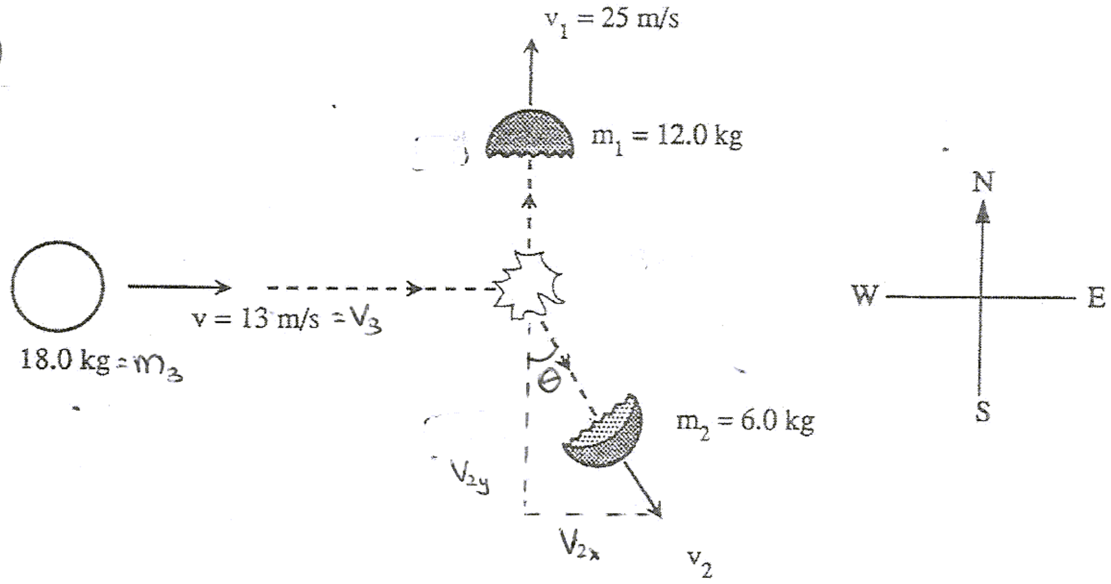
Mometum & Energy Cons.

2. An 18.0 kg object moving east at 13 m/s explodes into two unequal fragments, as shown below.
6/93 After the explosion, a 12.0 kg fragment moves north at 25 m/s.

#1



What are the speed and direction of the smaller 6.0 kg fragment?

$P_{xi} = P_{xf}$

$m_3 V_3 = m_2 V_{2x}$

$(18.0)(13) = (6.0) V_{2x}$

$V_{2x} = 39.0\,m/s$

$\tan\theta = \dfrac{V_{2x}}{V_{2y}}$

$\theta = \tan^{-1}\left(\dfrac{V_{2x}}{V_{2y}}\right)$

$P_{yi} = P_{yf} = 0$

$m_1 V_1 = m_2 V_{2y}$

$= \tan^{-1}\left(\dfrac{39.0}{50.0}\right)$

$(12.0)(25) = (6.0) V_{2y}$

$V_{2y} = 50.0\,m/s$

$= 38°$ East of South, OR:

$\boxed{52° \text{ South of East}}$

$V_2 = \sqrt{V_{2x}^2 + V_{2y}^2} = \sqrt{39^2 + 50^2}$

$= \boxed{63.4\,m/s}$

6/93

5. Work is equal to the change in

#2

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

A change in Kinetic energy will always create work.

6/93

6. A gun can fire 500 bullets in 60 seconds. Each bullet has a mass of 0.020 kg and leaves the gun at 400 m/s. What average recoil force is exerted on the gun?

#3

A. 8.0 N
B. 67 N
C. 4.0×10^3 N
D. 2.4×10^5 N

Time took to fire 1 bullet : 60 / 500 = 0.12 s

$V_f = V_o + at \rightarrow a = (V_f - V_o)/t$

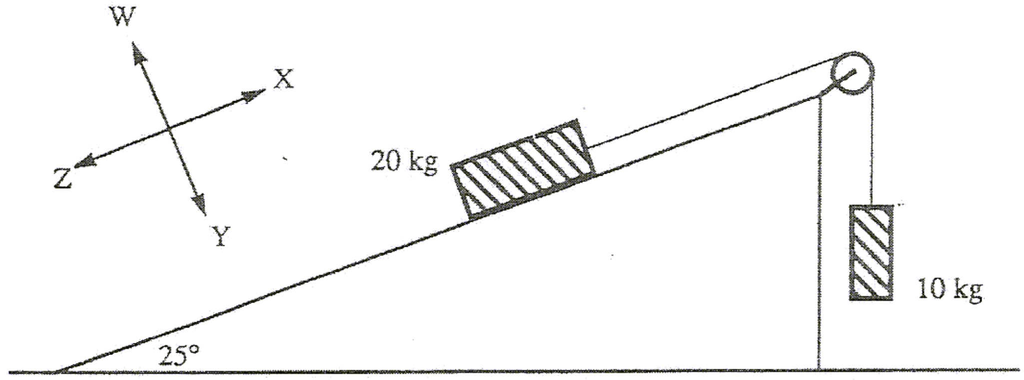
$= (400\,m/s - 0\,m/s)/(0.12\,s) = 3333\,m/s$

$F = ma = (0.020\,kg)(3333\,m/s) = 66.66\,N \Rightarrow \boxed{67\,N}$

6/93

7. Two blocks are connected by a string over a frictionless pulley as shown in the diagram below.

#4



If this system of masses is at rest, in what direction does the friction force act on the 20 kg block?

A. W
B. X
C. Y
D. Z

Force of friction is always in the opposite direction of the applied force

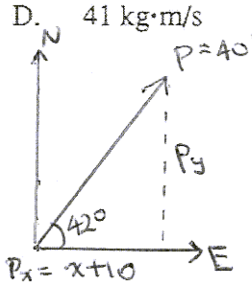
6/93

8. An impulse of 10 N·s is applied to an object in a direction due east. As a result of this impulse, the object's final momentum is 40 kg·m/s in the direction of 42 ° N of E. What was the magnitude of the momentum of the object before this impulse?

#5

A. 30 kg·m/s
B. 33 kg·m/s
C. 39 kg·m/s
D. 41 kg·m/s

let "x" denote the original horizontal momentum.
Since the 10 N·s impulse is due east, only horizontal momentum is affected.



$\cos 42° = \frac{adj}{hyp} = \frac{x+10}{40}$

$x = 40\cos 42° - 10 = 19.7\,kg \cdot m/s$

$\sin 42° = \frac{opp}{hyp} = \frac{P_y}{40}$

$P_y = 40 \sin 42° = 26.8\,kg \cdot m/s$

$P_i = \sqrt{x^2 + P_y^2} = \sqrt{19.7^2 + 26.8^2} = \boxed{33\,kg \cdot m/s}$

1/94 2. 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)**

(#6)

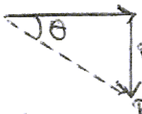
See bottom of this page for solution.

1/94 6. A 2.0 kg puck travelling due east at 2.5 m/s collides with a 1.0 kg puck travelling due south at 3.0 m/s. They stick together on impact. What is the resultant direction of the combined pucks?

(#7)

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

$P_1 = m_1v_1 = (2.0)(2.5) = 5.0\ kg\cdot m/s$



$P_2 = m_2V_2 = (1.0)(3.0) = 3.0\ kg\cdot m/s$

$\tan\theta = \frac{P_2}{P_1}$

$\theta = \tan^{-1}\left(\frac{P_2}{P_1}\right) = \tan^{-1}\left(\frac{3.0}{5.0}\right) = \boxed{31° \text{ South of East}}$

1/94 7. Two gliders having equal masses, each travelling along a level frictionless track at the same speed, approach each other head on. They stick together on impact and remain stationary at the point of impact. Does this situation mean that momentum has been lost during this particular collision? State your answer with supporting arguments which use principles of physics. **(4 marks)**

(#8)

<u>No. Since both gliders have equal mass and speed, their respective momentum is equal in magnitude but opposite in direction. Therefore, the initial total</u> momentum of the system of 2 gliders is zero. The final total momentum of zero is the result of momentum conservation instead of the result of momentum loss.

6) Use Law of Momentum Conservation to find speed of Stationary Block V_s.

$m_BV_{Bi} = m_BV_{Bf} + m_sV_s$

$(5.20kg)(9.40) = (5.20)(-1.80) + (8.60)V_s$

$V_s = 6.77\ m/s$

$\Delta KE = KE_f - KE_i$

$= (KE_{bf} + KE_s) - KE_{bi}$

$= \frac{1}{2}m_bV_{bf}^2 + \frac{1}{2}m_sV_s^2 - \frac{1}{2}m_bV_{bi}^2$

$= \frac{1}{2}(5.20)(1.80)^2 + \frac{1}{2}(8.60)(6.77)^2 - \frac{1}{2}(5.20)(9.40)^2$

$= -24\ J$

$\boxed{24\ J}$ of Kinetic Energy is lost during the collision.

6. 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?

6/94

#9

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

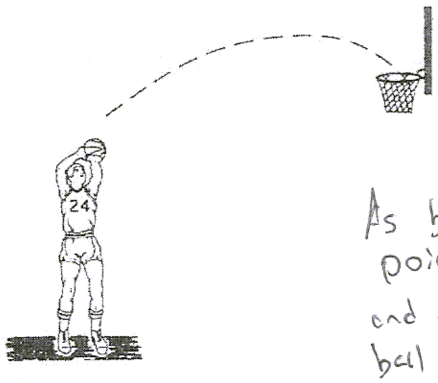
Impulse = change in momentum.

Impulse = $\Delta p = F(\Delta t)$

7. A basketball is thrown into the basket, as shown in the diagram below. The ball leaves the player's hand at t = 0 s and reaches the basket at t = 3 s.

6/94

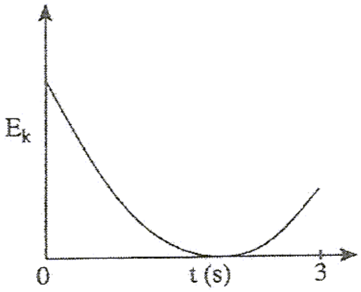
#10



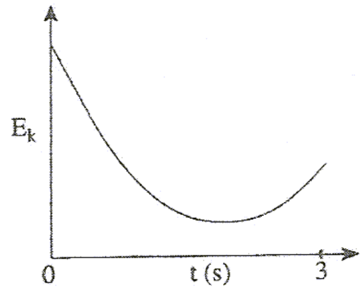
As ball closes in to highest point, E_k changes into E_p, and thus decreases. But, as the ball is travelling in projectile motion, the E_k will never decrease to as low as zero.

Which of the following graphs **best** represents the ball's kinetic energy E_k as a function of time?

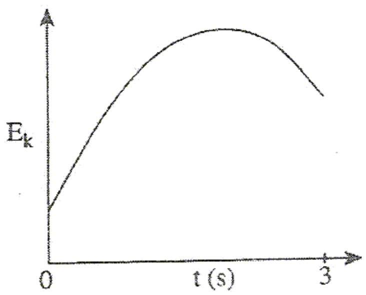
A.



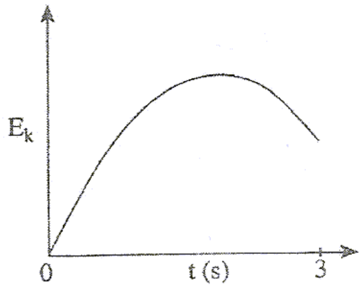
B.



C.



D.

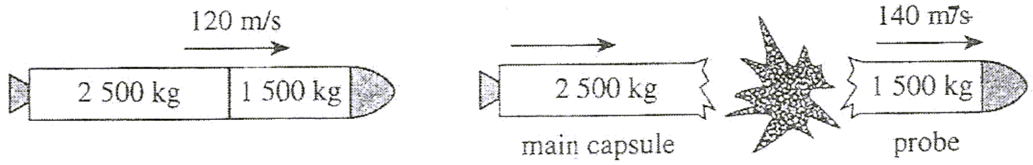


6/94

#11

2. 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.

Before   After



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

$(2500+1500)120 = 2500V + 140(1500)$

$480000 = 2500V + 21000$

$V = 108$ m/s

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

Impulse $= m\Delta V = 1500(140-120) = 30000 = 3.0 \times 10^4$ (Ns)

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)**

"Impulse" is the change in momentum. In a closed system, momentum is conserved and action-reaction occurs, therefore the force applied from the probe to the capsule is the same as the other way around, and with the same amount of time, the impulses are the same for both. (Impulse = Ft)

3

1/95 6. Impulse is measured in which units?

#12

A. J
B. N
C. N·m
D. N·s

$Impulse = F\Delta t$
$= [N] \times [s]$
$= N \cdot s$

1/95 7. How much work must be done to stop an 1 800 kg vehicle travelling at 30 m/s?

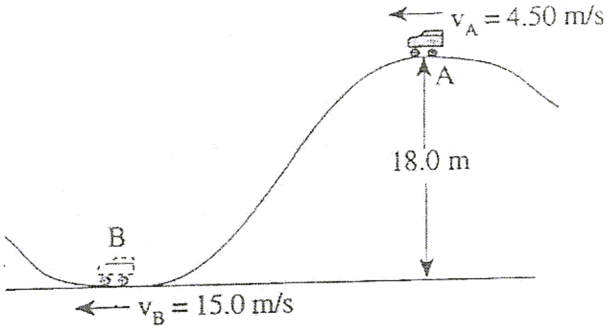
#13

A. 1.8×10^4 J
B. 5.4×10^4 J
C. 5.3×10^5 J
D. 8.1×10^5 J

$W = \Delta KE$
$= KE_f - KE_i$
$= 0 - \frac{1}{2}mv_i^2$
$= 0 - \frac{1}{2}(1800)(30)^2$
$= 8.1 \times 10^5 J$

1/95 2. A 250 kg roller coaster car travels past points A and B with speeds shown in the diagram below. How much heat energy is produced between these points? (7 marks)

#14



Assume Heat (Q) accounts for all lost energy.

$TE_i = TE_f + Q$

$KE_i + PE_i = KE_f + PE_f + Q$

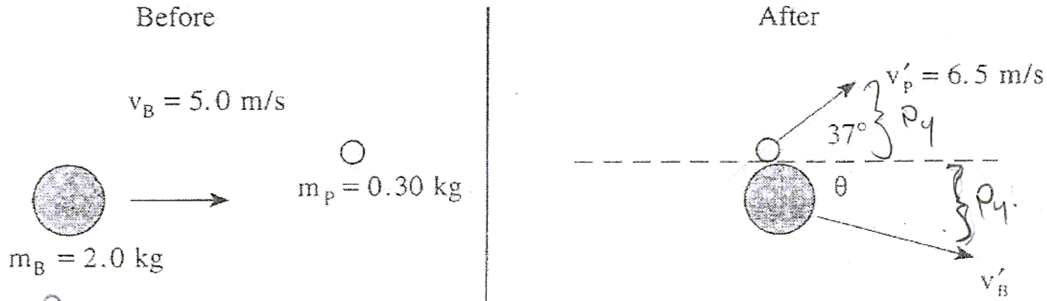
$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_B^2 + mgh_B + Q$

$\frac{1}{2}(250)(4.50)^2 + (250)(9.8)(18.0) = \frac{1}{2}(250)(15.0)^2 + 0 + Q$

$Q = \boxed{1.85 \times 10^5 J \quad OR \quad 18.5 kJ}$

6/95 2. 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)**

#15



$P_{yp} = P_{yb}$

$P_y = (6.5 \sin 37°)(0.3)$
$= 1.17$

$P_{xi} = P_{xf}$

$(2.0)(5.0) = (6.5 \cos 37°)(0.3) + P_{xb}$

$P_{xb} = 8.44$

$V = (\sqrt{P_x^2 + P_y^2})/m$

$\doteq 4.262$

$\doteq 4.3$ m/s

6/95 5. What is the minimum power developed by a 75 kg person who climbs a set of stairs 4.5 m high in 5.0 s?

#16

A. 6.8×10^1 W
B. 6.6×10^2 W
C. 1.7×10^3 W
D. 3.3×10^3 W

$P = W/s$
$= (Fd)/s$
$= (mgd)/s$
$= (75 \cdot 9.8 \cdot 4.5)/5$
$\doteq 6.6 \times 10^2$ (W) → B

6/95 4. Work is measured in which units?

#17

A. J
B. N
C. J/s
D. N·s

#15: Final direction — $\tan \theta = \frac{P_y}{P_x}$

$\theta \doteq 8°$

8/95 6. 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

418

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

Only elastic collisions have circumstances where no kinetic energy is lost.

8/95 2. A 150 kg roller coaster car passes the crest of a hill at 15.0 m/s.

$P_{EB} + K_{EB} = P_{EA} + K_{EA}$.

#19

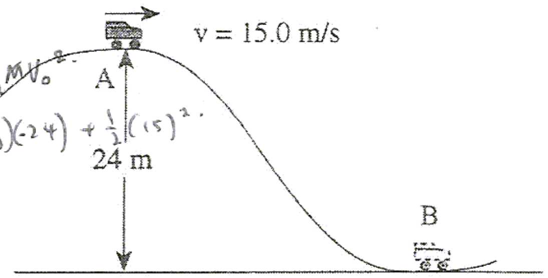
$mgh_B + \frac{1}{2}mv_f^2 = mgh_A + \frac{1}{2}mv_o^2$

$(-9.8)(0) + \frac{1}{2}(v_f^2) = (-9.8)(-24) + \frac{1}{2}(15)^2$.

$0 + \frac{1}{2}v_f^2 = 235.2 + 112.5$

$v_f^2 = 695.4$

$v_f = 26.4$ m/s.



a) What is the speed of the car at point **B** at the bottom of the hill? (Neglect friction.)**(5 marks)**

$v_o = 15$ m/s
$d = -24$ m
$g = -9.8$ m/s².

$$v_f^2 = v_o^2 + 2(g)(d) = 15^2 + 2(-9.8)(-24) = 695.4$$

$$v_f = 26.4 \text{ m/s}$$

b) i) If the mass of the roller coaster car is increased by adding a passenger, how will the speed at **B** now compare to your answer for part a)? (Circle one.) **(1 mark)**

A. equal to
B. less than
C. greater than

The masses remain the same throughout the calculation and therefore have no impact on the final speed.

ii) Explain your answer using principles of physics. **(3 marks)**

The masses remain the same throughout the calculation, and therefore have no impact on the final speed.

8/95 8. In order to stop two sliding objects, the greater impulse **must** be given to the one having the greater

#20

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

Impulse $= F(\Delta t) = m(\Delta v)$.

Therefore, as $m(\Delta v) \uparrow$, $F(\Delta t)$ must also increase.

8/95 7. 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?

#21

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

$P_i = (0.15)(40)$

$P_f = (0.15)(-50)$.

$\Delta P = P_f - P_i = (0.15)(-50) - (0.15)(40)$
$= 0.15(-50 - 40) = -13.5$

$\Delta P = F(\Delta t) = -13.5$.

$\Delta t = 6.0 \times 10^{-3}$ s.

$F(6.0 \times 10^{-3}) = -13.5$

$F = -2250$. Magnitude $= 2250$ N.

5

6/96 6. Are momentum and impulse scalar or vector quantities?

#22

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

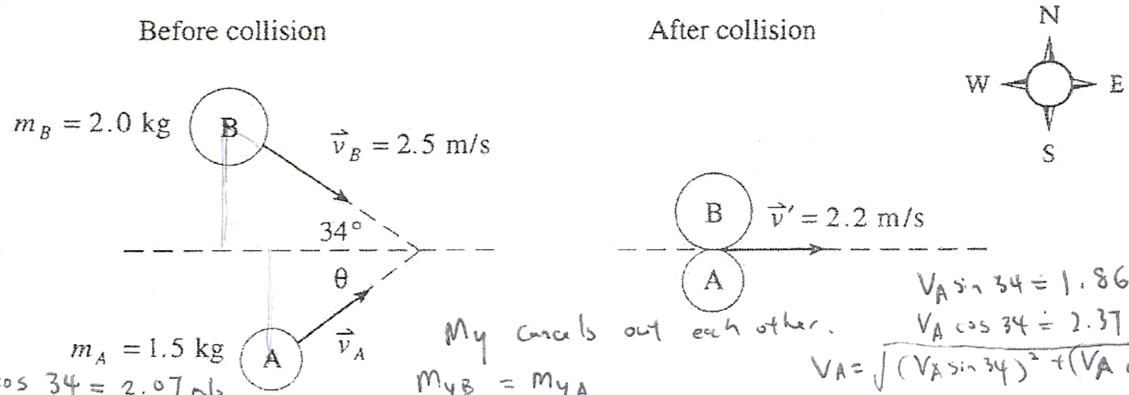
Momentum $= p = MV$
since it contains velocity (vector quantity), Momentum has a vector quantities.

Impulse $= F(\Delta t)$.
Since it contains Force (vector quantity), impulse has vector quantities.

* Note :- the product of 2 scalars is a scalar.
- the product of 2 vectors is a scalar.
- the product of 1 vector and 1 scalar is a vector.

6/96 2. 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)**

#23



$V_{xB} = 2.5 \cos 34 = 2.07$ m/s

$V_{yB} = 2.5 \sin 34 = 1.398$ m/s

My cancels out each other.

$m_{yB} = m_{yA}$

$2(1.4) = 1.5(V_A \sin 34)$

m_x adds to before $(1.5+2)(2.2) = 7.7$

$2(2.07) + 1.5(V_A \cos 34) = 7.7$

$V_A \sin 34 = 1.86$

$V_A \cos 34 = 2.37$

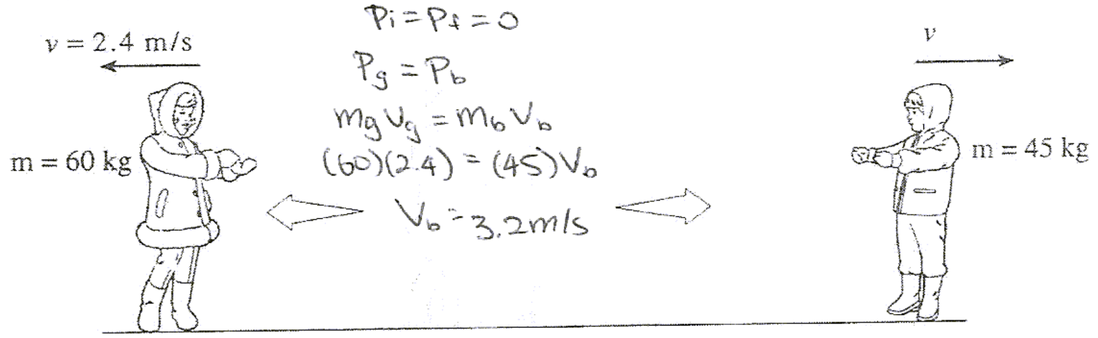
$V_A = \sqrt{(V_A \sin 34)^2 + (V_A \cos 34)^2} = 2.9$ m/s

$\tan\theta = \frac{1.86}{2.37}$

$\theta = 40°$

6/96 9. 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.)

#24



$P_i = P_f = 0$

$P_g = P_b$

$m_g V_g = m_b V_b$

$(60)(2.4) = (45)V_b$

$V_b = 3.2$ m/s

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

$W = \Delta KE_g + \Delta KE_b$

$= (KE_{gf} - KE_{gi}) + (KE_{bf} - KE_{bi})$

$= (\frac{1}{2} m_g V_{gf}^2 - 0) + (\frac{1}{2} m_b V_{bf}^2 - 0)$

$= \frac{1}{2}(60)(2.4)^2 + \frac{1}{2}(45)(3.2)^2 = \boxed{400 J}$

6/96 7. As a skier descends a slope, her kinetic energy increases from 600 J to 3 200 J while her gravitational potential energy decreases by 5 900 J. How much heat energy is created due to friction?

#25

A. 2 100 J
B. 3 300 J
C. 8 500 J
D. 9 700 J

$TE_i = TE_f + Q$

$PE_i + KE_i = PE_f + KE_f + Q$

$0 = (PE_f - PE_i) + (KE_f - KE_i) + Q$

$\Delta PE + \Delta KE = -Q$

$(-5900J) + (3200J - 600J) = -Q$

$Q = 3300J$

6

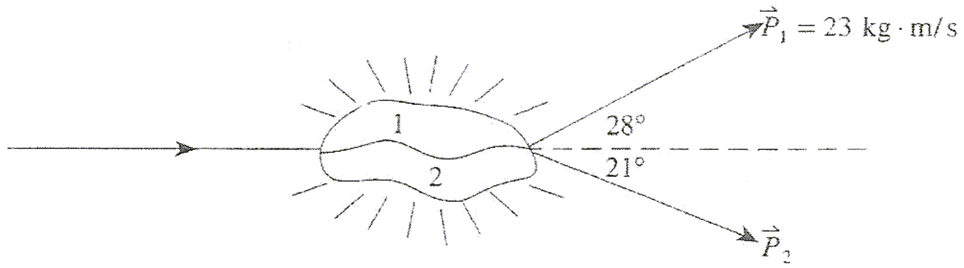
8/96 9. Which set of conditions is true in all inelastic collisions?

#26

	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

8/96 8. 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.

#27



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

$P_{yi} = P_{yf} = 0$

$P_{1y} = P_{2y}$

$P_1 \sin 28° = P_2 \sin 21°$

$P_2 = \frac{P_1 \sin 28°}{\sin 21°}$

$= \frac{(23 \text{ kg}\cdot\text{m/s}) \sin 28°}{\sin 21°} = \boxed{30 \text{ kg}\cdot\text{m/s}}$

8/96 7. Calculate the minimum power of a cyclist who can increase his kinetic energy from 480 J to 2 430 J by travelling 26 m in 4.0 s.

#28

A. 75 W
B. 3.6×10^2 W
C. 4.9×10^2 W
D. 7.3×10^2 W

$P = \frac{W}{t} = \frac{\Delta KE}{t} = \frac{KE_f - KE_i}{t} = \frac{2430 - 480}{4.0} = \boxed{4.9 \times 10^2 \text{ W}}$

8/96 6. Impulse is defined as

#29

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

Impulse $= \Delta p$

1/97 6. Which of the following describes kinetic energy and momentum before and after a perfectly elastic collision?

#30

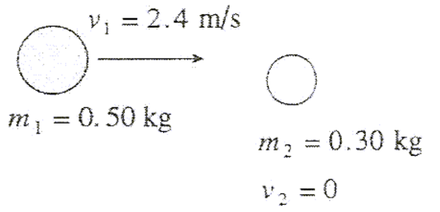
	KINETIC ENERGY	MOMENTUM
A.	Not Conserved	Not Conserved
B.	Not Conserved	Conserved
C.	Conserved	Not Conserved
D.	Conserved	Conserved

In a perfectly elastic collision, both momentum and kinetic energy are conserved.

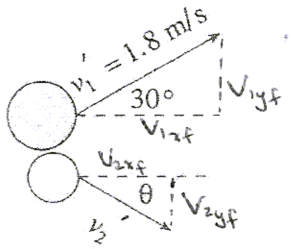
1/97 2. Two steel pucks collide as shown in the diagram below.

#31

BEFORE COLLISION



AFTER COLLISION



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

b) ~~Using principles of physics, comment on the horizontal and vertical components of the projectile's velocity and acceleration during the flight.~~ **~~(4 marks)~~**

~~Not part of this Problem.~~

$P_{yi} = P_{yf} = 0$

$P_{1yf} = P_{2yf}$

$m_1 V_{1yf} = m_2 V_{2yf}$

$(0.50)(1.8)\sin 30° = (0.30) V_{2yf}$

$V_{2yf} = 1.5\ m/s$

$P_{xi} = P_{xf}$

$m_1 V_{1i} = m_1 V_{1xf} + m_2 V_{2xf}$

$(0.50)(2.4) = (0.50)(1.8)\cos 30° + (0.30) V_{2xf}$

$V_{2xf} = 1.4\ m/s$

$V_{2f} = \sqrt{V_{2xf}^2 + V_{2yf}^2} = \sqrt{1.4^2 + 1.5^2} = \boxed{2.1\ m/s}$

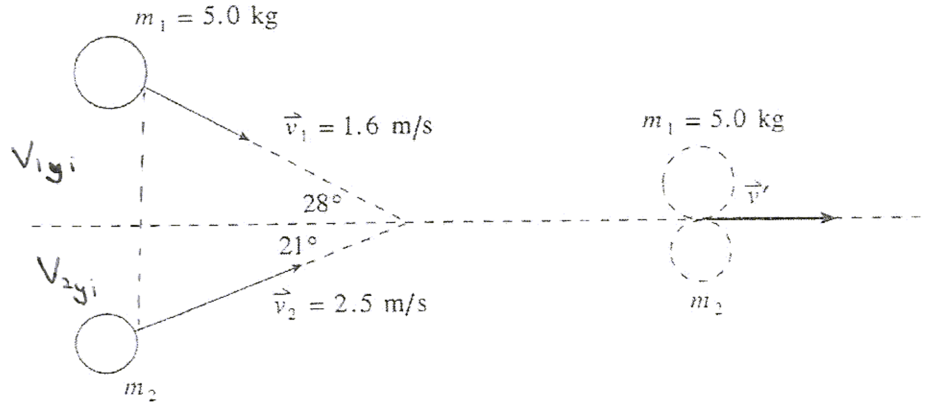
$\tan\theta = \frac{V_{2yf}}{V_{2xf}}$

$\theta = \tan^{-1}\left(\frac{V_{2yf}}{V_{2xf}}\right) = \tan^{-1}\left(\frac{1.5}{1.4}\right) = \boxed{47° \text{ South of East}}$

7

6/97 2. 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.

#32



Find the mass of object m_2. (7 marks)

$$P_{yi} = P_{yf} = 0$$

$$m_1 V_{1yi} = m_2 V_{2yi}$$

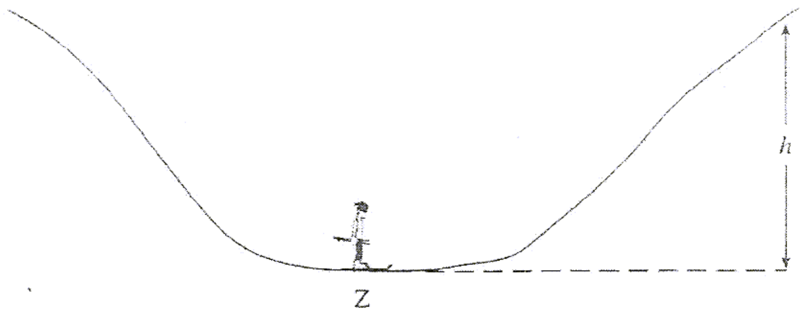
$$(5.0)(1.6)\sin 28^\circ = m_2 (2.5)\sin 21^\circ$$

$$m_2 = \frac{(5.0)(1.6)\sin 28^\circ}{(2.5)\sin 21^\circ}$$

$$= \boxed{4.2\text{ kg}}$$

6/97 6. René, whose mass is 85 kg, skis down the hill, passing Z with a kinetic energy of 9 700 J.

#33



If friction is ignored, to what maximum height, h, can René ski?

A. 12 m
B. 15 m
C. 1.1×10^2 m
D. 6.6×10^2 m

At Point Z, energy is all kinetic, and at maxime height the energy is all potential;

$E_{To} = E_{Tf}$

$E_{ko} + E_{Po} = E_{kf} + E_{Pf}$

$9700 + 0 = 0 + mgh$

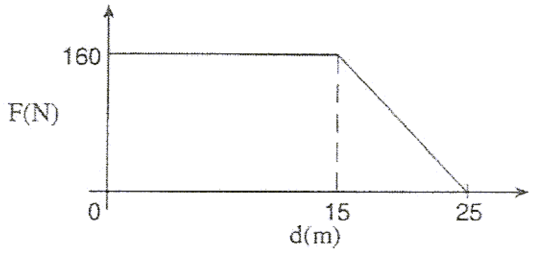
$9700 = (85)(9.8)\,h$

$h = \frac{9700}{(85)(9.8)}$

$h = 12$ m

6/97 7. A cyclist travelling at 10 m/s applies her brakes and stops in 25 m. The graph shows the magnitude of the braking force versus the distance travelled.

#34



What is the total mass of bike and cyclist?

A. 20 kg
B. 40 kg
C. 64 kg
D. 80 kg

$W = \Delta KE$ = area under graph

$= (160\,N)(15\,m) + \frac{1}{2}(160\,N)(10\,m) = 3200\,J$

$3200\,J = \Delta KE = KE_f - KE_i = 0 - \frac{1}{2}mv_i^2$

$3200\,J = \frac{1}{2}m(10\,m/s)^2$

$m = \boxed{64\,kg}$

6/97 5. Which equation is a form of Newton's second law?

#35

A. $\vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t}$

B. $W = \Delta E$

C. $E_k + E_p = E_k' + E_p'$

D. $\mathcal{E} = -N\frac{\Delta \Phi}{\Delta t}$

Newton's second law states:

$\vec{F}_{net} = ma \quad ; \quad a = \frac{\Delta v}{\Delta t}$

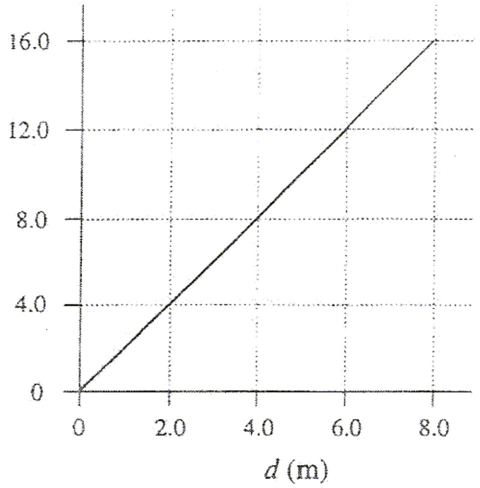
$\vec{F}_{net} = m\frac{\Delta v}{\Delta t} \quad ; \quad \Delta P = m\Delta v$

$\vec{F}_{net} = \frac{\Delta P}{\Delta t}$ ∴ answer is A

8

8/97 8. The graph below shows the relationship between the force applied and the distance moved for a 3.5 kg object on a frictionless horizontal surface.

#36



If the object was initially at rest, what is its kinetic energy after travelling 8.0 m?

A. 2.0 J
B. 32 J
C. 64 J
D. 130 J

$W = Fd$ ∴ area of the graph indicates the work

$W = \frac{16 \times 8}{2}$

$W = 64\ J$

$W = \Delta KE$

$64J = KE - 0$

$KE = 64J$

8/97 7. 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?

#37

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

$\Delta p = m\Delta v = f\Delta t$

$m(v_f - v_i) = f\Delta t$

$f = \frac{m(v_f - v_i)}{\Delta t}$

$= \frac{(0.15kg)(-15m/s - 25m/s)}{0.030s} = 2.0 \times 10^2\ N$

8/97 6. Which of the following is a correct unit for impulse?

#38

A. N
B. $N \cdot m$
C. N/s
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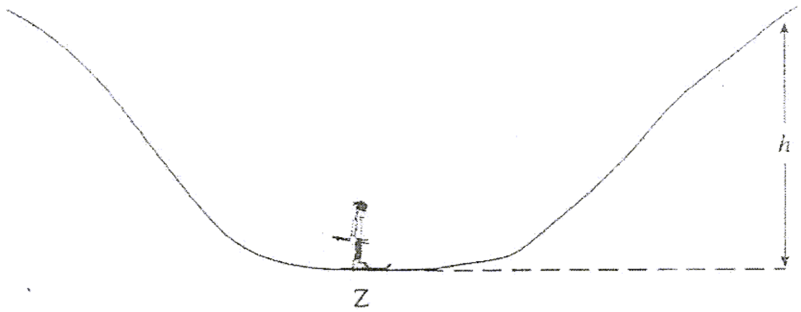

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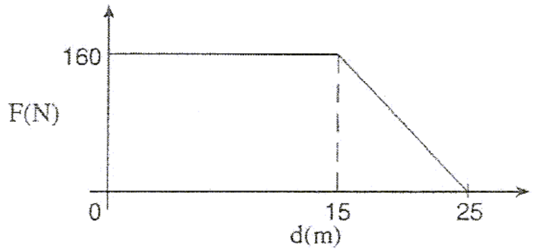

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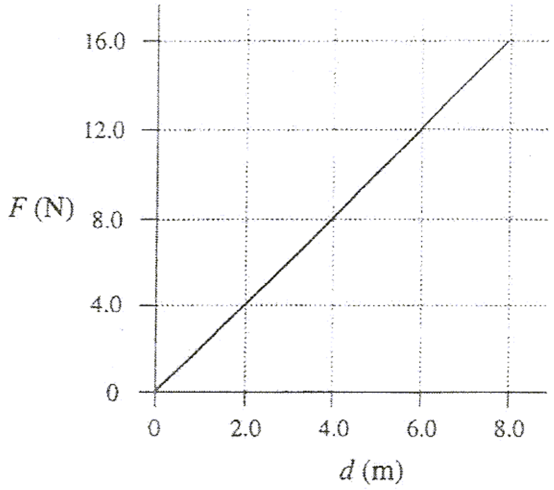

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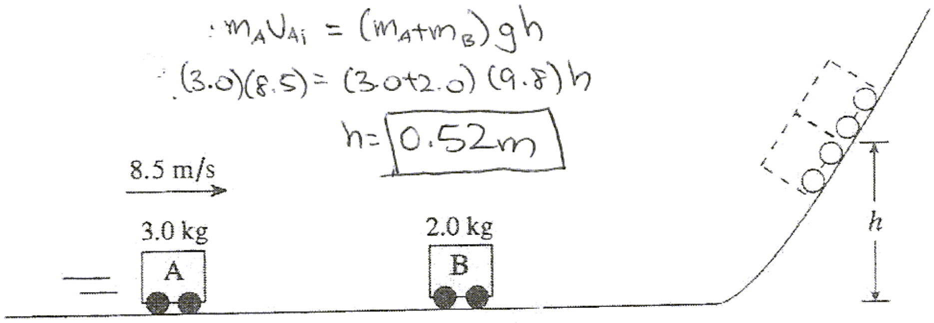
8/97 2. A 3.0 kg car A travelling 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car B. $KE_i = PE_f$

#39

$\therefore m_A v_{Ai} = (m_A + m_B) g h$

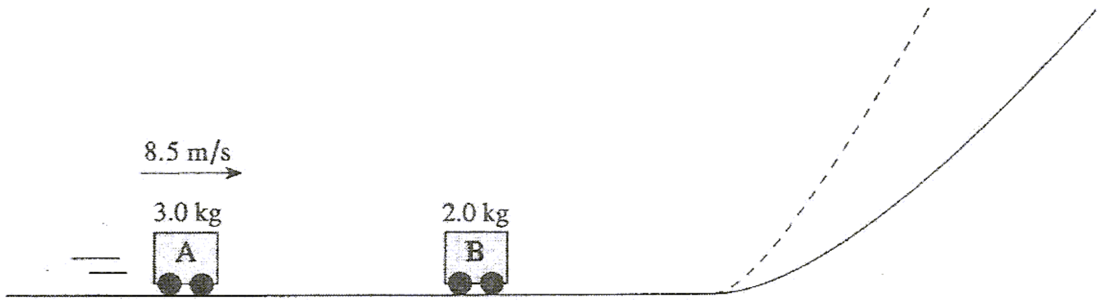
$\therefore (3.0)(8.5) = (3.0 + 2.0)(9.8) h$

$h = \boxed{0.52 m}$



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)

Cars will reach maximum height when all their kinetic energy is converted to potential energy. Decreasing slope does not change initial kinetic energy and therefore does not change maximum height.

9

Energy & Momentum

1 63m/s 52° S of E
2 B
3 B
4 d
5 B
6 24 Joules
7 A
8 No
9 B
10 B
11 108 m/s 3×10^4 N·s
12 d
13 d
14 18.5 KJ
15 4.3 m/s 8° S of E
16 B
17 A
18 A
19 26 m/s Equal to
20 d
21 d
22 d
23 2.9 m/s 40°
24 d
25 B
26 B
27 C
28 C
29 d
30 d
31 2.1 m/s 47° S of E
32 4.2 Kg
33 A
34 C
35 A
36 C
37 d
38 d
39 ~~1.3m~~ Same height
0.52m