Kuwait University Physics Department

Physics 101

Spring Semester
Second Midterm Exam
Saturday, September 12, 2020
3:30 pm – 05:00 pm

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

Student's Number: ….…… Section: ……

Choose your Instructor's Name:

Prof. Yacoub Makdisi	Dr. Tareq Al Refai
Dr. Ahmed Al-Jassar	Dr. Belal Salameh
Dr. Hala Al-Jassar	Dr. Abdel Khaleq
Dr. Nasser Demi	Dr. Fatma Douseri

For Instructors use only

Grades:

#	Q1	Q2	Q3	Q4	Q5	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Total
Pts	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	25

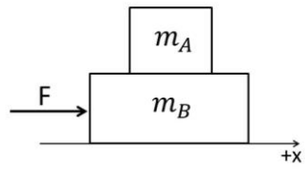
Important:

1. Answer all questions and problems.
2. Full mark = 25 points as arranged in the above table.
   i) 5 **Q**uestions
   ii) 10 **P**roblems
3. No solution = no points.
4. Check the correct answer for each question.
5. Assume g = 10 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.**

GOOD LUCK

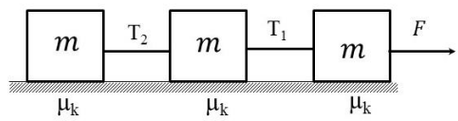
Part I: Questions (Choose the correct answer, one point each):

Q1. The two boxes **move together with constant speed** due to the applied force F. The direction and magnitude of the friction force acting **on the box of mass m_A** equals:



(*) zero
* $\mu_s m_A g$ (along the - x-axis)
* $\mu_s m_A g$ (along the + x-axis)
* $\mu_k m_A g$ (along the - x-axis)
* $\mu_k m_A g$ (along the + x-axis)

Q2. **Three identical boxes** are connected by light strings. They are pulled along a straight line with a **constant speed** on **a rough** horizontal surface by a force F. If T_1 and T_2 are the tensions in the strings as shown, then:



* $F = T_1$
* $F = T_1 + T_2$
* $F = \mu_k mg$
* $F = T_1 + 2\mu_k mg$
(*) $F = 3\mu_k mg$

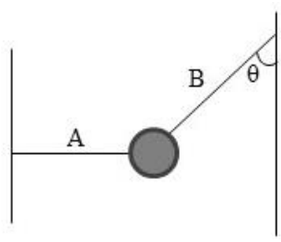
Q3. Which of the following objects has **the largest** kinetic energy?

* Mass M and speed 4V
(*) Mass 2M and speed 3V
* Mass 3M and speed 2V
* Mass 4M and speed V
* Mass 10M and speed V

Q4. An object is thrown straight up. Which of the following is true about **the sign of work done by the gravitational force** while the object moves up and then down?

* positive on both ways up and down.
* negative on both ways up and down.
(*) negative on the way up and positive on the way down
* positive on the way up and negative on the way down
* zero on the way up and zero on the way down

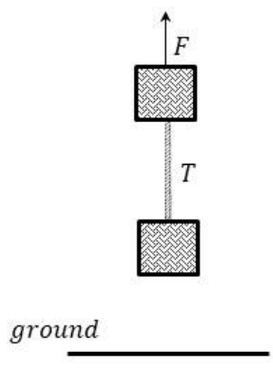
Q5. A ball of mass m is **held** in place by light steel cables. Cable B makes an angle θ with the wall. The tension in cable A equals



* Zero
* mg
(*) mg tan θ
* mg cos θ
* mg sin θ

Part II: Problems (Answer the following problems, two points each)

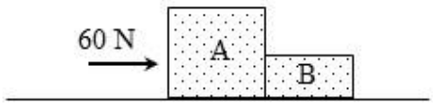
P1. Two **identical boxes** are connected by a light rope. An applied force F = 200 N is pulling the boxes vertically upward with a **constant velocity**. Find the tension in the rope.



$F - 2mg = 0 \quad \Rightarrow \quad mg = \frac{F}{2} = 100\ N$

$T - mg = 0 \quad \Rightarrow \quad T = mg = 100\ N$

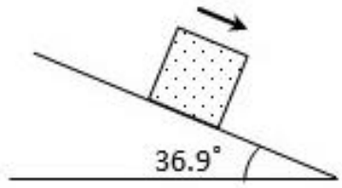
P2. Box A ($m_A = 20\ kg$) and box B ($m_B = 10\ kg$) are in contact on a horizontal **frictionless surface**. A horizontal force of 60 N is exerted on box A. Find the magnitude of the force that box A exerts on box B.



$$60\ N = (m_A + m_B)a_x \quad \Rightarrow \quad a_x = \frac{60}{m_A + m_B} = 2\ m/s^2$$

$$F_{AB} = m_B a_x = 20\ N$$

P3. A box **slides down on a rough ramp** ($\mu_k = 0.5$) as shown in the figure. Calculate the acceleration of the box.

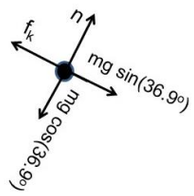


$$n = mg\cos(36.9^o)$$

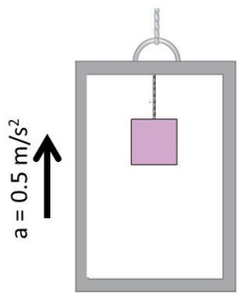
$$mg\sin(36.9^o) - f_k = ma_x$$

$$mg\sin(36.9^o) - \mu_k mg\cos(36.9^o) = ma_x$$

$$a_x = g[\sin(36.9^o) - \mu_k \cos(36.9^o)] = 2m/s^2$$



P4. A 2 kg box **is held** by a light cable that is fastened to the ceiling of an elevator. If the elevator accelerates **upward** at 0.5 m/s^2, find the tension in the cable.



$$T - mg = ma$$

$$T = m(g + a) = 2(10 + 0.5) = 21\ N$$

P5. Ali of weight 400 N sits on a Ferris wheel of radius 4 m. The wheel rotates in **a vertical circle** with constant speed of 2 m/s. Find the **force that the seat exerts on Ali** when Ali is **at the bottom** of the circle.

At the bottom

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

$$n = m\left(g + \frac{v^2}{R}\right) = 40\left(10 + \frac{2^2}{4}\right) = 440\ N$$

P6. **A variable horizontal** force acts on an object along the x axis is given by $F(x) = x^2 + 4x + 1$ (where x is in meters and F is in N). Find the work done by this force in moving the object from x = 0 m to x = 3 m.

$$W = \int_{x_1}^{x_2} F_x\, dx = \int_0^3 (x^2 + 4x + 1)\ dx$$

$$= [\frac{1}{3}x^3 + 2x^2 + \mathrm{x}]_0^3$$

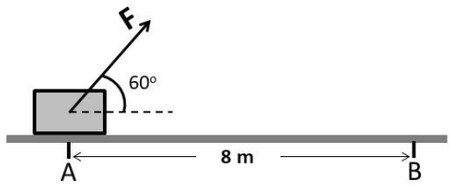
$$= 30\ J$$

P7. What is the **average power** needed to lift a box of 80 kg mass by 20 m in 40 s?

$$P_{av} = \frac{W}{t} = \frac{mgh}{t}$$

$$= \frac{(80)(10)(20)}{40} = 400\ watt$$

P8. A 20 kg box is pulled by a constant force F and moved along **a frictionless horizontal** surface as shown. If the speed of the box at point A is 3 m/s and at point B is 7 m/s, find the magnitude of the force F.

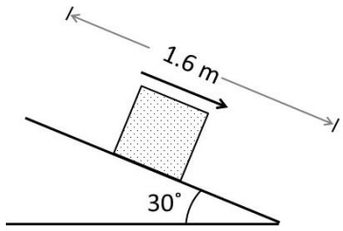


$$\sum W = \Delta K \quad \Rightarrow W_F = \Delta K$$

$$F\, r\cos(60^o) = K_f - K_i = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$F = \frac{1/2\, m(v_f^2 - v_i^2)}{r\cos(60^o)} = \frac{1/2\,(20)(7^2 - 3^2)}{8(0.5)} = 100\ N$$

P9. A 12 kg block is released from **rest** at the top of **a rough incline** as shown. The block reaches a speed of 3 m/s at the bottom of the incline. How much work is done **by the friction force** on the block?



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

$$W_{f_k} = \frac{1}{2}mv_f^2 - mgy_i$$

$$= \frac{1}{2}(12)(3^2) - (12)(10)(1.6)\sin(30^o) = -42\ J$$

P10. A block is pushed against spring 1 (k_1 = 625 N/m), compressing it 0.2 m. When it is released from rest, the block leaves spring 1 and travels along **a frictionless track** and then hits spring 2 (k_2 = 400 N/m). What is the **maximum compression distance of spring 2**?

$$E_f = E_i$$

$$\frac{1}{2}k_1x_1^2 = \frac{1}{2}k_2x_2^2$$

$$x_2 = x_1\sqrt{\frac{k_1}{k_2}} = 0.2\sqrt{\frac{625}{400}} = 0.25\ m$$