Kuwait University Physics Department

Physics 101

Summer Semester
Second Midterm Exam
Sunday, August 29, 2021
7:00 pm – 8:30 pm

Student's Name: ……..…….…… Serial Number: ….……

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Dr. Hala Al-Jassar
Dr. Fatema Al Dosari
Dr. Tareq Al Refai
Dr. Belal Salameh
Dr. Abdel Khaleq

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	Q5	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	1	1	1	1	3	3	3	3	3	5	5	**30**

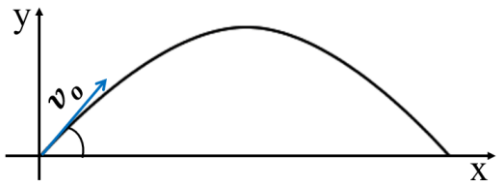
Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 30 points as arranged in the above table.
3. Assume g = 10 m/s^2.
4. Mobiles are **strictly prohibited** during the exam.
5. Programmable calculators, which can store equations, are not allowed.
6. **Please write down your final answer in the box shown in each problem.**
7. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

Part I: Questions (Choose the correct answer, 1 point each)

Q1. A projectile is fired, as shown. **Which of the following statements is correct?**



* $\Delta v_x = 0,\ \Delta v_y = 0$
* $\Delta v_x = 0,\ \Delta v_y = -g\Delta t$
* $\Delta v_x = -g\Delta t,\ \Delta v_y = 0$
* $\Delta v_x = -g\Delta t,\ \Delta v_y = -g\Delta t$

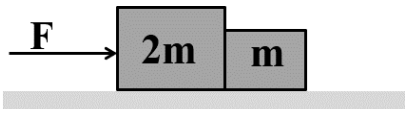
Q2. Which of the following figures describes **the velocity and acceleration vectors of a speeding up particle moving through the point P on a carved path.**

* * * *

Q3. A woman with masss (m) stands on a bathroom scale in an elevator. **While the elevator is accelerating downword, the scale reads (n)**

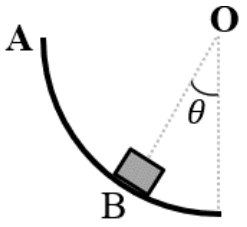
* $n > mg$
* $n = mg$
* $n < mg$
* $n = 0$

Q4. The figure shows two blocks of mass ($m_1 = 2m$) and ($m_2 = m$) acted on by an external horizontal force $\boldsymbol{F}$. Assume that the surface is **frictionless**. **Which of the following statements about the magnitude of the force that one block exerts on the other (F_{12}) is correct?**



* $F_{12} = \frac{F}{3}$
* $F_{12} = \frac{2F}{3}$
* $F_{12} = \frac{3F}{2}$
* $F_{12} = F$

Q5. A block of mass m is released **from rest** at point **A**, and slides down a frictionless surface in the shape of a quarter circle, as shown. **As the block passes point B, which of the following is true about the magnitude of the normal force (n)?**



* $n = mg\cos\theta$
* $n < mg\cos\theta$
* $n > mg\cos\theta$
* $n = 0$

Part II: Short Problems (3 points each)

SP1. An object is thrown **horizontally** from the open window of a building. If the initial speed of the object is 20 m/s and it hits the ground 2 s later, **from what height was it thrown?**

$v_{y0} = 0, v_{x0} = 20\ m/s$

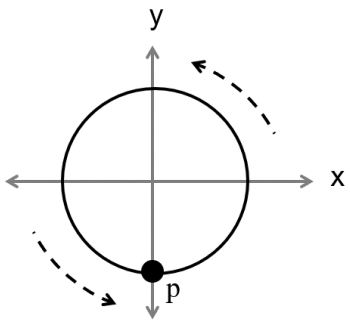
$y = y_0 + v_{y0}t - \frac{1}{2}gt^2$

$y = 0 + 0 - 5(2)^2 = -20\ m$

$h = 20\ m$

Answer: $h = 20\ m$

SP2. A particle moves with **constant speed** on a circle ($r = 2\ m$), as shown. The particle passes the point p at $t = 0\ s$ and completes one revelution in 20 s. **Find the particle's position, velocity and accelartaion at $t =$ 15 s, in unit vector notation.**



After 15 sec, the particle is on the negative x-axis:

$\vec{r} = -2\hat{\imath}$

$\vec{v} = -\frac{2\pi R}{T}\hat{\jmath} = -\frac{2\ (3.14)\ (2)}{20} = -0.63\ \hat{\jmath}$

$\vec{a} = \frac{v^2}{R}\hat{\imath} = \frac{0.63^2}{2}\hat{\imath} = 0.2\ \hat{\imath}$

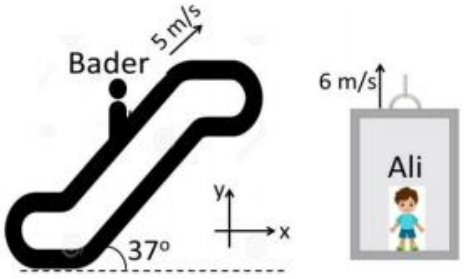
SP3. Bader rides an escalator which moves at a speed of 5 m/s and Ali rides an elevator which moves up at a speed of 6 m/s, as shown. **Find the speed of Bader with respect to Ali.**

$\vec{v}_{A/G} = 6\ \hat{\jmath}\ m/s$

$\vec{v}_{B/G} = 5\ cos(37^o)\hat{\imath} + 5\ sin(37^o)\ \hat{\jmath} = (4\ \hat{\imath} + 3\ \hat{\jmath})\ m/s$

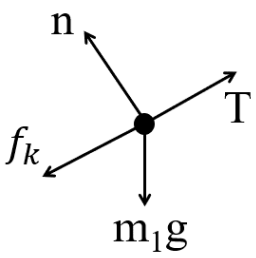
$\vec{v}_{B/A} = \vec{v}_{B/G} - \vec{v}_{A/G} = (4\ \hat{\imath} - 3\ \hat{\jmath})\ m/s$

$\left|\vec{v}_{B/A}\right| = \sqrt{(4)^2 + (3)^2} = 5\ m/s$

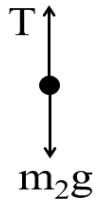


Answer: $\left|\vec{v}_{B/A}\right| = 5\ m/s$

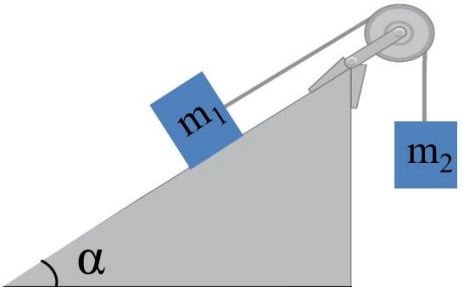
SP4. Two blocks (m_1 and m_2) are connected by a light rope that passes over a massless pulley as shown. The surface of the incline is **rough** and m_2 moves downward. **Draw two free-body diagrams, one for m_1 and one for m_2.**



For m_1



For m_2

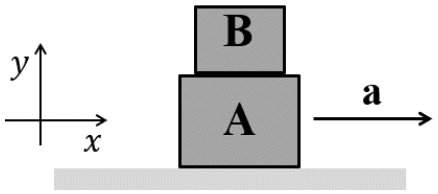


SP5. In the figure, block A has mass $m_A = 25\ Kg$ and block B has mass $m_B = 10\ Kg$. **Both blocks** move with constant acceleration $a = 2\ m/s^2$ to the right. The coefficient of static friction between the two blocks is $\mu_s = 0.8$. **Find the magnitude and direction of the static frictional force acting on block B.**

$f_s = m_B a = 10\ (2) = 20\ N$

$|f_s| = 20$ N

Direction: to the right



Answer: $20\hat{\imath}$ N

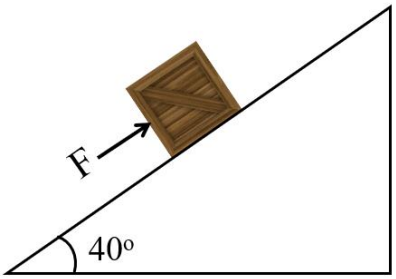
Part III: Long Problems (5 points each)

LP1. A block ($M = 20\ Kg$) is pushed by a force ($F = 50\ N$), as shown. The surface is rough ($\mu_s = 0.4$, $\mu_k = 0.3$).

a) What is the magnitude of the normal force acting on the block?

$n = mg\cos\theta$

$n = 200 \cos(40°) = 153.2\ N$



Answer: $n =$ 153.2 N

b) What is the magnitude and direction of the acceleration of the block?

$mg\sin\theta - F - f_k = ma$

$200 \sin(40°) - 50 - \mu_k(153.2) = 20\ a$

$a = 1.6\ \mathrm{m}/s^2$ down the incline

Answer : $a =$ 1.6 m/s^2 down the incline

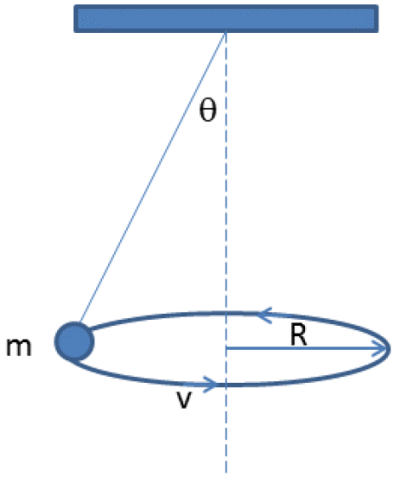
c) If the applied force is removed, then the magnitude of the blook's acceleration will

(*) **increase**

* **decrease**

* **stay the same**

LP2. For the canonical pendulum shown in the figure, a bob of mass ($m = 0.2\ Kg$) is attached to a string and rotates in a **horizontal** circle with **constant speed** ($v = 0.8\ m/s$). The string makes an angle ($\theta = 15°$) with the vertical.



a) What is the tension in the string?

$$T\cos\theta = mg$$

$$T = \frac{mg}{\cos\theta} = \frac{2}{\cos 15^o} = 2.1\ N$$

Answer: $T = 2.1\ N$

b) What is the radius of the circle?

$$T\sin\theta = \frac{mv^2}{R}$$

$$R = \frac{mv^2}{T\sin\theta} = \frac{0.2\ (0.8)^2}{2.1\sin(15^o)} = 0.24\ m$$

Answer: $R = 0.24\ m$

c) The net force acting on the bob equals:

- (*) $\boldsymbol{F_{net} = \frac{mv^2}{R}}$
- * $\boldsymbol{F_{net} = T - mg}$
- * $\boldsymbol{F_{net} = T\cos\theta}$
- * $\boldsymbol{F_{net} = 0}$