# Kuwait University Physics Department

# Physics 121

## Midterm I Exam
## Spring Semester (2023-2024)

**March 9, 2024**
**Time: 15:00 – 16:30**

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

Student's Number: ….…… Section No: ……

**Instructors:** Drs. Abdullah, Afrousheh, Alotaibi, Hadipour, Kokkalis, Razee, and Zaman.

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## Important Instructions to the Students:

1. Answer all questions and problems.
2. Full mark = 27
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 | P7 | Total |
|---|---|---|---|---|---|---|---|---|
| Pts | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 27 |
| | | | | | | | | |

GOOD LUCK

1. An athlete runs east at a constant speed of 2.5 m/s for 15 min. She then runs west at a constant speed of 4 m/s. The total distance covered in the roundtrip is 5 km. Find her average velocity. **[4 Points]**

$$d_1 = s_1 \times t_1 = 2.5\frac{m}{s} \times \left(15\ min \times 60\frac{s}{min}\right) = 2250\ \text{m}$$

$$d_2 = 5000 - 2250 = 2750$$

$$t_2 = \frac{d_2}{s_2} = \frac{2750}{4} = 687.5\ \text{s}$$

$$\bar{v} = \frac{\Delta x}{t} = \frac{(2250 - 2750) - 0}{15 \times 60 + 687.5} = -0.315\ \text{m/s}$$

2. A driver moving at a speed of 30 m/s notices a red traffic light 75 m ahead. He slows down at a constant acceleration and stops the car at the traffic light.
   a) Find the acceleration of the car. **[2 Points]**
   b) How long does it take for the car to stop? **[2 Points]**

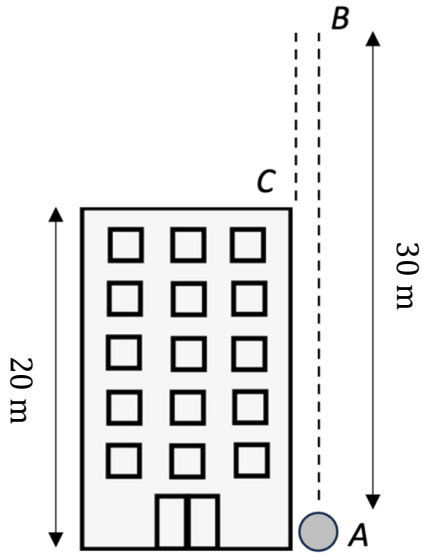
a) $v^2 = v_0^2 + 2a\Delta x$

$$a = \frac{v^2 - v_0^2}{2\Delta x} = \frac{0 - (30)^2}{2(75)} = -6\ \text{m/s}^2$$

b) $v = v_0 + at$

$$t = \frac{v - v_0}{a} = \frac{0 - 30}{-6} = 5\ \text{s}$$

3. A ball is thrown up at point $A$ with initial velocity $v_0$ and reaches a maximum height of 30 m (Point $B$), then returns to the top of a building that is 20 m high (Point $C$) as shown.
   a) Find the initial velocity $v_0$. **[2 Points]**
   b) Find the total time that the ball is in the air until it reaches point $C$. **[2 Points]**




a) $v^2 - v_0^2 = 2a\Delta y$

$v_0 = \sqrt{v^2 - 2a\Delta y}$

$v_0 = \sqrt{0 - 2(-9.8)(30)}$

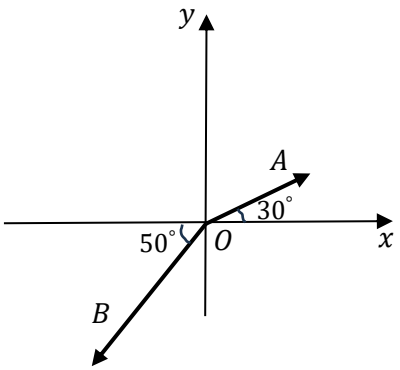
$v_0 = 24.2\ \text{m/s}$

b) $\Delta y = v_0 t + 0.5at^2$

$20 = 24.2t - 4.9t^2$

~~$t = 1\ s$~~ & $\boldsymbol{t = 3.9\ s}$

4. The two vectors shown have magnitudes $A = 10$ units and $B = 20$ units. If $\vec{C} = \vec{A} + \vec{B}$,
   a) Find the magnitude of $\vec{C}$. **[3 Points]**
   b) Find the direction of $\vec{C}$ (the angle of $\vec{C}$ with respect to $+x$ direction). **[1 Points]**




a) $C_x = A\,cos30 + B\,cos230 = -4.2$

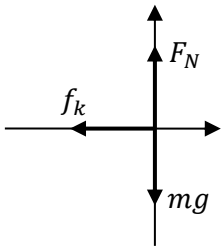
$C_y = A\,sin30 + B\,sin230 = -10.3$

$C = \sqrt{(-4.2)^2 + (-10.3)^2} = 11.1$

b) $\theta = 180 + tan^{-1}\left(\frac{-10.3}{-4.2}\right) \cong 248^\circ$

5. An object of mass 2.0 kg is kicked at some initial velocity on a horizontal surface where it slows down uniformly. The coefficient of kinetic friction between the object and the surface is 0.3. Find the acceleration of the object on the surface. **[3 Points]**

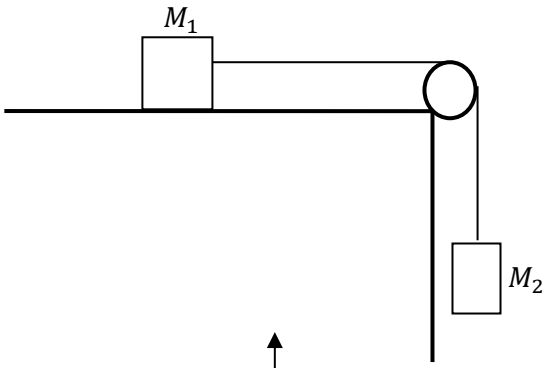
$$f_k = \mu_k F_N = \mu_k mg = ma$$
$$a = \mu_k g = 2.94 \text{ m/s}^2$$

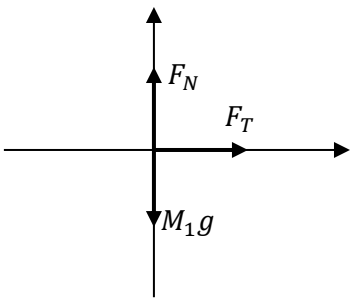


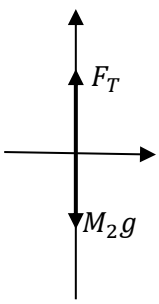

6. Two blocks of mass $M_1 = 6.0$ kg and $M_2 = 2.0$ kg are connected by a massless cord as shown. Block $M_1$ is on a horizontal frictionless table and block $M_2$ is hanging vertically. The two blocks are released from rest.
   a) Find the acceleration of the two blocks. **[3 Points]**
   b) Find the tension in the cord. **[1 Points]**

a) $F_T - M_2 g = -M_2 a$
$F_T = M_1 a$
$M_1 a - M_2 g = -M_2 a \ \rightarrow \ a = 2.45 \text{ m/s}^2$

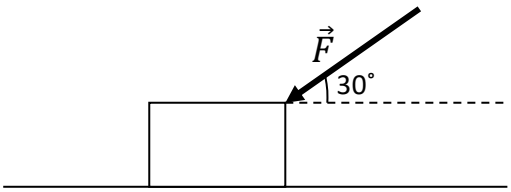
b) $F_T = M_1 a = 14.7$ N



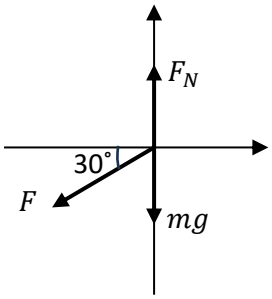



7. A force $F = 60$ N pushes a 5.0 kg block on a horizontal frictionless surface as shown.
   a) Calculate the normal force on the block. **[2 Points]**
   b) What is the acceleration of the block? **[2 Points]**




$F_N - mg - F\ sin30 = 0$

$F_N = 79$ N




$F\ cos30 = ma$

$a = 10.4\ \mathrm{m/s^2}$