Kuwait University Physics Department

Physics 121

Mid-Term Exam I
Fall Semester (2022-2023)

October 29, 2022
Time: 15:00 – 16:30

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

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

Instructors: Drs. Ali, Alotaibi, Alsmadi, Hadjipour, Kokkalis, Razee

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Important Instructions to the Students:

1. Answer all questions and problems.
2. Full mark = 28 points as arranged in the table below.
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

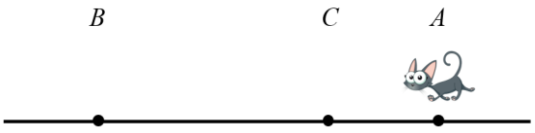
#	P1	P2	P3	P4	P5	P6	P7	Total
Pts	4	4	4	3	5	3	5	28

GOOD LUCK

P1. A cat moves along a straight line from point *A* to point *B* and then turns back to point *C*, as shown in the figure. The distance between points *A* and *C* is 5.0 m, and between points *B* and *C* is 10.0 m. The entire motion took 15.0 s.

a. Find the average speed for the entire trip. **(2 points)**

b. Find the average velocity for the entire trip. **(2 points)**



Taking positive *x-axis* to the east and origin at point A.

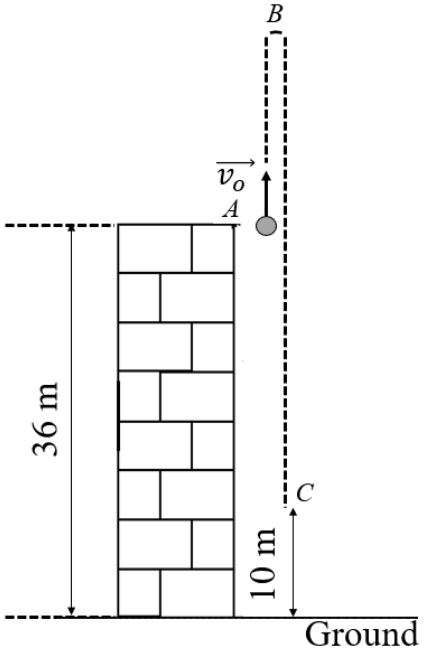
(a) $Average\ speed = \frac{total\ distance}{time} = \frac{25}{15} = 1.67\,\frac{m}{s}$

(b) $Average\ velocity = \frac{displacement}{time} = \frac{-5-0}{15} = -0.3\,\frac{m}{s}$

P2. A rock is thrown vertically upward from the roof of a 36.0 m tall building (point *A*), with an initial speed of 12.0 m/s. Ignore air resistance.

a. Find the time takes the rock to reach its maximum height (point *B*). **(2 points)**

b. Find the velocity of the rock at point *C* located 10.0 m above ground. **(2 points)**



Taking positive *y-axis* upwards and origin at the ground:

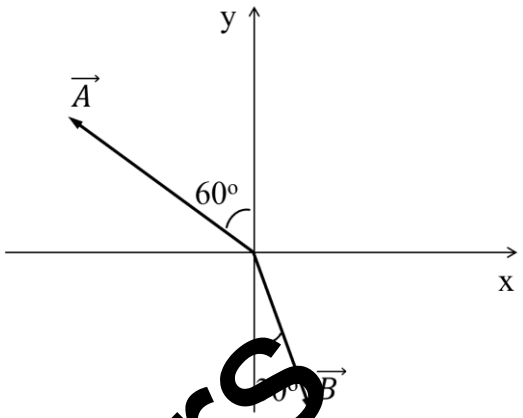
a. $v = v_0 + at \rightarrow 0 = 12 + (-9.8)t \rightarrow t = 1.2\ s$

b. $v^2 = v_0^2 + 2a(y - y_0) = 12^2 + 2(-9.8)(10 - 36) = 653.6 \rightarrow v = -25.6\,\frac{m}{s}$

P3. Vectors with magnitudes $A = 6.0$ units and $B = 4.0$ units, are shown. Vector $\overrightarrow{C}$ is given by the equation $\overrightarrow{C} = 2\overrightarrow{A} + \overrightarrow{B}$.

a. Find the magnitude of vector $\overrightarrow{C}$. **(3 points)**

b. Find the direction of vector $\overrightarrow{C}$, with respect to the positive x-axis. **(1 point)**



$C_x = 2A_x + B_x = (2)(-6)sin(60) + 4\ sin(30) = -8.4\ units$ **(1 point)**

$C_y = 2A_y + B_y = (2)(6)cos(60) - 4\ cos(30) = 2.5\ units$ **(1 point)**

$C = \sqrt{C_x^2 + C_y^2} = 8.8\ units$ **(1 point)**

$\theta' = \tan^{-1}\left|\frac{2.5}{8.4}\right| = 16.6 \rightarrow \theta = 180^o - 16.6^o = 163.4^o$ **(1 point)**

P4. A 1200 kg car is travelling initially with constant speed of 120 km/h. The driver hits the break and stops completely over a distance of 65 m.

a. Find the acceleration of the car, assuming that is uniform. **(2 points)**

b. Find the net force needed to bring the car to a complete stop. **(1 point)**

$v_0 = 120\frac{km}{h} = 33.3\ m/s$ **(1 point)**

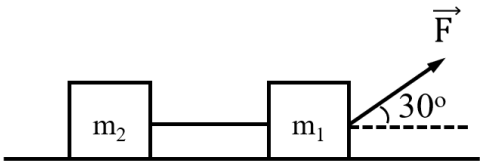
$a = \frac{v_f^2 - v_0^2}{2d} = \frac{-33.3^2}{2\times 65} = -8.5\ m/s^2$ **(1 point)**

$F = ma = -10{,}200\ N$ **(1 point)**

P5. Two blocks of masses $m_1 = 4.0$ kg and $m_2 = 5.0$ kg are connected by a massless cord. A force of magnitude 40 N is pulling m_1 as shown below, so that the system is uniformly accelerated to the east.

a. Find the tension in the cord between the blocks. **(4 points)**

b. Find the net force acting on m_2. **(1 point)**



Taking positive *x-axis* to the east and positive *y-axis* upwards:

a.

m_1:

$x-$axis

$F\cos(30) - F_T = F\cos(30) - F_T = m_1 a$ (Eq. 1) **(1 point)**

m_2:

$x-$axis

$F_T = m_2 a$ (Eq. 2) **(1 point)**

From Eqs (1) & (2): $a = \frac{F\cos(30)}{m_1+m_2} = 3.8\frac{m}{s^2}$ **(1 point)**

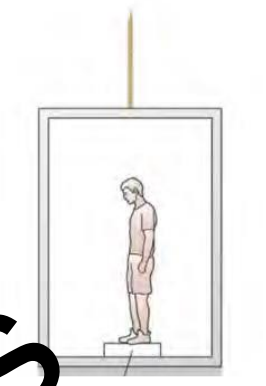
(Eq. 2) $F_T = m_2 a \rightarrow F_T = 5 \times 3.8 = 19\ N$ **(1 point)**

b. $F_{net\ 2} = m_2 a = 5 \times 3.8 = 19\ N$ **(1 point)**

P6. A 55.0 kg man is standing on a scale inside an elevator that is uniformly accelerated upwards with $a = 1.2\ \mathrm{m/s^2}$.

a. What is the reading on the scale (in kg)? **(2 points)**

b. Starting from rest at the ground floor, how long it will take for the elevator to move 50 m upwards? **(1 point)**



Taking positive *y-axis* upward and origin at the ground floor.

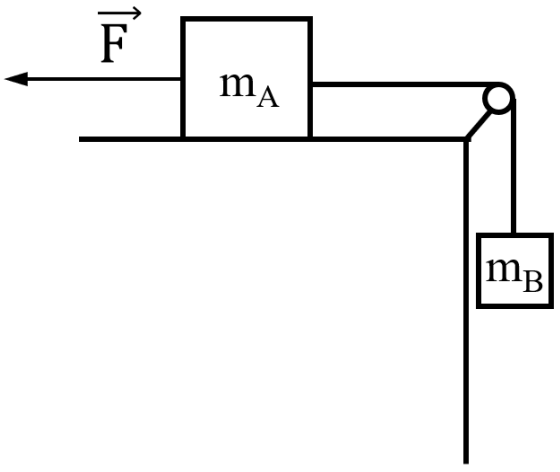
$F_N - mg = ma \rightarrow F_N = mg + ma = 605\ N \rightarrow$ Scale reading is $61.7kg$ **(2 points)**

$y = y_o + v_o t + \frac{1}{2}at^2 \rightarrow 50 = 0 + 0 + \frac{1}{2} \times 1.2 \times t^2 \rightarrow t =$ **(1 point)**

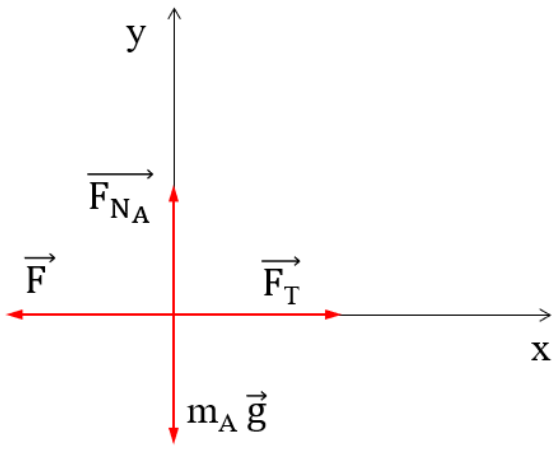
P7. Two blocks with masses $m_A = 15.0$ kg and m_B are connected through a frictionless and massless pulley by a lightweight cord. A force of magnitude 88.2 N is applied on m_A as shown.

a. Draw the free body diagram for mass m_A. **(1 point)**

b. Find the value of m_B, so that the system remains **at rest**. **(4 points)**



a.



(1 point)

b.

Taking positive *x-axis* to the east and positive *y-axis* upward for both masses:

The system remains at rest, and therefore $a = 0\ m/s^2$. **(1 point)**

x − axis

$F_T - F = 0$ (Eq. 2) **(1 point)**

m_B:

y − axis

$F_T - m_B g = 0$ (Eq. 3) **(1 point)**

From Eqs (2) & (3): $F = m_B g \rightarrow m_B = \frac{F}{g} = \frac{88.2}{9.8} \rightarrow m_B = 9.0\ kg$ **(1 point)**