Total time: 1 hr **Total Points: 10 pt** **Student Name:**

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page.

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{velocity} = \frac{\text{displacement}}{\text{time}} \qquad \text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$\text{velocity} = \text{initial velocity} + \text{acceleration} \times \text{time}$$

$$g = 9.8 \text{ m/s}^2 \qquad F = ma \qquad F_g = mg \qquad F_{fr} = \mu F_N \qquad \text{Torque} = \text{Force} \times \text{Lever Arm}$$

$$\text{momentum} = mv \qquad \text{change in momentum} = \text{impulse} = (\text{force})(\text{time})$$

$$\text{work} = (\text{force})(\text{distance}) \qquad \text{power} = \frac{\text{work}}{\text{time}} \qquad \text{K.E.} = \frac{1}{2}mv^2 \qquad \text{P.E.} = mgh$$

1. Find the momentum of a heavy automobile of mass 2630 kg traveling 21.0 m/s.

Solution: $2630 \times 21.0 = 55,230 \text{kg.m/s}$

2. What force is required to stop a 1350-kg car traveling 95.0 km/h within 4.0 s?

Solution: $95.0 \text{km/h} = 26.389 \text{ m/s}$

$$\text{change in momentum} = \text{force} \times \text{time}$$

$$(1350)(0) - (1350)(26.389) = \text{force} \times (4.0 \text{ s}) \rightarrow \text{force} = 8,906 \text{ N opposite direction}$$

3. What force is required to slow a 1350-kg car traveling 95.0 km/h to 25.0 km/h within 3.0 s?

Solution: $95.0 \text{ km/h} = 26.389 \text{ m/s} \quad 25.0 \text{ km/h} = 6.94 \text{ m/s}$

$$\text{change in momentum} = \text{force} \times \text{time}$$

$$(1350)(6.94) - (1350)(26.389) = \text{force} \times 3.0 \text{ s} \rightarrow \text{force} = 8,752 \text{ N opposite in direction}$$

4. A bullet with mass 60.0 g is fired with an initial velocity of 575 m/s from a gun with mass 4.50 kg. What is the speed of the recoil of the gun?

Solution: 60.0 g = 0.060 kg

$$(0.060)(575) = (4.50 \text{ kg})(v_{\text{gun}}) \rightarrow v = 7.67 \text{ m/s}$$

5. A railroad car of mass 2.00×10^4 kg is traveling north 6.00 m/s and collides with a railroad car of mass 1.50×10^4 kg traveling south 4.00 m/s. Find the velocity of the railroad cars that become coupled after the collision.

Solution:

$$(20,000)(6.00) + (15,000)(-4.00) = (20,000 + 15,000)v \rightarrow v = 1.71 \text{ m/s}$$

6. One ball of mass 0.500 kg traveling 6.00 m/s to the right collides with a ball of mass 0.200 kg initially at rest. After the collisions, the heavier ball is traveling 2.57 m/s to the right. What is the velocity of the lighter ball after the collision?

Solution: Momentum just before the collision must be equal to the momentum just after the collision.

$$(0.500 \text{ kg})(6.00 \text{ m/s}) + (0.200 \text{ kg})(0) = (0.500 \text{ kg})(2.57 \text{ m/s}) + (0.200 \text{ kg})(v)$$

$$3.0 = 1.285 + (0.2)v \rightarrow v = 8.575 \text{ m/s}$$

7. How much work is required for a mechanical hoist to lift a 9000-N automobile to a height of 1.80 m for repairs?

Solution: $W = 9,000 \times 1.80 = 16.200$ kJ

8. The work required to lift eleven 94.0-lb bags of cement from the ground to the back of a truck is 4340 ft.lb. What is the distance from the ground to the bed of the truck?

Solution: Work is equal to the force times the distance

$$4,340 \text{ ft.lb} = (F)(94.0 \text{ lb}) \rightarrow F = \frac{4340}{94.0} = 46.2 \text{ lb}$$

9. How much work is done lifting a 200-kg wrecking ball 6.50 m above the ground?

Solution: In order to lift the ball, you must exert force that will counteract the weight (mg) of the ball. Thus you need to exert a force equal to

$$F = (200 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2}) = 1,960 \text{ N}$$

$$W = ((1,960 \text{ N})(6.50 \text{ m}) = 12,740 \text{ J}$$

10. What is 2,000 W in horsepower?

Solution: $2,000 \text{ W} = 2.682 \text{ hp}$

11. What is the rating in kW of a 2.00-hp motor?

Solution: $2.00 \text{ hp} = 1.4914 \text{ kW}$

12. What is 2.5 BTU in Joules?

Solution: 2.638 kJ

13. What is 4.186 kJ in BTU?

Solution: 3.97 BTU

14. What is 10.0 kJ in ft.lb?

Solution: 7,376 ft.lb

15. An engine supplies 132 J of energy in 7.00 s. What is its power?

Solution: $P = \frac{132}{7.00} = 18.86 \text{ W}$

16. A 231 ft lb/s motor runs for 14.3 s. How much energy in ft.lb does it deliver?

Solution: $P = \frac{W}{t} \rightarrow 231 \text{ ftlb/s} = \frac{W}{14.3 \text{ s}} \rightarrow W = 3,303 \text{ W} = 3.303 \text{ kW}$

17. How much energy can a 5.0-kW motor deliver in 10 minutes?

Solution: We must convert the minutes into seconds: 10 min = 600 s.

$$P = \frac{W}{t} \rightarrow 5,000 \text{ W} = \frac{W}{600 \text{ s}} \rightarrow W = 8.33 \text{ W}$$

18. A pump is needed to lift 750 mL (mass 0.750 kg) of water every minute a vertical distance of 25.0 m. What power in W must the pump be able to deliver?

Solution: If we were to get the power in Watts, we need to work in seconds (and not minutes). The power is the amount of work done during those 60 seconds.

$$P = \frac{\text{Work}}{\text{time}} = \frac{(0.750)(9.8)(25.0)}{60} = 3.06 \text{ W}$$

19. A 50-kg welder is to be raised 15.0 m above the ground by a motor. How much work did the motor do in the process?

Solution: $(50 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2})(15.0 \text{ m}) = 7,350 \text{ J}$

20. If the motor from the previous example lifted the 50-kg welder 15.0 m above the ground in 12.0 s, how much is its power?

Solution: Power $= \frac{\text{Work}}{\text{time}} = \frac{7,350}{12.0} = 612.5 \text{ W}$

21. A bullet with mass 12.0 g ravels 415 m/s. Find its kinetic energy?

Solution: K.E. $= (\frac{1}{2})(0.012 \text{ kg})(415 \text{ m/s})^2 = 1,033 \text{ J}$

22. A 1,500-kg car is moving at 25.0 m/s. What is it kinetic energy?

Solution: K.E. $= \frac{1}{2}(1,500 \text{ kg})(25.0 \text{ m/s})^2 = 4.69 \times 10^5$ J

23. A 475-kg pressed concrete beam is to be raised 10.0 m above the ground. How much is its potential energy at the top?

Solution: P.E. $= mgh = (475 \text{ kg})(9.8 \frac{\text{m}}{\text{s}^2})(10.0 \text{ m}) = 4.66 \times 10^4$ J