Student name: ______________________________ Class: ___________

Sydney Boys High School

Multiple Choice Answer Sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ~~●~~ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

correct

A ~~●~~ B ~~●~~ C ○ D ○

Start Here ➔

1.	A○	B○	C○	D○	**11.**	A○	B○	C○	D○
2.	A○	B○	C○	D○	**12.**	A○	B○	C○	D○
3.	A○	B○	C○	D○	**13.**	A○	B○	C○	D○
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5.	A○	B○	C○	D○	**15.**	A○	B○	C○	D○
6.	A○	B○	C○	D○	**16.**	A○	B○	C○	D○
7.	A○	B○	C○	D○	**17.**	A○	B○	C○	D○
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Student name: ________________________________ Class: ____________

Sydney Boys High School

Year 11 Physics

June 2020

Half-Yearly Cohort Assessment
Kinematics and Dynamics

General Instructions

- Reading time: 5 minutes
- Working time: 75 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- SHOW ALL WORKING
- Board approved calculators may be used
- A data sheet, formula sheets and Periodic Table are provided at the back of this paper
- Write your name in ALL spaces provided

Total marks – 50

Part A – Multiple Choice
- 20 marks

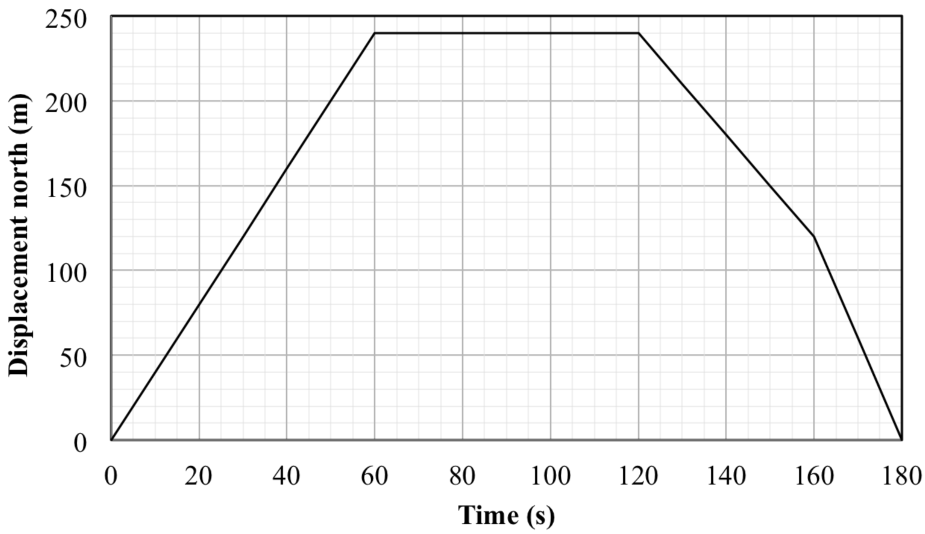
Part B – Free Response
- 30 marks

PART A – Multiple Choice (20 marks)

Choose the most correct answer.

Questions 1−3. Use the graph below.

A car's displacement was measured as it drove along a race track. The results are shown in the graph below.



1. In what time was the car's speed closest to 11 km/h ?

(A) t= 115 seconds
(B) t= 150 seconds
(C) t = 25 seconds
(D) t= 170 seconds

2. What is the car's average speed after 160 seconds?

(A) 0 m s^{-1}
(B) 1.3 m s^{-1}
(C) 2.25 m s^{-1}
(D) 2.4 m s^{-1}

3. What is the car's change in velocity between t = 44 seconds and t = 140 seconds?

(A) 7 m/s south
(B) 5 m/s north
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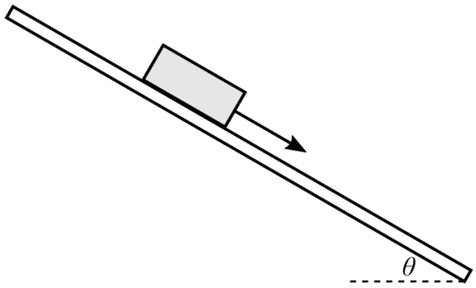
4. A brick is placed on a wooden plank. The plank is tilted until the brick starts to accelerate down the wooden plank at a constant rate, as shown below.



Which diagram best represents the forces of Friction, Gravity and the Normal force acting on the brick while it is accelerating down the plane?

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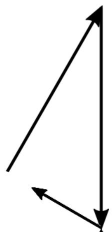

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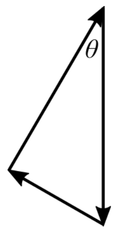
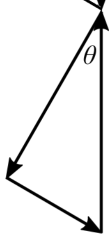
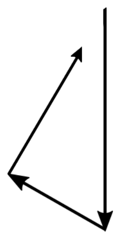


(C)



(D)



5. An astronaut weighs 135 N on the Moon ($g = 1.62\ ms^{-2}$). What would his mass be on Earth in SI units (g_{earth}= 9.8 ms^{-2})

(A) 817
(B) 135
(C) 77
(D) 83

6. In an inelastic collision between a 2 kg ball and a 1kg ball:

	Total Momentum is	*Kinetic energy is*	*The change in momentum of each ball is*
(A)	not conserved	not conserved	equal but opposite
(B)	not conserved	conserved	equal
(C)	conserved	conserved	zero
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7. During a trip to Jupiter, a space probe's booster rocket is fired, tripling the speed and halving the mass of the probe. If the space probe originally had a kinetic energy of K and a momentum of p, which of the following choices show the correct values after the booster rocket has been fired?

	Kinetic energy	*Momentum*
(A)	$3.0K$	$0.5p$
(B)	$3.0K$	$3.0p$
(C)	$4.5K$	$1.5p$
(D)	$4.5K$	$2.0p$

8. A horse walks 2.6 km north in 20 minutes, then turns right and gallops east 2.6 km in 10 minutes. The average speed and average velocity are:

	Average speed (m s^{-1})	*Average velocity (m s^{-1})*
(A)	2.9	2.0 NE
(B)	10.4	7.2 NE
(C)	2.7	2.2 NNE
(D)	2.8	2.0 NW

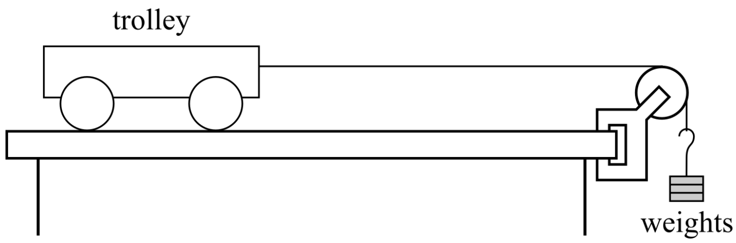
9. The women's world record for the 100 m race is 10.5 s, held by Florence Griffith-Joyner. Assume that she has a constant acceleration for the first 3 seconds and then travels at constant velocity, what is her maximum speed during the 100 m race?

(A) 13.3 m s^{-1}
(B) 11.1 m s^{-1}
(C) 12.9 m s^{-1}
(D) 10.5 m s^{-1}

10. An apple is sitting on a desk. The Earth's gravity exerts a downward force on the apple. According to Newton's 3rd Law forces come in pairs. What is the other force in this example?

(A) The upwards force of the apple on the Earth
(B) The downwards force of the apple on the desk
(C) The upwards force of the desk acting on the apple
(D) The gravitational force of the desk acting on the Earth

11. A 1.6 kg trolley is tied to a 450 g mass that hangs over a pulley, as shown below. A frictional force of 0.99 N acts what is the acceleration of the trolley across the bench?



Choose the best answer.

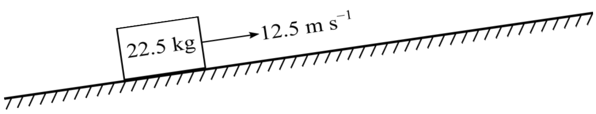
(A) 1.5 m s^{-2}
(B) 1.6 m s^{-2}
(C) 1.7 m s^{-2}
(D) 1.8 m s^{-2}

12. A 800 kg hot air balloon(including pilot) floats motionless at an altitude of 2.5 km.

The pilot then throws 100kg of ballast overboard. Choose the correct statement:

(A) the hot air balloon has become weightless
(B) the hot air balloon's lift is less than it's weight
(C) The magnitude of the initial acceleration of the balloon will be 0.13 m/s^2
(D) the net force on the hot air balloon will be approximately 1000 N

13. A box is pulled up a 15 degree ramp with a dynamic coefficient of friction of 0.120 at a speed of 12.5 m s^{-1}. What is the pulling force being applied to the box to maintain this speed?

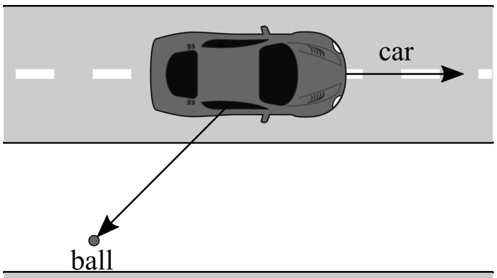


Ramp angle = 15 °, μ_d = 0.120

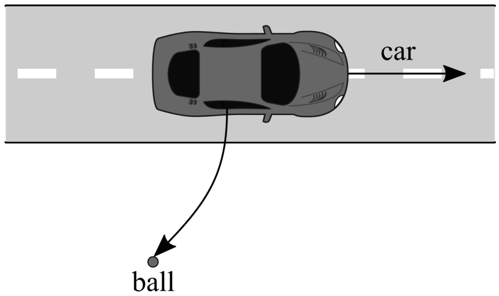
Choose the closest answer.
(A) 83 N
(B) 26 N
(C) 221 N
(D) 281 N

14. A ball is thrown out of the passenger window of a car accelerating to the right (ignore air resistance). If the ball is thrown out perpendicular to the velocity of the car, which of the following best depicts the path the ball takes, as viewed from a stationary observer above?

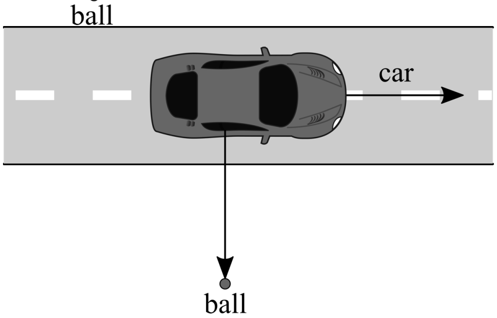
(A)



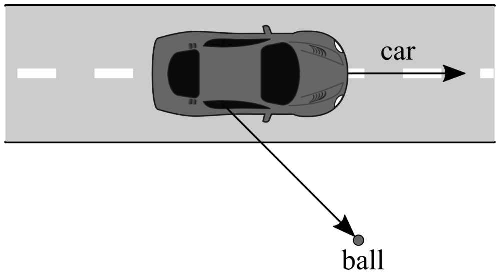
(B)



(C)



(D)



15. A eagle is flying at 145 km/h due north and a hawk is flying at 270 km/h due west, what is the velocity of the hawk relative to the eagle?

(A) 415 km/h S62°W
(B) 361 km/h W62°S
(C) 346 km/h 210 T
(D) 306 km/h S26°W

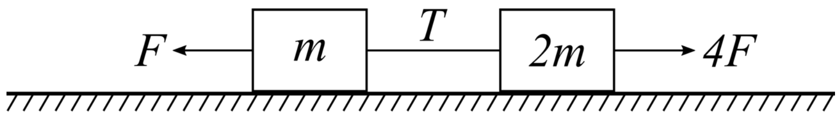
16. Airbags increase stopping time in a crash. Which alternative would be most useful to explain why airbags reduce injury during a car accident?

(A) Law of Conservation of Momentum
(B) Airbags decrease the force experienced by occupants
(C) Newton's 3rd Law
(D) Airbags decrease the change in momentum experienced by occupants

17. A juggler throws a ball into the air with an initial speed of v so that it reaches a maximum height s, at time t. If the juggler throws a second ball with an initial speed of $2v$, the time to maximum height, and the maximum height will be:

(A) t and s
(B) 4t and 2s
(C) 2t and 4s
(D) 4t and 4s

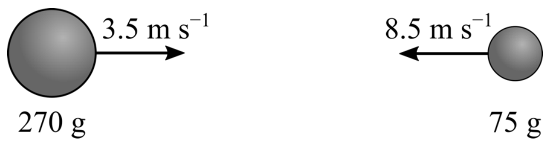
18. Two blocks of masses *m* and 2*m*, connected by a light, inextensible string are resting on a rough horizontal surface. Opposing forces *F* and 4*F* are applied to each side of the connected blocks, as shown below.



If m=3 kg and F=2 N and a = 0.47m/s^2 what is the value of the coefficent of friction ?

(A) 0.05
(B) 0.04
(C) 0.03
(D) 0.02

19. The initial conditions of two balls are shown below before they collide.



If the 270 g ball continues to the right at 0.72 m s^{-1} after the collision, what is the final velocity of the 75 g ball? (choose the closest answer from below)

(A) 1.5 m s^{-1} to the right
(B) 2.1 m s^{-1} to the left
(C) 19 m s^{-1} to the right
(D) 3.3 m s^{-1} to the left

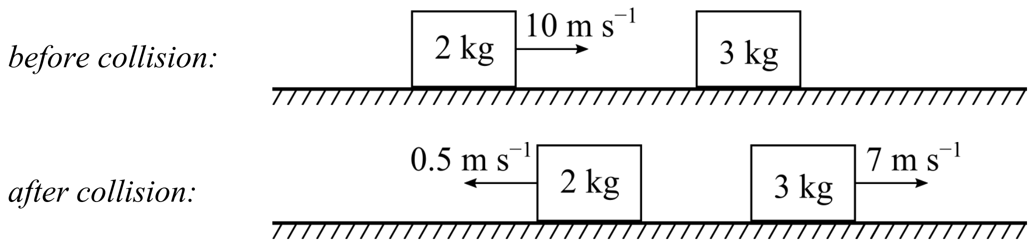
20. An 85 kg man applies a force to a 12.5 kg block along a smooth, frictionless surface so that it increases its speed from 5.5 m s^{-1} to 18.4 m s^{-1} in 7 seconds. How much power is the man generating?

(A) 1927 W
(B) 275 W
(C) 275 J
(D) 1927 J

PART B – Free Response (30 marks)
Marks are allocated to working in this section.

Question 21 (4 marks).

Two blocks collide on a smooth, frictionless surface. The motion of the two blocks are shown below.



a) Identify whether the collision is consistent with the Law of Conservation of Momentum. Justify your answer. **2**

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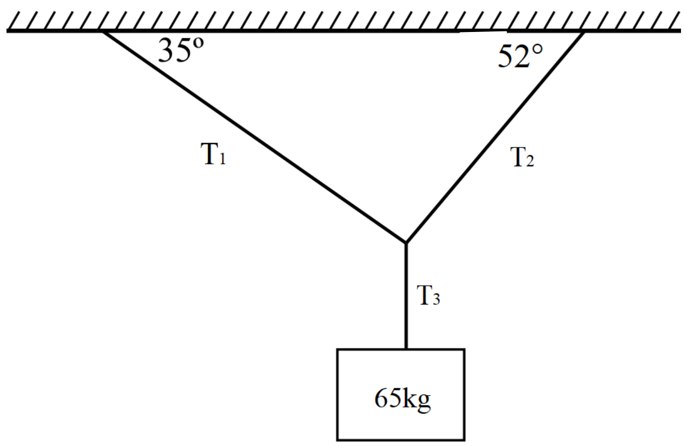
b) Prove that this collision is inelastic. Justify your answer **2**

Question 22 (5 marks)

A block of mass 65 kg hangs on two strings suspended from the ceiling of a lift travelling downwards at 2.5 m/s^2, as shown below. (m= 65kg. g = 9.8m/s^2)



(a) What is the net force acting on the 65 kg mass? **2**

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(Question 22 cont'd)

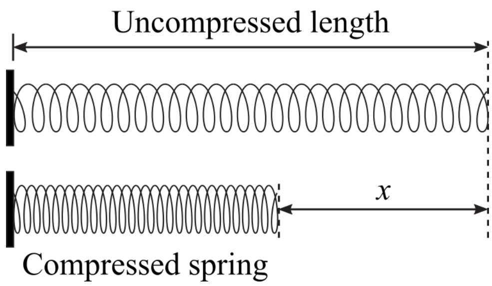
(b) Calculate the magnitudes of T_1, T_2 and T_3 **3**

Question 23 (10 marks)

The elastic potential energy stored by a spring when it is compressed is given by:

$$U_{elastic} = \frac{1}{2}kx^2$$

where k is the spring constant and x is the distance the spring is compressed.



A 2.00 kg ball is placed in front of a horizontally compressed spring. The spring was then released and the ball launched off a 1 metre high table. Launch velocities of the ball were measured for different amounts of spring compression(x). The results are shown below.

	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Spring compression (m)	0.10	0.20	0.30	0.40	0.50
Launch velocity (ms^{-1})	0.10	0.25	0.37	0.49	0.61
Kinetic Energy (J)					
x^2 (m^2)					

(a) The vertical distance to the ground was 1 metre so the flight time was the same for each launch. Calculate the time of flight. **2**

(b) Complete the kinetic energy row of the table. **1**

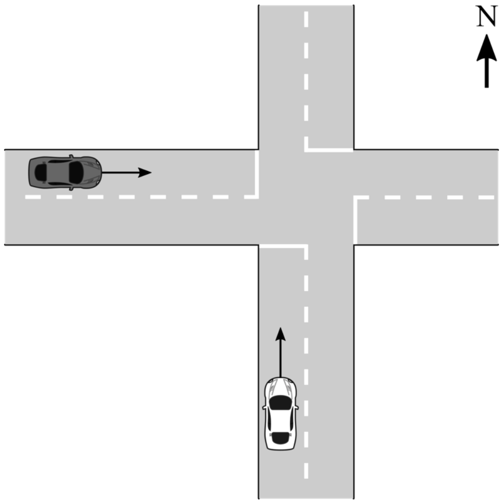
(c) Graph KE v x^2 in the space provided below. **4**

(c) Assuming that the spring converts $U_{elastic}$ completely into KE use your line of best fit to determine the value of the spring constant k.(Show full working) **3**

(Continued over the page)

Question 24 (5 marks)

Two cars are approaching an intersection, as shown below. The white car has a mass of 1750 kg and is driving north at 65 km h^{-1}. The grey car has a mass of 1450 kg and is driving east at 95 km h^{-1}.



The cars collide at the intersection, fusing together after the collision.

(a) Calculate the velocity of the fused cars immediately after the collision. **3**

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(b) If the coefficient of friction between the tires of the cars and the road is 0.65, calculate how far the fused cars will travel before stopping. **2**

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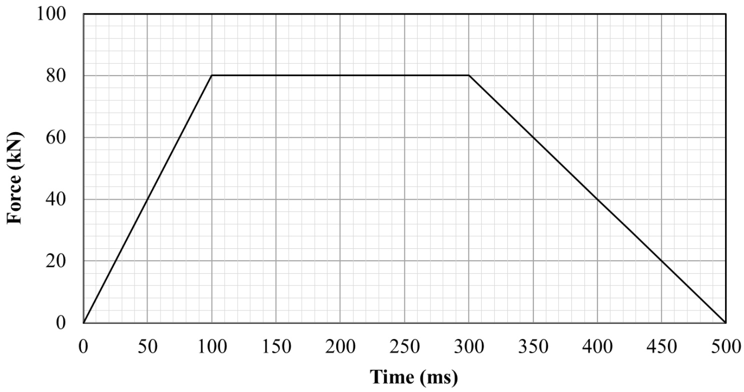
Question 25 (4 marks)

During a crash test, a car of mass 1750 kg collides with a wall. Force sensors on the car measure the force applied during the collision. A force-time graph for the collision is shown below.



(a) Calculate the maximum deceleration of the car during the collision? **2**

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(b) Calculate the speed of the car before collision. **2**

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Question 26 (2 marks) **2**

Crumple zones increase stopping time during a collision. With reference to Newton's Second Law explain why crumple zones reduce injurys in car accidents.

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− **End of Paper** −

Student name: ______________________________ Class: ____________

Sydney Boys High School

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Sydney Boys High School

Year 11 Physics

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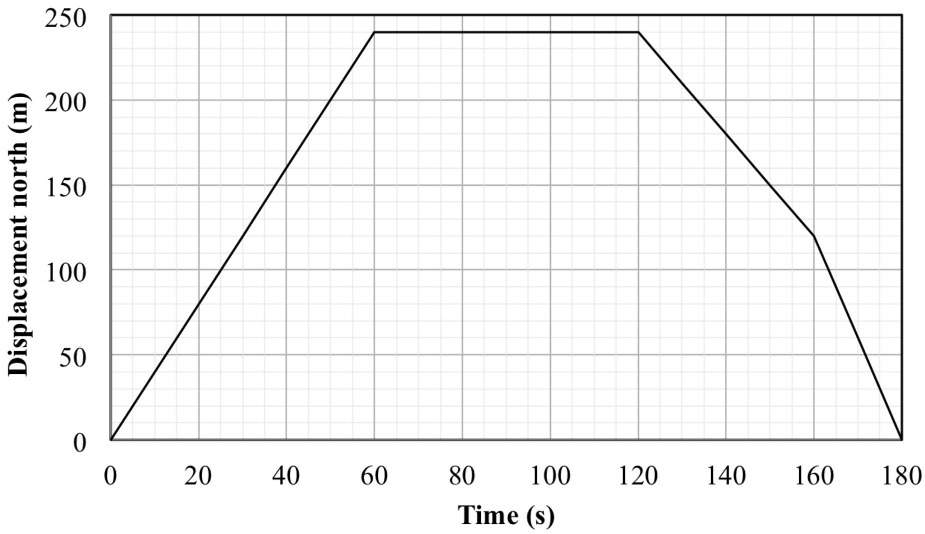

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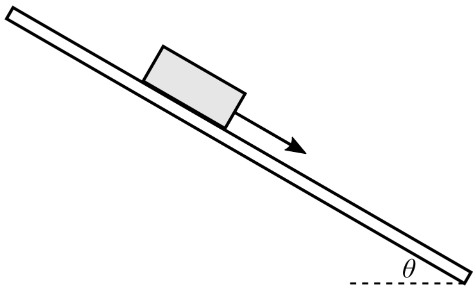

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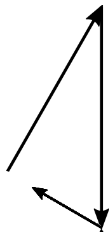
A

(A)



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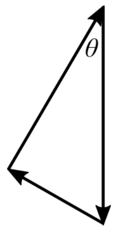
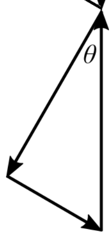


(C)



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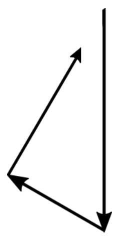

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9. The women's world record for the 100 m race is 10.5 s, held by Florence Griffith-Joyner. Assume that she has a constant acceleration for the first 3 seconds and then travels at constant velocity, what is her maximum speed during the 100 m race?

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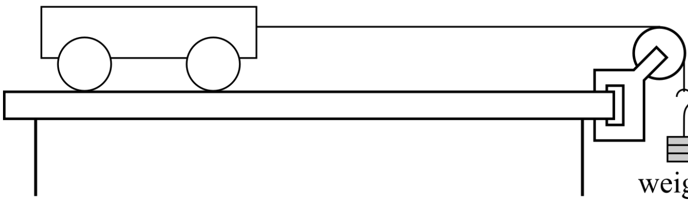
(A) The upwards force of the apple on the Earth
(B) The downwards force of the apple on the desk
(C) The upwards force of the desk acting on the apple
(D) The gravitational force of the desk acting on the Earth

11. A 1.6 kg trolley is tied to a 450 g mass that hangs over a pulley, as shown below. A frictional force of 0.99 N acts what is the acceleration of the trolley across the bench?



Choose the best answer.

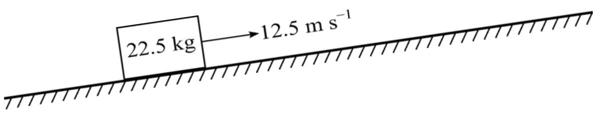
(A) 1.5 m s^{-2}
(B) 1.6 m s^{-2}
(C) 1.7 m s^{-2}
(D) 1.8 m s^{-2}

12. A 800 kg hot air balloon(including pilot) floats motionless at an altitude of 2.5 km.

The pilot then throws 100kg of ballast overboard. Choose the correct statement:

(A) the hot air balloon has become weightless
(B) the hot air balloon's lift is less than it's weight
(C) The magnitude of the initial acceleration of the balloon will be 0.13 m/s^2
(D) the net force on the hot air balloon will be approximately 1000 N

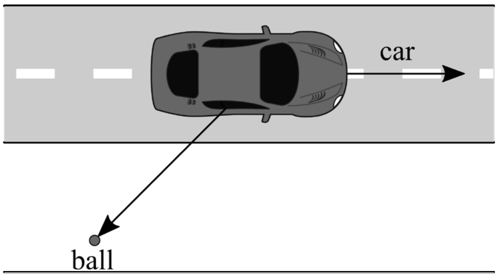
13. A box is pulled up a 15 degree ramp with a dynamic coefficient of friction of 0.120 at a speed of 12.5 m s^{-1}. What is the pulling force being applied to the box to maintain this speed?

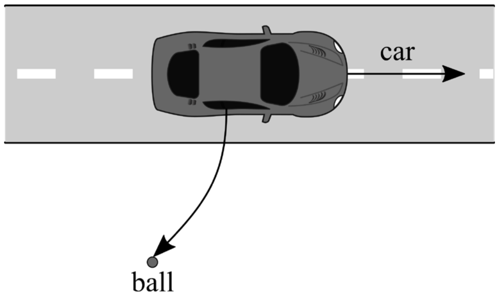


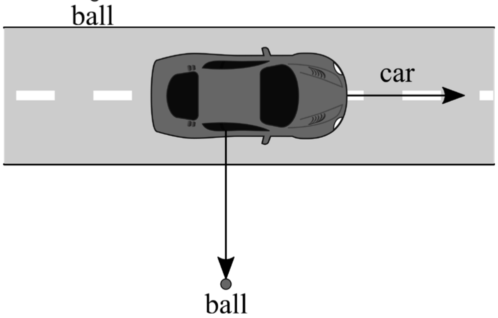
Ramp angle = 15 °, μ_d = 0.120

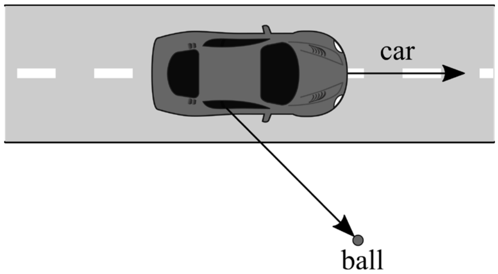
Choose the closest answer.
(A) 83 N
(B) 26 N
(C) 221 N
(D) 281 N

14. A ball is thrown out of the passenger window of a car accelerating to the right (ignore air resistance). If the ball is thrown out perpendicular to the velocity of the car, which of the following best depicts the path the ball takes, as viewed from a stationary observer above?

(A)


(B)


(C)


(D)


15. A eagle is flying at 145 km/h due north and a hawk is flying at 270 km/h due west, what is the velocity of the hawk relative to the eagle?

(A) 415 km/h S62°W
(B) 361 km/h W62°S
(C) 346 km/h 210 T
(D) 306 km/h S26°W

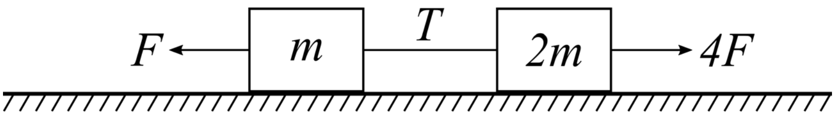
16. Airbags increase stopping time in a crash. Which alternative would be most useful to explain why airbags reduce injury during a car accident?

(A) Law of Conservation of Momentum
(B) Airbags decrease the force experienced by occupants
(C) Newton's 3rd Law
(D) Law of Conservation of Momentum

17. A juggler throws a ball into the air with an initial speed of v so that it reaches a maximum height s, at time t. If the juggler throws a second ball with an initial speed of $2v$, the time to maximum height, and the maximum height will be:

(A) t and s
(B) 4t and 2s
(C) 2t and 4s
(D) 4t and 4s

18. Two blocks of masses m and $2m$, connected by a light, inextensible string are resting on a rough horizontal surface. Opposing forces F and $4F$ are applied to each side of the connected blocks, as shown below.



If m=3 kg and F=2 N and a = 0.47 m/s^2, what is the value of the coefficent of friction ?

(A) 0.05
(B) 0.04
(C) 0.03
(D) 0.02

19. The initial conditions of two balls are shown below before they collide.

If the 270 g ball continues to the right at 0.72 m s^{-1} after the collision, what is the final velocity of the 75 g ball? (choose the closest answer from below)

(A) 1.5 m s^{-1} to the right
(B) 2.1 m s^{-1} to the left
(C) 19 m s^{-1} to the right
(D) 3.3 m s^{-1} to the left

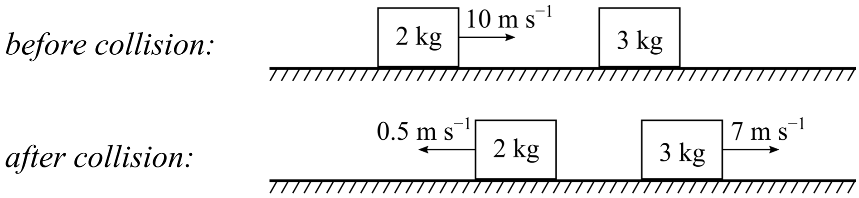
20. An 85 kg man applies a force to a 12.5 kg block along a smooth, frictionless surface so that it increases its speed from 5.5 m s^{-1} to 18.4 m s^{-1} in 7 seconds. How much power is the man generating?

(A) 1927 W
(B) 275 W
(C) 275 J
(D) 1927 J

PART B – Free Response (30 marks)
Marks are allocated to working in this section.

Question 21 (4 marks).

Two blocks collide on a smooth, frictionless surface. The motion of the two blocks are shown below.



a) Identify whether the collision is consistent with the Law of Conservation of Momentum. Justify your answer. 2

$$p_{before} = m_1u_1 + m_2u_2 = 2 \times 10 + 3 \times 0 = 20 \text{ kg m s}^{-1} \text{ to the right}$$

$$p_{after} = m_1v_1 + m_2v_2 = 2 \times -0.5 + 3 \times 7 = 20 \text{ kg m s}^{-1} \text{ to the right}$$

The momentum before the collision is equal to the momentum after the collision. Therefore the collision is consistent with the Law of Conservation of Momentum.

✓ correct calculations showing $p_{before} = p_{after}$
✓ relates momentum calculations to LoCoM

* must demonstrate an understanding of what "conservation" means

b) Prove that this collision is inelastic. Justify your answer 2

$$K_{before} = \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2} \times 2 \times 10^2 + \frac{1}{2} \times 3 \times 0^2 = 100 \text{ J}$$

$$K_{after} = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2} \times 2 \times 0.5^2 + \frac{1}{2} \times 3 \times 7^2 = 73.75 \text{ J}$$

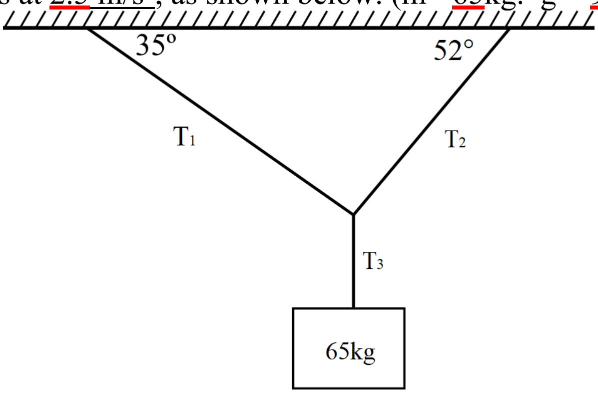
The kinetic energy after the collision is less than the kinetic energy before the collision. Therefore kinetic energy has not been conserved and the collision is inelastic.

✓ correct calculations of K_{before} & K_{after}
✓ correctly relates kinetic energies to collision

* must demonstrate an understanding of what "conservation" means

Question 21 (5 marks)

A block of mass 65 kg hangs on two strings suspended from the ceiling of a lift travelling downwards at 2.5 m/s^2, as shown below. (m= 65kg. g = 9.8m/s^2)



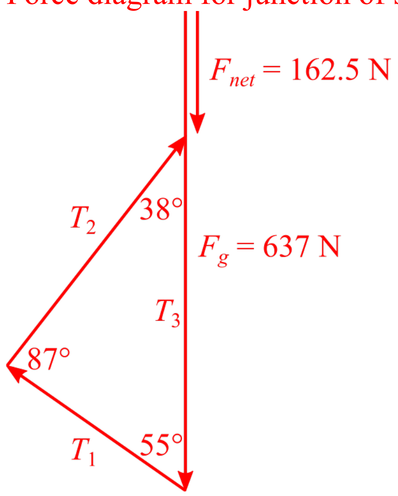
(a) What is the net force acting on the 65 kg mass? 2

$$F = ma = 65 \times 2.5 = 162.5 = 160 \text{ N downwards (to 2 sig. fig.)}$$

✓ correct equation & substitution
✓ correct sig. figs. & units

(b) Calculate the magnitudes of T_1, T_2 and T_3 3

Force diagram for junction of strings:



from sine rule:

$$\frac{T_1}{\sin 38} = \frac{T_2}{\sin 55} = \frac{T_3}{\sin 87}$$

$$T_3 = F_g - F_{net} = 637 - 162.5 = 474.5 \text{ N}$$

$$T_1 = \frac{T_3 \times \sin 38}{\sin 87} = \frac{474.5 \times \sin 38}{\sin 87} = 292.5 \text{ N}$$

$$T_2 = \frac{T_3 \times \sin 55}{\sin 87} = \frac{474.5 \times \sin 55}{\sin 87} = 389.2 \text{ N}$$

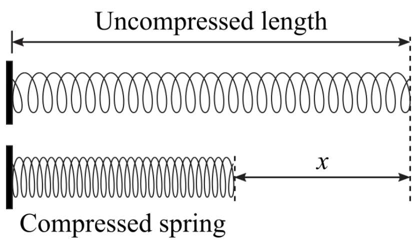
✓ correct calculation for T_3
✓ correct use of force vectors
✓ correct calculations for T_1 & T_2

Question 23 (10 marks)

The elastic potential energy stored by a spring when it is compressed is given by:

$$U_{elastic} = \frac{1}{2}kx^2$$

where k is the spring constant and x is the distance the spring is compressed.



A 2.00 kg ball is placed in front of a horizontally compressed spring. The spring was then released and the ball launched off a 1 metre high table. Launch velocities of the ball were measured for different amounts of spring compression(x). The results are shown below.

	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Spring compression (m)	0.10	0.20	0.30	0.40	0.50
Launch velocity (ms^{-1})	0.10	0.25	0.37	0.49	0.61
Kinetic Energy (J)	0.010	0.063	0.14	0.24	0.37
x^2 (m^2)	0.010	0.040	0.090	0.16	0.25

(a) The vertical distance to the ground was 1 metre so the flight time was the same for each launch. Calculate the time of flight. 2

The horizontal velocity is irrelevant to the time of flight. So, from the vertical uniform linear acceleration, $u = 0$, and:

$$s = \frac{1}{2}at^2$$

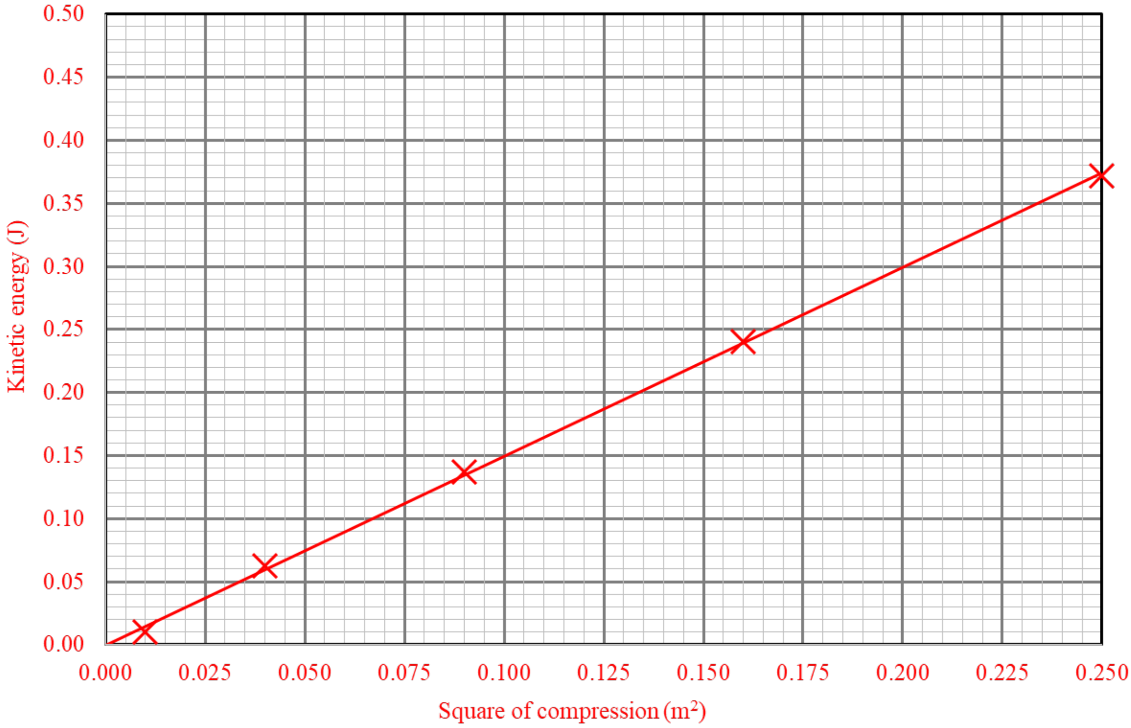
$$t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times -1}{-9.8}} = 0.452 \text{ s}$$

✓ correct equation & substitution
✓ value with correct units

(b) Complete the kinetic energy row of the table. 1

✓ correct values in table (without units)

(c) Graph KE v x^2 in the space provided below. 4



✓ correctly arranged axes (x^2 on x-axis)
✓ correctly labelled axes (variables & units)
✓ correctly plotted data using accepted symbols
✓ appropriate LOBF, drawn with a ruler & appropriate scale (>½ of axes)

(c) Assuming that the spring converts $U_{elastic}$ completely into KE use your line of best fit to determine the value of the spring constant k. (Show full working) 3

$$gradient = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.30 - 0.15}{0.200 - 0.100} = 1.5 \text{ J m}^{-2} \text{ or N m}^{-1}$$

$$K = U_{elastic} = \frac{1}{2}kx^2$$

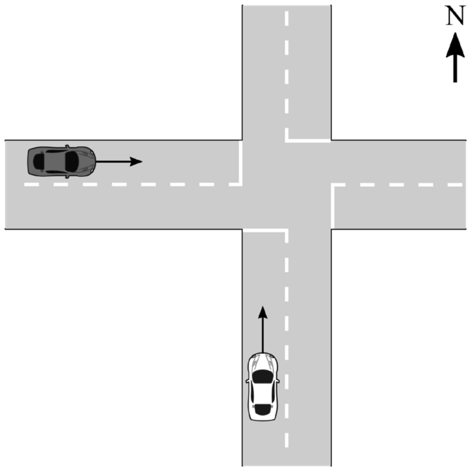
$$gradient = \frac{rise}{run} = \frac{K}{x^2} = \frac{1}{2}k$$

$$k = 2 \times gradient = 2 \times 1.5 = 3.0 \text{ J m}^{-2} \text{ or N m}^{-1}$$

✓ correctly relates *gradient* to k
✓ correct value (±0.2)
✓ correct units for k

Question 24 (5 marks)

Two cars are approaching an intersection, as shown below. The white car has a mass of 1750 kg and is driving north at 65 km h^{-1}. The grey car has a mass of 1450 kg and is driving east at 95 km h^{-1}.



The cars collide at the intersection, fusing together after the collision.

(a) Calculate the velocity of the fused cars immediately after the collision. **3**

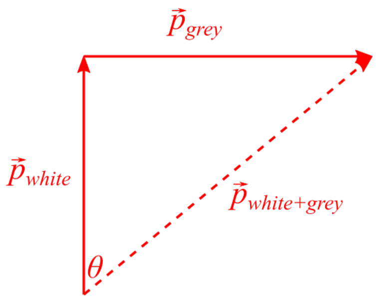
Before collision, $u_{white} = 65 \times \frac{1000}{3600} = 18.1\ \text{m s}^{-1}$ and $u_{grey} = 65 \times \frac{1000}{3600} = 26.4\ \text{m s}^{-1}$:

$$p_{white} = m_{white}u_{white} = 1750 \times 18.1 = 31597\ \text{kg m s}^{-1}\ \text{north}$$

$$p_{grey} = m_{grey}u_{grey} = 1450 \times 26.4 = 38264\ \text{kg m s}^{-1}\ \text{east}$$

Applying conservation of momentum to the collision:

$$\vec{p}_{white} + \vec{p}_{grey} = \vec{p}_{white+grey}$$



from right angled triangle:

$$p_{white+grey} = \sqrt{p_{white}^2 + p_{grey}^2}$$

$$p_{white+grey} = \sqrt{31597^2 + 38264^2}$$

$$p_{white+grey} = 49624\ \text{kg m s}^{-1}$$

$$v = \frac{p_{white+grey}}{m_{white} + m_{grey}} = \frac{49624}{1750 + 1450} = 15.5\ \text{m s}^{-1}$$

$$\theta = \tan^{-1}\left(\frac{p_{grey}}{p_{white}}\right) = \tan^{-1}\left(\frac{38264}{31597}\right) = 50.5°$$

Velocity of fused cars is 15.5 m s^{-1} / 55.8 km h^{-1} N50.5°E

✓ correct equation and substitution line clearly set out
✓ correct numerical answer (max. 3 s.f.)
✓ correct direction

(b) If the coefficient of friction between the tires of the cars and the road is 0.65, calculate how far the fused cars will travel before stopping. **2**

The frictional force of braking is:

$$F_{friction} = \mu F_N = \mu mg = 0.65 \times (1750 + 1450) \times 9.8 = 20384\ \text{N}$$

The brakes do work to stop the car (change kinetic energy):

$$W = \Delta K$$

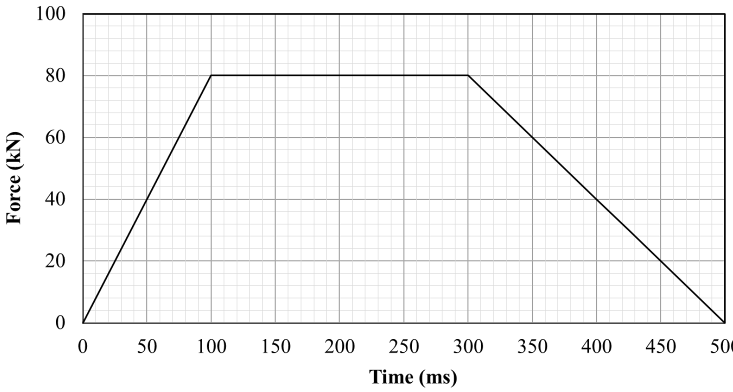
$$Fs = \frac{1}{2}mv^2 \quad \rightarrow \quad s = \frac{mv^2}{2F} = \frac{(1750 + 1450) \times 15.5^2}{2 \times 20384} = 18.9\ \text{m}$$

✓ correct frictional force or acceleration (6.37 m s^{-2})
✓ correct answer & max. 3 s.f.

* carry over only allowed if correct equation and substitution lines are shown and correct sig. figs.

Question 25 (4 marks)

During a crash test, a car of mass 1750 kg collides with a wall. Force sensors on the car measure the force applied during the collision. A force-time graph for the collision is shown below.



(a) Calculate the maximum deceleration of the car during the collision? **2**

Maximum acceleration occurs when there is maximum force (from 100–300 ms):

$$F_{max} = ma_{max} \quad \Rightarrow \quad a_{max} = \frac{F_{max}}{m} = \frac{80 \times 10^3}{1750} = 45.7 \text{ m s}^{-2}$$

✓ correct value

✓ correct units & max. 3 sig. figs.

(b) Calculate the speed of the car before collision. **2**

Impulse is equal to area under the curve:

$$J = \left(\frac{1}{2} \times 100 \times 10^{-3} \times 80 \times 10^3\right) + (200 \times 10^{-3} \times 80 \times 10^3) + \left(\frac{1}{2} \times 200 \times 10^{-3} \times 80 \times 10^3\right)$$

$$= 4000 + 16000 + 8000 = 28000 \text{ kg m s}^{-1}$$

$$J = \Delta p = m\Delta v = m(v - u) \quad \Rightarrow \quad u = \frac{J}{m} + v = \frac{28000}{1750} + 0 = 16 \text{ m s}^{-1}$$

✓ correct equation line $Ft = m(v - u)$ =area under graph

✓ correct value & units

Question 26 (2 marks)

Crumple zones increase stopping time during a collision. With reference to Newton's Second Law explain why crumple zones reduce injurys in car accidents.

Newton's Law states that $F = ma = m\left(\frac{v-u}{t}\right)$. Crumple zones increase the time of impact (t) thus reducing the average negative acceleration (deceleration) during the collision. Since force is proportional to acceleration, a lower acceleration means lower forces experienced by passengers and less injurys.

1 MARK – explicitly demonstrates an understanding of Newton's 2nd Law. (Saying Force is proportional to mass and acceleration is not good enough).

1 MARK- Explains that crumple zones increase the time of the collision. This reduces the acceleration and hence injury causing forces since F is proportional to acceleration.

– End of Paper –