

P30 Unit A Momentum Review Package

1. An 80 kg skier initially travelling at 6.0 m/s exerts a net sideways force of 40 N for 1.3 seconds.
- a) What is the impulse on the skier caused by the force? (2 marks)
 - b) What will be the change in momentum? (1 mark)
 - c) What will be the acceleration of the skier due to the sideways force? (2 marks)
- a) **52 Ns**
b) **52 Ns**
c) **0.50 m/s²**

2. While playing tennis Herman returns a 70 km/h serve at 63 km/h. If the 0.098 kg tennis ball was in contact with racket for 8.0 ms (milli = 10^{-3}) what was the force applied to the ball expressed in scientific notation $\mathbf{b} \times 10^w$. The value of \mathbf{b} is

_____.

(Record your **three digit** answer on the numerical response answer sheet provided).

F=0.45 kN

3. The 1300 kg “Drop of Doom” at W.E.M drops for 20 m and reaches 19.8 m/s. If it takes 2.1 s for the ride to stop at the bottom, what is the braking force applied to stop the ride? (Assume for this question that there is no friction).

- A. 445 kN
- B. 894 N
- C. 12.3 kN
- D. 7.55 kN

4. A 0.240 kg ball moving at 32.0 m/s strikes a brick wall perpendicularly and rebounds with a speed of 28.0 m/s. The wall received an impulse of

_____.

(Record your **three digit** answer on the numerical response answer sheet provided).

$\Delta p=14.4$ Ns

5. At West Edmonton Mall, a 200 kg roller coaster cart travelling at a speed of 3.0 m/s hits and couples to an additional two identical stationary carts. Calculate the speed of the three carts travelling together assuming negligible friction. (3 marks)

$v_{\text{final}}= 1.0$ m/s

Use the following information to answer the next three questions.

During the war of 1812 large cannons were used to smash down the walls of forts and destroy enemy ships. These cannons were made from large amounts of cast iron and were moved from place to place by teams of horses. The cannon itself often had a mass of 3000 kg and fired 10 kg balls distances of up to a kilometer. The cannon ball was propelled from the cannon by an explosion of gun powder. The explosion gave the cannon ball an initial velocity of 200 km/h which was achieved just before the ball left the barrel. It was not until WW I that a more effective long range weapon was developed.

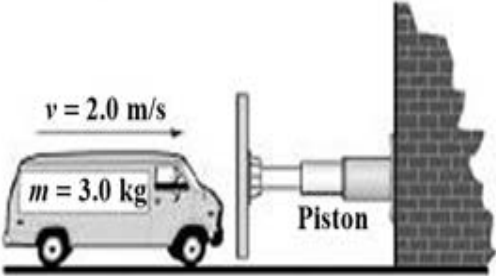
6. What is the force on the cannon ball if it takes 0.021 seconds for the ball to reach the end of the barrel?
Put abcd into answer sheet
Answer a.bc x 10^d
F = 2.65 x 10⁴ N
7. What is the recoil velocity of the cannon in km/h
 A. 1.50 km/h
 B. 0.667 km/h
 C. 1.21 km/h
 D. 1.33 km/h
v_c = 0.667 km/h
8. If a 7.0 kg Confederate cannon ball at 180 km/h collided in mid air with a 10 kg Yankee cannon ball moving at 200 km/h. If the Confederate ball was deflected straight down with a velocity of 70 km/h, what is the resulting velocity of the Yankee cannon ball? (Assume that both balls were traveling parallel to the Earth when they collided). (8 marks)
v = 88.8 km/h or 25 m/s
9. A 3.1 kg ball moving west to east struck a 2.0 kg stationary ball. If the 3.1 kg ball slowed to 1.2 m/s and was deflected to 25° north of east and the 2.0 kg ball was deflected to 48° south of east with a velocity of 1.06 m/s. What was the original velocity of the 3.1 kg ball? (4 marks)
V_{1x} = 1.55 m/s
10. A space ship travelling between Mars and Jupiter needs to change its speed of 1.83 km/s to 1.89 km/s. Its mass is 20 tonnes. (1 t = 1 Mg or 1000 Kg)
 a) What is the impulse required?
 b) It has two impulse engines (not a warp engine) a small one with a thrust of 500 N and the large one has a thrust of 3.0 kN. How long would you have to burn the engines to obtain the impulse required to affect the change in momentum (velocity) described above? (6 marks)
Δp = 1.20 x 10⁶ Ns
Δt = 343 s
11. While playing tennis Herman returns a 70.0 km/h serve at 63 km/h in the opposite direction. If the 0.0980 kg tennis ball was in contact with racket for 8.00 ms (milli = 10⁻³), what was the force applied to the ball? (4 marks)
F = 453 N

12. If a 2 000 kg car moving 20.0 m/s collides with a bridge abutment and stops in 0.0550 s. What was the force of the collision?
- A. 2.20 kN
 B. 727 kN
 C. 100 kN
 D. 5.5 kN

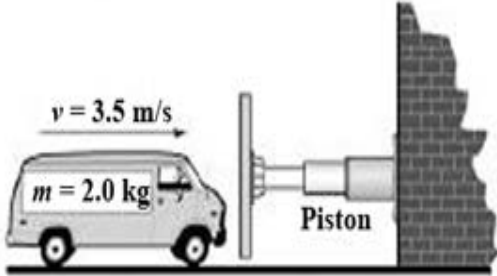
Use the following information to answer the next question.

A student performs an experiment to investigate the time required to stop a toy van. In each of four trials, the student varies the speed and mass of the van. The toy van is brought to rest by a piston that applies a uniform force that is the same for each trial.

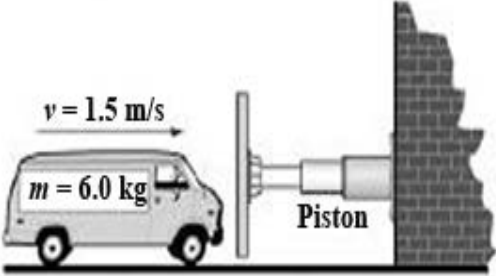
Trial 1



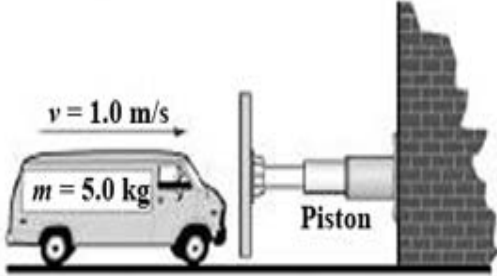
Trial 2



Trial 3



Trial 4



13. When the trials above are listed in order from the trial that has the longest stopping time to the trial that has the shortest stopping time, the order is

_____ .

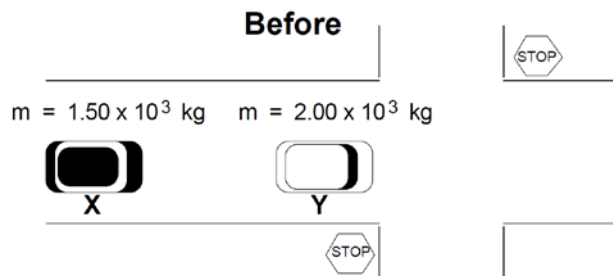
(Record your **four digit** of answer on the numerical response answer sheet provided).

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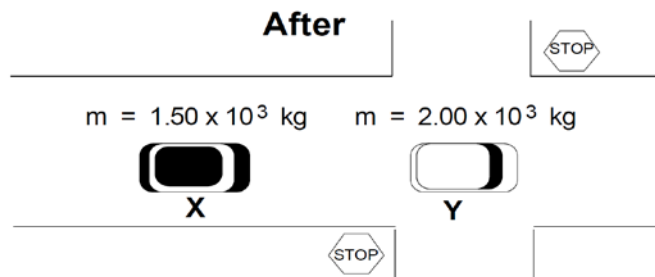
14. For vehicles that become stuck in snow or mud, a chain of fixed length, or a nylon tow rope that stretches, is often used to recover the stuck vehicle. When the stuck vehicle is being pulled, its change in momentum will
- decrease over a shorter time when the chain is used
 - increase over a longer time when the tow rope is used
 - decrease over a longer time when the tow rope is used
 - increase over a longer time when the chain is used

Use the following information to answer the next question.

A police officer's investigation of an accident involving a collision between vehicles X and Y provided the following information:



- A test on the road surface with a $2.00 \times 10^3 \text{ kg}$ vehicle showed that the vehicle slowed down at the rate of 5.00 m/s^2 due to friction
- Each vehicle, X and Y, received some damage
- After impact, vehicle Y travelled 19.6 m before stopping
- Vehicle X did not have the brakes applied before the collision
- Vehicle Y was stationary before the collision
- Vehicle X was stationary after the collision



15. What was the speed of vehicle Y just after the collision?
- 1.56 m/s
 - 19.6 m/s
 - 14.0 m/s
 - 11.0 m/s

16. Immediately before the collision, the speed of vehicle X in m/s was expressed in scientific notation $\mathbf{b} \times 10^w$. The value of \mathbf{b} is _____ .

(Record your **three digit** answer on the numerical response answer sheet provided).

\mathbf{b} is 1.87

17. In analyzing the scene of the accident, the officer most often applied her understanding of

- A. the Law of Conservation of Momentum
- B. Newton's First Law
- C. Newton's Second Law
- D. the Law of Conservation of Energy

18. Herman's 1500 kg car moving at 90 km/h to the west hits Alice's 2250 kg truck head on, when she was moving at 110 km/h to the east. If Alice's truck slows to 30 km/h after the collision what happened to Herman's car? (4 marks)

$\mathbf{v_H} = 30 \text{ km/h}$

19. A 11.0 g bullet is fired from a 2.4 kg rifle with a velocity 329 m/s. What is the resulting velocity of the rifle? (3 marks)

$\mathbf{v_r} = -1.5 \text{ m/s}$

20. A 90.0 kg running back hits a stationary 140 kg lineman at 8.30 m/s, and the lineman holds onto the running back. The magnitude of their velocity after the contact is _____ m/s.

(Record your **three digit** answer on the numerical response answer sheet provided).

$\mathbf{v} = 3.25 \text{ m/s}$

21. A 200 g toy car moving at 6.0 m/s North hits a 300 g toy truck moving North at 2.0 m/s. After the collision the toy truck travels 4.0 m/s North. Calculate the velocity of the dinky car after the collision.

- A. 0 m/s
- B. 3.0 m/s
- C. 6.0 m/s
- D. 4.0 m/s

$\mathbf{v_{car}} = 3.0 \text{ m/s}$

Use the following information to answer the next three questions.

Jim, a student of Ross Sheppard., is the first person to travel to Mars. Once there he goes for a space walk. He realizes that his control pack is not functioning properly so remembering his Physics 30 course takes off his space pack and throws it away from the spaceship so that he will be forced towards the ship. The space pack has a mass of 50 kg. He has a mass of 200 kg (without the pack). If initially he and the pack are at rest compared to the ship and he reaches the spacecraft with a speed of 10 m/s

- 22.
- Find the force with which he pushed the pack away from him if he applied the force for 1.5 s.
 - Determine the velocity of the pack. (5 marks)
 $F = 1.3 \times 10^3 \text{ N}$
 $v = 40 \text{ m/s}$
23. A 150 kg man sits in a 250 kg stationary boat in which there is also a 25 kg rock. The man throws the rock out of the back of the boat with a velocity of 20 m/s. Calculate the velocity of the boat with the man in it now.
- 2.0 m/s
 - 1.0 m/s
 - 3.33 m/s
 - 1.25 m/s
24. In a railroad yard, a 5.0×10^4 kg freight car travelling at 4.0 m/s east collides "head on" with a stationary tanker car, having a mass of 6.0×10^4 kg. If the two cars stick together, the final speed of the cars is
- 1.8 m/s east
 - 0.40 m/s east
 - 4.8 m/s east
 - 3.3 m/s east
25. A 400 kg cannon with a 1.5 m long barrel sits on a frictionless rails and fires a 10 kg shell horizontally with a speed of 100 m/s.
- Find the recoil speed of the cannon.
 - What is the impulse given to the cannon ball?
 - What is the average force on the cannon ball while in the barrel, if it takes only 0.030s for it to reach the end of the barrel? (Remember that the cannon ball reaches maximum velocity at the end of the barrel).
 $\Delta p = 1.0 \text{ kNs}$
 $F = 33.3 \text{ kN}$

26. A 1000 kg cannon with a 5.0 m long barrel sits on a frictionless rails and fires a 10 kg ball horizontally with a speed of 500 m/s.
- Find the recoil speed of the cannon.
 - What is the impulse given to the cannon ball?
 - What is the average force on the cannon ball while in the barrel, if it takes only 0.020s for it to reach the end of the barrel? (remember that the cannon ball reaches maximum velocity at the end of the barrel)

$$\mathbf{v}_{\text{cannon}} = -5.0 \text{ m/s}$$

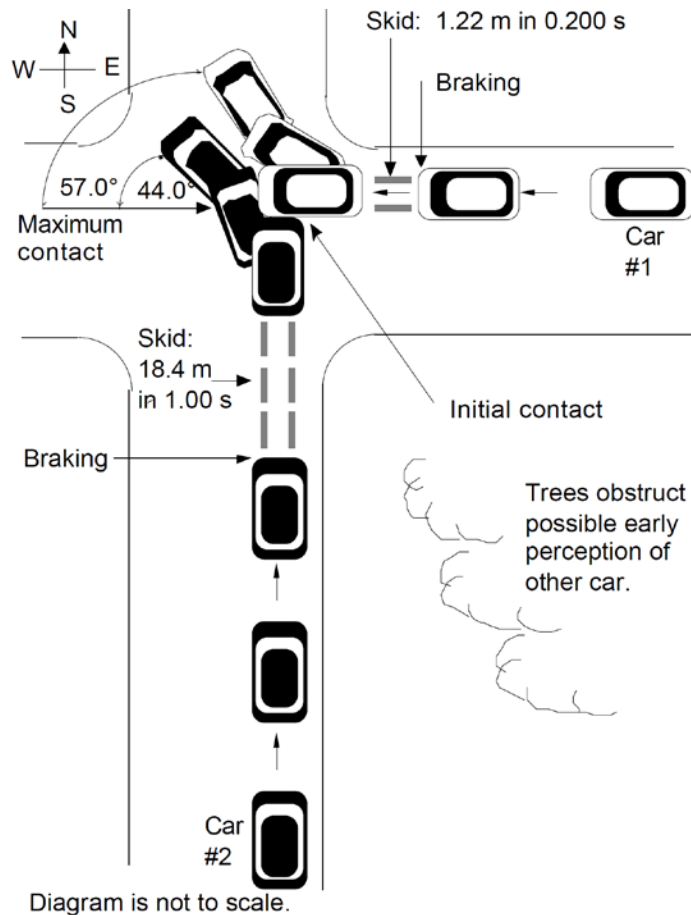
$$\Delta \mathbf{p} = 5.0 \text{ kNs}$$

$$\mathbf{F} = 250 \text{ kN}$$

27. Alice is traveling west in her (1300 kg) car at 100 km/h and hits Herman who is traveling south at 140 km/h in his 800 kg car. If the cars hit and stick together in the inelastic collision, how far will the two cars slide after they hit, if there is a constant force due to friction of 20 kN after the collision. Explain in simple terms how the problem was solved as you solved it. (8 marks)
- 27.0 m @ 40.7° south west from the point of contact**

Use the following information to answer the next question.

After measuring and evaluating skid marks, police were able to determine that Car #1, of mass 765 kg, was travelling at 70.0 km/h at 57° N of W just after the impact. Car #2, of mass 1100 kg, was determined to be moving at 41.0 km/h at 44° N of W just after impact. In analyzing this accident scene, it is important for police to establish the velocity of each car just before impact.



28. a) Describe in detail the physics concepts the police investigator would use to determine the speeds of the cars
 b) Calculate the speeds of the two cars just as they make contact. (8 marks)
 $v = 69.3 \text{ km/h}$
 $v = 80.5 \text{ km/h}$
29. A 2000 kg truck moving Northbound at a velocity of 50 km/h hits a small car of mass 1000 kg travelling at a velocity of 10 km/h Eastbound. Find the velocity of the wreckage given that the vehicles remain locked. (5 marks)
 $v = 33 \text{ km/h}$
 $\theta = 5.7^\circ \text{ E of N}$

30. a) A stationary rock explodes into four pieces. After the explosion a 2.0 kg piece moves west at 5.0 m/s. A 5.0 kg piece moves north at 8.0 m/s. A 1.0 kg piece moves east at 40 m/s. Calculate the mass of the missing piece if its speed is 25 m/s.
 b) If the explosion released 10 kJ of energy, what percentage ended up as kinetic energy? (7 marks)
m = 2.0 kg
31. A 1200 kg cannon is pointed North. The angle of the barrel is 30° with respect to the horizontal ground. A 150 kg shell is placed in the cannon. Upon firing, the cannon moves backwards horizontally with a velocity of 3.0 m/s. Calculate the speed of the shell.
- A. 12 m/s
 B. 28 m/s
 C. 48 m/s
 D. 21 m/s

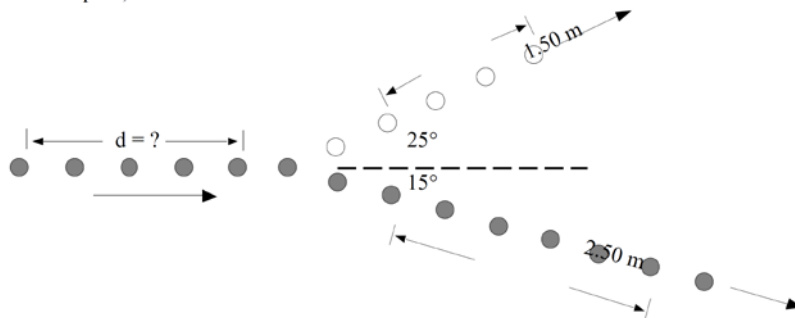
Use the following information to answer the next question.

A physics 20 student that doesn't know much about chemistry added several chemicals into a flask. As the chemicals reacted, a volatile reaction took place. The 0.400 kg flask (ignore the mass of the chemicals) exploded into three pieces. One 0.20 kg piece flew off in an easterly direction at a speed of 10 m/s. Another piece (mass 0.100 kg) flew off in a northerly direction with a speed of 15 m/s.

32. Find the speed of the third piece.
- A. 25 m/s 36.9° W of S
 B. 25 m/s 36.9° S of W
 C. 5 m/s west
 D. 35 m/s 36.9° N of W

Use the following information to answer the next question.

Students place two balls on a floor. The ball with a mass 3.00 kg is initially at rest and the ball with a mass of 5.00 kg is put into motion so that it will collide with the ball. After the collision, both pucks are moving as shown. (In the diagram, each and each appears 1.00 s apart).



33. What was the distance traveled by the ball as indicated on the diagram? (8 marks)
 $\Delta d = 3.0$ m

34. During an elastic collision, which of the following is conserved?
- A. neither momentum or kinetic energy
 - B. momentum
 - C. kinetic energy
 - D. both momentum and kinetic energy
35. What are the three collisions that happen in a car accident?
- A. There is only one collision per accident
 - B. car hits car; cars continue and hit another car; all three cars hit something else
 - C. car hits something; person hits the inside of car; internal organs hit the skeleton.
 - D. car hits something; person hits other car owner; car owners hit lawyer
36. Herman was standing at the back of a bus doing 100 km/h when it hit the side of a mountain. If the bus stopped in a fraction of a second, what happened to Herman?
- A. He hit the floor of the bus.
 - B. He was okay because he never studied Newton's laws.
 - C. He hit the front of the bus at 100 km/h a fraction of a second after the bus hit the mountain.
 - D. He escaped with fewer injuries than others.
37. If momentum is conserved, what happens when Herman increases his velocity on his bike?
- A. Energy is conserved.
 - B. Momentum of his bike is unchanged.
 - C. The momentum of the Earth is changed equally in the opposite direction.
 - D. Energy is lost to the universe.

Multiple Choice Answers

- 3. C
- 12. B
- 14. B
- 15. C
- 17. A
- 23. D
- 24. A
- 31. B
- 32. B
- 34. D
- 35. C
- 36. C
- 37. C