Kuwait University Physics Department

Physics 101

Spring Semester
Second Midterm Exam
Saturday, May 14, 2022
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 Instructors use only

Grades:

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

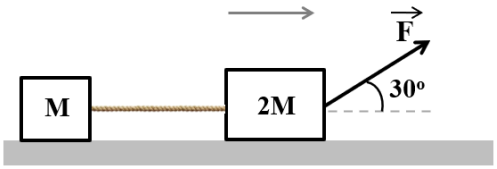
Important:

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 **strictly prohibited** 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, the force $|\vec{F}| = 35\ N$ acts to move the two blocks on a horizontal **frictionless surface**. The blocks are connected by a massless string. **Find the magnitude of the tension (T) in the string**.



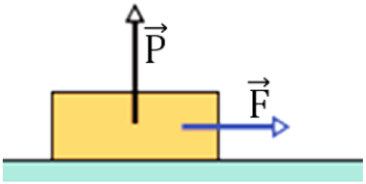
Block 2M: $F\ cos\ 30^o - T = 2Ma$

Block M: $T = Ma$

$$F\ cos\ 30^o - T = 2T$$

$$T = \frac{F \cos 30^o}{3} = 10.1\ N$$

SP2. A block of mass ($m = 3\ Kg$) is initially **at rest** on **a rough** horizontal surface. A horizontal force $|\vec{F}| = 8\ N$ and a vertical force $|\vec{P}| = 6\ N$ are then applied to the block, as shown. The coefficients of friction between the block and surface are (μ_s= 0.4 and μ_k= 0.3). **Find the magnitude of the frictional force acting on the block. Is it static or kinetic?**

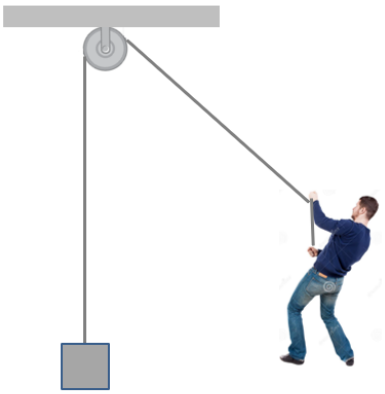


$(f_s)_{max} = \mu_s(mg - P) = 0.4\ (30 - 6) = 9.6\ N$

$F = 8N < (f_s)_{max}$, so the block will stay at rest.

$f_s = F = 8\ N$, it is static friction.

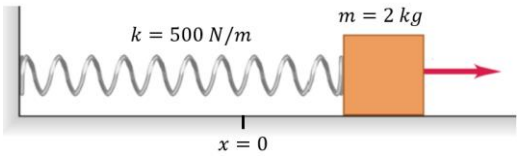
SP3. A 90 kg block is connected to a light rope that passes over a massless pulley, as shown. A man pulls the rope, and the block moves vertically upward at **constant speed**. **Find the average power output of the man if the block moves 6 m in 12 s .**



$w_{man} = mgh = 90(10)(6) = 5400\ J$

$$P_{av} = \frac{w_{man}}{t} = \frac{5400}{12} = 450\ W$$

SP4. A block ($m = 2\ kg$) is attached to a spring ($k = 500\ N/m$). The block is pulled 5 cm to the right of equilibrium and **released from rest**. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.35$. **Find the speed of the block as it passes through equilibrium position ($x = 0$).**



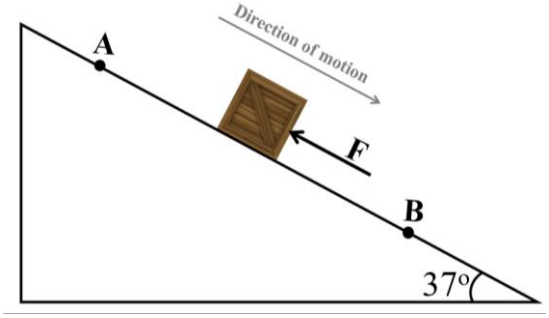
$$E_f - E_i = W_{other}$$

$$\frac{1}{2}mv_f^2 - \frac{1}{2}kx_i^2 = -f_k d$$

$$\frac{1}{2}(2)v_f^2 - \frac{1}{2}(500)(0.05)^2 = -\mu_k mgd$$

$$v_f = \sqrt{0.625 - 0.35(2)(10)(0.05)} = 0.52\ m/s$$

SP5. A 4 kg block is **lowered down** a 37° **rough** incline a distance of 5 m **<u>from point A to point B</u>**. A constant force $|\vec{F}| = 12\ N$ is applied to the block between A and B, as shown. The kinetic energy of the block at A is 15 J and at B is 30 J. **Use work energy theorem to find the work done on the block by the force of friction between A and B?**



$$W_F + W_g + W_n + W_{f_k} = K_f - K_i$$

$$-5F + mg(5\sin 37^o) + W_{f_k} = 30 - 15$$

$$W_{f_k} = -45.4\ J$$

Part II: Long Problems (3 points each)

LP1. Only two forces $\vec{F}_1$, and $\vec{F}_2$ act on a particle with mass $m = 3\ kg$. The forces are:

$$\vec{F}_1 = 2\hat{\imath} - 5\hat{\jmath} + 2\hat{k}$$

$$\vec{F}_2 = -5\hat{\imath} + 8\hat{\jmath} + \hat{k}$$

F_1 and F_2 are measured in N.

(a) What is the net force in unit vector notation?

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = \left(-3\hat{\imath} + 3\hat{\jmath} + 3\hat{k}\right) N$$

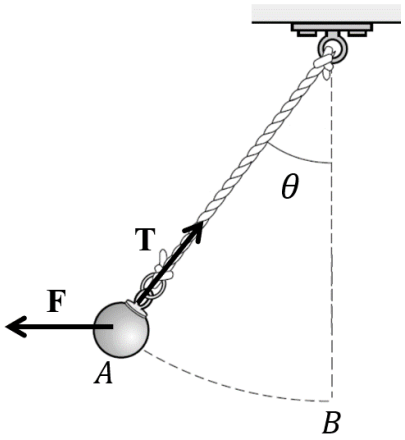
(b) What is the magnitude of the acceleration?

$$\vec{a} = \frac{\vec{F}_{net}}{m} = \left(-1\hat{\imath} + 1\hat{\jmath} + 1\hat{k}\right) m/s^2$$
$$|\vec{a}| = \sqrt{1+1+1} = 1.73\ m/s^2$$

(c) **If the particle starts <u>from rest</u> at the origin, what is its speed at the position $\vec{r} = \left(-2\hat{\imath} + 2\hat{\jmath} + 2\hat{k}\right)m$**

$$w = \vec{F}.\Delta\vec{r} = \Delta K$$
$$6 + 6 + 6 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$
$$18 = \tfrac{1}{2}(3)v_f^2$$
$$v_f = 3.46\ m/s$$

LP2. In the figure below, a ball ($m = 0.5\ kg$) hangs from the ceiling. The length of the string is $l = 1.2\ m$. A horizontal force, $\vec{F}$, holds the ball steady. Given $\theta = 30°$.



a) Find the magnitude of the tension (T) in the string at point A.

$$mg = T\ cos\ \theta\ \Rightarrow T = \frac{mg}{cos\ \theta} = 5.77\ N$$

b) If the ball is released ($F = 0$), what will be the speed of the ball at point B?

$$E_i = E_f$$

$$mgh_i = \frac{1}{2}mv_B^2$$

$$10(1.2 - 1.2\cos(30)) = \frac{1}{2}v_B^2$$

$$v_B = 1.8\ m/s$$

c) What is the magnitude of the net force on the ball at point B?

$F_{tan} = zero$ at the bottom point

$$F_{net} = F_r = \frac{mv^2}{R} = \frac{0.5(1.8)^2}{1.2} = 1.35\ N$$

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

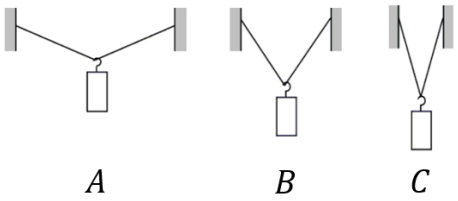
Q1. A block of mass m is suspended by **a string of fixed length**. The ends of the string are held at various positions, as shown. **In which case, if any, is the magnitude of the tension (T) in the string the largest?**

(*) case A

* case B

* case C

* same in all three cases.



Q2. A 20 kg boy stands on a scale while riding in the elevator. If the scale reads 180 N, then the elevator is moving

* upward with increasing speed

(*) upward with decreasing speed

* downward with decreasing speed

* upward with constant speed

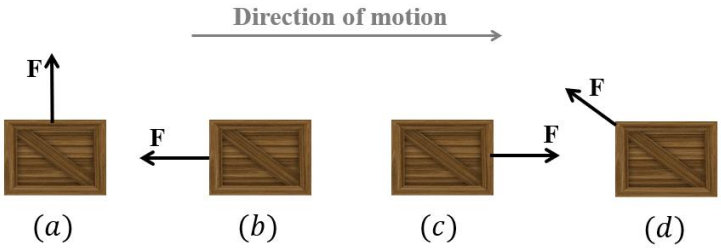
Q3. The figure shows four situations in which a force is applied to an object. In all cases, **the force (F) has the same magnitude, and the object moves 4 m <u>to the right</u>. Rank the situations according to the work done by the force F, from most positive to most negative.**

* a b c d

* c d a b

* b d c a

(*) c a d b



Q4. If only **conservative forces** are acting on a body, then **the work done by these forces**

* does not change the potential energy

* does not change the kinetic energy

(*) does not change the total mechanical energy

* is always negative