Physics 12
Unit 3B Provincial Package

1. A 2.0 kg puck travelling due east at 2.5 m/s collides with a 1.0 kg puck travelling due south at 3.0m/s. They stick together on impact. What is the resultant direction of the combined pucks?

   A. 31° S of E
   B. 40° S of E
   C. 50° S of E
   D. 59° S of E

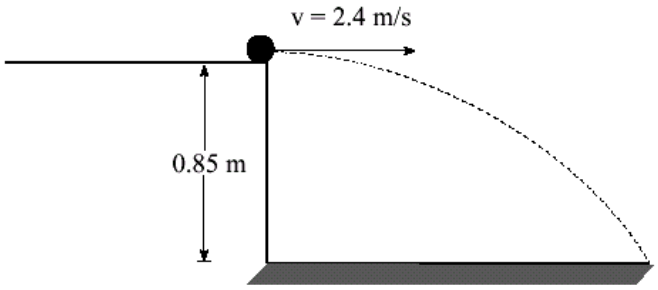
2. A puck sliding on a frictionless table undergoes a change in momentum due to a constant force. Which of the following expressions could be used to determine the change in momentum?

   A. $F \times \Delta d$
   B. $F \times \Delta t$
   C. $F \times \Delta v$
   D. $F \times (\Delta v / \Delta t)$

3. Impulse is measured in which units?

   A. J
   B. N
   C. $N \cdot m$
   D. $N \cdot s$

4. A 0.15 kg ball rolls off a bench at 2.4 m/s as shown in the diagram below. What is the vertical component of the ball's momentum when it strikes the floor 0.85 m below?



   A. $0.36\ kg \cdot m/s$
   B. $0.61\ kg \cdot m/s$
   C. $0.71\ kg \cdot m/s$
   D. $1.2\ kg \cdot m/s$

5. Two carts collide while travelling on a smooth surface. It is found that the sum of the kinetic energies of the carts after the collision is the same as before the collision. This collision **must** be

   A. elastic.
   B. inelastic.
   C. between carts of identical mass.
   D. between carts that stick together.

6. A 0.15 kg ball moving at 40 m/s is struck by a bat. The bat reverses the ball's direction and gives it a speed of 50 m/s. What average force does the bat apply to the ball if they are in contact for 6.0×10^{-3} s?

   A. 14 N
   B. 2.5×10^{2} N
   C. 1.3×10^{3} N
   D. 2.3×10^{3} N

7. In order to stop two sliding objects, the greater impulse **must** be given to the one having the greater

A. mass.
B. speed.
C. velocity.
D. momentum.

8. Which expression is equal to the net force on an object?

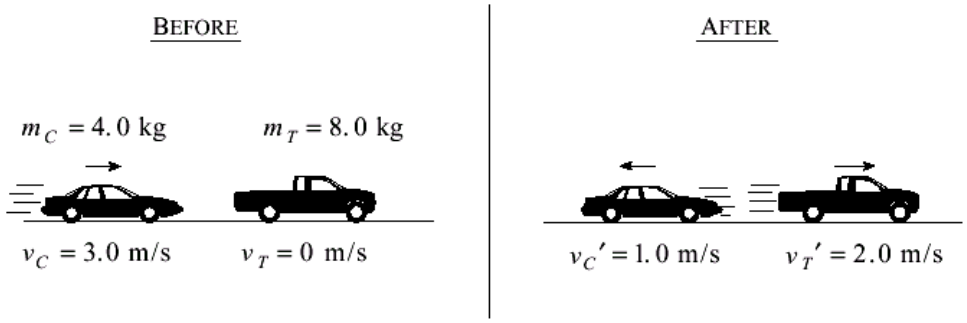
A. $\frac{\Delta p}{\Delta t}$

B. $\frac{W}{\Delta t}$

C. $m\Delta v$

D. ΔE

9. The diagram shows a collision between a 4.0 kg toy car and a stationary 8.0 kg toy truck. After the collision, the car bounces back at 1.0 m/s while the truck goes forward at 2.0 m/s. **Based on these values**, are momentum and kinetic energy conserved?

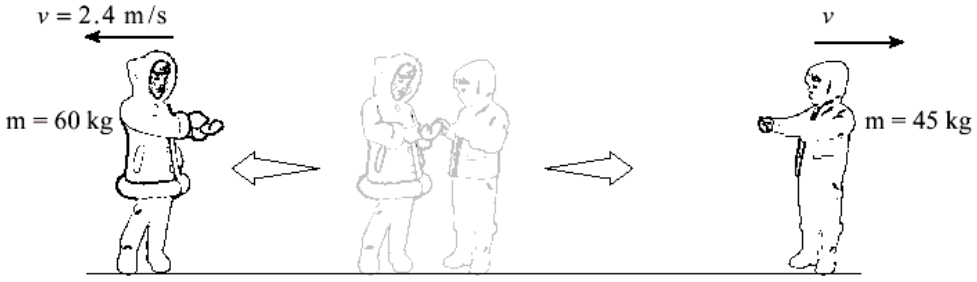


	MOMENTUM	KINETIC ENERGY
A.	Conserved	Conserved
B.	Conserved	Not Conserved
C.	Not Conserved	Conserved
D.	Not Conserved	Not Conserved

10. Are momentum and impulse scalar or vector quantities?

	MOMENTUM	IMPULSE
A.	Scalar	Scalar
B.	Scalar	Vector
C.	Vector	Scalar
D.	Vector	Vector

11. A 60 kg girl and her 45 kg brother are at rest at the centre of a frozen pond. He pushes her so that she slides away at 2.4 m/s. How much total work is done? (Ignore friction.)



A. 58 J
B. 170 J
C. 350 J
D. 400 J

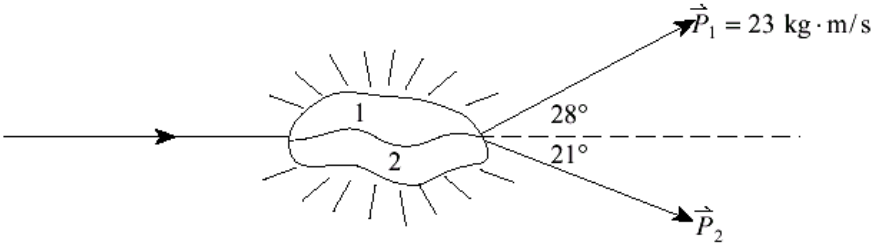
12. Impulse is defined as

A. total energy.
B. total momentum.
C. a change in energy.
D. a change in momentum.

13. Which set of conditions is true in all inelastic collisions?

	MOMENTUM	KINETIC ENERGY	TOTAL ENERGY
A.	Conserved	Conserved	Conserved
B.	Conserved	Not conserved	Conserved
C.	Not conserved	Not conserved	Conserved
D.	Not conserved	Conserved	Not conserved

14. A small explosive device sliding to the right breaks into two pieces. The momentum of fragment **1** after the explosion is 23 kg·m/s.



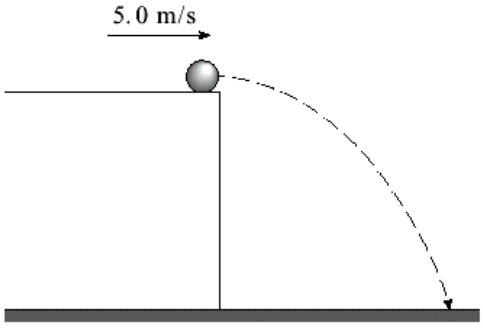
What is the momentum of fragment **2** after the explosion?

A. 22 kg·m/s
B. 23 kg·m/s
C. 30 kg·m/s
D. 32 kg·m/s

15. Which of the following describes kinetic energy and momentum before and after a perfectly elastic collision?

	KINETIC ENERGY	MOMENTUM
A.	Not Conserved	Not Conserved
B.	Not Conserved	Conserved
C.	Conserved	Not Conserved
D.	Conserved	Conserved

16. A 0.30 kg ball rolls off a horizontal surface as shown in the diagram. What is the magnitude of the impulse given to the ball by gravity during the 0.90 s it takes the ball to fall to the ground?



A. 1.5 N·s
B. 2.6 N·s
C. 3.0 N·s
D. 4.1 N·s

17. Which equation is a form of Newton's second law?

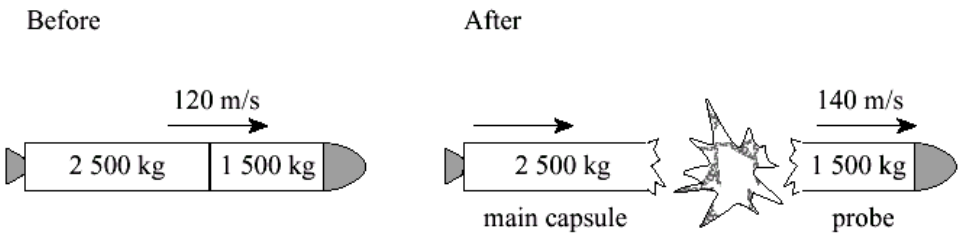
A. $\vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t}$
B. $W = \Delta E$
C. $E_k + E_p = E_k' + E_p'$
D. $\mathcal{E} = -N\frac{\Delta \Phi}{\Delta t}$

18. A 0.15 kg ball travelling at 25 m/s strikes a wall and bounces back in the opposite direction at 15 m/s. The ball is in contact with the wall for 0.030 seconds. What average force does the wall exert on the ball?

A. 25 N
B. 50 N
C. 1.0×10^2 N
D. 2.0×10^2 N

19. A 5.20 kg block sliding at 9.40 m/s across a horizontal frictionless surface collides head on with a stationary 8.60 kg block. The 5.20 kg block rebounds at 1.80 m/s. How much kinetic energy is lost during this collision? **(7 marks)**

20. A 4 000 kg space vehicle consists of a 2 500 kg main capsule and a 1 500 kg probe. The space vehicle is travelling at 120 m/s when an explosion occurs between the capsule and the probe. As a result, the probe moves forward at 140 m/s, as shown in the diagram below.

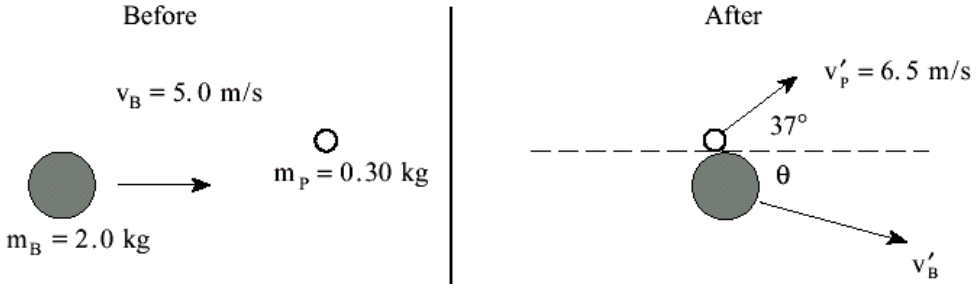


a) (i) What is the speed of the main capsule after the explosion? **(3 marks)**

(ii) What is the magnitude of the impulse given to the probe? **(2 marks)**

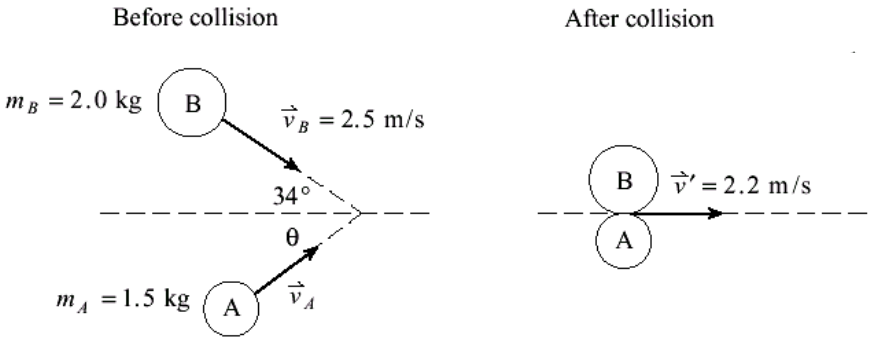
b) Define *impulse* and briefly explain why the impulse on the probe is equal in magnitude to the impulse on the main capsule. **(4 marks)**

21. A 2.0 kg bowling ball travelling 5.0 m/s collides with a stationary 0.30 kg bowling pin. After the collision, the pin moves at a speed of 6.5 m/s in the direction shown in the diagram. What is the velocity (magnitude and direction) of the bowling ball after the collision? **(7 marks)**

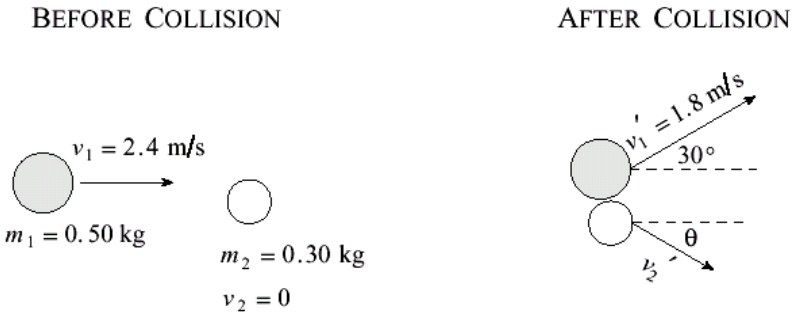


22. Two students throw identical tennis balls towards a building at the same speed. One ball strikes the wall, bouncing back at half its original speed. The other ball smashes a window and continues in the same direction at half its original speed. Did the two tennis balls experience the same impulse when in contact with the wall and the window? Justify your answer using principles of physics. **(4 marks)**

23. Two air pucks approach each other, stick together and then travel due east as shown below. Find the initial velocity (magnitude and direction) of puck **A**. **(7 marks)**

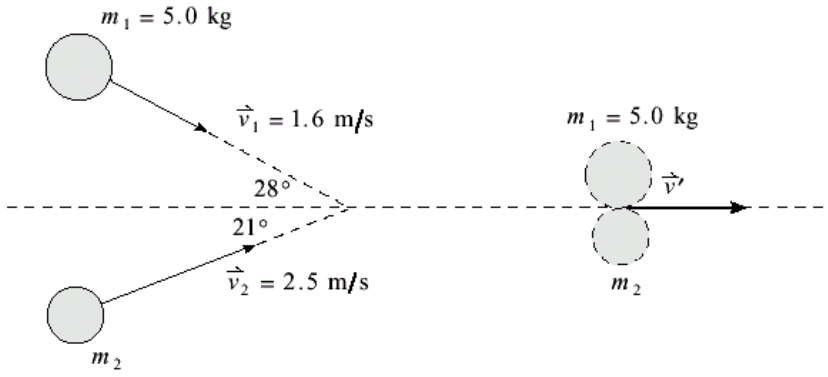


24. Two steel pucks collide as shown in the diagram below.



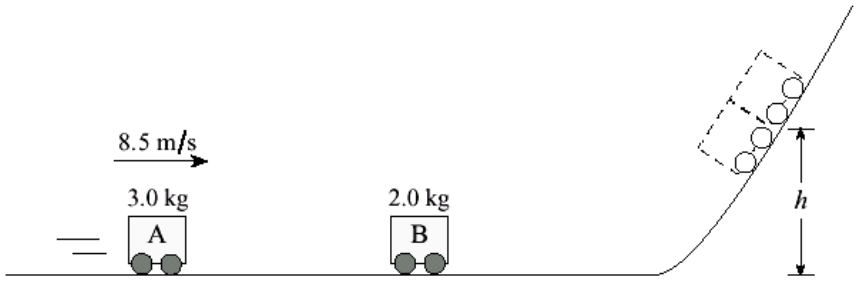
Determine the speed and direction (angle θ) of the 0.30 kg puck after the collision. **(7 marks)**

25. A 5.0 kg object travelling at 1.6 m/s collides with an object of unknown mass m_2 travelling at 2.5 m/s. The two objects stick together and move towards the right as shown in the diagram.



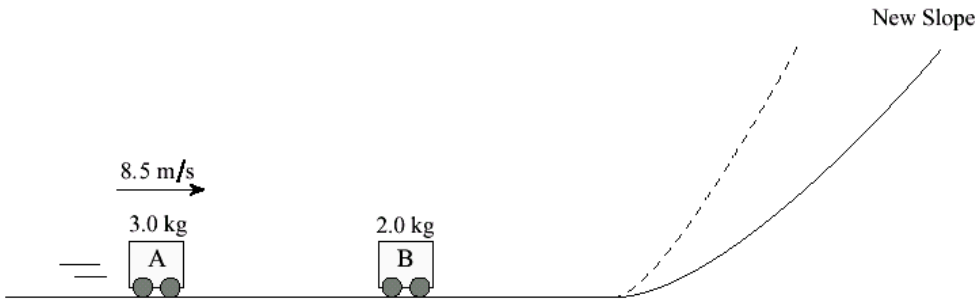
Find the mass of object m_2. **(7 marks)**

26. A 3.0 kg car A travelling 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car B.



a) The combined cars will reach what height h? **(5 marks)**

b) The steepness of the slope is decreased as shown below.



With this decreased slope, the combined cars will reach (check one response) **(1 mark)**

- ❒ a lesser height.
- ❒ the same height.
- ❒ a greater height.

c) Using principles of physics, explain your answer to b). **(3 marks)**

KEY

1.	A	4.	B	7.	D	10.	D	13.	B	16.	B
2.	B	5.	A	8.	A	11.	D	14.	C	17.	A
3.	D	6.	D	9.	A	12.	D	15.	D	18.	D

19. 24.1 J
20. a) i) 108 m/s
    ii) 3.00×10^4 Ns
    b) Impulse is a force acting for a given time interval, or a change in momentum.
    (i) Newton's Third Law states that for every force there is an equal and opposite reacting force. As the time of the explosion is equal for both the probe and the capsule, the impulse must be equal and opposite also.
    OR
    (ii) Impulse is equal to a change in momentum. As momentum is conserved, the momentum gained by the probe must equal the momentum lost by the capsule.
21. 4.26 m/s; 7.9°
22. • The two tennis balls experienced different impulses.
    • Impulse, or change in momentum, is a vector quantity. The ball that bounced from the wall sustained an impulse given by: $m\Delta v = m\left(\frac{1}{2}v - v\right) = -\frac{3}{2}mv$
    (The negative sign indicates the direction of the impulse.)
    • The ball which smashed the window experienced an impulse given by:
    $m\Delta v = m\left(\frac{1}{2}v - v\right) = -\frac{1}{2}mv$
    • Therefore, the balls experienced different impulses.
23. 3.02 m/s; 38.2° N of E
24. 2.05 m/s; 46.9° S of E
25. 4.19 kg
26. a) 1.33 m
    b) same height
    c) The steepness of the slope does not matter. All of the cars kinetic energy will be transferred to gravitational potential energy. Since the original kinetic energy of the cars has not changed, they must have the same potential. Therefore, they go to the same vertical height.