1. A 0.030 kg toy car is pushed back against a spring-based launcher as shown in Diagram 1.

Diagram 1
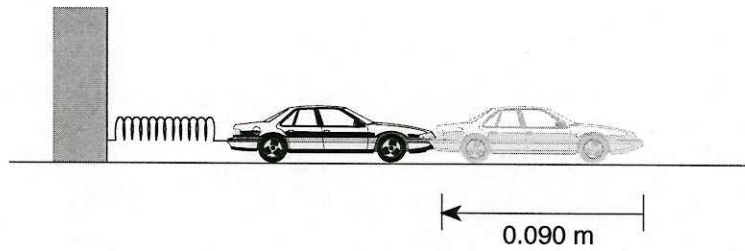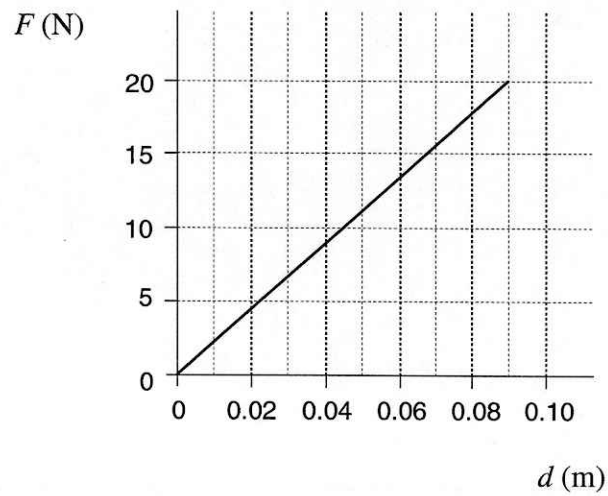

0.090 m

Diagram 2 shows a graph of the force required to compress the spring 0.090 m.

Diagram 2

F (N)

d (m)

a) What is the work done in compressing the spring?   (3 marks)

b) Assuming no losses due to heat, what maximum speed is reached by the toy car when it is released? **(3 marks)**

c) If in fact the maximum kinetic energy of the car is 0.18 J, what is the efficiency of the spring-based launcher? **(1 mark)**

2. A 7.0 kg object moving at 12 m/s to the east explodes into two unequal fragments. The larger 5.0 kg fragment moves at 15 m/s south.
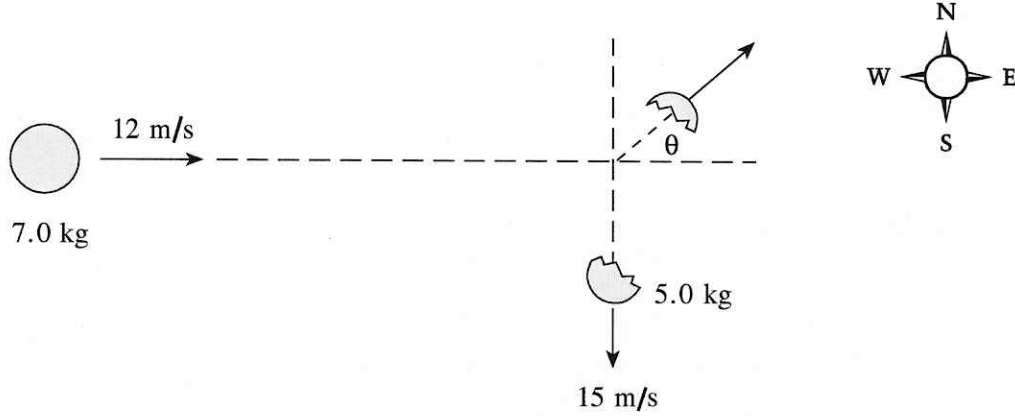
What is the velocity (speed and direction) of the smaller 2.0 kg fragment?   **(7 marks)**
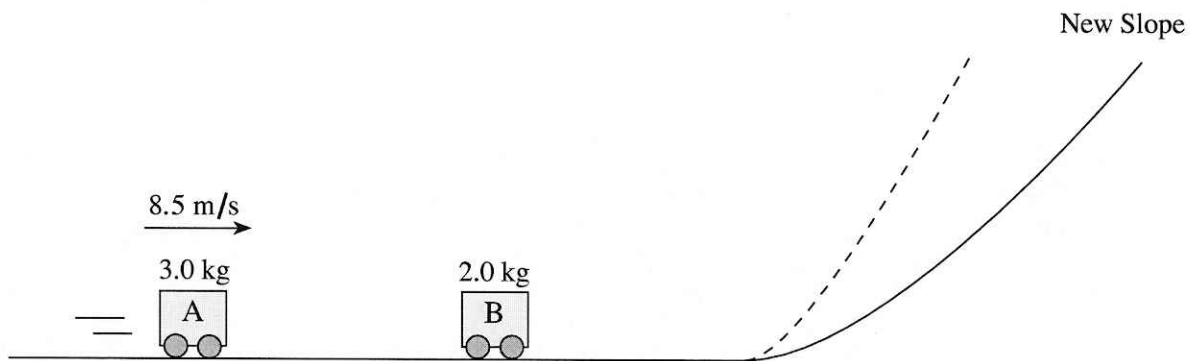
3. A 3.0 kg car A travelling 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car B.

8.5 m/s

3.0 kg
A

2.0 kg
B

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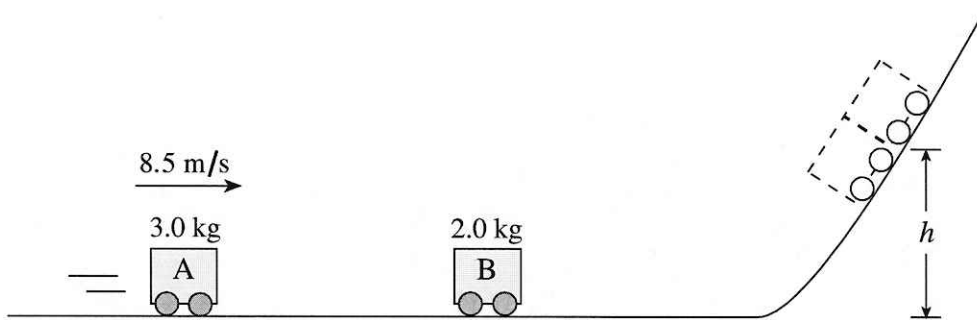
a) The combined cars will reach what height h? **(5 marks)**

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

New Slope

8.5 m/s

3.0 kg
A

2.0 kg
B

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)**

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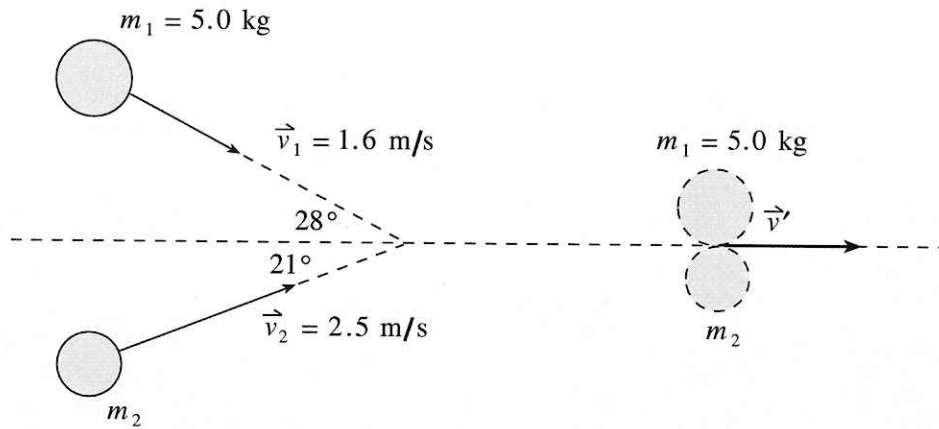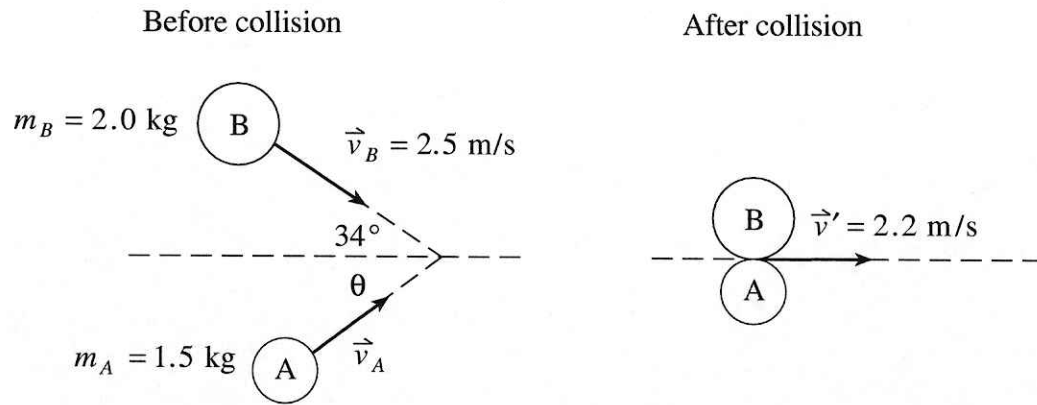
4. A 5.0 kg object travelling at 1.6 m/s collides with an object of unknown mass m_2 travelling at 2.5 m/s. The two objects stick together and move towards the right as shown in the diagram.
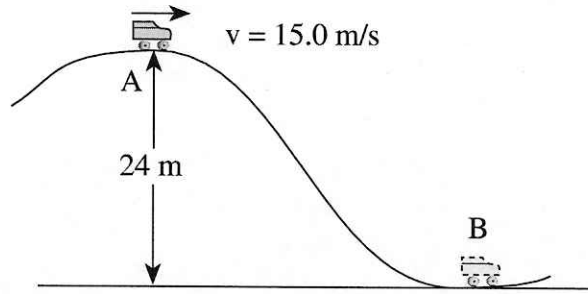

$m_1 = 5.0$ kg

$\vec{v}_1 = 1.6$ m/s

$28°$

$21°$

$\vec{v}_2 = 2.5$ m/s

m_2

$m_1 = 5.0$ kg

$\vec{v}'$

m_2

Find the mass of object m_2.

(7 marks)

5. 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)**

Before collision   After collision

$m_B = 2.0$ kg (B) $\vec{v}_B = 2.5$ m/s

34°

θ

$m_A = 1.5$ kg (A) $\vec{v}_A$

(B) $\vec{v}' = 2.2$ m/s

(A)

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

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

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

ii) Explain your answer using principles of physics.   **(3 marks)**
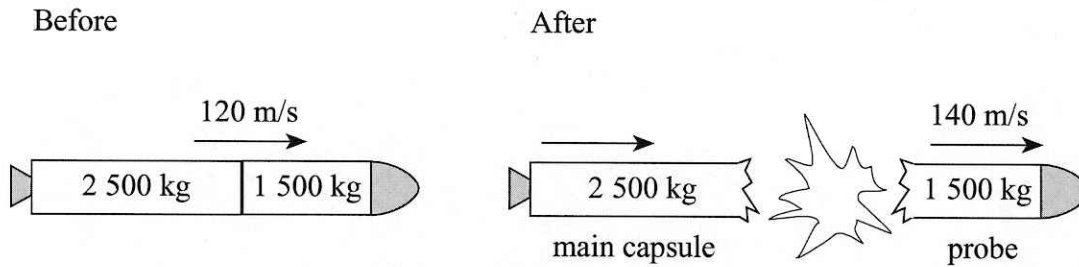
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7. A 4 000 kg space vehicle consists of a 2 500 kg main capsule and a 1 500 kg probe. The space vehicle is travelling at 120 m/s when an explosion occurs between the capsule and the probe. As a result, the probe moves forward at 140 m/s, as shown in the diagram below.

Before   After

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

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