \frac{100000}{3600}}{345 - \frac{60000}{3600}} \right) \]

\[\Rightarrow f_0 = 568 \, \text{Hz} \]

14. \[\Delta y = 0 \quad \Rightarrow \quad 0 = v_0 y - \frac{1}{2} g t^2 \]
\[\Rightarrow t = \frac{2v_0 \sin \theta}{g} \]
\[\Delta x = R = v_0 \cos \theta t = \frac{2v_0^2 \sin \theta \cos \theta}{g} = \frac{v_0^2 \sin 2\theta}{g} \]
\[R_{max} = \frac{v_0^2}{g} \quad \Rightarrow \text{On the moon} \quad R_{moon} = \frac{v_0^2}{(g/6)} = \frac{6v_0^2}{g} \]
\[= 14.4 \, \text{m} \]
15 \[ P_{km} + 0 + \rho gh = P_{km} + \frac{1}{2} \rho u^2 + 0 \]
\[ \Rightarrow \quad u = \sqrt{2gh} \]
\[ v_{oy} = 0 \quad \Rightarrow \quad -1 = 0 - \frac{1}{2} gt^2 \]
\[ \Rightarrow \quad t = \sqrt{\frac{2}{g}} \]
\[ \Delta x = 0.6 = ut = \sqrt{2gh} \cdot \sqrt{\frac{2}{g}} = 2\sqrt{h} \]
\[ \Rightarrow \quad h = (0.3)^2 = 0.09 = 9 \text{ cm} \]

16 \[ x = A \cos(\omega t) \]
\[ \Rightarrow \quad \omega = \frac{\pi}{16} = 2\pi f \]
\[ \Rightarrow \quad f = \frac{1}{32} \Rightarrow T = \frac{1}{f} \]
\[ \Rightarrow \quad T = 32 \text{ s} \]

18 \[ f = \frac{38}{25}, \quad c = \frac{4.28}{10} \]
\[ c = f \lambda \quad \Rightarrow \quad \lambda = \frac{c}{f} = \frac{0.428}{(38/25)} = 0.282 \text{ m} \]
\[ = 28.2 \text{ cm} \]

19 \[ (PE_i)_g = mgh = 2000 \times 9.8 \times 50 \sin 10^\circ \]
\[ (PE_i)_g = (PE_f)_{\text{spring}} = \frac{1}{2} kx^2 = 170175 \text{ J} \]
\[ x = 0.7 \text{ m} \quad \Rightarrow \quad k = 695 \times 10^3 \text{ N/m} \]
\( z = I \alpha \)

\( \Rightarrow \alpha = \frac{0.11}{0.034} = 3.23 \text{ rad/s}^2 \)

\[ \omega_f = \omega_i + \alpha t \]

\( \Rightarrow \omega_f = 8 \times 3.23 = 25.9 \text{ rad/s} \)

\[ K \varepsilon_f = \frac{1}{2} I \omega_f^2 = 11 \text{ J} \]