King Saud University
Faculty of Science
Physics & Astronomy Dept.

15

2nd midterm exam 103 Physics	(1st term 1434/1435 H)	time: 1.5 hour

الإسم: الرقم الجامعى: الشعبة:

☼Circle the right answers of the following questions ☼

N.B. Take g (gravitational acceleration) = 10 m/s^2

1- A box slides down an inclined plane that makes an angle of 30° with the horizontal. If the coefficient of kinetic friction is 0.22, the acceleration of the box is:

a) 15.5 m/s² **b)** 4.7 m/s² **c)** 3.1 m/s² **d)** 0.22 m/s² **e)** 9.8 m/s²

$\sum F = ma$

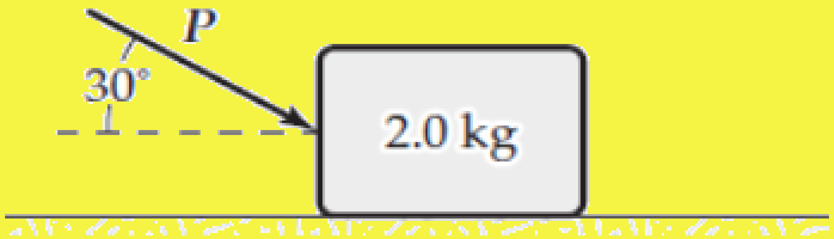
$\rightarrow mg\sin\theta - f = ma$

$\rightarrow mg\sin\theta - mg\cos\theta\,\mu = ma$

$a = 10 \times \sin 30 - 10 \times \cos 30 \times 0.22$

$= 3.4\ m/s^2$

2- A **2 kg** block slides on a rough horizontal surface. A force (P = 6 N) is applied to the block as shown in the figure. If the magnitude of the block's acceleration is 1.2 m/s^2, the coefficient of kinetic friction between the block and the surface is: $\mu = ?$



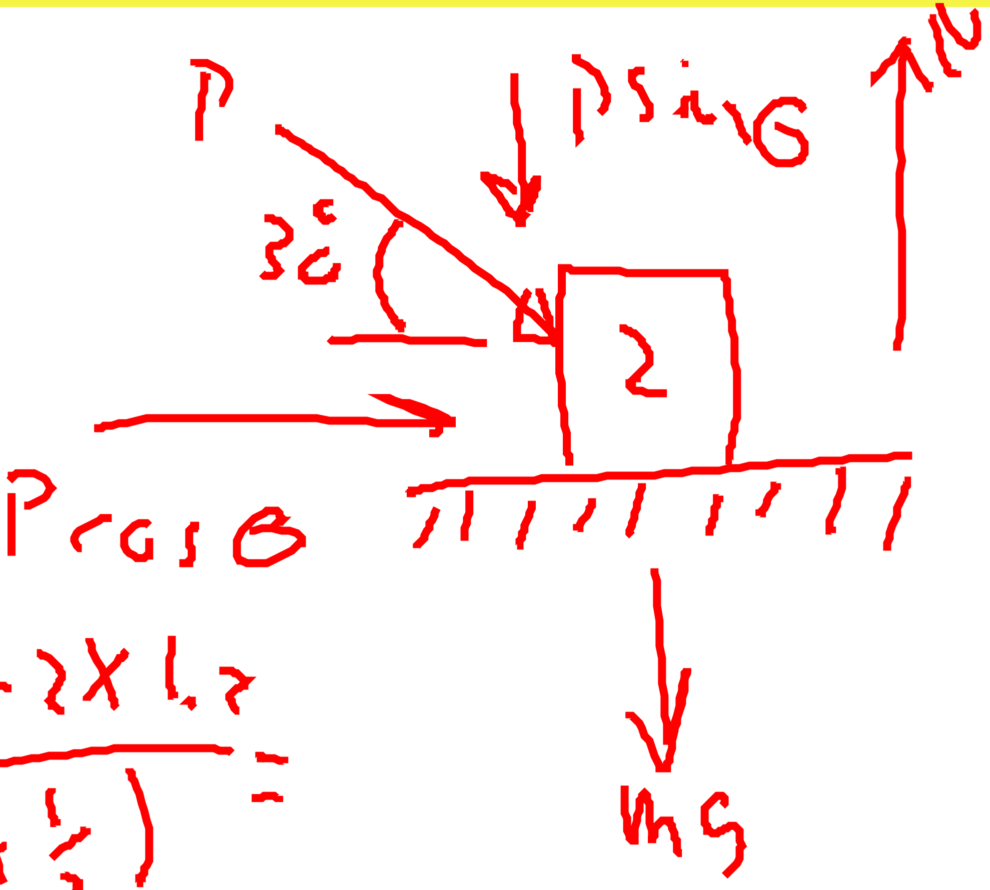
a) 0.12 **b)** 0.32 **c)** 0.42 **d)** 0.51 **e)** 0.22

$$\sum F = ma$$

$$\rightarrow P\cos\theta - f = ma$$

$$\Rightarrow P\cos\theta - (mg + P\sin\theta)\mu = ma$$

$$\rightarrow \mu = \frac{P\cos\theta - ma}{(mg + P\sin\theta)} = \frac{6\cos 30 - 2\times 1.2}{(2\times 10 + 6\times \frac{1}{2})} =$$



3- If a flying pilot feels weightless as he passes over the top of a vertical circular path of radius 4940 m, his speed at that position is:

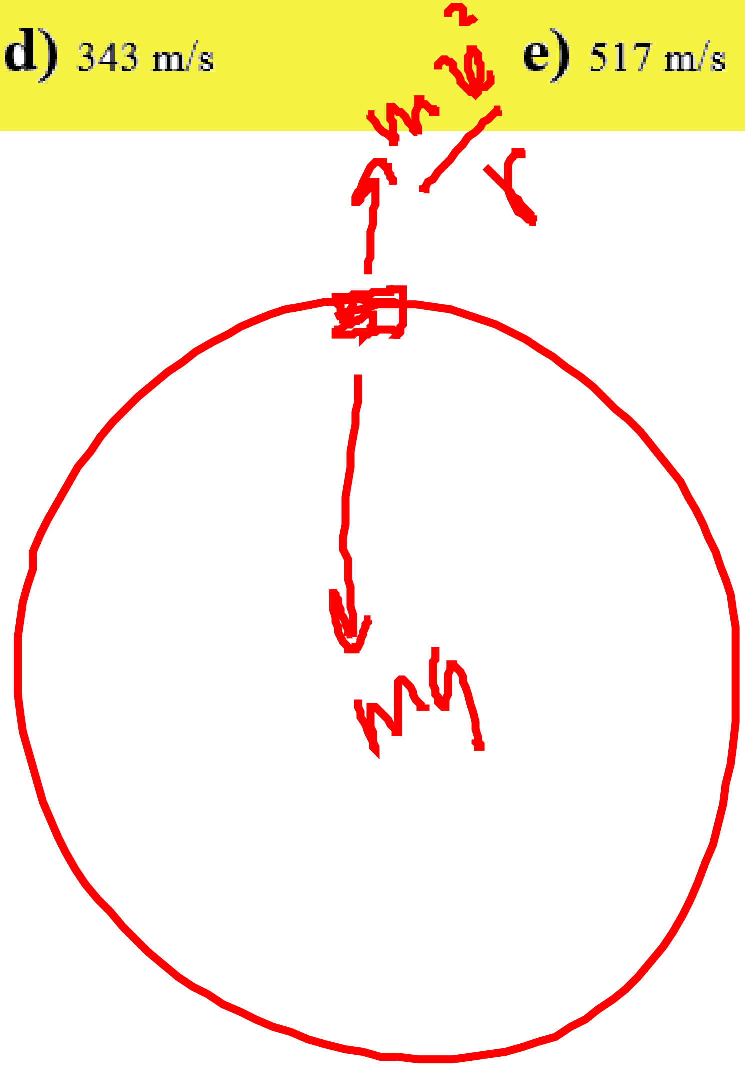
a) 155 m/s **b)** 222 m/s **c)** 494 m/s **d)** 343 m/s **e)** 517 m/s

$\because W = 0$

$\rightarrow mg = m\frac{v^2}{r}$

$\rightarrow v = \sqrt{gr}$

$= \sqrt{10 \times 4940}$



4- A 6 kg block initially at rest is pulled to the right along a horizontal frictionless surface by a constant horizontal force of 10 N. The speed of the block after it moved 3 meter is:

a) 5.13 m/s **b)** 7.22 m/s **c)** 4.73 m/s **d)** 2.25 m/s **e)** 3.16 m/s

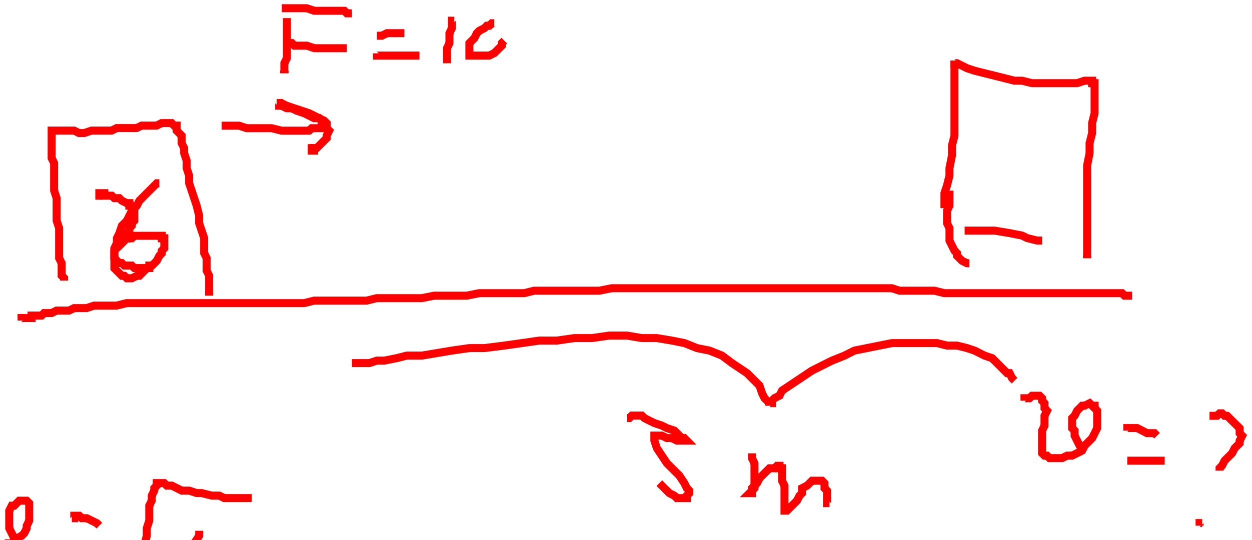
① method ①

$\because v_f^2 = v_i^2 + 2ax$

$\because F = ma$

$\rightarrow a = F/m = 10/6$

$\therefore v_f^2 = 0 + 2 \times \frac{10}{6} (3) \rightarrow v_f = \sqrt{10} =$



② method ②: $\frac{1}{2} m v_f^2 = W = Fd = 10 \times 3$

$\rightarrow v_f = \sqrt{10}$

5- A bullet of mass 5 g was fired horizontally with a speed of 600 m/s to penetrate a wall for a depth of 4 cm. The average frictional force that stopped the pullet is:

a) 11.5 kN **b)** 33.2 kN **c)** 22.5 kN **d)** 42.2 kN **e)** 56.3 kN

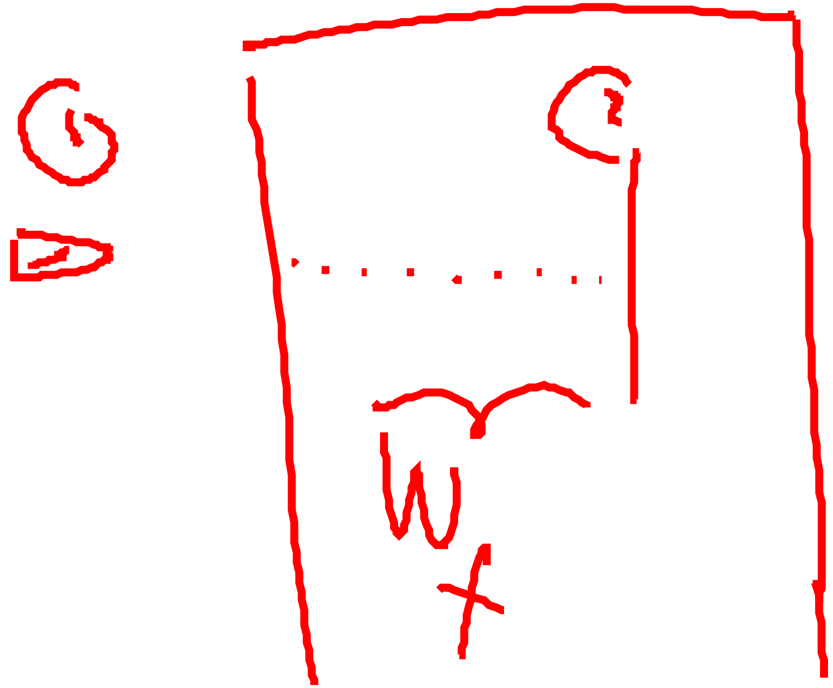
① $\frac{1}{2} m v^2$ ② $= 0$

$\frac{1}{2} m v^2 = W_f$

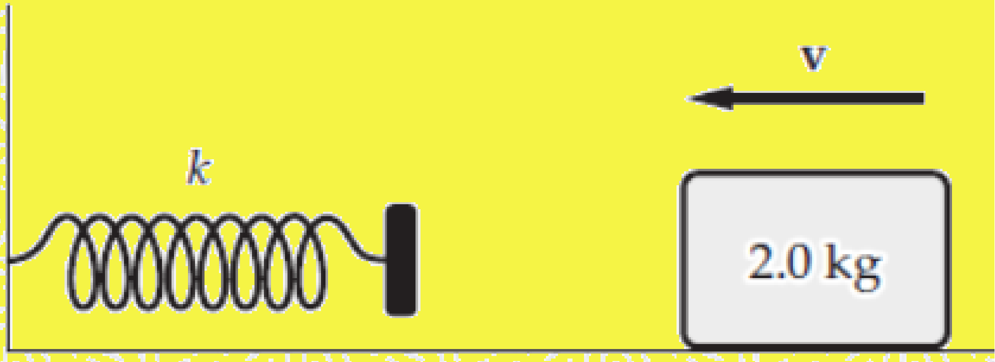
$= f d$

$\therefore \frac{1}{2} m v^2 = f (4 \times 10^{-2})$

$$\therefore f = \frac{\frac{1}{2} \times 5 \times 10^{-3} \times (600)^2}{4 \times 10^{-2}} =$$



6- A block of mass **2 kg** slides on a frictionless horizontal surface towards the free end of a fixed spring of $k = 2$ kN/m (as shown in the figure). If the speed of the block before it touches the spring is 6 m/s, the speed of the block when the spring is compressed 15 cm is:



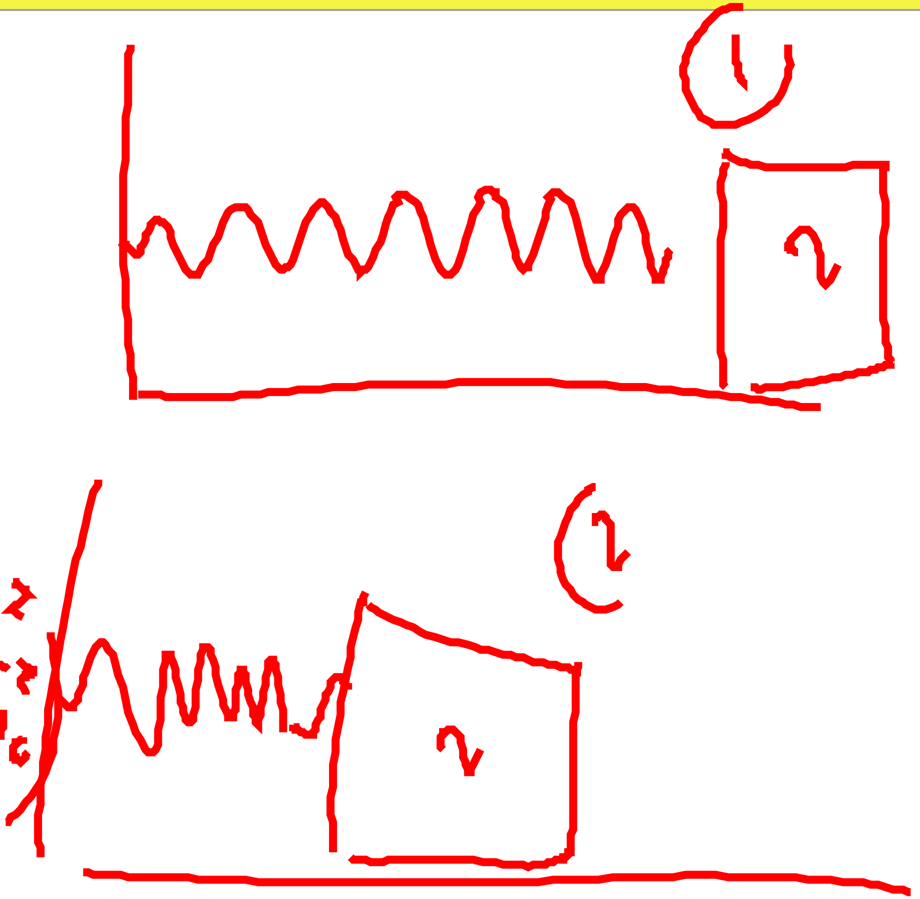
a) 3.7 m/s **b)** 4.4 m/s **c)** 4.9 m/s **d)** 5.4 m/s **e)** 1.4 m/s

① $\frac{1}{2} m v_i^2$

② $\frac{1}{2} m v_f^2 + \frac{1}{2} k x^2$

$\therefore \frac{1}{2} m v_i^2 = \frac{1}{2} m v_f^2 + \frac{1}{2} k x^2$

$\therefore v_f^2 = \frac{2 \times 36 - \frac{1}{2} \times 2000 \times (15 \times 10^{-2})^2}{2}$



7- A car is traveling at 22.4 m/s on a horizontal highway. If the coefficient of static friction between road and tires on a rainy day is 0.1, the minimum distance in which the car will stop is:

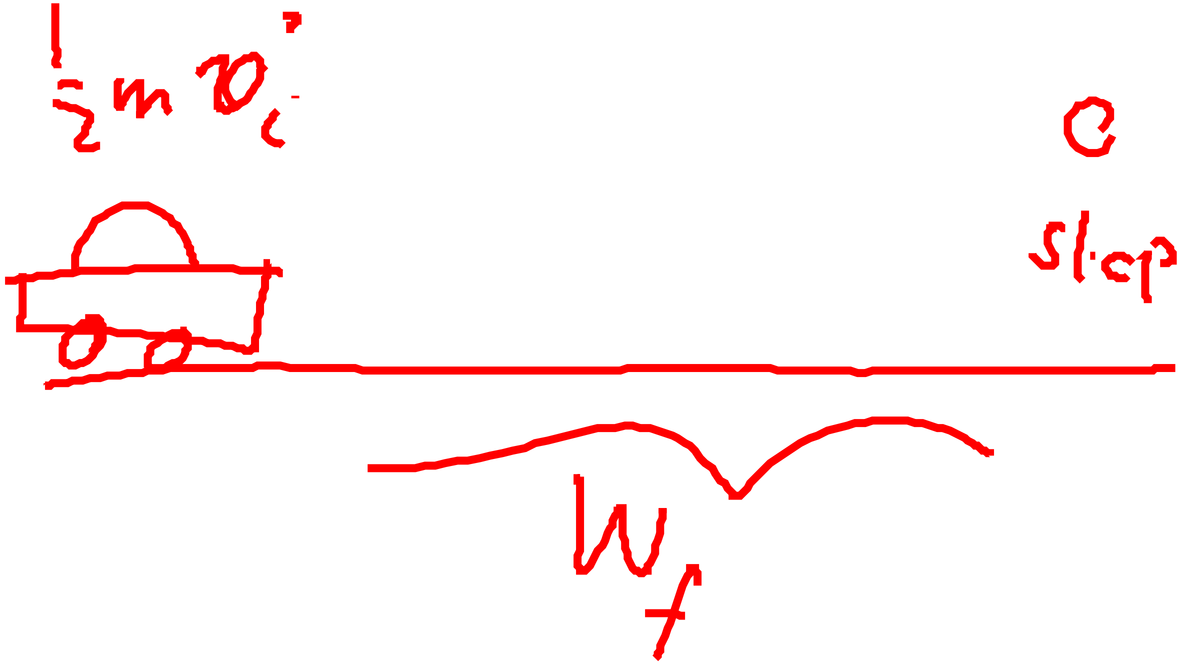
a) 511 m **b)** 90 m **c)** 323 m **d)** 123 m **e)** 251 m

$$\therefore \frac{1}{2} m v^2$$

$$\frac{1}{2} m v^2 - W_f = 0$$

$$\therefore \frac{1}{2} m v^2 - m g \mu d = 0$$

$$d = \frac{\frac{1}{2} v^2}{g \mu} = \frac{\frac{1}{2} \times 22.4^2}{10 \times 0.1}$$



8- An elevator has a mass of 1000 kg and carries a load of 800 kg. If a constant frictional force of 2000 N retards its motion upward, the required power delivered by the motor to lift the elevator at a constant speed of 3.00 m/s is:

a) 60 kW **b)** 44 kW **c)** 100 kW **d)** 150 kW **e)** 127 kW

$$P = f.v$$

$$f = (1000+800)\times 10 + 2000$$

$$\therefore P = [\quad\quad] \times 3$$

$$=$$

9- A force acting on an object moving along the x axis is given by $F_x = (14x - 3x^2)$ N, where x is in m. The work done by this force as the object moves from x = –1 m to x = +2 m is:

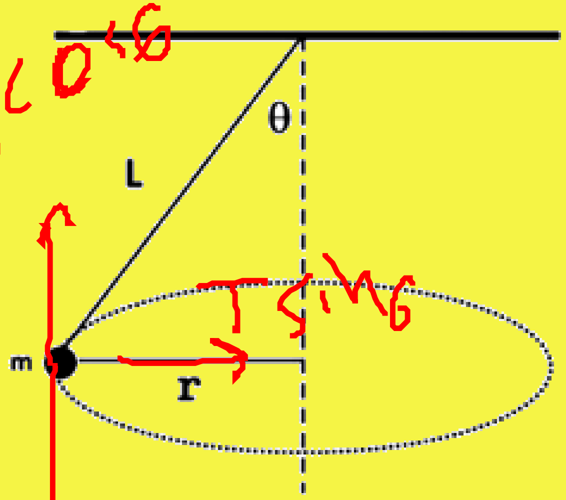
a) -28 J **b)** 28 J **c)** 40 J **d)** 42 J **e)** 12 J

$$W = \int_{-1}^{2} (14x - 3x^2)$$

$$= \int_{-1}^{2} 14x\,dx - \int_{-1}^{+2} 3x^2$$

$$= 7x^2\Big|_{-1}^{2} - x^3\Big|_{-1}^{2} = 21 - (\ ) = 12$$

10- Consider the conical pendulum as shown in the figure. If the speed of the circular motion is 0.3 m/s and $\theta = 20°$, the radius r is:



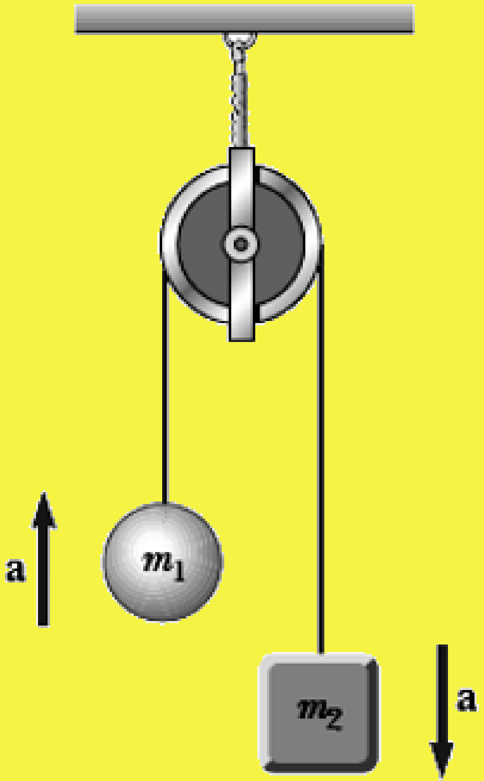
a) 0.025 m **b)** 1.125 m **c)** 0.662 m **d)** 3.75 m **e)** 2.45 m

$$T\sin\theta = \frac{mv^2}{r}$$

$$T\cos\theta = mg$$

$$\tan\theta = \frac{v^2}{gr} \rightarrow r = \frac{v^2}{g\tan\theta} =$$

11- Two masses connected through the Atwood machine system (as shown in the figure) have an acceleration $\frac{1}{3}$g, where g is the earth gravitational acceleration. The relation exists between the two masses is:



①

② eq. $m_2 g - T = m_2 a$ (1)

$T - m_1 g = m_1 a$ (2)

③ $(m_2 - m_1) g = (m_2 + m_1) a$

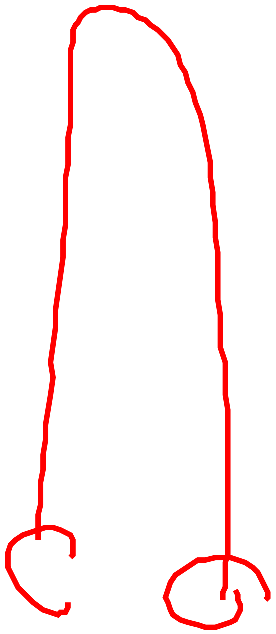
a) $m_1 = m_2$ **b)** $m_1 = 4m_2$ **c)** $m_1 = 0.5m_2$ **d)** $m_1 = 2m_2$ **e)** $m_1 = 3m_2$

④ $(m_2 - m_1) g = (m_2 + m_1) \frac{1}{3} g$

$\Rightarrow 3m_2 - 3m_1 = m_1 + m_2 \rightarrow 2m_2 = 4m_1 \rightarrow m_1 = \frac{1}{2} m_2$

12- When a ball rises vertically to a height h and returns to its original point of projection, the work done by the gravitational force is:

a) Zero **b)** - mgh **c)** + mgh **d)** -2mgh **e)** + 2mgh

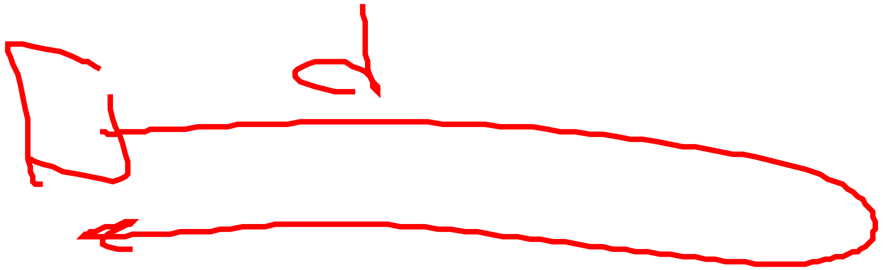


13- When a box of mass m is pulled a distance d along a rough horizontal surface with coefficient of kinetic friction μ, then pulled back along the same path to its original position, the work done by friction is:

a) Zero **b)** $-\mu_k mgd$ **c)** $+\mu_k mgd$ **d)** $-2\mu_k mgd$ **e)** $+2\mu_k mgd$

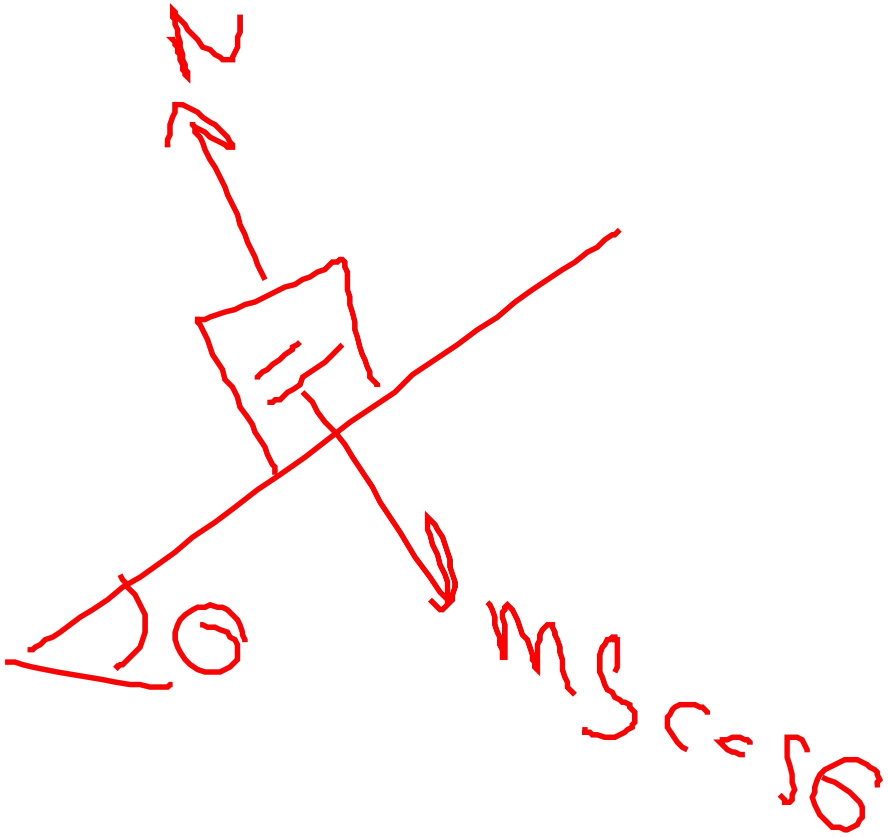
$W = -mg\mu d$

$\therefore W = -2mg\mu d$



14- An object rests upon an inclined plane. If the angle of incline (θ) is increased, then the normal force

a) increases **b)** decreases **c)** remains constant **d)** equals weight **e)** equals tan θ



15- The frictional force of the floor on a large suitcase has a minimum value when the suitcase is:

a) pushed by a force parallel to the floor.

b) pulled by a force parallel to the floor.

c) pulled by a force directed at an angle θ above the floor.

d) pushed by a force directed at an angle θ into the floor.

e) turned on its side and pushed by a force parallel to the floor

$f = ~~mg~~ N \mu$

(1) $= mg\mu$

(2) $= mg\mu$

(3) $= (mg - f\sin\theta)\mu$

(4) $= (mg + f\sin\theta)\mu$

(5) $mg\mu$