Kuwait University **Physics Department**

Physics 101

Fall Semester
Second Midterm Exam
Saturday, December 25, 202
9:00 AM – 10:30 AM

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

Student's Number: ….…………………………………….…   Section: ……………………

Choose your Instructor's Name:

Dr. Ahmed Al-Jassar	Dr. Belal Salameh
Dr. Hala Al-Jassar	Dr. Nasser Demir
Dr. Tareq Al Refai	Dr. Ruqayyah Askar
Dr. Abdul Khaleq	Dr. Bedoor Alkurtass

For Instructor use only

Grades:

#	SP1	SP2		SP4	SP5	LP1	LP2	Q1	Q2	Q3	Q4	Total
Pts	2	2	2	2	2	3	3	1	1	1	1	20

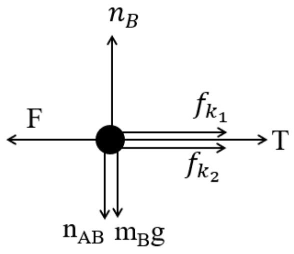
Important:

1. Answer all questions and problems (No solution = no points).
2. Full mark = 20 points as arranged in the above table.
3. **Give your final answer in the correct units.**
4. Assume g = 10 m/s^2.
5. Mobiles are **<u>strictly prohibited</u>** during the exam.
6. Programmable calculators, which can store equations, are not allowed.
7. **Cheating incidents will be processed according to the university rules.**

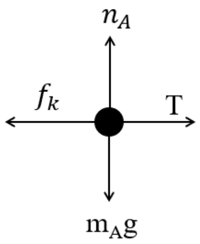
GOOD LUCK

Part I: Short Problems (2 points each)

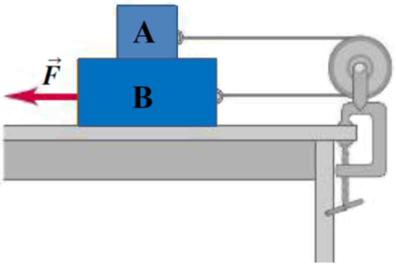
SP1. In the shown figure, Block B **slides to the left** at a **constant speed** under the effect of the horizontal force $\vec{F}$. **All surfaces are rough. Draw two labelled free-body diagrams one for block A and one for block B.**



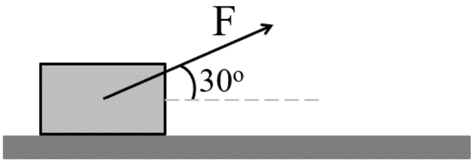
For B



For A



SP2. A 5 kg block is pulled along a horizontal **frictionless** floor by a force F at an angle of 30^o above the horizontal, as shown. If the force F is **slowly increased**, **what is its value just before the block is lifted off the floor?** [**Hint: the block leaves the floor when $n = 0$**]

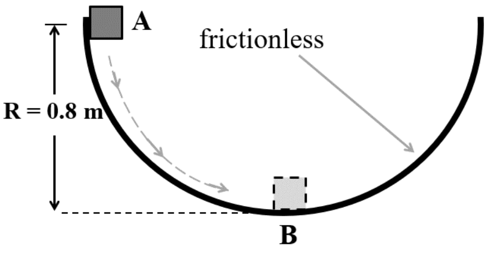


$$n + F\sin 30^o - mg = 0$$

$$when\ n = 0 \Rightarrow F\sin 30^o = mg$$

$$F = \frac{mg}{\sin 30^o} = 100\ N$$

SP3. A block of mass $m = 0.5\ kg$ is released from **rest at point A** and slides inside a **frictionless** circular path of radius R, as shown. **Find the speed of the block and the normal force on it at point B.**



$$E_i = E_f$$

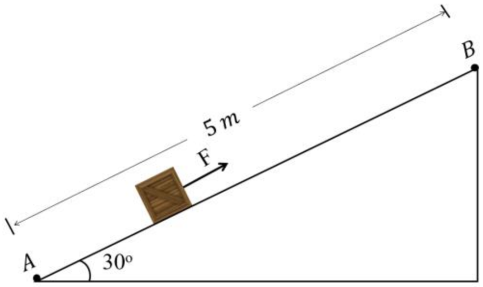
$$mgR = \frac{1}{2}mv^2$$

$$v = \sqrt{2gR} = 4\ m/s$$

$$n - mg = \frac{mv^2}{R}$$

$$n = mg + \frac{mv^2}{R} = 5 + \frac{8}{0.8} = 15N$$

SP4. A 10 kg box is pushed up a rough incline ($\mu_k = 0.2$) by a **constant force (F)** parallel to the incline, as shown. The box moves from point A to point B **with <u>constant speed</u>, find the work done by the force F on the box between points A and B.**



$$W_{tot} = W_F + W_{mg} + W_n + W_{f_k} = \Delta K = 0$$

$$W_F - \text{mg}(5\ \sin 30^o) + 0 - \mu_k(\text{mg}\cos 30^o)(5) = 0$$

$$W_F = 250 + 86.6 = 336.6\,J$$

<u>OR</u>

$$\sum F = ma$$

$$F - f_k - \text{mg}\sin\theta = 0$$

$$F = \mu_k(\text{mg}\cos 30^o) + \text{mg}\sin\theta = 17.3 + 50 = 67.32\ N$$

$$W_F = |\text{F}||s|\cos 0^o = 336.6\,J$$

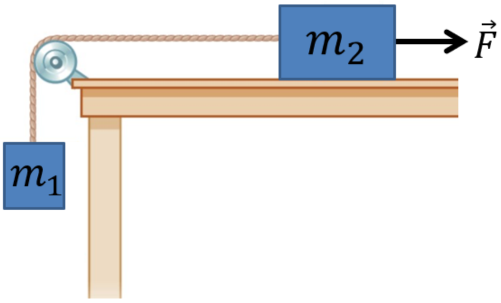
SP5. A single **variable force** acts on a 5 kg block. The equation $F_x = (2x + 4)\ N$ describes the force, where x is in meters. As the block moves along the $x\ axis$ from $x = 1\ m$ to $x = 5\ m$, **calculate the change in the kinetic energy of the block.**

$$W_{tot} = W_{F_x} = \int_1^5 F_x dx \int_1^5 (2x + 4)dx = (x^2 + 4x)]_1^5 = 40J$$

$$\Delta K = W_{tot} = 40\,J$$

Part II: Long Problems (3 points each)

LP1. Two blocks ($m_1 = 2\ kg, m_2 = 8\ kg$) are connected by a light rope passing over a massless, frictionless pulley. The horizontal surface is **frictionless** and a constant force $F = 25N$ acts on m_2, as shown.



a) Find the acceleration of the system.

for $\boldsymbol{M_{total}}$

$$\sum F = M_{total}a$$

$$F - m_1 g = M_{total}a$$

$$25 - 20 = 10a$$

$$a = 0.5\ m/s^2$$

b) Find the tension in the rope.

for $\boldsymbol{m_2}$

$$\sum F = m_2 a$$

$$F - T = m_2 a$$

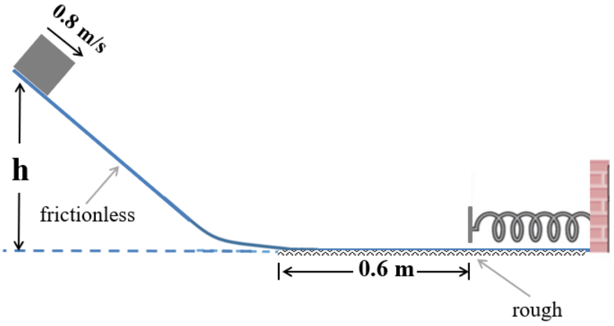
$$25 - T = 8(0.5)$$

$$T = 21\ N$$

c) Find the power supplied by the force $\vec{F}$ when the system has a speed of $\mathbf{0.8}\ \boldsymbol{m/s}$.

$$P = \vec{F}.\vec{v} = |\vec{F}||\vec{v}|\cos 0^o = (25)(0.8) = 20\ W$$

LP2. A block $(m = 4\,kg)$ initially moves with a speed $v_i = 0.8\,m/s$ slides down a **smooth inclined surface**, as shown. The block passes a $0.6\,m$ long horizontal **rough surface** $(\mu_k = 0.4)$ then it hits a massless spring $(k = 100\,N/m)$. The **spring is compressed <u>a maximum distance</u> of 0.2 m.**



a) **Find the height h.**

$$E_f - E_i = W_{f_k}$$

$$\frac{1}{2}kx^2 - \left(\frac{1}{2}mv_i^2 + mgh\right) = -\mu_k mg(d + x)$$

$$h = \frac{\frac{1}{2}kx^2 - \frac{1}{2}mv_i^2 + \mu_k mg(d + x)}{mg}$$

$$= \frac{2 - 1.28 + 12.8}{40} = 0.34\,m$$

b) **What force (magnitude and direction) does the spring exert on the block when it is at the maximum compression?**

$F = kx = 20\,N$ to the left

c) **At the maximum compression of the spring the block stops <u>momentarily</u>, the net force acting on the block at this instant is:**

* $|\vec{F}_{net}| = 0$

* $|\vec{F}_{net}| > 0 \quad to\ the\ right$

[✓ * $|\vec{F}_{net}| > 0 \quad to\ the\ left$]

Part III: Questions (Choose the correct answer, one point each)

Q1. The **action** and **reaction** forces

* act on the same body

[✓ *act on different bodies, and in opposite directions]

* act in the same direction

* act on different bodies, but in the same direction

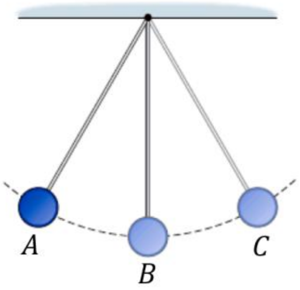
Q2. For the **pendulum** shown in the figure, the bob swings from point A to point C. **At what point does the ball have the maximum total mechanical energy (E)**? Ignore all resistance forces.

* at point A

* at point B

* at point C

[✓ *E is the same at all these points]



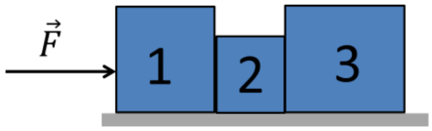
Q3. The three blocks, shown in the figure, are moving on **a frictionless** surface. The **contact force** between blocks (1) and (2) is F_{12}, while that between blocks (2) and (3) is F_{23}.**Which of the following is true?**

[✓ *$F_{12} > F_{23}$]

* $F_{12} < F_{23}$

* $F_{12} = F_{23}$

* $F_{12} < F_{23}$, only if $m_3 > m_1$



Q4. Two **identical blocks** are connected by a spring and suspended, **at rest**, from a string attached to the ceiling, as shown. The string breaks suddenly. **Immediately after the string breaks, the magnitude of the downward acceleration of the upper block:**

* $= 0$

* $< g$

* $= g$

[✓ *$> g$]