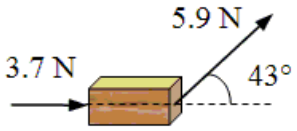
Exam 2 PHY231 Spring 2013 Section 2

Form C

1. Two forces act on a 4.5-kg block resting on a frictionless surface as shown. What is the magnitude of the horizontal acceleration of the block?



A) 1.78 m/s^2
B) 1.22 m/s^2
C) 1.05 m/s^2
D) 1.95 m/s^2
E) 2.04 m/s^2
F) 0.82 m/s^2
G) 8.90 m/s^2
H) 3.20 m/s^2

$$F_x = ma_x$$
$$a_x = \frac{F_x}{m} = \frac{(3.7 + 5.9\cos 43°)\text{N}}{4.5\text{kg}} = 1.78\text{m/s}$$

2. A 2.00-kg projectile is fired upward at an angle of 20.0°. What is the magnitude of the force exerted on the projectile when it is at the highest position in its trajectory? Neglect any effects of air resistance.

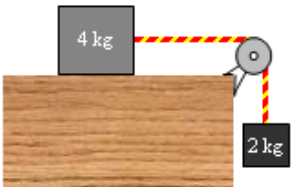
A) 6.24 N
B) 10.4 N
C) 15.8 N
D) 0.68 N
E) 0.34 N
F) 9.81 N
G) 19.6 N
H) 0.00 N

$\mathbf{F} = mg$ (downward), throughout motion
$F = (2.00\,\text{kg})(9.81\ \text{N/kg}) = 19.6\,\text{N}$

3. A rock is suspended from a string and moves downward at constant speed. Which statement is true concerning the string tension if air resistance is ignored?

A) The string tension has a magnitude of zero newtons.
B) The string tension acts downward on the rock
C) The string tension is equal to the weight of the rock
D) The string tension is twice the weight of the rock
E) The string tension is half the weight of the rock
F) The string tension is only slightly less than the weight of the rock
G) The string tension is only slightly greater than the weight of the rock
H) The string tension starts less than, but becomes greater than the weight of the rock

4. A 4.00 kg block is connected by means of a mass-less rope to a 2.00 kg block as shown in the figure. Complete the following statement: If the 4.00 kg block is to begin sliding, the coefficient of static friction between the 4.00 kg block and the surface must be

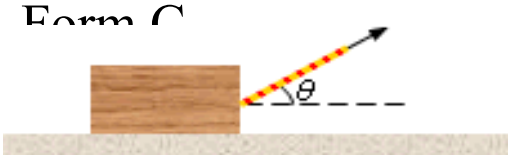


A) less than zero
B) greater than 2.00
C) less than 2.00 but greater than 1.50
D) less than 1.50 but greater than 1.00
E) Less than 1.00 but greater than 0.75
F) Less than 0.75 but greater than 0.50
G) Less than 0.50 but greater than 0.00
H) Need more information to answer the question.

5. A 71.0-kg man stands on a bathroom scale in an elevator. What does the scale read if the elevator is ascending with an acceleration of 3.00 m/s^2?

A) 697 N
B) 213 N
C) 484 N
D) 142 N
E) 910 N
F) 537 N
G) 362 N
H) 440 N

scale reads normal force, N
$ma = F_{\text{net}} = N - mg$
$N = m(a+g) = (71.0\text{kg})(3.00{+}9.81)\text{m/s}^2$
$= 910\,\text{N}$



6. A concrete block is pulled 7.00 m across a frictionless surface by means of a rope. The rope tension is 40.0 N; and the net work done on the block is 247 J. What angle does the rope make with the horizontal?

A) 28.1° E) 50.1°
B) 35.1° F) 53.1°
C) 43.1° G) 57.1°
D) 47.1° H) 88.1°

$$W = F_x \Delta x = T(\cos\theta)\Delta x$$
$$\theta = \cos^{-1}\left(W/T\Delta x\right) = \cos^{-1}\left(247/\left[(40)(7)\right]\right)$$
$$= 28.1°$$

7. A 10.0 g bullet traveling horizontally at 755 m/s strikes a stationary target and stops after penetrating 14.5 cm into the target. What is the average force of the target on the bullet?

A) 1.97×10^4 N E) 3.93×10^4 N
B) 2.07×10^5 N F) 5.67×10^5 N
C) 6.26×10^3 N G) 8.03×10^4 N
D) 3.13×10^4 N H) 1.12×10^4 N

$$W = F_x \Delta x = \Delta K$$
$$F_x = \frac{\Delta K}{\Delta x} = \frac{\frac{1}{2}mv^2}{\Delta x} = \frac{(0.5)(0.010\,\text{kg})(755\,\text{m/s})^2}{0.145\,\text{m}} = 1.97\times10^4\,\text{N}$$

8. The kinetic energy of a car is 8.00×10^6 J as it travels along a horizontal road. How much work is required to stop the car in 10 s?

A) 0.00 J E) 8.00×10^7 J
B) 8.00×10^4 J F) 8.00×10^8 J
C) 8.00×10^5 J G) 8.00×10^9 J
D) 8.00×10^6 J H) 8.00×10^{10} J

$$W = \Delta K = 8.00\times10^6\,\text{J}$$

9. A skier leaves the top of a slope with an initial speed of 5.00 m/s. Her speed at the bottom of the slope is 13.0 m/s. What is the height of the slope?

A) 11.0 m E) 1.82 m
B) 9.82 m F) 5.55 m
C) 6.56 m G) 8.02 m
D) 7.34 m H) 3.57 m

$$K + U = K_0 + U_0; \quad U = 0$$
$$\tfrac{1}{2}mv^2 = \tfrac{1}{2}mv_0^2 + mgy$$
$$y = \tfrac{1}{2}\frac{v^2 - v_0^2}{g} = 0.5\frac{(13\,\text{m/s})^2 - (5\,\text{m/s})^2}{9.81\,\text{m/s}^2}$$
$$= 7.34\,\text{m}$$

10. A projectile is launched with a momentum of 200 kg · m/s and 1000 J of kinetic energy. What is the mass of the projectile?

A) 5.00 kg E) 25 kg
B) 10.0 kg F) 30 kg
C) 15.0 kg G) 40 kg
D) 20.0 kg H) 50 kg

$$\frac{p^2}{2m} = K \quad \Rightarrow m = \frac{p^2}{2K} = \frac{\left(200\,\text{kg}\cdot\text{m/s}\right)^2}{2(1000\,\text{J})} = 20\,\text{kg}$$

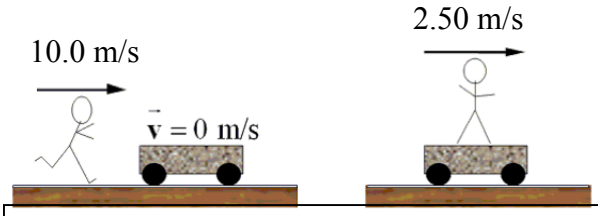
11. A football player kicks a 0.41-kg football initially at rest; and the ball flies through the air. If the kicker's foot was in contact with the ball for 0.051 s and the ball's initial speed after the collision is 21.0 m/s, what was the magnitude of the average force on the football?

A) 9.70 N E) 135 N
B) 46.0 N F) 152 N
C) 81.1 N G) 169 N
D) 190 N H) 243 N

$$F\Delta t = \Delta p$$
$$F = \frac{\Delta p}{\Delta t} = \frac{(0.41\,\text{kg})(21\,\text{m/s})}{0.051\,\text{s}} = 169\ \text{N}$$

12. Complete the following statement: Momentum will be conserved in a two-body collision <u>only if</u>
A) both bodies come to rest.
B) the collision is perfectly elastic
C) the kinetic energy of the system is conserved
<u>D) the net external force acting on the two-body system is zero</u>
E) the internal forces of the two body system cancel in action-reaction pairs
F) the internal forces have the same vector magnitudes and directions
G) the forces acting are non-conservative
H) the forces acting are conservative

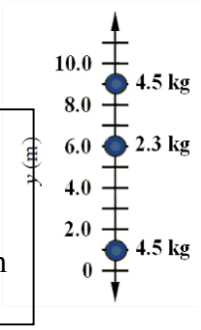
13. A 50.0-kg boy runs at a speed of 10.0 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest. If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?



$$p_i = m_b v_b; \quad p_f = (m_b + m_c) v_c$$
$$p_f = p_i \quad \Rightarrow \quad (m_b + m_c) v_c = m_b v_b$$
$$m_c = \frac{m_b(v_b - v_c)}{v_c} = \frac{(50.0\,\text{kg})(10\text{-}2.5)}{2.5} = 150\ \text{kg}$$

A) 100 kg
B) 125 kg
<u>C) 150 kg</u>
D) 175 kg
E) 210 kg
F) 260 kg
G) 300 kg
H) 165 kg

14. The drawing shows two 4.5-kg balls located on the y-axis at 1.0 and 9.0 m, respectively, and a third ball with a mass 2.3 kg which is located at 6.0 m. What is the location of the center of mass of this system?



$$x_{cm} = \frac{m_1(x_1 + x_2) + m_3 x_3}{m_1 + m_2 + m_3} = \frac{4.5\text{kg}(1.0 + 9.0)\text{m} + 2.3\text{kg}(6.0\,\text{m})}{11.3\ \text{kg}} = 5.2\,\text{m}$$

A) 4.8 m
<u>B) 5.2 m</u>
C) 5.6 m
D) 6.0 m
E) 6.4 m
F) 4.4 m
G) 4.0 m
H) 0.0 m

15. A mother is holding her 4.5-kg baby in her arms while riding in a car moving at 22 m/s. The car is involved in a head-on collision and stops within 1.5 seconds. What is the magnitude of the force exerted by the baby on his mother's arms?

$$F\Delta p = \Delta p = mv$$
$$F = \frac{mv}{\Delta t} = \frac{(4.5\text{kg})(22\,\text{m/s})}{1.5\text{s}} = 66\,\text{N}$$

A) 45 N
<u>E) 66 N</u>
B) 90 N
F) 33 N
C) 99 N
G) 57 N
D) 150 N
H) 80 N

16. A man with a mass of 100-kg and a supply crate with a mass of 500-kg are on a frozen pond that is essentially frictionless. The initial separation of the man and crate is a distance of 600 m. The man uses a very light rope to pull the crate closer to him. How far has the man moved when the crate reaches him?

$$x_{cm} = \frac{m_c x_c + m_m x_m}{m_c + m_m}; \quad x_c = 0, x_m = 600\text{m}$$
$$= \frac{0 + 100\,\text{kg}(600\,\text{m})}{600\,\text{kg}} = 100\,\text{m} \quad (\text{touch at } x_{cm})$$
$$\Delta x_m = x_{cm} - x_m = (100 - 600)\,\text{m} = -500\,\text{m}$$

A) zero m
B) 90.0 m
C) 80.0 m
D) 100 m
E) 200 m
F) 300 m
G) 400 m
<u>H) 500 m</u>