## Diploma Exam Review Questions

## Momentum

> Use the following information to answer the next question.

$$
\text { A batter hits a fly ball. The } 0.130 \mathrm{~kg} \text { baseball moves at a rate of } 20.0 \mathrm{~m} / \mathrm{s} \text { at }
$$ the point where it is 5.00 m above the ground.

1. What is the magnitude of the momentum of the baseball the instant before it reaches the ground?
A. $1.29 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
B. $1.41 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
C. $2.60 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
D. $2.90 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$

Use the following information to answer the next question.

A particular supertanker is fully loaded with oil and has a mass of $1.00 \times 10^{9} \mathrm{~kg}$. The supertanker has a cruising speed of $20.0 \mathrm{~km} / \mathrm{h}$. One way to stop the ship is to reverse its engines. At maximum reverse thrust, the ship takes 32.0 min to stop.
2. The momentum of the supertanker at cruising speed, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w} \mathrm{~kg} . \mathrm{m} / \mathrm{s}$. The value of $\boldsymbol{b}$ is $\qquad$ .
(Record your three-digit answer in the numerical-response section on the answer sheet.)

## Impulse

3. In an automobile collision, the severity of injury to the driver can be reduced by an airbag. In a car initially traveling at $100 \mathrm{~km} / \mathrm{h}$, the airbag stops a 62 kg driver in 90 ms . The magnitude of average force exerted by the airbag on the driver is
A. $6.9 \times 10^{4} \mathrm{~N}$
B. $1.9 \times 10^{4} \mathrm{~N}$
C. $9.6 \times 10^{3} \mathrm{~N}$
D. $6.1 \times 10^{2} \mathrm{~N}$
4. The SI units for impulse may be written as
A. $\frac{\mathrm{kg}-\mathrm{m}^{2}}{\mathrm{~s}^{2}}$
B. $\frac{\mathrm{kg}-\mathrm{m}}{\mathrm{s}}$
C. $\frac{\mathrm{kg}-\mathrm{m}^{2}}{\mathrm{~s}}$
D. $\frac{\mathrm{kg}-\mathrm{m}}{\mathrm{s}^{2}}$

Use the following information to answer the next question.

$$
\begin{aligned}
& \text { A "full draw" is the maximum distance that an archer can pull back an arrow. } \\
& \text { Using the "recurve bow" shown below, a particular archer requires an average } \\
& \text { force of } 130 \mathrm{~N} \text { to pull a full draw of } 70.0 \mathrm{~cm} \text {. }
\end{aligned}
$$

5. Assuming the maximum speed of a 20.6 g arrow, when released from full draw, is $94.0 \mathrm{~m} / \mathrm{s}$, the magnitude of the impulse that the bow gives to the arrow when released from full draw is $\qquad$ $\mathrm{N} \cdot \mathrm{s}$.
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Communication satellites require rocket thrusters that must be fired periodically, in short bursts, to keep the satellites from drifting out of their orbits. Usually, a gas such as ammonia is heated using electrodes. The expanding hot gas is allowed to escape, which provides the thrust. Unfortunately, the ammonia erodes the electrodes, eventually rendering them useless.

An alternative method to heat the ammonia uses microwaves. A $1.00 \times 10^{3} \mathrm{~W}$ microwave generator is used. The microwaves in the thrusters heat the gas to tens of thousands of degrees.
6. A satellite has a mass of 172 kg . To correct its orbit, a thruster is fired for 2.27 s , which changes the velocity of the satellite by $5.86 \times 10^{-3} \mathrm{~m} / \mathrm{s}$. The force generated by the thrusters, expressed in scientific notation, is $\boldsymbol{b} \times 10^{-w} \mathrm{~N}$. The value of $\boldsymbol{b}$ is $\qquad$ _.
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next two questions.

7. The magnitude of the impulse delivered by the hammer to the pile is
A. $61.8 \mathrm{kN} \cdot \mathrm{s}$
B. $30.9 \mathrm{kN} \cdot \mathrm{s}$
C. $7.46 \mathrm{kN} \cdot \mathrm{s}$
D. $3.73 \mathrm{kN} \cdot \mathrm{s}$
8. The impulse is delivered by this pile-driver in $2.10 \times 10^{-3} \mathrm{~s}$. The magnitude of the force that the hammer exerts on the pile, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w} \mathrm{~N}$. The value of $\boldsymbol{b}$ is $\qquad$ .
(Record your three-digit answer in the numerical-response section on the answer sheet.)
9. A rock climber falls and is saved from injuries by a climbing rope that is slightly elastic. The importance of the elasticity of the climbing rope can be understood in
terms of impulse because elasticity results in
A. decreased force during an increased time interval
B. increased force during an increased time interval
C. decreased force during a decreased time interval
D. increased force during a decreased time interval

## Conservation of Momentum (1D)

10. A 2100 kg van collides with a 1200 kg car that is at rest. They lock together and move together at a speed of $4.50 \mathrm{~m} / \mathrm{s}$. The initial speed of the van is $\qquad$ $\mathrm{m} / \mathrm{s}$.
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

## Pool Table

An illustration depicting an overhead view of a pool table is shown below.


The pool table has rubber cushions around the playing surface so that when a ball hits the side it will be deflected back to the playing surface. A simplified analysis of the physics of playing pool assumes that Hooke's Law is valid:

$$
F=-k x \text { and } E_{\mathrm{p}}=\frac{1}{2} k x^{2}
$$

11. Assume that the white ball is moving at a speed of $3.13 \mathrm{~m} / \mathrm{s}$ when it collides with the black ball, which was initially at rest. The white ball continues in its original direction. The speed of the white ball after the collision is $0.147 \mathrm{~m} / \mathrm{s}$. The speed of the black ball immediately after the collision is $\qquad$ $\mathrm{m} / \mathrm{s}$.
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

A lump of clay with a mass of 50.0 g is moving south at a speed of $20.0 \mathrm{~cm} / \mathrm{s}$. It collides head on with a second lump of clay with a mass of 70.0 g that is moving north at a speed of $40.0 \mathrm{~cm} / \mathrm{s}$.
12. The two lumps stick together, and no external horizontal forces act on the system. The velocity of the combined lump after the collision is
A. $60.0 \mathrm{~cm} / \mathrm{s}$, south
B. $31.7 \mathrm{~cm} / \mathrm{s}$, south
C. $20.0 \mathrm{~cm} / \mathrm{s}$, north
D. $15.0 \mathrm{~cm} / \mathrm{s}$, north
13. An empty freight car of mass $m$ coasts along a track at $2.00 \mathrm{~m} / \mathrm{s}$ until it couples to a stationary freight car of mass 2 m . The final speed of the two freight cars immediately after collision is
A. $1.50 \mathrm{~m} / \mathrm{s}$
B. $1.33 \mathrm{~m} / \mathrm{s}$
C. $1.15 \mathrm{~m} / \mathrm{s}$
D. $0.667 \mathrm{~m} / \mathrm{s}$
14. Two boys, Ted and Larry, initially at rest, push each other apart on a frictionless surface. Ted has a mass of 40 kg and Larry has a mass of 60 kg . After the boys push each other apart, Ted has a speed of $6 \mathrm{~m} / \mathrm{s}$. As the boys move apart, Larry has
A. more momentum than Ted
B. less momentum than Ted
C. more kinetic energy than Ted
D. less kinetic energy than Ted

## Elastic / Inelastic Collisions

15. The following statements all relate to a collision between any two objects on a horizontal frictionless surface. Which of these statements is always true?
A. The kinetic energy of each object before and after the collision is the same.
B. The momentum of each object before and after the collision is the same.
C. The total momentum of the two objects before and after the collision is the same.
D. With respect to the surface, the gravitational potential energy of each object before and after the collision increases.

Use the following information to answer the next question.

16. Which of the following statements best describes the inelastic collision shown above?
A. Momentum is not conserved, and kinetic energy is not conserved.
B. Momentum is conserved, but kinetic energy is not conserved.
C. Momentum is not conserved, but kinetic energy is conserved.
D. Momentum is conserved, and kinetic energy is conserved.

## Conservation of Momentum (2D)

Use the following information to answer the next two questions.

17. The magnitude of the momentum of the third piece of glass, fragment C , is
A. $5.19 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
B. $3.85 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
C. $2.28 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
D. $0.610 \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
18. The speed of the third fragment of glass, expressed in scientific notation, is $\boldsymbol{b}_{-} 10 w \mathrm{~m} / \mathrm{s}$. The value of $\boldsymbol{b}$ is $\qquad$ .
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

19. The speed of the red rock, after contact, is
A. $0.15 \mathrm{~m} / \mathrm{s}$
B. $0.22 \mathrm{~m} / \mathrm{s}$
C. $0.33 \mathrm{~m} / \mathrm{s}$
D. $0.39 \mathrm{~m} / \mathrm{s}$

## Unit 1 Mixed Review Questions

20. Which of the following quantities is a scalar quantity?
A. Force
B. Power
C. Impulse
D. Momentum
21. A golf ball has a mass of 45.0 g . A golf club is in contact with the golf ball for $3.00 \times 10^{-4} \mathrm{~s}$, and the ball leaves the club with a speed of 72.0 $\mathrm{m} / \mathrm{s}$. The average force exerted by the club on the ball, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w} \mathrm{~N}$. The value of $\boldsymbol{b}$ is $\qquad$ -.
(Record your three-digit answer in the numerical-response section on the answer sheet.)
22. In a vehicle safety test, a 1580 kg truck traveling at $60.0 \mathrm{~km} / \mathrm{h}$ collides with concrete barrier and comes to a complete stop in 0.120 s . The magnitude of the change in the momentum of the truck, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w} \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$. The value of $\boldsymbol{b}$ is $\qquad$ -
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

23. The speed of the hopper car immediately after receiving the load of coal, expressed in scientific notation, is $b \times 10^{-w} \mathrm{~m} / \mathrm{s}$. The value of $\boldsymbol{b}$ is
$\qquad$ .
(Record your three-digit answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.


The two objects shown above collide head-on. The velocity of the 9.5 kg object after collision is $5.4 \mathrm{~m} / \mathrm{s}$ to the left.
24. The velocity of the 2.4 kg object after collision is
A. $15 \mathrm{~m} / \mathrm{s}$ to the right
B. $8.7 \mathrm{~m} / \mathrm{s}$ to the left
C. $8.0 \mathrm{~m} / \mathrm{s}$ to the right
D. $6.2 \mathrm{~m} / \mathrm{s}$ to the left
25. Two carts, each with a spring bumper, collide head-on. At one point during the collision, both carts are at rest for an instant. At that instant, the kinetic energy that the carts originally possessed is almost completely
A. lost to friction
B. transformed into heat and sound
C. converted into kinetic energy in the spring bumpers
D. converted into potential energy in the spring bumpers
26. A 1575 kg car, initially traveling at $10.0 \mathrm{~m} / \mathrm{s}$, collides with a stationary 2250 kg car. The bumpers of the two cars become locked together. The speed of the combined cars immediately after impact is $\qquad$ $\mathrm{m} / \mathrm{s}$.
(Record your three-digit answer in the numerical-response section on the answer sheet.)
27. A 115 g arrow traveling east at $20 \mathrm{~m} / \mathrm{s}$ imbeds itself in a 57 g tennis ball moving north at $42 \mathrm{~m} / \mathrm{s}$. The direction of the ball-and-arrow combination after impact is
A. $46^{0} \mathrm{~N}$ of E
B. $46^{0} \mathrm{E}$ of N
C. $25^{0} \mathrm{E}$ of N
D. $25^{0} \mathrm{~N}$ of E
28. In an inelastic collision, the energy that appears to be missing is converted into
A. sound and momentum
B. force and momentum
C. sound and heat
D. heat and force
29. Which of the following units are correct units for momentum?
A. J•s
B. $\mathrm{N} \cdot \mathrm{m}$
C. $\mathrm{N} \cdot \mathrm{s}$
D. $\mathrm{N} / \mathrm{J}$

Use the following information to answer the next two questions.

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30. The magnitude of the impulse on the car during the test drive is
A. $4.80 \times 10^{3} \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
B. $1.92 \times 10^{4} \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
C. $2.40 \times 10^{4} \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$
D. $2.88 \times 10^{4} \mathrm{~kg} \cdot \mathrm{~m} / \mathrm{s}$

Use your recorded answer from the previous question to answer the next question.
31. The average net force on the car during the test drive, expressed in scientific notation, is $\boldsymbol{a} . \boldsymbol{b} \boldsymbol{c} \times 10^{\boldsymbol{d}} \mathrm{N}$. The values of $\boldsymbol{a}, \boldsymbol{b}, \boldsymbol{c}$, and $\boldsymbol{d}$ are $\qquad$
$\qquad$
$\qquad$ , and $\qquad$
(Record all four digits of your answer in the numerical-response section on the answer sheet.)

