Kuwait University Physics Department

Physics 121

Midterm II Exam
Summer semester (2023-2024)

July 20, 2024
Time: 14:00 – 15:30

Student's Name: ……………….……………………….…… Serial No: ……………………

Student's Number: ….……………………………………… Section No: …………………

Instructors: Drs. Afrousheh, Alotaibi, Alsamadi, and Hadipour.

Important Instructions to the Students:

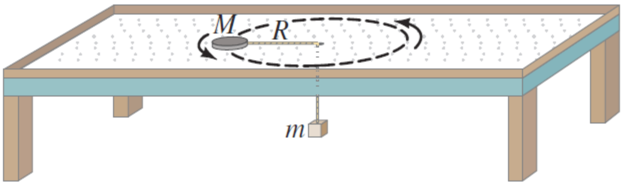
1. Answer all questions and problems.
2. Full mark = 24
3. No solution = no points.
4. **Use SI units.**
5. Take g = 9.8 m/s^2.
6. Mobiles are **strictly prohibited** during the exam.
7. Programmable calculators, which can store equations, are not allowed.
8. **Cheating incidents will be processed according to the university rules.**

For use by Instructors only

#	P1	P2	P3	P4	P5	P6	Total
Pts	4	4	4	4	4	4	24

GOOD LUCK

1. A small disk of mass $M = 0.3$ kg is rotating in a circle of radius $R = 0.6$ m on a frictionless horizontal table at a constant speed. The disk is connected by a light string through a central hole to a suspended block of mass $m = 1.8$ kg that remains at rest, as shown. Find the speed of the rotating disk. **[4 Points]**

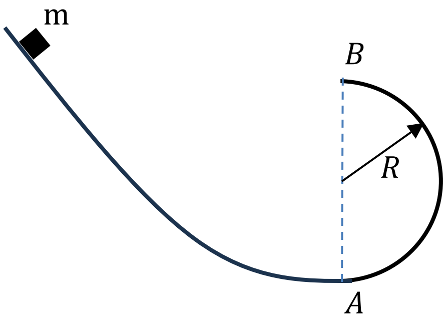


$F_T = mg$

$F_T = \frac{Mv^2}{R}$

$v = \sqrt{\frac{Rmg}{M}} = \sqrt{\frac{0.6 \times 1.8 \times 9.8}{0.3}} = 5.9\ m/s$

2. A small block of mass $m = 0.150$ kg slides down a frictionless surface that is bent at the end into a semicircle of radius $R = 20$ cm as shown. If the normal force on the block at point A (bottom of the semicircle) is 8.0 N,
   a) what is the speed of the block at point A? **[2 Points]**
   b) What is the speed of the block at point B (top of the semicircle)? **[2 Points]**



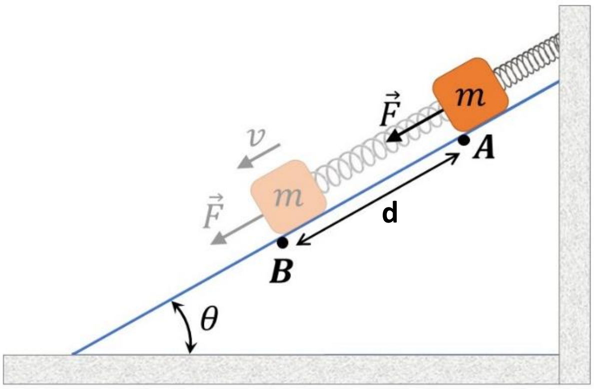
a) $F_N - mg = m\frac{v^2}{R}$

$v_A = 2.95\ \text{m/s}$

b) $\frac{1}{2}mv_A^2 = mg(2R) + \frac{1}{2}mv_B^2$

$v_B = 0.93\ \text{m/s}$

3. A block of mass $m = 0.8$ kg is attached to a light spring ($k = 100$ N/m) on a rough inclined surface with $\theta = 30°$ and $\mu_k = 0.2$. An applied force $F = 30$ N acts on the block as shown. The block is lowered down a distance of $d = 0.4$ m from point A to point B. At point A the spring is relaxed. Find the change in the kinetic energy of the block going from A to B. **[4 Points]**

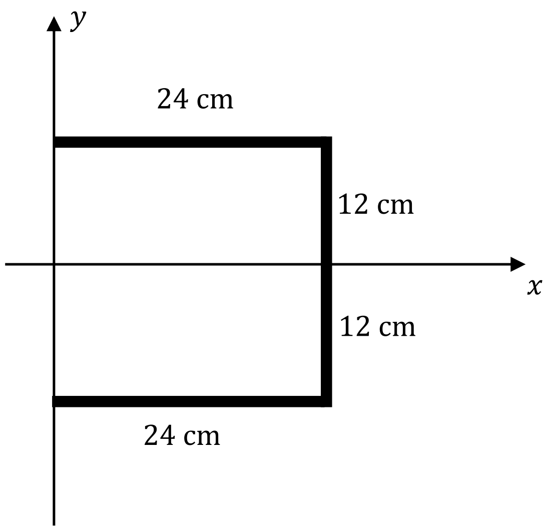


$\Delta K_E = W_{net}$

$W_{net} = mgsin\theta \cdot d - \mu_k mgcos\theta \cdot d + Fd - \frac{1}{2}kd^2$

$W_{net} = 5$ J

4. The three thin uniform beams shown in the figure have the same mass and length. Find the position of the center of mass of the structure (x_{cm}, y_{cm}). **[4 Points]**



$x_{cm} = \frac{12m+12m+24m}{3m} = 16$ cm

$y_{cm} = \frac{12m-12m+0}{3m} = 0$ cm

5. A rotating wheel is slowing down at a rate of 1.5 rad/s^2 due to friction. At $t = 0$ its angular velocity is 12 rad/s. At $t = 6$ s, for a point that is 40 cm from the center of the wheel,
   a) find the radial acceleration. **[2 Points]**
   b) Find the magnitude of the tangential and total acceleration. **[2 Points]**

a) $\omega = \omega_0 + \alpha t = 12 - 1.5 \times 6 = 3 \text{ rad/s}$

$a_R = r\omega^2 = 3.6 \text{ m/s}^2$

b) $a_{tan} = r\alpha = 0.6 \text{ m/s}^2$

$a = \sqrt{3.6^2 + 0.6^2} = 3.65 \text{ m/s}^2$

6. A small wheel (A) of radius $R_A = 8.0$ cm is used to rotate a bigger wheel (B) of radius $R_B = 25.0$ cm through a belt. The smaller wheel turns at a constant angular velocity of 15.0 rad/s.
   a) Find the angular velocity of the wheel B. **[2 Points]**
   b) How many revolutions does the wheel B make in 2 min? **[2 Points]**

a) $v_A = v_B = R_A \omega_A = 1.2 \text{ m/s}$

$\omega_B = \dfrac{v_B}{R_B} = 4.8 \text{ rad/s}$

b) $\Delta\theta = \omega_B t = 576 \text{ rad}$

$N = \dfrac{\Delta\theta}{2\pi} = 91.7$