1. Which of the following best represents the momentum of a small car travelling at a city speed limit?

A. $1\ 000\ kg \cdot m/s$
B. $10\ 000\ kg \cdot m/s$
C. $100\ 000\ kg \cdot m/s$
D. $1\ 000\ 000\ kg \cdot m/s$

2. A $0.080\ kg$ tennis ball travelling east at $15\ m/s$ is struck by a tennis racquet, giving it a velocity of $25\ m/s$, west. What are the magnitude and direction of the impulse given to the ball?

	MAGNITUDE	DIRECTION
A.	$0.80\ N \cdot s$	Eastward
B.	$0.80\ N \cdot s$	Westward
C.	$3.2\ N \cdot s$	Eastward
D.	$3.2\ N \cdot s$	Westward

3. A climber's gravitational potential energy increases from $14\ 000\ J$ to $21\ 000\ J$ while climbing a cliff. She expends $18\ 000\ J$ of energy during this activity. What is the efficiency of this process?

A. 3%
B. 39%
C. 61%
D. 97%

4. A $40\ 000\ kg$ rail car travelling at $2.5\ m/s$ collides with and locks to a stationary $30\ 000\ kg$ car. Determine the speed of the locked cars and state whether the collision is elastic or inelastic.

	SPEED OF LOCKED CARS	TYPE OF COLLISION
A.	$1.4\ m/s$	Elastic
B.	$1.4\ m/s$	Inelastic
C.	$1.9\ m/s$	Elastic
D.	$1.9\ m/s$	Inelastic

5. Which of the following correctly describes momentum and impulse?

	MOMENTUM	IMPULSE
A.	vector	vector
B.	vector	scalar
C.	scalar	vector
D.	scalar	scalar

6. A stationary object explodes into two fragments. A $4.0\ \text{kg}$ fragment moves westwards at $3.0\ \text{m/s}$. What are the speed and kinetic energy of the remaining $2.0\ \text{kg}$ fragment?

	SPEED	KINETIC ENERGY
A.	4.2 m/s	18 J
B.	4.2 m/s	36 J
C.	6.0 m/s	18 J
D.	6.0 m/s	36 J

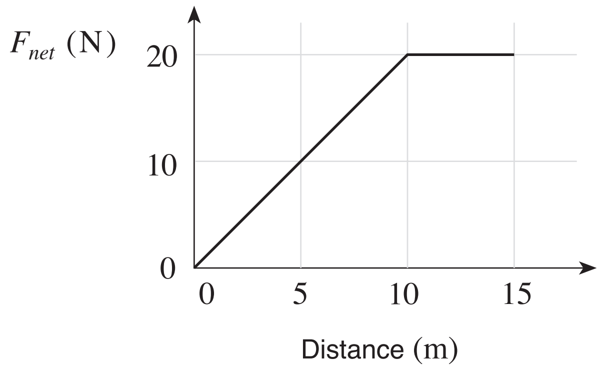
7. A $1\,000\ \text{kg}$ vehicle travelling westward at $15\ \text{m/s}$ is subjected to a $1.0\times10^4\ \text{N}\cdot\text{s}$ impulse northward. What is the magnitude of the final momentum of the vehicle?

A. $5.0\times10^3\ \text{kg}\cdot\text{m/s}$
B. $1.5\times10^4\ \text{kg}\cdot\text{m/s}$
C. $1.8\times10^4\ \text{kg}\cdot\text{m/s}$
D. $2.5\times10^4\ \text{kg}\cdot\text{m/s}$

8. A cyclist increases his kinetic energy from $1\,100\ \text{J}$ to $5\,200\ \text{J}$ in $12\ \text{s}$. His power output during this time is

A. 92 W
B. 260 W
C. 340 W
D. 430 W

9. A force is applied to an 8.0 kg object initially at rest. The magnitude of the net force varies with distance as shown.



What is the speed of the object after moving 15 m?

A. 5.0 m/s
B. 6.1 m/s
C. 7.1 m/s
D. 8.7 m/s

10. A machine rated at 1 500 W lifts a 100 kg object 36 m vertically in 45 s. What is the efficiency of this machine?

A. 0.053
B. 0.48
C. 0.52
D. 0.65

11. Two cars collide head-on and come to a complete stop immediately after the collision. Which of the following is correct?

	TOTAL MOMENTUM	TOTAL ENERGY
A.	is conserved	is conserved
B.	is conserved	is not conserved
C.	is not conserved	is conserved
D.	is not conserved	is not conserved

12. A crane lifts a 3 900 kg shipping container through a vertical height of 45 m in 8.0 s. What is the minimum average power that the crane motor must supply?

A. 2.7×10^3 W
B. 7.7×10^3 W
C. 2.1×10^5 W
D. 1.7×10^6 W

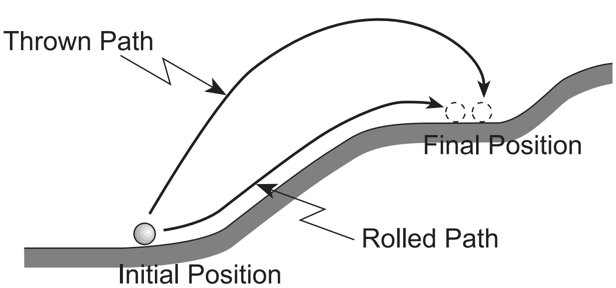
13. A change in kinetic energy is equivalent to

A. work.
B. power.
C. impulse.
D. momentum.

14. A 16 kg object is dropped from a height of 25 m and strikes the ground with a speed of 18 m/s. How much heat energy was produced during the fall?

A. 0 J
B. 1 300 J
C. 2 600 J
D. 3 900 J

15. A child rolls a ball up a hill as shown. The same child then throws an identical ball up the hill.



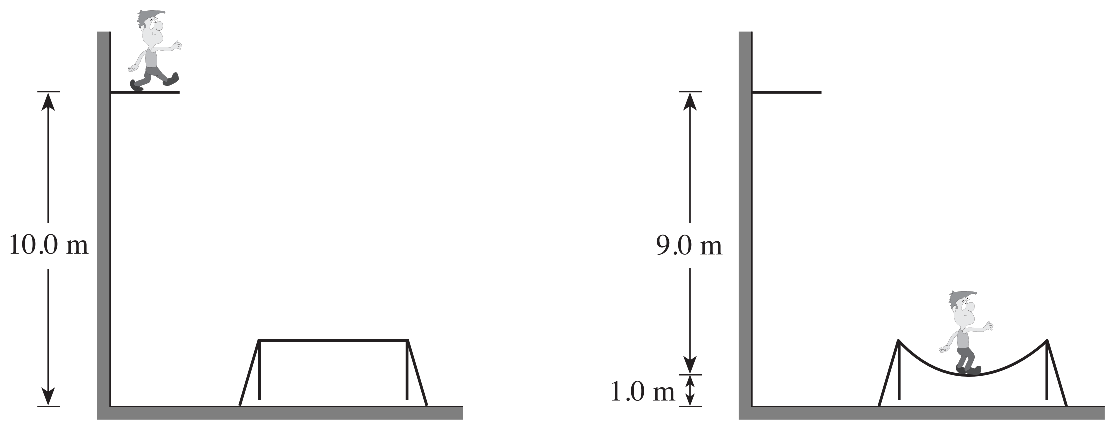
When both balls end up in the same location on the hill, which of the following correctly describes the potential energy change for each ball?

A. Both balls have the same potential energy change.
B. There is no potential energy change for either ball.
C. The thrown ball has a greater potential energy change than the rolled ball.
D. The thrown ball has a smaller potential energy change than the rolled ball.

16. A 950 kg elevator ascends a vertical height of 410 m with an average speed of 9.1 m/s . What average power must the lifting motor supply?

A. 8.6×10^3 W
B. 8.5×10^4 W
C. 4.2×10^5 W
D. 3.8×10^6 W

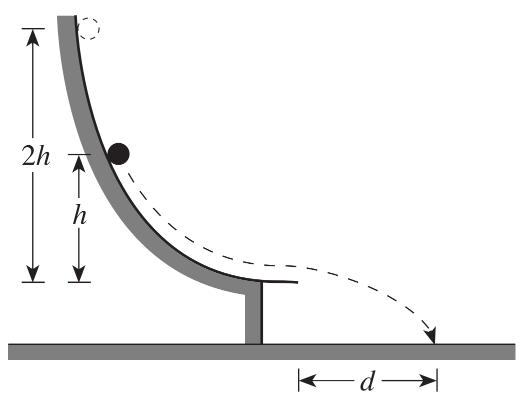
17. A 55.0 kg athlete steps off a 10.0 m high platform and drops onto a trampoline. As the trampoline stretches, it brings him to a stop 1.00 m above the ground.



How much energy must have been momentarily stored in the trampoline when he came to rest?

A. 0 J
B. 539 J
C. 4 850 J
D. 5 390 J

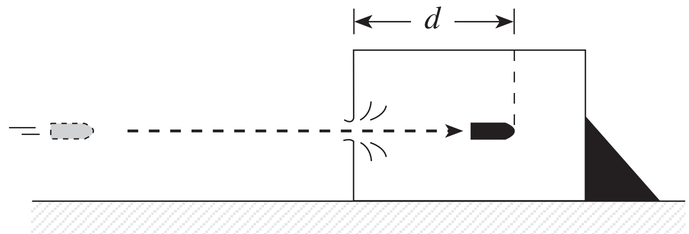
18. An object starts from rest and slides down a frictionless track as shown. It leaves the track horizontally, striking the ground at a distance d as shown.



The same object is now released from twice the height, $2h$. How far away will it land?

A. d
B. $\sqrt{2}\, d$
C. $2d$
D. $4d$

19. A 0.055 kg bullet was fired at 250 m/s into a block of wood as shown in the diagram below.



Assuming an average force of 9 500 N brings the bullet to rest in the wood, what distance *d* did the bullet penetrate the block?

A. 1.4×10^{-3} m
B. 1.4×10^{-2} m
C. 1.8×10^{-1} m
D. 3.6×10^{-1} m

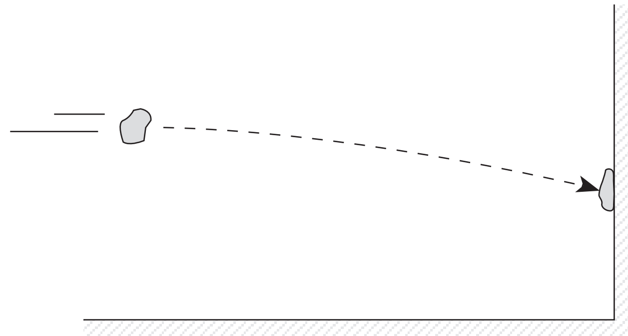
20. An electric winch operates from a 120 V source at 3.5 A. The winch lifts a 360 kg object 2.5 m vertically in 45 s. What is the efficiency of the winch?

A. 4.8%
B. 17%
C. 19%
D. 47%

21. A 0.40 kg ball rolls at 8.5 m/s towards a player. The player kicks the ball so that it then travels at 15.2 m/s in the opposite direction. What is the magnitude of the impulse that the ball sustained?

A. 1.3 N·s
B. 2.7 N·s
C. 4.7 N·s
D. 9.5 N·s

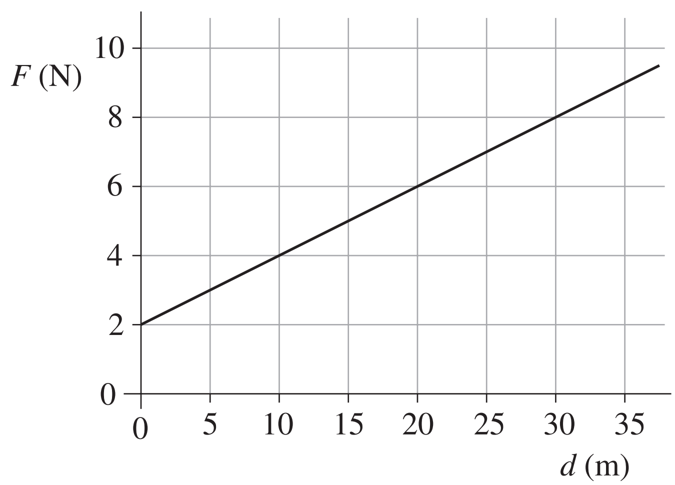
22. A wad of putty is thrown against a wall as shown. The wad of putty sticks against the wall.



Which of the following statements best applies the application of the law of conservation of energy to this collision?

A. All energy has been lost.
B. Kinetic energy is converted to heat.
C. Kinetic energy is converted to momentum.
D. Kinetic energy is converted to potential energy.

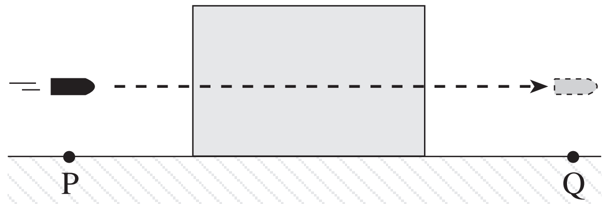
23. The graph below shows how the force applied to an object varies with distance.



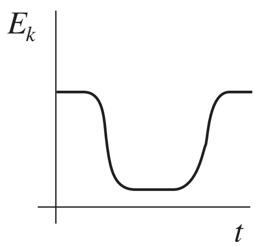
What is the work done to move the object from 10 m to 30 m?

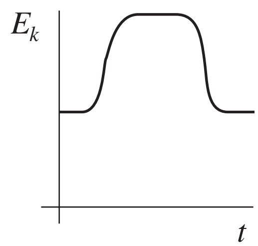
A. 40 J
B. 80 J
C. 120 J
D. 240 J

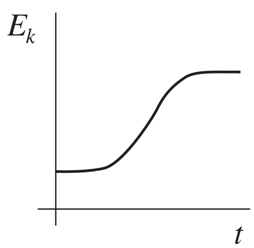
24. A projectile is fired through a fixed block of wood. The diagram shows the projectile above point P just before it enters the block and again above point Q just after leaving the block.

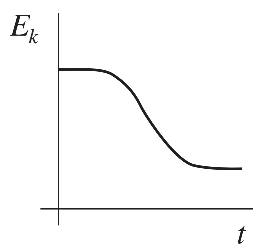


Which of the graphs best illustrates how the kinetic energy of the projectile varies over the time it takes to travel from P to Q?

A.


B.


C.


D.


25. A 1.0 kg cart moves to the right at 6.0 m/s and strikes a stationary 2.0 kg cart. After the head-on collision, the 1.0 kg cart moves back to the left at 2.0 m/s and the 2.0 kg cart moves to the right at 4.0 m/s. In this collision

A. only momentum is conserved.
B. only kinetic energy is conserved.
C. both momentum and kinetic energy are conserved.
D. neither momentum nor kinetic energy is conserved.

26. A 12.0 kg shopping cart rolls due south at 1.50 m/s. After striking the bumper of a car, it travels at 0.80 m/s, 30° E of S. What is the magnitude of the change in momentum sustained by the shopping cart?

A. 8.4 kg · m/s
B. 9.7 kg · m/s
C. 11 kg · m/s
D. 27 kg · m/s

27. Identify momentum and kinetic energy as scalar or vector quantities.

	MOMENTUM	KINETIC ENERGY
A.	scalar	scalar
B.	scalar	vector
C.	vector	scalar
D.	vector	vector

28. Which of the following best represents the work-energy theorem?

A. $W = \Delta E$
B. $E_k = E_p$
C. $W = F_f \times d$
D. $E_p = P \times t$

29. A 1500 kg car moving at 8.0 m/s comes to a stop in 16 m when its brakes are applied. The speed of the car is now doubled to 16 m/s. Assuming the same braking force as before, how far will the car travel before coming to a stop?

A. 16 m
B. 32 m
C. 64 m
D. 130 m

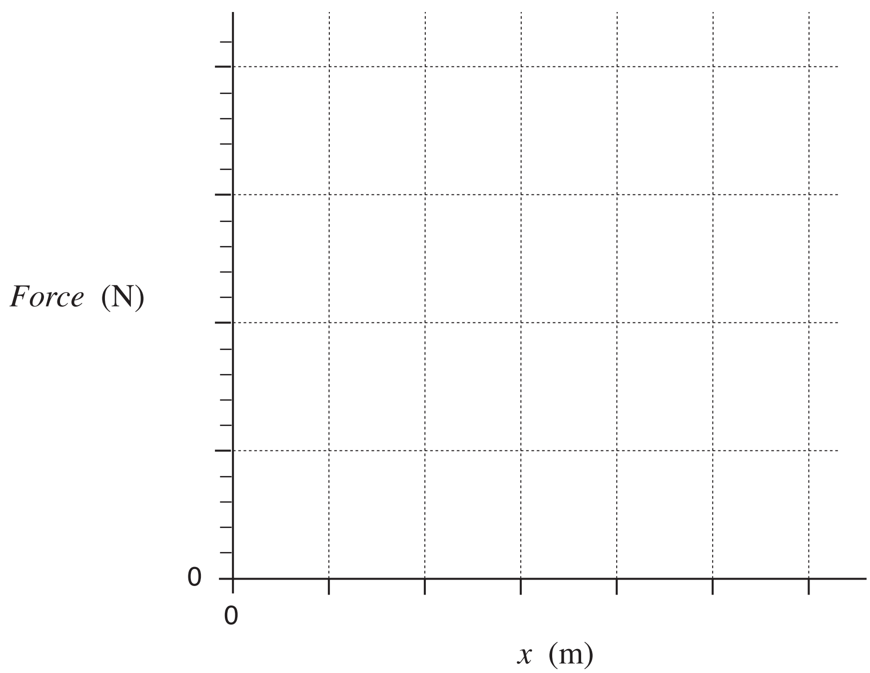
30. The momentum of a male Olympic sprinter is about

A. 10 kg · m/s
B. 100 kg · m/s
C. 1000 kg · m/s
D. 10 000 kg · m/s

1. A daredevil is attached by his ankles to a bungee cord and drops from the top of a bridge. The force exerted on the daredevil by the bungee cord is measured against the change in length, x, of the cord as the cord is stretched, slowing the daredevil's fall.

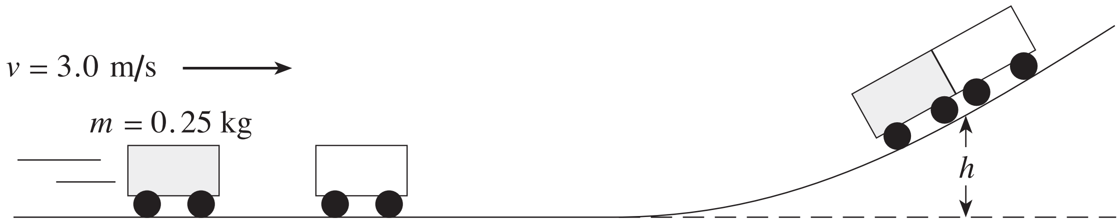
Force (N)	0	300	600	1 000	1 200	1 700	1 900
x (m)	0	5	10	15	20	25	30

a) Plot a graph of force vs. change in length on the graph below. **(2 marks)**



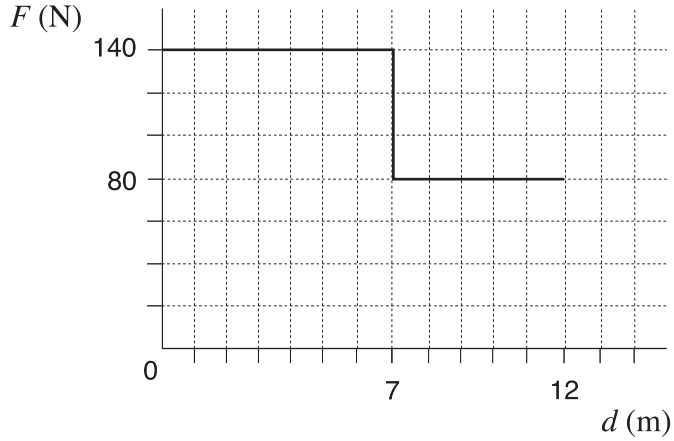
b) Use the graph to determine the work done by the bungee cord during its stretch. **(3 marks)**

2. A 0.25 kg cart travelling at 3.0 m/s collides with and sticks to an identical stationary cart on a level track. (Ignore friction.)



To what height h do the combined carts travel up the hill? **(7 marks)**

3. Starting from rest, a farmer pushed a cart 12 m. The graph shows the force F which he applied, plotted against the distance d.

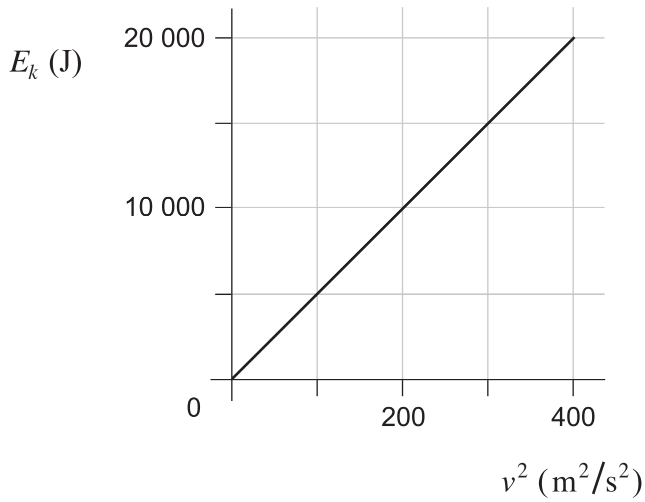


a) How much work did the farmer do moving the cart 12 m? **(3 marks)**

b) After the farmer had pushed the 240 kg cart 12 m, it was moving with a velocity of 2.2 m/s. What was the cart's kinetic energy? **(2 marks)**

c) What was the efficiency of this process? **(2 marks)**

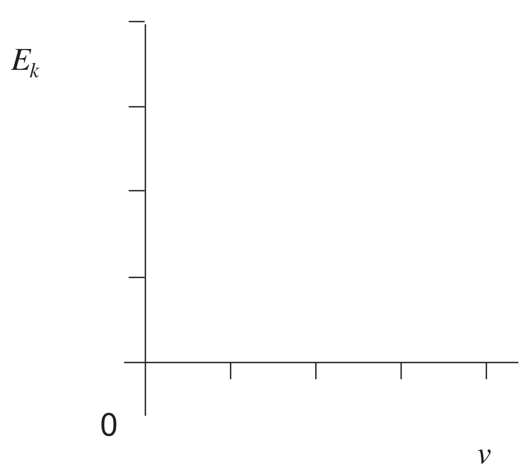
4 . A student plots the graph below, showing the kinetic energy E_k of a motorbike versus the square of its velocity v^2.



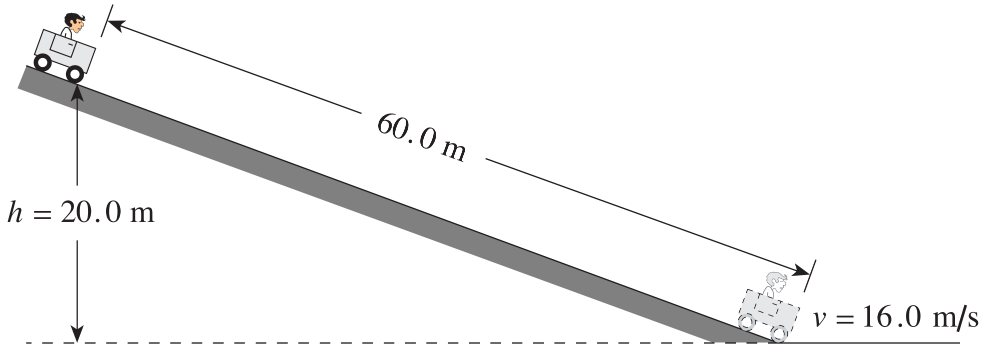
a) What is the slope of this graph? **(2 marks)**

b) What does the slope represent? **(2 marks)**

c) Using the axes below, sketch the graph of kinetic energy E_k versus velocity v for this motorbike. There is no need to plot any data points. **(1 mark)**



5. A 170 kg cart and rider start from rest on a 20.0 m high incline.

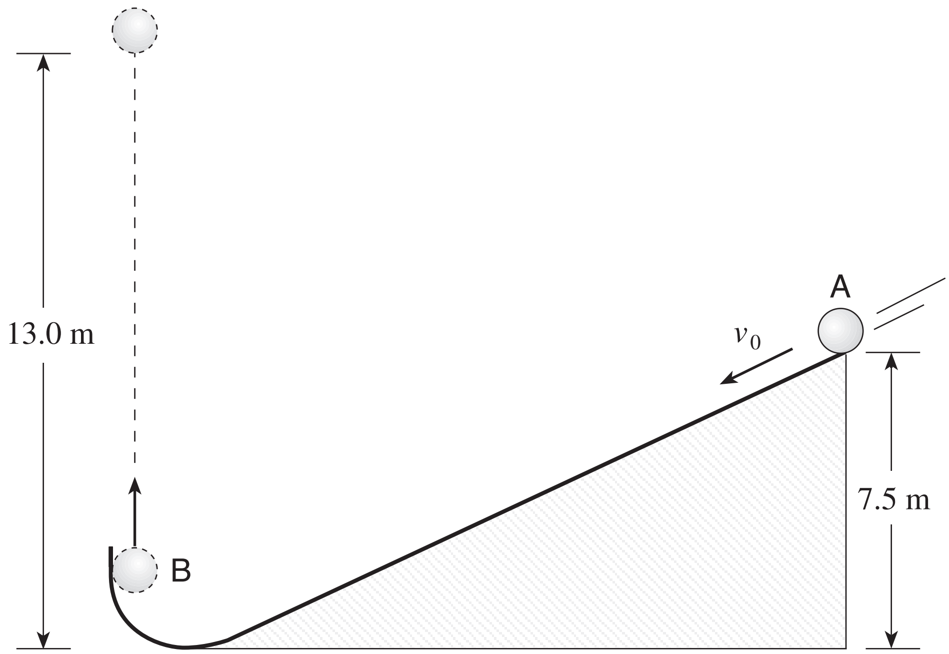


a) How much energy is transformed to heat? **(5 marks)**

b) What is the average force of friction acting on the cart? **(2 marks)**

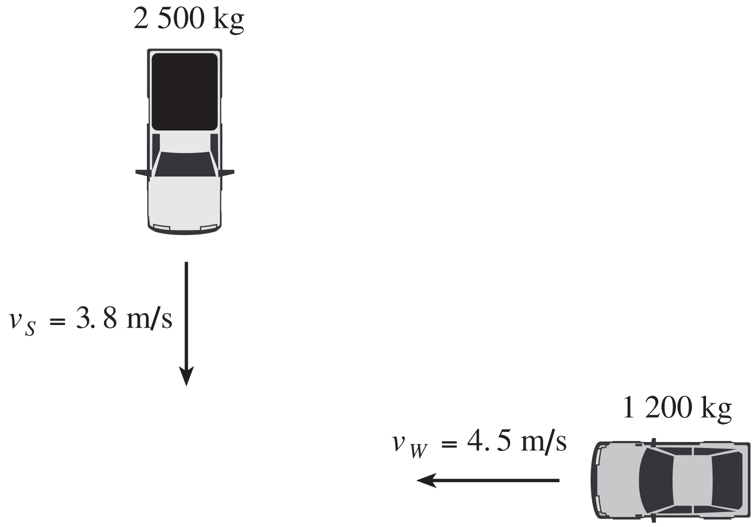
6. A 0.50 kg ball starting from position A which is 7.5 m above the ground, is projected down an incline as shown. Friction produces 10.7 J of heat energy.

The ball leaves the incline at position B travelling straight upward and reaches a height of 13.0 m above the floor before falling back down.



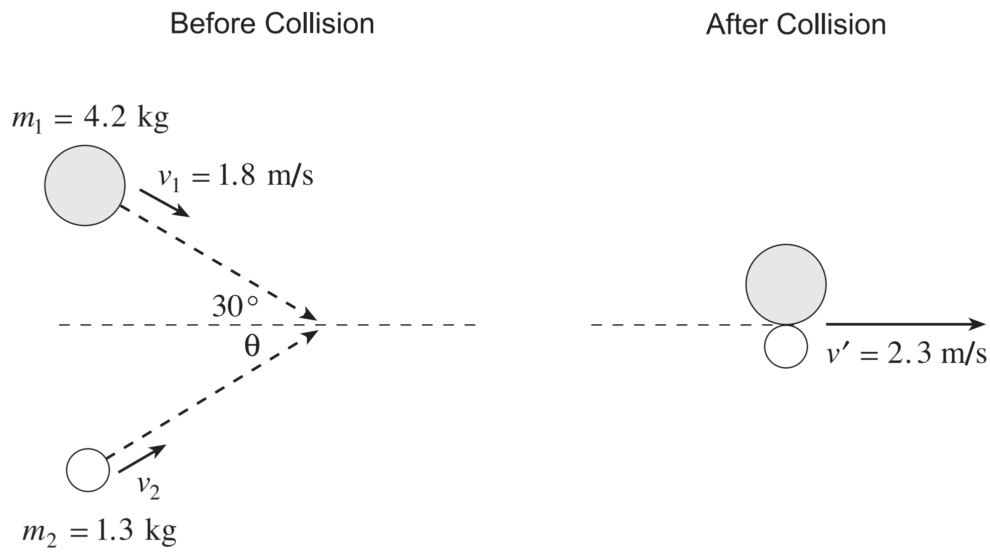
What was the initial speed, v_0, at position A? Ignore air resistance. **(7 marks)**

7. Sally is driving south in her 2 500 kg pickup truck at 3.8 m/s when she collides with Willy driving west in his 1 200 kg car at 4.5 m/s.



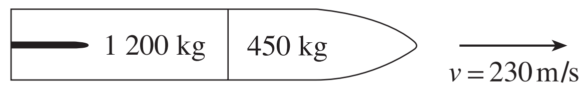
The two vehicles lock together and slide over the wet parking lot. Find the speed and direction of the damaged vehicles immediately after the collision. **(7 marks)**

8. Two steel pucks are moving as shown in the diagram. They collide inelastically.

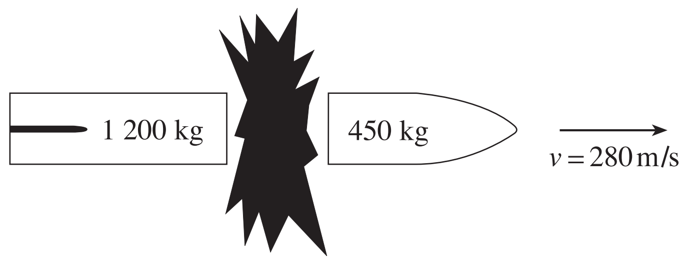


Determine the speed and direction (angle θ) of the 1.3 kg puck before the collision. **(7 marks)**

9. A space vehicle made up of two parts is travelling at 230 m/s as shown.



An explosion causes the 450 kg part to separate and travel with a final velocity of 280 m/s as shown.



a) What was the momentum of the space vehicle before the explosion? **(2 marks)**

b) What was the magnitude of the impulse on the 1 200 kg part during the separation?

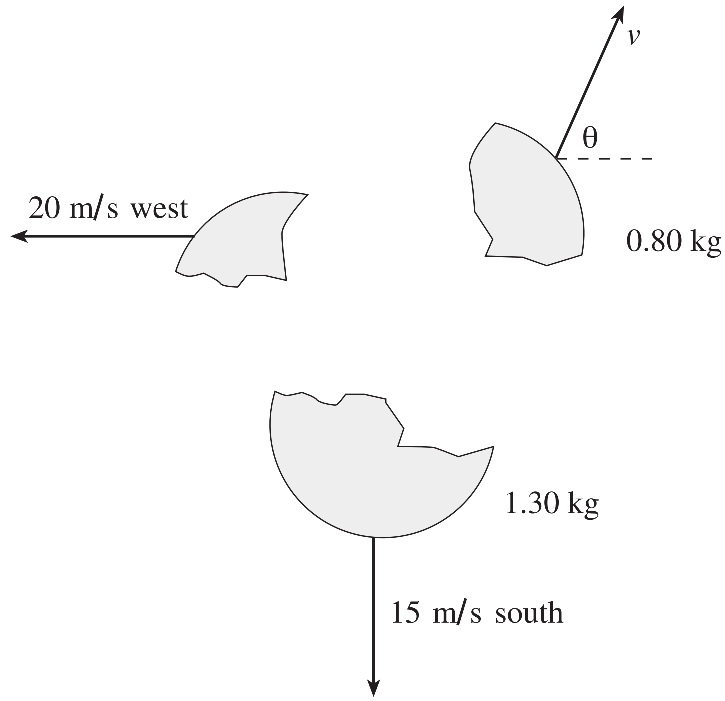
(3 marks)

c) Using principles of physics, explain what changes occur, if any, to the

i) momentum of the system as a result of the explosion. **(2 marks)**

ii) kinetic energy of the system as a result of the explosion. **(2 marks)**

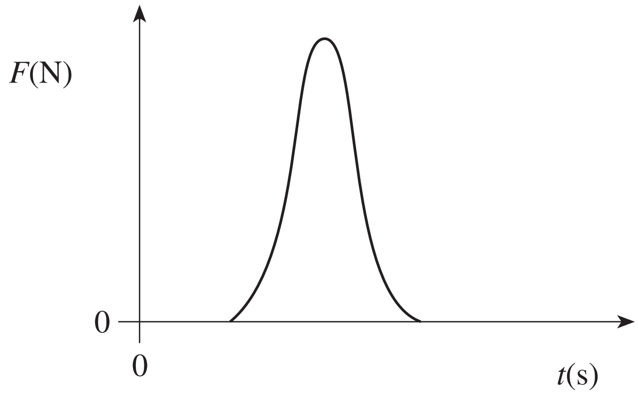
10. A 3.00 kg object initially at rest explodes into three fragments as shown in the diagram below.



What are the speed and direction of the 0.80 kg fragment? **(7 marks)**

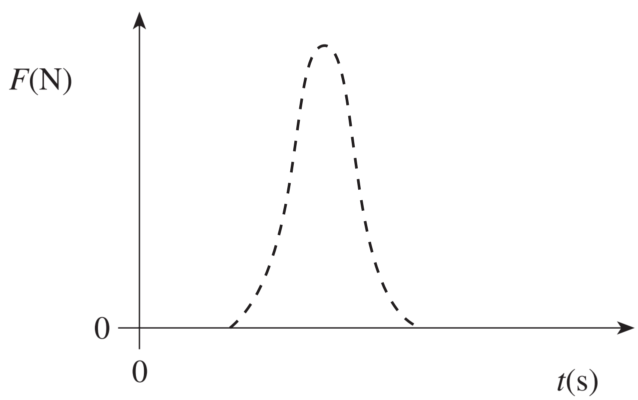
11. A 5.20 kg block sliding at 9.40 m/s across a horizontal frictionless surface collides head on with a stationary 8.60 kg block. The 5.20 kg block rebounds at 1.80 m/s. How much kinetic energy is lost during this collision? **(7 marks)**

12. In sports such as golf, tennis and baseball, a player exerts a force over a time interval on a ball, as shown on the graph, in order to give it a high speed.



Players are instructed to "follow through" on their swing. A weaker player may not exert as large a force but may give the ball a higher speed than a stronger player.

a) Sketch on the graph below how a weaker player can overcome the force handicap. **(1 mark)**



b) Explain how the player can impart a greater impulse on a ball. **(3 marks)**

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