Kuwait University Physics Department

Physics 101

Summer Semester

Second Midterm Exam

Monday, July 09, 2018

6:00 pm – 7:30 pm

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

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

Choose your Instructor's Name:

Dr. Hala Al-Jassar
Dr. Fatema Al Dosari

Dr. Tariq Al Refai
Dr. Abdul Khaleq
Dr. Belal Salameh

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	SP1	SP2	SP3	SP4	SP5	LP1	LP2	Total
Pts	1	[illegible]	1	1	2	2	2	2	2	3	3	20

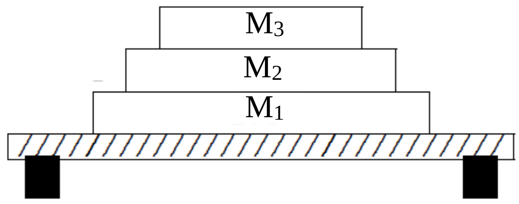
Important:

1. Answer all questions and problems.
2. Full mark = 20 points as arranged in the above table.
   i) 4 **Q**uestions
   ii) 5 **S**hort **P**roblems
   iii) 2 **L**ong **P**roblems.
3. No solution = no points.
4. **Use correct units.**
5. Check the correct answer for each question.
6. Assume g = 10 m/s^2.
7. Mobiles are **strictly prohibited** during the exam.
8. Programmable calculators, which can store equations, are not allowed.
9. **Cheating incidents will be processed according to the university rules.**

GOOD LUCK

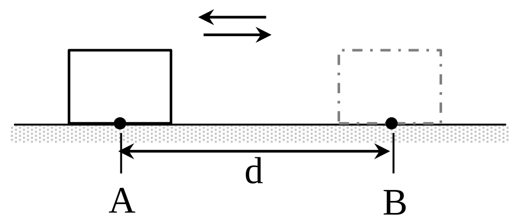
Part I: Questions (Choose the correct answer, one point each)

Q1. Three blocks (M_1, M_2, and M_3) **rest** on a table. **The table exerts a normal force**



* on all three masses.
* only on M_1.
* only on M_2.
* upward on M_1 and downward on M_2.

Q2. When a box of mass m is pushed a distance **d (from point A to point B)** along a surface with coefficient of kinetic friction μ_k, then pushed back **(from point B to point A)** along the same path, **the work done by friction is**



* 0.
* $-\mu_k mgd$.
* $-2\mu_k mgd$.
* $+2\mu_k mgd$.

Q3. The **apparent weight** (**Normal force**) of a man in an elevator is **greatest** when the elevator

* moves downward at constant velocity.
* moves upward at constant velocity.
* accelerates downward.
* accelerates upward.

Q4. As an object moves from point A to point B with **only two forces act on it**: one force is **non-conservative** and does **–30 J** of work, the other force is **conservative** and does **+50 J** of work. Then between A and B,

* the kinetic energy of the object increases, and the mechanical energy decreases.
* the kinetic energy of the object decreases, and the mechanical energy decreases.
* the kinetic energy of the object decreases, and the mechanical energy increases.
* the kinetic energy of the object increases, and the mechanical energy increases.

Part II: Short Problems (2 points each)

SP1. If the only forces acting on a 2 kg box are $\vec{F}_1 = (3\hat{i} - 9\hat{j})$N and $\vec{F}_2 = (5\hat{i} + 3\hat{j})$N, **what is the magnitude of the acceleration (in m/s²) of the box?**

$$\vec{F}_1 + \vec{F}_2 = m\vec{a}$$

$$\vec{a} = \frac{(3\hat{i}-9\hat{j})+(5\hat{i}+3\hat{j})}{2}$$

$$\vec{a} = (4\hat{i} - 3\hat{j})m/s^2$$

$$a = \sqrt{4^2 + 3^2} = 5\ \mathrm{m/s^2}$$

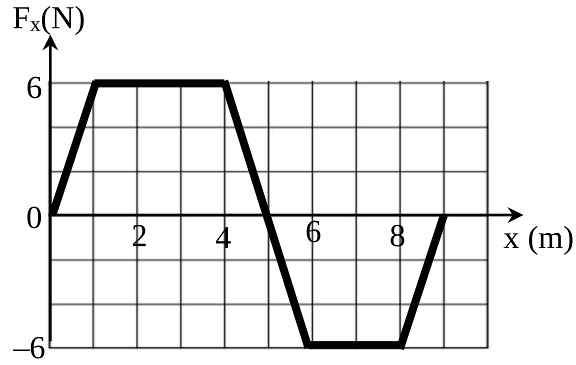
Answer: $5\ m/s^2$

SP2. A 2 Kg object moving along the x axis is acted upon by a force F_X that varies with position as shown. **How much work (in J) is done by this force as the object moves from x = 2 m to x = 8 m?**

$$w = \int_2^8 F_x \, dx = \text{Area under the curve}$$

$$w = 2 \times 6 + \frac{1}{2}(1)(6) + \frac{1}{2}(1)(-6) + 2(-6)$$

$$w = 0 \ \ J$$

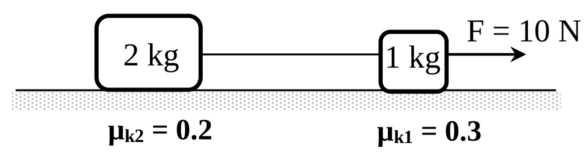


Answer: $w = 0 \ \ J$

SP3. In the figure, the coefficient of kinetic friction between the surface and the 2 Kg block is 0.2, and the coefficient of kinetic friction between the surface and the 1 kg block is 0.3. **What is the acceleration (in m/s²) of the system?**

$$F - f_{k_1} - f_{k_2} = (m_1 + m_2)a$$

$$F - \mu_{k_1} m_1 g - \mu_{k_2} m_2 g = (m_1 + m_2)a$$



$$a = \frac{F - \mu_{k_1} m_1 g - \mu_{k_2} m_2 g}{m_1 + m_2} = \frac{10 - 0.3(1)(10) - (0.2)(2)(10)}{3} = 1 \ m/s^2$$

Answer: $a = 1 \ m/s^2$

SP4. As a particle moves along the x axis it is acted upon by **a single conservative force** given by $F_X = (20 - 4x)$ N where x is in m. The potential energy associated with this force has the value +30 J at the origin (x = 0 m). **Find the potential energy (in J) at x = 4 m.**

$$w = -\Delta U$$

$$\int_0^4 (20 - 4x)dx = -[U(4\text{ m}) - 30]$$

$$20x - 2x^2 \Big|_0^4 = -U(4\text{ m}) + 30$$

$$U(4\text{ m}) = -18 \text{ J}$$

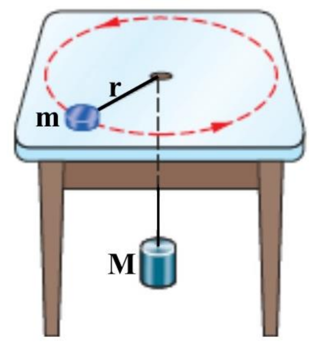
Answer: $U(4\text{ m}) = -18 \text{ J}$

SP5. A disc (m=1.5 Kg) rotates in a circle of radius r = 0.24 m on a **frictionless** table while attached to a hanging cylinder of mass M = 2.5 Kg by a cord that extends through a hole in the table as shown. **What is the speed (in m/s) of the disc that keeps the cylinder at rest?**

$$F_r = T = \frac{mv^2}{R} = Mg$$

$$Mg = \frac{mv^2}{R}$$

$$v = \sqrt{\frac{MgR}{m}} = \sqrt{\frac{25\times 0.24}{1.5}} = 2\ \mathrm{m/s}$$

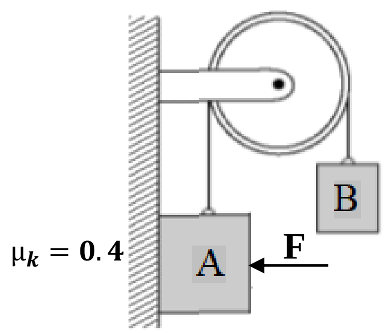


Answer: $v = 2\ \mathrm{m/s}$

Part III: Long Problems (3 points each)

LP1. Block **A** of mass 5 Kg and block **B** are attached to a rope which passes over a massless and frictionless pulley as shown in the figure. A force $\mathbf{F} = \mathbf{50\ N}$ is applied horizontally to block **A**, **keeping it in contact** with **a rough vertical wall**. The coefficient of kinetic friction between the wall and block A is $\mu_k = \mathbf{0.4}$. **Block A moves upward with an acceleration of $a = 2\ m/s^2$.**

a) What is the tension (in N) in the cord?



$$T - m_A g - f_k = m_A a$$

$$f_k = \mu_k n = \mu_k F$$

$$T = m_A(g + a) + \mu_k F$$

$$T = 5(10 + 2) + (0.4)(50) = 80\ \mathrm{N}$$

Answer: $T = 80\ \mathrm{N}$

b) What is the mass (in kg) of block B?

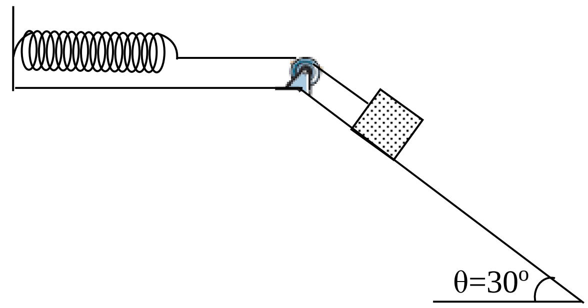
$$m_B g - T = m_B a$$

$$m_B = \frac{T}{(g-a)} = \frac{80}{8} = 10\ \mathrm{kg}$$

Answer: $m_B = 10\ \mathrm{kg}$

LP2. A 6 Kg box on **a frictionless** incline of angle $\theta = 30°$ is connected, by a light cord that runs over a massless and frictionless pulley, to a spring of spring constant $k = 150$ N/m, as shown in the figure. The box is released **from rest when the spring is unstretched**.

a) **What is the speed (in m/s) of the block when it has moved 0.2 m down the incline?**



$$E_i = E_f$$

$$mg(0.2)\sin\theta = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$$

$$6 = 3v^2 + 3$$

$$v = 1 \text{ m/s}$$

Answer: $v = 1$ m/s

b) **How far down the incline (in m) from its point of release does the box slide before it momentarily stops?**

$$E_i = E_f$$

$$mgx\sin\theta = \frac{1}{2}kx^2$$

$$x = \frac{mg\sin\theta}{\frac{1}{2}k} = 0.4 \text{ m}$$

Answer: $x = 0.4$ m

c) **At the instant the box momentarily stops down the incline, its acceleration is**

- Up the incline
- Down the incline
- zero