

A. Select the correct answer for the following multiple choice questions and write your answer in the line next to the question number.

d 1. The push or pull on an object can be best described by what scientific term?  
a. Friction    b. motion    c. gravity    d. force    e. mass

a 2. Which one of the following objects has the least inertia?  
a. paper clip    b. book    c. bicycle    d. car    e. truck

e 3. Which one of the following is Newton's third law motion?

b 4. Which one of the following is Newton's law of universal gravitation?

Answers for 3-4

- a. Every particle in the universe exerts a repulsive force on every other particle  
b. Every particle in the universe exerts an attractive force on every other particle  
c. An object will remain in a state of rest or of uniform motion in a straight line unless acted on by an outside net force.  
d. The net force acting on an object is equals to the product of the mass of the object and the acceleration of the object.  
e. When one object exerts a force on a second object, the second object exerts a force on the first that has an equal magnitude but opposite direction.  
f. Frictional forces are in the opposite direction of motion.

c 5. Which one of the following is also the unit newton, N?

d 6. Which one of the following is a unit for power?

f 7. What is the SI unit for G, gravitational constant?

Answers for 5-7

- a.  $\text{kg}\cdot\text{m}^2/\text{s}^2$     b.  $\text{kg}/(\text{m}\cdot\text{s}^2)$     c.  $\text{kg}\cdot\text{m}/\text{s}^2$     d.  $\text{kg}\cdot\text{m}^2/\text{s}^3$     e.  $\text{kg}\cdot\text{m}/\text{s}^3$     f.  $\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}$

~~8. Which one of the following is a non-conservative force?~~

- ~~a. pushing    b. frictional force    c. Tension  
d. normal force    e. gravitational force~~

e 9. Which one of the following is a scalar?

- a. Impulse    b. Momentum    c. Force    d. Acceleration    e. Power

c 10. What is the centripetal force for a vehicle turning along a flat curve?

- a. Normal force    b. Kinetic frictional force  
c. Static frictional force    d. Gravitational force

c 11. What is represented by the area under a Force VS. Displacement, graph?

- a. Velocity    b. Acceleration    c. Work    d. Impulse    e. Power

b 12. Estimate the annual cost of electricity for operating an electric iron (1100-W) for 30 minutes a week, every week of the year. Assume a cost of 13 cents per kWh.

- a. \$ 0.86    b. \$ 3.72    c. \$ 28.60    d. \$ 44.62    e. \$ 223

$$1.1\text{Kw} \times 0.5 \times 52 \times 0.13 = 3.718 \approx 3.72$$

↑  
(1 year)

- d 13. A stack of books whose true weight is 165 N is placed on a scale in an elevator. The scale reads 160 N. What can be said about the motion of the elevator?
- It is at rest
  - It is moving with a constant velocity upward
  - It is moving with a constant velocity downward
  - It is accelerating downward
  - It is accelerating upward

b 14. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 7.0 m/s. Determine the maximum height that the slide can be.

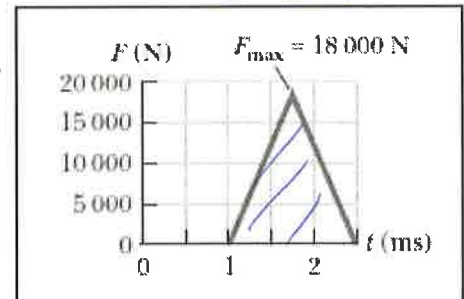
- 1.4 m
- 2.5 m
- 5.0 m
- 6.5 m
- 7.0 m

$\frac{1}{2}mv^2 = mgh$   
 $h = \frac{v^2}{2g} = \frac{7^2}{2 \times 9.8}$

e 15. The force applied to a ball as a function of time (in milli second) can be approximated as shown in the figure. What is the impulse delivered to the ball?

- 27.0 N.s
- 22.5 N.s
- 18.0 N.s
- 15.0 N.s
- 13.5 N.s
- 9.0 N.s

$Area = \frac{1}{2}bh$   
 $= \frac{1}{2} \times 1.5 \times 10^{-3} \times 18000$



a 16. What is the angle between the acceleration and net force of an object in uniform circular motion?

e 17. What is the angle between the frictional force and displacement for a moving object?

Answers for 16 & 17

- 0
- $30^\circ$
- $45^\circ$
- $90^\circ$
- $180^\circ$

$v_0 = 6 \text{ m/s}, v = 0, x = 0.015 \text{ m}$

c 18. A 0.40 kg hammer is moving right, horizontally at 6.0 m/s, strikes a nail and comes to rest after driving the nail 1.5 cm into a board. Calculate the average force on the nail in SI units. For the direction use + for right and - for left.

- 4.8 N
- 4.8 N
- 480 N
- 480 N
- 1200 N
- 1200 N

$v^2 = v_0^2 + 2ax$   
 $a = -\frac{v_0^2}{2x} = -\frac{6^2}{2 \times 0.015}$   
 $a = -1200 \text{ m/s}^2$   
 $F_H = -480 \text{ N}$   
 $F_N = +480 \text{ N}$

c 19. Which one of the following energy transformations takes place in a windmill?

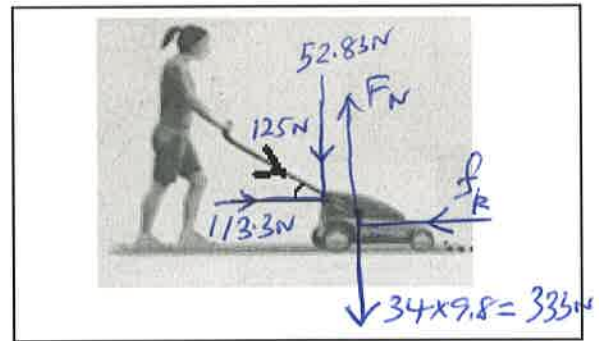
f 20. Which one of the following energy transformations takes place in an electric heater?

Answers for 19-20

- Electrical energy is converted into mechanical energy
- Solar energy is converted into electrical energy
- Mechanical energy is converted into electrical energy
- Solar energy is converted into thermal energy
- Chemical energy is converted into electrical energy
- Electrical energy is converted into thermal energy

26 B. A 34-kg lawn mower is pushed down along a horizontal yard at a constant velocity. The pushing force has a magnitude, 125 N, which is applied at  $25^\circ$  above the horizontal as shown below. Frictional force is also present.

- 6 1. Draw a free-body diagram for the lawn mower.
- 4 2. Resolve the 125-N force into horizontal and vertical components, in the diagram.
- 4 3. Determine the normal force.
- 4 4. Determine the frictional force.
- 4 5. Determine the coefficient of kinetic friction between the box and surface.
- 4 6. How much work is done in cutting a 9.5 m strip.



$$2. \quad 125 \cos 25^\circ = 113.3 \text{ N}$$

$$125 \sin 25^\circ = 52.83 \text{ N}$$

$$3. \quad F_N = 333 + 52.83 = 386 \text{ N}$$

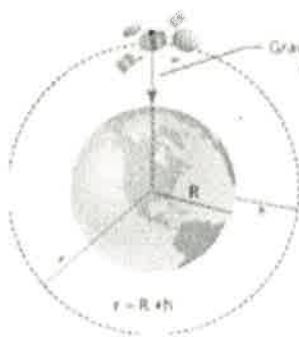
$$4. \quad f_R = 113.3 \text{ N}$$

$$5. \quad f_R = \mu_k \cdot F_N \rightarrow 113.3 = \mu_k \cdot 386 \rightarrow \mu_k = \frac{113.3}{386} = \underline{\underline{0.29}}$$

$$6. \quad W = F \cdot d = 113.3 \times 9.5 = \underline{\underline{1076 \text{ J}}}$$

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C. A satellite circles the Earth in an orbit whose altitude is 545 km. Calculate the acceleration due to gravity at this altitude. ( $G = 6.673 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{Kg}^2$ , Mass of Earth =  $M = 5.98 \times 10^{24} \text{ Kg}$ , Radius of Earth =  $R = 6380 \text{ km}$ )



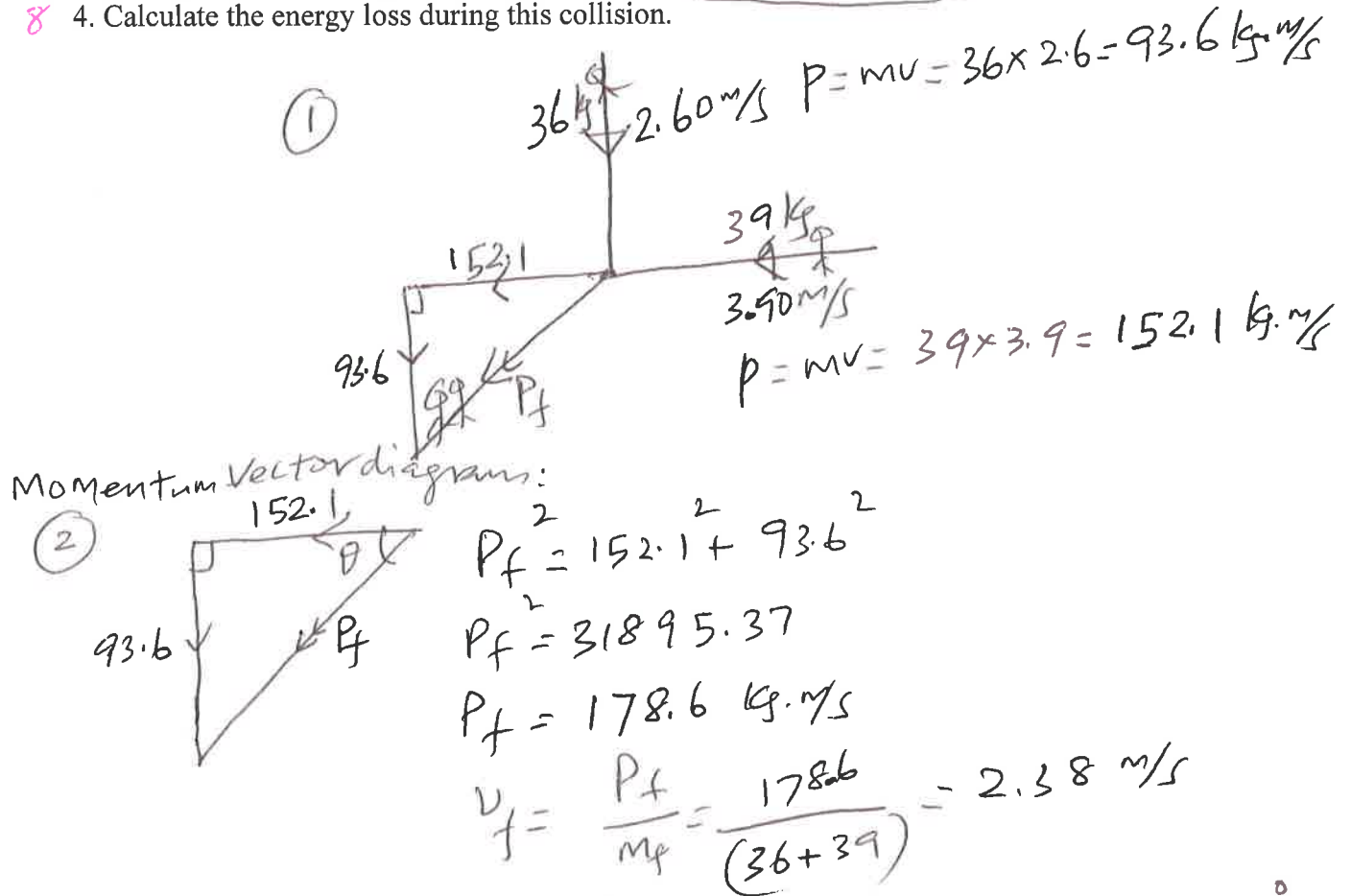
$$\text{Gravitational force} = \frac{GMm}{r^2} = mg = \frac{GM}{r^2} = \frac{6.673 \times 10^{-11} \times 5.98 \times 10^{24}}{[(6380 + 545) \times 10^3]^2}$$

$$g = 8.32 \text{ m/s}^2$$

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D. A 39.0-kg skater is moving due west at a speed of 3.90 m/s. A 36.0-kg skater is moving due south at a speed of 2.60 m/s. They collide and hold on to each other after the collision.

- 6 1. Sketch a diagram of the above situation, showing the skaters before and after the collision.
- 6 2. Find the velocity (speed and direction) of the skaters after the collision, assuming that friction can be ignored.
- 4 3. Identify the collision type: Elastic or Inelastic or Completely Inelastic.
- 8 4. Calculate the energy loss during this collision.



$$\tan \theta = \frac{93.6}{152.1} = 0.6154$$

$$\theta = \tan^{-1}(0.6154) = 31.6^\circ$$

④

$$KE_i = \frac{1}{2} \times 39 \times 3.9^2 + \frac{1}{2} \times 36 \times 2.6^2 =$$

$$KE_i = 296.6 + 121.68 = 418.3 \text{ J}$$

$$KE_f = \frac{1}{2} mv^2 = \frac{1}{2} \times 75 \times 2.38^2 = 212.4 \text{ J}$$

Energy loss =  $418.3 - 212.4$

" = 206 J