PHYSICS 1301, SPRING 2015

TEST 2, April 3rd 2015, 5.30 – 7.00 PM

A

Prof. Jateen Gandhi

Bubble your name and UH ID # on the scantron. Also specify on the scantron the letter seen on the top right corner of this page.

LAST NAME: _____

FIRST NAME: _____

UH ID: _____

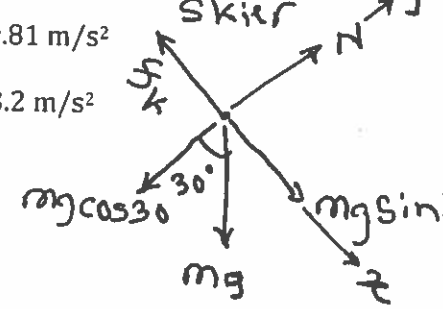
MULTIPLE CHOICE. Choose the right answer and bubble it on the scantron. Answer all 16 questions (15 + 1 bonus).

1) A skier slides down a slope which forms an angle of 30° with the horizontal. Her mass is 70.0 kg. The coefficient of kinetic friction is μ_k=0.10. Calculate the acceleration of the skier.

(A) 4.05 m/s²
B) 6.25 m/s²
C) 9.81 m/s²
D) 3.2 m/s²

* Net force on the skier = $m_{skier} \times a_{skier}$. [x-direction]

FBD of skier



$\Sigma F_y = N - mg\cos 30 = 0$.

$N = mg\cos 30$

$\Sigma F_x = mg\sin 30 - f_K = ma$

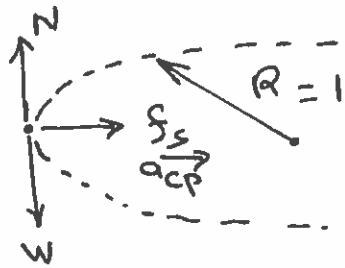
$\Rightarrow mg\sin 30 - mg\cos 30 \times \mu_K = ma$

$(9.81)\sin 30 - 9.81(\cos 30)(0.1) = a$

$a = 4.05\ m/s^2$

2) A car is entering a curve of radius r=100 m. If the static friction coefficient between the wheels and the street is 0.500, calculate the maximum speed the car can have without skidding.

A) 32.5 m/s
(B) 22.2 m/s
C) 14.7 m/s
D) 29.8 m/s



$\Sigma F_y = N - W = 0$

$N = W = mg$

$\Sigma F_x = f_s = ma_x = ma_{cp}$

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

$v = \sqrt{rg\mu_s} = \sqrt{100 \times 0.5 \times 9.81} = 22.14\ \frac{m}{s}$

3) An object of mass m=20 kg, attached to an ideal massless spring, is pulled across a frictionless surface. If the spring constant is 46 N/m and the spring is stretched by 0.88 m, calculate the acceleration of the object when released.

(A) 2.0 m/s²

B) 4.5 m/s²

C) 3.8 m/s²

4) 0.3 m/s²

Force by the spring = ~~ma~~ $+kx = mxa$. [magnitude only].

$+kx = ma$

$46 \times 0.88 = 20 \times a$

$a = 2.02 \frac{m}{s^2}$

4) A block of mass m_1= 3 kg lies on a frictionless table. It is connected to a string that passes over a pulley and suspends a mass m_2=5 kg (see Fig. 1). Calculate the acceleration of the system.

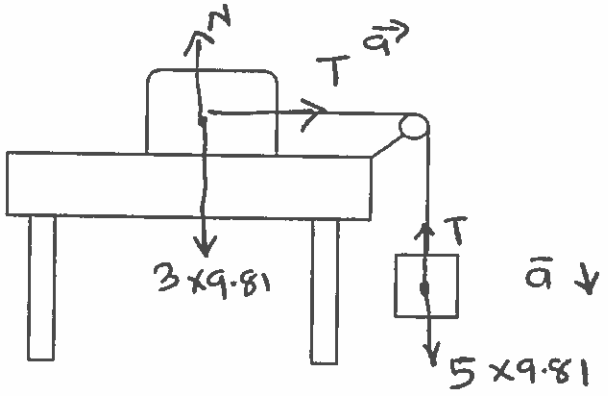


Fig. 1

A) 4.81 m/s²

B) 9.71 m/s²

(C) 6.13 m/s²

D) 2.50 m/s²

$\Sigma F_x = \rightarrow T = ma = 3(a)$.

$\Sigma F_y = \uparrow T - 5 \times 9.81 = 5(-a)$

$\hookrightarrow T = 5 \times 9.81 - 5a = 5(9.81 - a)$.

$3a = 5(9.81 - a)$

$3a = 49.05 - 5a \qquad 8a = 49.05 \Rightarrow a = 6.13 \frac{m}{s^2}$

5) A Ping-Pong ball is shot into a circular tube that is lying flat (horizontal) on a tabletop. When the Ping-Pong ball leaves the track, which path will it follow (see Fig. 2)?

* Tangential velocity.

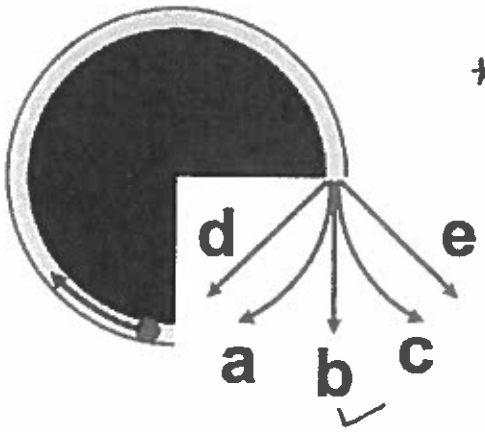


Fig. 2

A) a

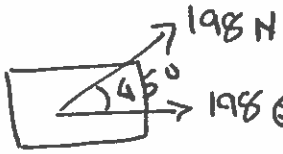
B) b

C) c

D) d

E) e

6) A block is pulled for 10 meters by a force F=198 N at an angle of 45° with respect to the horizontal. Calculate the work done by the force.



A) 3.5×10^3 J

B) 2.0×10^3 J

C) 0.5×10^3 J

D) 1.4×10^3 J

$W = F \times x = 198 \cos 45 \times 10$

$= 1400\ J = 1.4 \times 10^3\ J$

7) Two paths lead to the top of a hill. Path 1 is steep and direct, while path 2 is twice as long but less steep. How does the potential energy that you gain if you take path 2 compare to the one that you gain if you take path 1?

(A) the same

B) twice as much

C) four times as much

D) half as much

Potential energy does not depend on the path but only on the difference between initial & final positions.

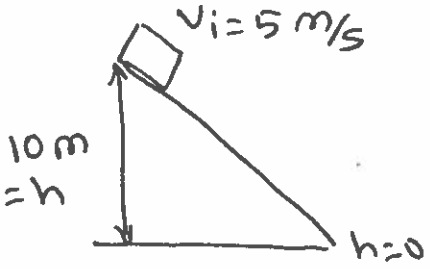
8) A block of mass 20.0 kg is moving with a speed of 5.0 m/s at the top of a 10-m high hill. What is the speed of the block after it sled down to the bottom of the hill?

A) 8.3 m/s

B) 10.1 m/s

(C) 14.9 m/s

D) 20.4 m/s



$$K_1 + U_1 = K_2 + U_2$$

$$\frac{1}{2}mv_i^2 + mgh = \frac{1}{2}mv_f^2 + 0$$

$$v_f = \sqrt{\left[\frac{1}{2}v_i^2 + gh\right] \times 2}$$

$$= \sqrt{\left[(0.5)(5)^2 + 9.81 \times 10\right] \times 2}$$

$$v_f = 14.87 \ \frac{m}{s}$$

9) A ball slides on the frictionless track in Fig. 3. At which position does the ball have maximum kinetic energy?

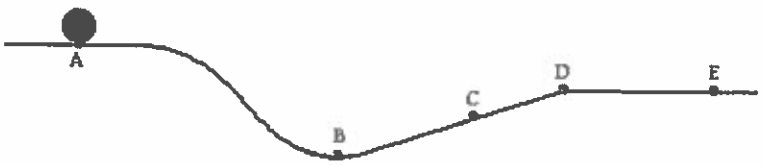


Fig. 3

A) A

(B) B

C) C

D) D

E) E

At point B the maximum potential energy will be lost to KE, hence the ball will have gained highest velocity

10) A block of mass m=1.0 kg, initially at rest, slides on the track in Fig. 4. From A to B the track is frictionless. The block then slides horizontally from B and stops at position C. Knowing that r=1.3 m and d=2.8 m, calculate the kinetic friction coefficient of the horizontal surface.

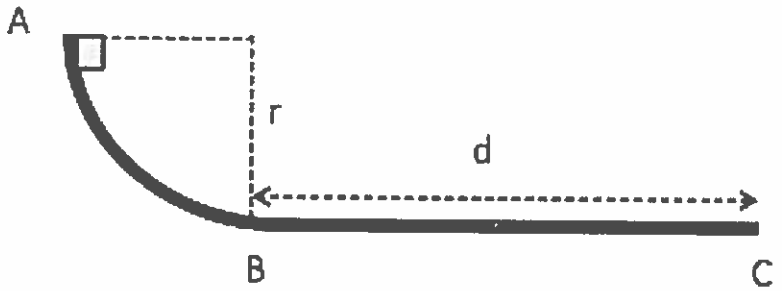


Fig. 4

(A) 0.46

B) 0.23

C) 0.52

D) 0.37

From A to B $K_1 + U_1 = K_2 + U_2$ [No frictional loss].

$0 + mgh = \frac{1}{2}mv_B^2 + 0$

$v_B = \sqrt{2gh}$

[$v_C = 0$]

From B to C the work done by friction = ΔKE.

$W_{fric} = f_K \times x = \mu_K N \times d = \mu_K \times mg \times d = \frac{1}{2}mv_B^2$

$\mu_K \cdot m \cdot g \cdot d = \frac{1}{2} m \times 2gh$. $\mu_K = \frac{h}{d} = \frac{r}{d} = \frac{1.3}{2.8} = 0.46$

11) A 0.2 kg-ball is thrown horizontally against a wall with a constant velocity of 20.0 m/s. After a contact of 0.04s, it bounces back with a velocity of 15 m/s. Calculate the constant force exerted on the ball by the wall.

A) 54 N

B) 128 N

C) 75 N

(D) 175 N

* Impulse = change in momentum

$F \times \Delta t = m_1 v_1 - m_2 v_2$ $\quad v_1 = 20 \frac{m}{s}$

$F \times 0.04 = m_1 (v_1 - v_2)$ $[m_1 = m_2]$ $\quad v_2 = -15 \frac{m}{s}$

$F = \frac{0.2(20-(-15))}{0.04} = 175\ N$

12) A 80 kg-man, running with a velocity of 5.0 m/s, jumps on a cart which is initially not moving. The mass of the cart is 200 kg. Calculate the velocity of the system (man+cart) after the jump.

A) 2.3 m/s

(B) 1.4 m/s

C) 0.8 m/s

D) 3.2 m/s

Conservation of momentum.

$m_1 v_1 = m_2 v_2$

Before Jump $\quad m_1$ = man

After jump $\quad m_2$ = man + cart.

$80 \times 5 = (200 + 80) v_2$

$v_2 = 1.43 \frac{m}{s}$

13) A cart, moving with a velocity of 5.0 m/s, hits a stationary cart of mass 3.0 kg. The collision is completely inelastic (the two carts stick together after the collision), and the velocity of the system after the collision is 2.5 m/s. Calculate the mass of the first cart.

(A) 3.0 kg

B) 2.5 kg

C) 4.0 kg

D) 5.0 kg

Same concept as no. 12

$m_1 v_1 = m_2 v_2$

$m_1 (5) = (m_1 + 3) 2.5$.

$5m_1 = 2.5m_1 + 7.5$.

$5m_1 - 2.5m_1 = 7.5 \quad m_1 = \frac{7.5}{2.5} = 3$ kg

14) In an INELASTIC collision between two perfectly rigid objects

A) the kinetic energy of each object is conserved.
(B) the momentum of the system is conserved but the kinetic energy of the system is not conserved.
C) both the momentum and the kinetic energy of the system are conserved.
D) the kinetic energy of the system is conserved, but the momentum of the system is not conserved.

KE is conserved only during elastic collision.

During elastic & inelastic collisions momentum is conserved.

15) A 4.0 kg-rifle shoots a 10.0 gram-bullet at a muzzle speed of 400 m/s. What is the recoil velocity of the rifle as the bullet leaves the barrel?

A) -1.0 m/s

B) -2.0 m/s

C) +1.0 m/s

D) -2.5 m/s

Conservation of momentum

$m_1 v_1 = m_2 v_2$

rifle bullet

$4 \times v_R = 10 \times 10^{-3} \times 400$

$v_R = 1 \frac{m}{s}$ [negative because opposite of $+400 \frac{m}{s}$]

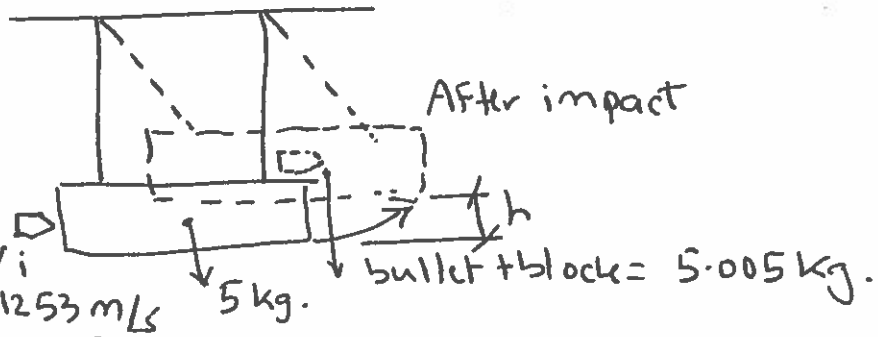
16) A 5-g bullet, with an initial velocity of 1253 m/s, is stopped in a suspended block of wood of 5 kg mass. What is the maximum height that the bullet-plus-wood ballistic pendulum reaches after the collision?

A) 1.3 cm

B) 2.8 cm

C) 8.0 cm

D) 9.4 cm



$m_{bullet} = 5 \times 10^{-3}$ kg

Right at the moment when bullet hits the block the momentum from bullet will be transferred to the bullet + block.

$m_1 v_1 = m_2 v_2$

$5 \times 10^{-3} \times 1253 = 5.005 \times v_2$

$v_2 = 1.25 \frac{m}{s}$

Due to this velocity the block will swing & reach a heigh 'h' where it's KE will be converted to gravitational PE.

$K_1 + U_1 = K_2 + U_2$

$\frac{1}{2} m_{\text{bullet + block}} \times v_2^2 + 0 = 0 + m_{\text{bullet + block}} \times g \times h$

$h = \frac{1}{2} v_2^2 \times \frac{1}{g}$

$h = 0.0798\ m = 8\ cm$