PHYS 111 FINAL EXAM NAME_____SECT_____

The exam is closed book and closed notes.

Vectors: $A_x = A\cos\theta$; $A_y = A\sin\theta$; $A = \sqrt{A_x^2 + A_y^2}$ $\theta = \tan^{-1}\frac{A_y}{A_x}$; $\vec{A} = A_x\vec{i} + A_y\vec{j}$ $\vec{A} + \vec{B} = (A_x + B_x)\vec{i} + (A_y + B_y)\vec{j}$

$\vec{A}\cdot\vec{B} = AB\cos\theta = A_xB_x + A_yB_y$ $\vec{A}\times\vec{B} = AB\sin\theta = (A_xB_y - A_yB_x)\vec{k}$ **One-dimen. motion:** $x = v_{avr}t$ $x = \frac{v_i + v_f}{2}t$

$x = v_ot + \frac{1}{2}at^2$ $x_f = x_i + \frac{v_f^2 - v_i^2}{2a}$ $v = v_o + at$; **Free-fall:** $y = v_o t - \frac{1}{2}gt^2$, $v = v_o - gt$,

$y_f = y_i + \frac{v_f^2 - v_i^2}{-2g}$; $y_{max} = \frac{v_i^2}{2g}$ $t_{tot} = \frac{2v_i}{g}$ $r = r_0 + (v_{ox}t + \frac{1}{2}a_x t^2)\hat{i} + (v_{oy}t + \frac{1}{2}a_y t^2)\hat{j}$ $v = (v_{ox} + a_x t)\hat{i} + (v_{oy} + a_y t)\hat{j}$; **Projectile motion:** $x = v_{ox}t$; $y = v_{oy}t - \frac{1}{2}gt^2$; $v_y = v_{oy} - gt$; $v_{ox} = v_o\cos\theta$; $v_{oy} = v_o\sin\theta$;

$y = \frac{v_y^2 - v_{oy}^2}{-2g}$ $t_{tot} = \frac{2v_{0y}^2}{g}$ $R = \frac{v_o^2\sin 2\theta}{g}$; $y = (\tan\theta)\cdot x - \frac{gx^2}{2(v_o\cos\theta)^2}$ $F_{net} = ma$; $F_g = mg$, **incline:** $F_{gx} = mg\sin\theta$, $F_{gy} = mg\cos\theta$, **Friction:** $f_{s,max} = \mu_s N$; $f_k = \mu_k N$; **Circular motion:** $a_c = \frac{v^2}{R}$; **period** $T = \frac{2\pi R}{v}$; $F_{net} = \frac{mv^2}{r}$;

Work: $W = F\cdot d\cdot\cos\theta$ $W_g = mg(y_o - y_f)$ $W_{spr} = \frac{1}{2}k(x_i^2 - x_f^2)$ $W_{tot} = K_f - K_i$ $W_{tot} = F_{net}\cdot d$ $K = \frac{1}{2}mv^2$

$P = \frac{dW}{dt}$ $P_{avg} = \frac{W}{\Delta t}$ $U_g = mgy$ $U_s = \frac{1}{2}kx^2$ $U_{gi} + U_{si} + K_i + W_{fr} = U_{gf} + U_{sf} + K_f$ $\Delta U + \Delta K = W_{nc}$ $p = mv$;

$\vec{F}\Delta\vec{t} = m\vec{v}_f - m\vec{v}_i$ $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$; **perf. inelastic:** $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)V$

Rotational motion: 1 rev $= 2\pi$ rad; $\omega = \omega_0 + \alpha t$; $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$; $\theta = \frac{\omega^2 - \omega_0^2}{2\alpha}$ $s = \theta r$ $v = \omega r$; $a_t = \alpha r$

$\tau = rF\sin\phi$; $\tau_{net} = I\alpha$; **work:** $W = \tau\theta$; $W = \frac{1}{2}I\omega_f^2 - \frac{1}{2}I\omega_i^2$ $P_{avr} = \frac{W}{\Delta t}$ $I_{point\ mass} = mr^2$ $I_{disk,cyl} = \frac{1}{2}mR^2$ $I_{hoop} = mR^2$ $I_{ball} = \frac{2}{5}mR^2$ $I_{shell} = \frac{2}{3}mR^2$ $I_{rod} = \frac{1}{12}mL^2$ $I_{rod(end)} = \frac{1}{3}mL^2$ $I = I_{com} + MD^2$

Rolling: $v_{com} = R\omega$ $K = \frac{1}{2}I\omega^2 + \frac{1}{2}m(v_{com})^2$ **Angular momentum:** $\vec{L}_{point\ mass} = m\vec{r}\times\vec{v}$ $L = mrv\sin\theta$; $\vec{L} = m(r_xv_y - r_yv_x)\vec{k}$ $L = I\omega$ $L_I = L_f$

Equilibrium: $\Sigma\vec{F} = 0$: $\Sigma\vec{\tau} = 0$ **Gravitation:** $G = 6.67\times10^{-11}\ Nm^2/kg^2$ $F = G\frac{m_1\cdot m_2}{R^2}$ $g = G\frac{M_p}{R^2}$;

$U = -G\frac{M_Em_o}{R}$; **period** $T = \frac{2\pi R}{v}$; $v_{esc} = \sqrt{\frac{2GM_p}{R}}$ $v_{sat} = \sqrt{\frac{GM_p}{R}}$; $T^2 = \frac{4\pi^2}{GM}R^3$;

$E_{sat} = -G\frac{M_Em_o}{2R}$ **Oscillations:** $F = -kx$ $x = A\cos(\omega t + \theta)$ $v = -\omega A\sin(\omega t + \theta)$ $a = -\omega^2 x$ $\omega = 2\pi f = \frac{2\pi}{T}$

$\omega = \sqrt{\frac{k}{m}}$ **period:** $T_{spring} = 2\pi\sqrt{\frac{m}{k}}$; $f = \frac{1}{T}$ $T_{pend} = 2\pi\sqrt{\frac{L}{g}}$ $T_{phys.pend} = 2\pi\sqrt{\frac{I}{mgd}}$ $U_{spr} = \frac{1}{2}kx^2$ $E_{tot} = \frac{1}{2}kA^2$

$E_{tot} = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$ $v_{max} = A\omega$ $a_{max} = A\omega^2$ $x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$ $y_{cm} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2}$

PHYS 111 FINAL EXAM

NAME_____SECT_____

Honors Code Pledge: *As an NJIT student I _____, pledge to comply with the provisions of the NJIT Academic Honor Code. I assert that I have not violated the NJIT Academic Honor Code.*

Answer each question on the Scantron card using #2 pencil. Also circle your answers on the question papers. SHOW HOW YOU GOT YOUR ANSWERS ON THE EXAM SHEETS. Use the back if necessary.

1. If **A** = 24**i**-32**j** and B=24**i**+10**j**, what is the direction of the vector **C** = **A**-**B**?

a. –49°
b. –41°
c. –90°
d. +49°
e. +21°

2. A motorist drives south at 20 m/s for 3 min, then turns west and travels at 25 m/s for 2 min. What is the average velocity for this 5 min trip?

a. 12.2 m/s
b. 15.6 m/s
c. 5.4 m/s
d. 22.0 m/s
e. 25 m/s

3. The position of a particle as it moves along the x axis is given by $x = 15e^{-2t}$ m, where t is in s. What is the acceleration of the particle at $t = 1.0$ s?

a. 22 m/s
b. 60 m/s
c. 8.1 m/s
d. 15 m/s
e. 35 m/s

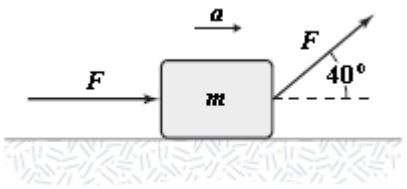
4 . A ball is thrown horizontally from the top of a building 0.10 km high. The ball strikes the ground at a point 65 m horizontally away from and below the point of release. What is the initial speed of the ball?

a. 43 m/s
b. 47 m/s
c. 39 m/s
d. 36 m/s
e. 14 m/s

5. A 1.5-kg mass has an acceleration of $(4.0\hat{\mathbf{i}} - 3.0\hat{\mathbf{j}})$ m/s^2. Only two forces act on the mass. If one of the forces is $(2.0\hat{\mathbf{i}} - 1.4\hat{\mathbf{j}})$ N, what is the magnitude of the other force?

a. 4.1 N
b. 6.1 N
c. 5.1 N
d. 7.1 N
e. 2.4 N

6. If F = 4.0 N and m = 2.0 kg, what is the magnitude a of the acceleration for the block shown below? The surface is frictionless.



a. 5.3 m/s^2
b. 4.4 m/s^2
c. 3.5 m/s^2
d. 6.2 m/s^2
e. 8.4 m/s^2

7. A 4.0-kg block slides down a 35° incline at a constant speed. What is the coefficient of kinetic friction between the block and the surface of the incline?
a. 0.20
b. 0.33
c. 0.46
d. 0.53
e. 0.70

8. A 2.0-kg projectile moves from its initial position to a point that is displaced 20 m horizontally and 15 m above its initial position. How much work is done by the gravitational force on the projectile?
a. +0.29 kJ
b. –0.29 kJ
c. +30 J
d. –30 J
e. –50 J

9. A moving particle is subject to conservative forces only. When its kinetic energy decreases by 10 J, what happens to its mechanical energy?

a. It increases by 10 J.
b. It decreases by 10 J.
c. It increases, but not necessarily by 10 J.
d. It decreases, but not necessarily by 10 J.
e. It remains the same.

10. A 25-kg block on a horizontal surface is attached to a light spring (force constant = 8.0 kN/m). The block is pulled 10 cm to the right from its equilibrium position and released from rest. When the block has moved 2.0 cm toward its equilibrium position, its kinetic energy is 12 J. What is the change in mechanical energy caused by the frictional force on the block as it moves the 2.0 cm?

a. –4.0 J
b. –0.5 J
c. –2.4 J
d. –7.9 J
e. –15 J

11. A 2.4-kg ball falling vertically hits the floor with a speed of 2.5 m/s and rebounds with a speed of 1.5 m/s. What is the magnitude of the impulse exerted on the ball by the floor?

a. 9.6 N·s
b. 2.4 N·s
c. 6.4 N·s
d. 1.6 N·s
e. 1.0 N·s

12. A 10-g bullet moving horizontally with a speed of 1.8 km/s strikes and passes through a 5.0-kg block initially at rest on a horizontal frictionless surface. The bullet emerges from the block with a speed of 1.0 km/s. What is the speed of the block immediately after the bullet emerges?

a. 25 m/s
b. 1.6 m/s
c. 5.3 m/s
d. 9.4 m/s
e. 125 m/s

13. A 2.0-kg object moving horizontally at 3.0 m/s strikes a 1.0-kg object initially at rest. Immediately after the collision, the 2.0-kg object has a velocity of 1.5 m/s directed 30° from its initial direction of motion. What is the *y* component of the velocity of the 1.0-kg object just after the collision?

a. –3.7 m/s
b. –3.4 m/s
c. –1.5 m/s
d. –2.4 m/s
e. –4.1 m/s

14. A wheel rotating about a fixed axis has an angular position given by $\theta = 3.0 - 2.0t^3$, where θ is measured in radians and t in seconds. What is the angular acceleration of the wheel at $t = 2.0$ s?

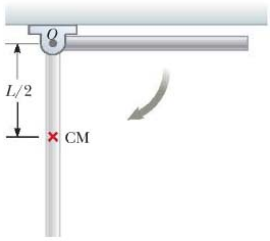
a. –1.0 rad/s^2
b. –24 rad/s^2
c. –2.0 rad/s^2
d. –4.0 rad/s^2
e. –3.5 rad/s^2

15. A horizontal 98 N disk of radius 75 cm, initially at rest, rotates under a constant force of 50 N applied tangentially to the edge of the disk. The acceleration of the disk is closest to

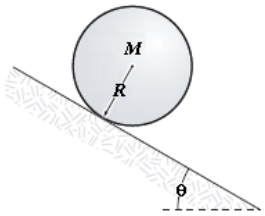
a. 13.3 rad/s^2
b. 1.8 rad/s^2
c. 15.0 rad/s^2
d. 8.9 rad/s^2
e. 4.3 rad/s^2

16. A uniform rod of mass M=1.2 kg and length 1.8 m is free to rotate on a frictionless pin passing through one end. The rod is released from rest in the horizontal position. What is its angular speed as it swings through the vertical position?

a. 1.4 rad/s
b. 4.0 rad/s
c. 9.9 rad/s
d. 7.8 rad/s
e. 16.8 rad/s

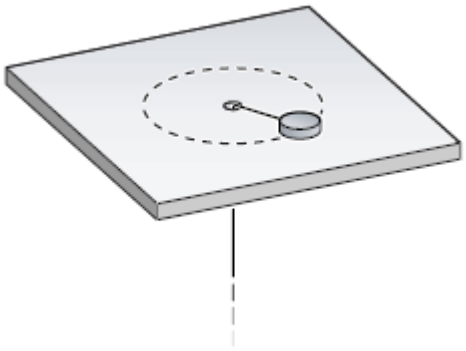


17. A solid cylinder (radius $R = 20\ cm$, mass $M = 2.5\ kg$) rolls without slipping down an 15^0- incline as shown in the figure. If the incline is 1.2 m long and the cylinder starts from rest, what is the linear velocity of its center of mass at the bottom of the incline?



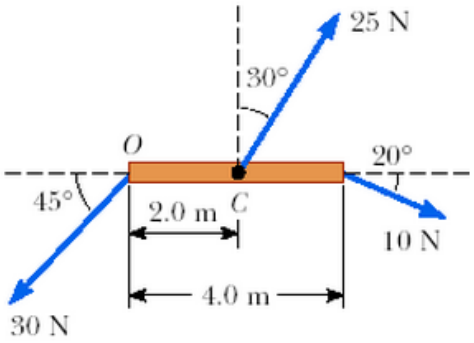
a. 0.7 m/s
b. 1.3 m/s
c. 2.0 m/s
d. 3.5 m/s
e. 4.4 m/s

19. A puck on a frictionless air hockey table has a mass of 0.5 kg and is attached to a cord passing through a hole in the surface as in the figure. The puck is revolving at a distance 1.2 m from the hole with an angular velocity of 1.0 rev/s. The angular momentum of the puck (in $kg \cdot m^2/s$) is



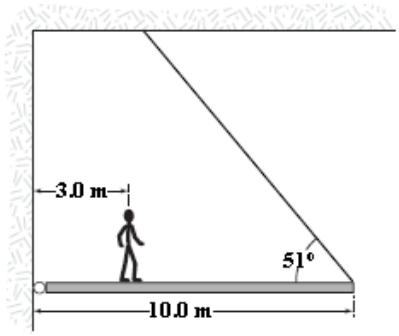
a. 8.0
b. 2.8
c. 30.0
d. 4.5
e. 7.5

21. Calculate the magnitude of the net torque on the beam in the figure about an axis through zero, perpendicular to the page.



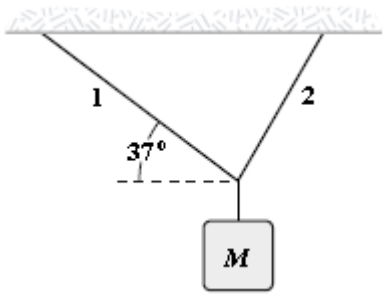
a. 29.6 Nm
b. 13.7 Nm
c. 43.3 Nm
d. 57 Nm
e. 78 NM

22. The figure shows a uniform, horizontal beam (length = 10 m) that is pivoted at the wall, with its far end supported by a cable that makes an angle of 51° with the horizontal. If a person (mass = 60 kg) stands 3.0 m from the pivot, what is the tension in the cable? Ignore the mass of the beam.



a. 0.83 kN
b. 1.30 kN
c. 0.23 kN
d. 0.42 kN
e. 3.0 kN

23. An object of unknown weight is suspended as shown. The tension in rope 1 is 25 N, and the tension in rope 2 is 31 N. What is the weight of the suspended object?



a. 6 N
b. 13 N
c. 23 N
d. 39 N
e. 56 N

24. The planet Venus requires 225 days to orbit the sun, which has a mass $M = 1.99 \times 10^{30}$ kg, in an almost circular trajectory. Calculate the radius of the orbit as it circles the sun.

a. 6.2×10^{7} m
b. 5.0×10^{22} m
c. 8.5×10^{10} m
d. 1.1×10^{11} m
e. 3.7×10^{25} m

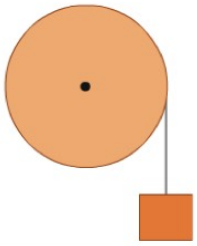
1. A 1.2-kg object moving with a speed of 8.0 m/s collides perpendicularly with a wall and emerges with a speed of 6.0 m/s in the opposite direction. If the object is in contact with the wall for 2.0 ms, what is the magnitude of the average force on the object by the wall?

A) 9.8 kN
B) 8.4 kN
C) 7.7 kN
D) 9.1 kN
E) 1.2 kN

2. A 5.0-kg mass with an initial velocity of 4.0 m/s, east collides with a 4.0-kg mass with an initial velocity of 3.0 m/s, west. After the collision the 5.0-kg mass has a velocity of 1.2 m/s, south. What is the magnitude of the velocity of the 4.0-kg mass after the collision?

A) 2.0 m/s
B) 1.5 m/s
C) 1.0 m/s
D) 2.5 m/s
E) 3.0 m/s

17. A frictionless pulley free to rotate about a frictionless axle has a radius R = 0.12 m and a moment of inertia I = 0.050 kg×m^2. A 1.5-kg object is attached to a very light wire that is wrapped around the rim of the pulley. The system is released from rest and mass m moves downward a distance of 63.7 cm. Find the angular velocity of the pulley at this instant.

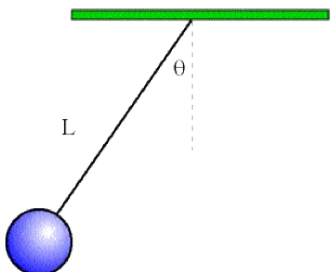


A) 28.4 rad/s
B) 5.75 rad/s
C) 16.2 rad/s
D) 0.25 rad/s
E) 32.2 rad/s

25. A 20-N crate starting at rest slides down a rough 5.0-m long ramp, inclined at 25° with the horizontal. 20 J of energy is lost to friction. What will be the speed of the crate at the bottom of the incline?

A) 0.98 m/s
B) 1.9 m/s
C) 3.2 m/s
D) 4.7 m/s
E) 0.7 m/s

26. A simple pendulum, 1.00 m in length, is released from rest when the support string is at an angle of 35.0° from the vertical. What is the speed of the suspended mass at the bottom of the swing? (g = 9.80 m/s^2 and ignore air resistance)



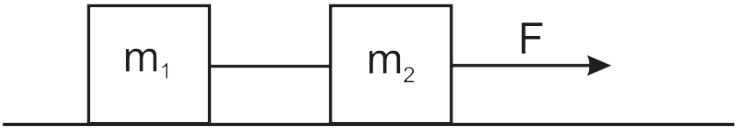
A) 0.67 m/s
B) 0.94 m/s
C) 1.33 m/s
D) 1.88 m/s
E) 1.55 m/s

28. A solid rock, suspended in air by a spring scale, has a measured mass of 9.00 kg. When the rock is submerged in water, the scale reads 3.30 kg. What is the density of the rock? (water density = 1,000 kg/m^3).

A) 4.55 $\times$ 10^3 kg/m^3
B) 3.50 $\times$ 10^3 kg/m^3
C) 1.20 $\times$ 10^3 kg/m^3
D) 1.58 $\times$ 10^3 kg/m^3
E) 1.35 $\times$ 10^3 kg/m^3

2. Two blocks (m_1 =2kg, m_2 =4kg) are tied together by a string and pulled across a horizontal frictionless surface as shown in the figure. The external force which pulls m_2 has a magnitude of F=10N. Calculate the magnitude of the tension in the string between the two blocks.

A) 10 N
B) 1.7 N
C) 6.7 N
D) 3.3 N
E) none of the above



3. The position of a particle as a function of time is given by $\vec{r}(t) = 15t^2\hat{i} + 5t\hat{j} - 20t\,\hat{i} + 4t^4\hat{j}$. What is the magnitude of the acceleration at t=0.5s?

A) 22 m/s^2
B) 42 m/s^2
C) 2 m/s
D) 8.6 m/s
E) none of the other answers

16. A fast 9-gram bullet gets stuck in a wooden block with mass M=3 kg, initially at rest. After the impact, the block starts moving with velocity 1.5 m/s . Find the initial speed of the bullet.

A) 250 m/s
B) 500 m/s
C) 750 m/s
D) 1000 m/s
E) 1500 m/s

17. A solid ball is at the top of an incline of vertical height H=10m. It is released from rest and rolls without slipping. The mass of the ball is M = 2 kg and radius is R = 0.2 m. Calculate the final speed of the ball at the bottom of the incline.

A) 12 m/s
B) 11 m/s
C) 9.9 m/s
D) 14 m/s
E) 22 m/s