UNIVERSITY OF GAZIANTEP
DEPARTMENT OF ENGINEERING PHYSICS
EP 105 General Physics I
First Midterm Exam *FALL SEMESTER*

Date: 06/11/2018 Time: 08:30 Duration: 100 min.

Ques.	Mark
1	20
2	20
3	20
4	20
5	20
Total	100

DEPARTMENT : ☐ CE ☐ MME ☐ IE ☐ ME ☐ TE

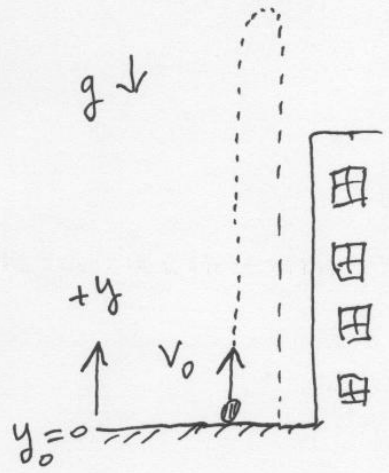
Name	Surname	Student No	Signature
	SOLUTIONS		

- Cheating is a serious offence and may lead to your dismissal from the university.
- Ignore air resistance in all problems unless otherwise stated.
- Write clearly your solutions steps to the space provided and results to the boxes.
- Constants: $g = 9.8\ m/s^2$, $\pi = 3.141593$
- Conversions: $1\ mm = 10^{-3}\ m$, $1\ cm = 10^{-2}\ m$, $1\ km = 10^{3}\ m$, $1\ h = 3600\ s$, $1\ min = 60\ s$, $1\ rev = 2\pi\ rad$.

QUESTION 1 (20 %)

A rock is thrown vertically upward from ground level at time $t = 0$. When $t = 1.5$ s, it passes the top of a tall tower, and 1.0 s later it reaches its maximum height.

(a) What is the height of the tower?



At maximum height $v = 0$

$V = V_0 - gt$

$0 = V_0 - (9.8)(2.5)$ (5)

$V_0 = 24.5\ m/s$

when it passes the top of the tower, time is $t = 1.5$ s

$y = y_0 + V_0 t - \frac{1}{2} g t^2$

$y = 0 + (24.5)(1.5) - \frac{1}{2} 9.8 (1.5^2)$

$= 26.0\ m$

$y = 26.0\ m$ (5)

(b) Calculate the speed of the rock when it comes back to ground level.

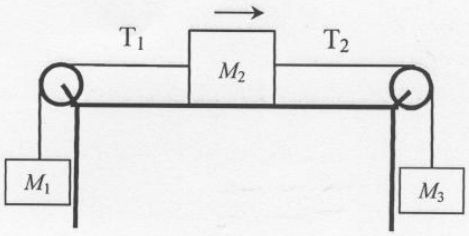
when it comes back to the ground, the ball will have the lunch velocity.

that is: $V = V_0 = 24.5\ m/s$ (10)

$V = 24.5\ m/s$

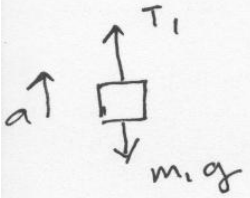
QUESTION 2 (20 %)

The drawing shows three objects. They are connected by strings that pass over massless and frictionless pulleys. The objects move and the coefficient of kinetic friction between the middle object and the surface of the table is 0.1. (M_1 = 10 kg, M_2 = 80 kg and M_3 = 25 kg)



(a) What is the common acceleration of the three objects?

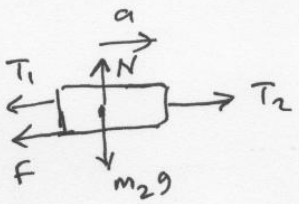
Direction of motion of the system is right.



Newton's 2nd law:

$T_1 - m_1 g = m_1 a$

$T_1 - 98 = 10a$ (1)



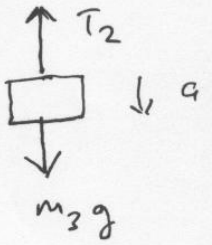
$T_2 - T_1 - f = m_2 a$

$T_2 - T_1 - \mu N = m_2 a$

$T_2 - T_1 - \mu m_2 g = m_2 a$

$T_2 - T_1 - (0.1)(80)(9.8) = 80a$

$T_2 - T_1 - 78.4 = 80a$ (2)



$m_3 g - T_2 = m_3 a$

$245 - T_2 = 25a$ (3)

adding (1) + (2) + (3) yields

$68.6 = 115a$

$a = 0.6\ m/s^2$ (10)

$\boxed{a = 0.6\ m/s^2}$

(b) Find the tensions (T_1, T_2) in strings.

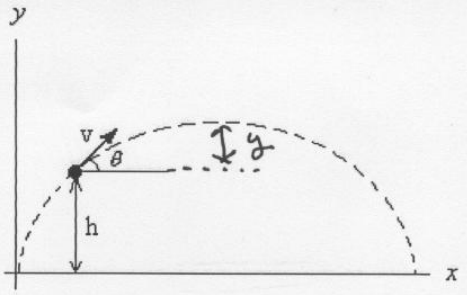
(5) From eqn (1) → $T_1 = 98 + 10a = 98 + (10)(0.6) = 104\ N$

(5) From eqn (3) → $T_2 = 245 - 25a = 245 - 25(0.6) = 230.4$ a

$\boxed{T_1 = 104.0\ N}$ $\boxed{T_2 = 230.4\ N}$

QUESTION 3 (20 %)

A ball is thrown from the ground into air. At height of $h = 10.0\ m$, the speed is observed to be $v = 20\ m/s$ and the angle between speed of the ball and the horizontal axis is $\theta = 37^0$, as shown in Figure. Use only equations of motion.



(a) To what maximum height will the ball rises?

$$y = \frac{v_y^2}{2g} = \frac{(20\sin 37^\circ)^2}{2(9.8)} = 7.3\ m$$

$$h_{max} = h + y = 10 + 7.3 = 17.3\ m \quad (8)$$

$$\boxed{h_{max} = 17.3\ m}$$

(b) What are the initial speed V_0 and the components of the initial speed of the ball at t=0?

$$v^2 = v_0^2 - 2gh$$

$$20^2 = v_0^2 - 2(9.8)(10)$$

solving for v_0

$$v_0 = 24.4\ m/s \quad (4)$$

$$V_x = V_{ox} = V\cos 37 = 20\cos 37^\circ = 16\ m/s \quad (4)$$

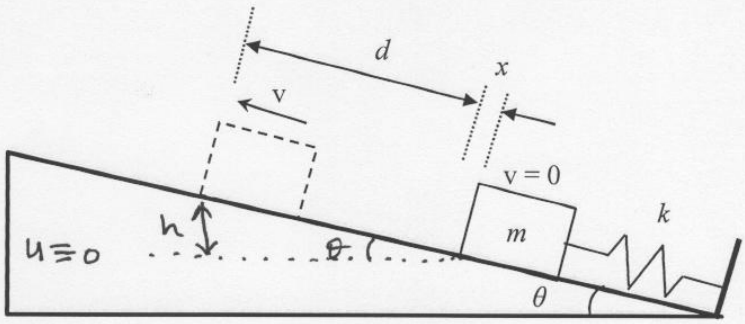
$$V_{oy} = \sqrt{V_0^2 - V_{ox}^2} = \sqrt{24.4^2 - 16^2} = 18.4\ m/s \quad (4)$$

$$V_{ox} = 16.0\ m/s,\ V_{oy} = 18.4\ m/s$$

$$\boxed{V_0 = 24.4\ m/s}$$

QUESTION 4 (20 %)

A block $m = 0.4$ kg is connected to a spring of spring constant $k = 1000$ N/m. Spring is initially compressed by a distance $x = 0.2$ m on a frictionless inclined plane ($\theta = 30^0$). The spring-block system is released and the block slides up as shown in Figure. Determine the speed of the block when it moves $d = 1$ m on the plane. Use conservation of energy law.



Conservation of mechanical Energy:

$$E_i = E_f$$

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + mgh$$

From geometry

$$h = (d+x)\sin\theta$$

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + mg(d+x)\sin\theta \quad (10)$$

$$\frac{1}{2}(1000)(0.2)^2 = \frac{1}{2}(0.4)V^2 + (0.4)(9.8)(1+0.2)\sin 30^\circ$$

$$V^2 = 88.2\ m^2/s^2$$

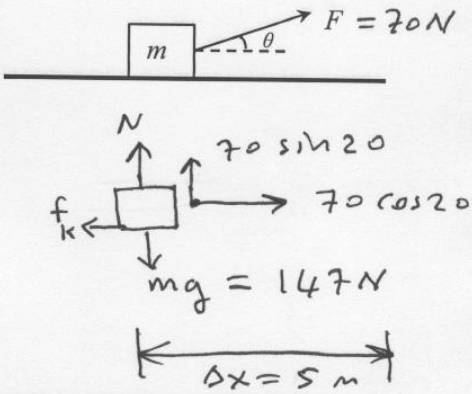
Solving for

$$V = 9.4\ m/s \quad (10)$$

$$\boxed{V = 9.4\ m/s}$$

QUESTION 5 (20 %)

A 15-kg block which is at rest is dragged over a rough horizontal surface by a 70 N force acting at 20° above the horizontal. The block is displaced 5 m on the surface and the coefficient of kinetic friction is 0.3.



$mg = (15)(9.8) = 147\ N$

(a) Find the work done on the block by 70-N force.

$\Sigma F_y = N + 70\sin 20 - 147 = 0$

$N = 123\ N.$

$f_k = \mu_k N = (0.3)(123) = 36.9\ N$

$W = F\Delta x \cos\theta = (70)(5)(\cos 20) = 329\ J$

W = 329 J (4)

(b) Find the work done on the block by the normal force.

$W = F\Delta x \cos\alpha = N\Delta x \cos\alpha = (123)(5)\cos 90° = 0$

α is the angle between N and Δx

W = 0 (4)

(c) Find the work done on the block by the gravitational force.

$W = F\Delta x \cos\alpha = mg\Delta x \cos\alpha = (147)(5)\cos 90 = 0$

W = 0 (4)

(d) What is the increase in internal energy of the block-surface system due to friction?

$|W_f| = \Delta E_{int} = f_k \Delta x = (36.9)(5) = 185\ J$

ΔE_{int} = 185 J (4)

(e) What is the speed of the block after being pulled 5 m?

$\Delta K = K_f - K_i = W - \Delta E_{int}$

$= W + W_f = 329 - 185 = 144\ J$

$\frac{1}{2} m v_f^2 - \underbrace{\frac{1}{2} m v_i^2}_{0} = 144$

$\frac{1}{2} m v_f^2 = 144$

Solving for $v_f = 4.4\ m/s$

V = 4.4 m/s (4)