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.

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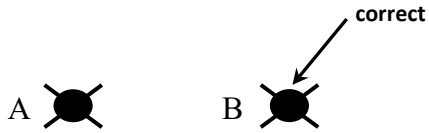

Start Here ➔

1.	A○	B○	C○	D○		**11.**	A○	B○	C○	D○
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Sydney Boys High School

2022 Year 11 Physics

Half-Yearly Cohort Assessment
Module 1 and Module 2 - Kinematics and Dynamics

General Instructions

- Reading time: 5 minutes
- Working time: 75 minutes
- Write using black or blue pen
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Total marks – 50

Part A – Multiple Choice
- 20 marks

Part B – Free Response
- 30 marks

PART A – Multiple Choice (20 marks)

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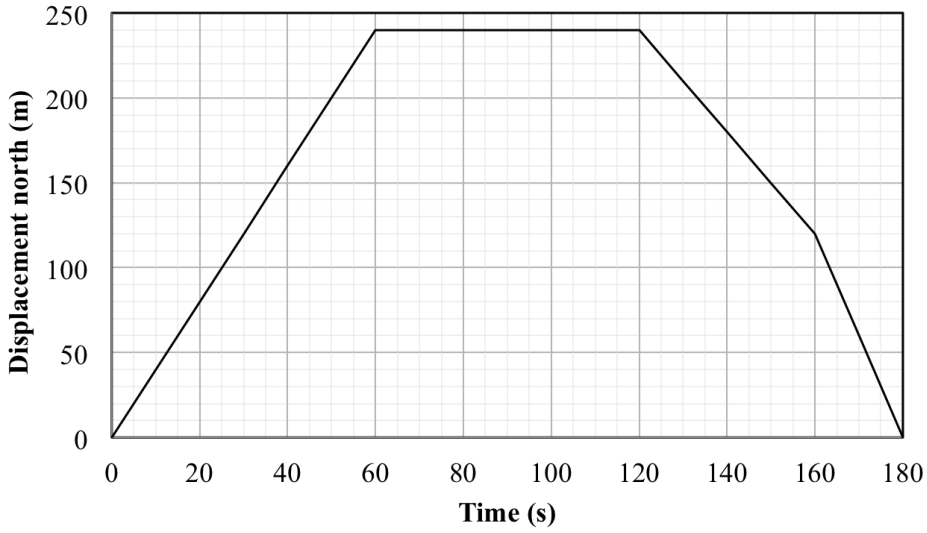
Questions 1−3. Use the graph below.

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



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2. What is the car's average speed for the period t = 40s and t = 100s?

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3. What is the car's change in velocity between t = 40 seconds and t = 175 seconds?

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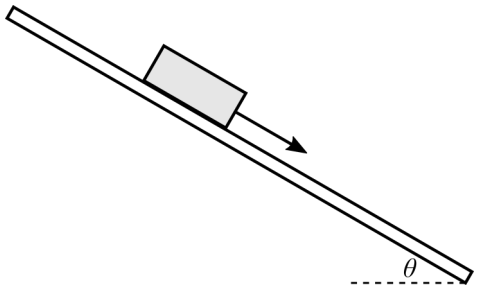
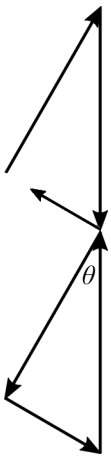


Which diagram best represents the forces of Friction, Gravity and the Normal force acting on the brick before it started to accelerate down the plank?

(A)



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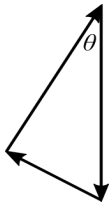
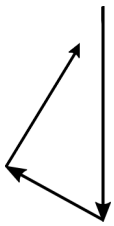


(C)

(D)



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

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6. In an elastic collision between two 1 kg balls :

	Total Momentum is	*Kinetic energy is*	*The change in momentum of each ball is*
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7. During a trip to Jupiter, a space probe's booster rocket is fired resulting in its kinetic energy doubling. During this time there was negligible change in rocket mass. If the initial momentum of the rocket was *p*, what was its final momentum? (choose the closest value)

	Momentum
(A)	*p x 7/6*
(B)	*p x 1/6*
(C)	*p*
(D)	*p x 7/5* .

8. A horse walks 2.6 km north in 10 minutes, then turns right and gallops east 2.6 km in 5 minutes. The average speed and displacement for the journey are:

	Displacement (km NE)	*Average speed (m s^{-1})*
(A)	3.7 km	4.1
(B)	5.2 km	5.9
(C)	3.9 km	4.2
(D)	3.7 km	5.8 .

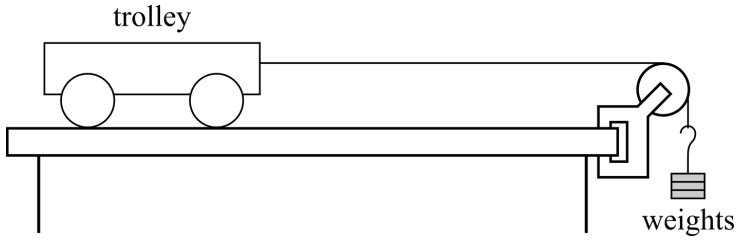
9. A boy ran a 100 m race in 12 s. Assume that he had constant acceleration for the first 4 seconds and then ran at constant velocity. What was the acceleration during the first 4 seconds?

(A) 1.9 m s^{-2}
(B) 2.5 m s^{-2}
(C) 4.5 m s^{-2}
(D) 9.4 m s^{-2}

10. You are sitting on your chair enjoying this test question. The Earth's gravity exerts a downward force on you. According to Newton's 3rd Law forces come in pairs. What is the other force in this force pair?

(A) The upwards gravitational force that you exert on the Earth .
(B) The downwards force of your chair on the floor
(C) The upwards force of the chair on you
(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. There is a maximum frictional force of 6.4 N. What is the acceleration of the trolley across the bench?



Choose the best answer.

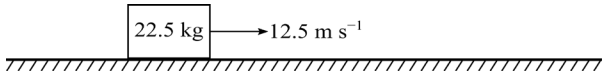
(A) 1.2 m s^{-2}
(B) 1.1 m s^{-2}
(C) 0 m s^{-2}
(D) 0.98 m s^{-2}

12. A 800 kg hot air balloon (including pilot) is descending at a constant rate of 9.8 m/s.

Choose the correct statement:

(A) There is no net force on the pilot and he will feel weightless
(B) The hot air balloon's lift is less than its weight. The pilot will feel lighter than normal
(C) There is no net force on the balloon. The pilot will feel her normal weight
(D) The net force on the hot air balloon will be approximately 7840 N

13. A 22.5 kg box is pulled along the floor with a coefficient of friction of 0.20 with an initial velocity of 12.5 m s^{-1} and an acceleration of 1.5 m/s^2. What is the pulling force being applied to the box to maintain this acceleration?



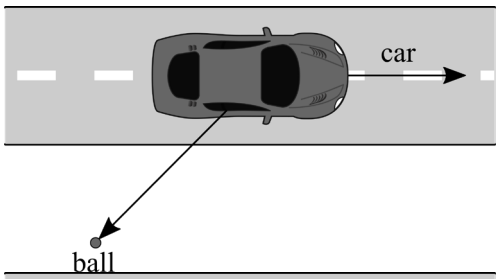
$\mu = 0.20$

Choose the closest answer.

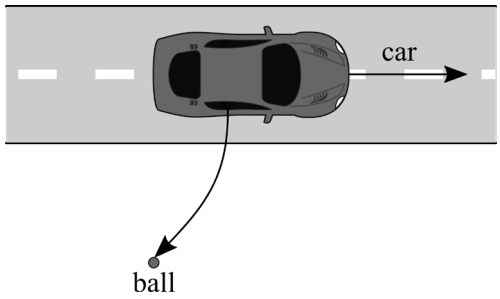
(A) 44 N
(B) 78 N
(C) 34 N
(D) 220 N

14. A ball is thrown out of the passenger window of a car travelling at constant velocity 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 the car?

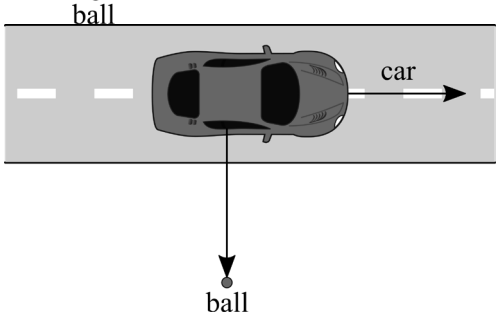
(A)



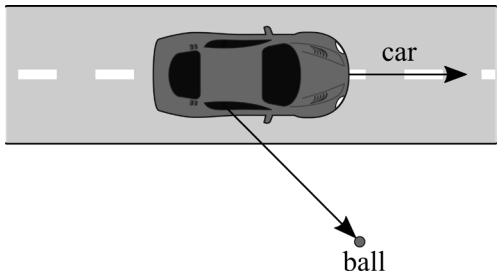
(B)



(C)



(D)



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15. A river is 30 m wide and is flowing at 2 m/s north. A canoeist points his canoe perpendicular to the river bank (ie.east) and paddles at 2 m/s, relative to the water, across the river. How long will it take the canoe to reach the other bank and how far will the canoe have travelled from its starting point?

(A) 15 s and 42 m .
(B) 21 s and 30 m
(C) 15 s and 30 m
(D) 21 s and 42 m

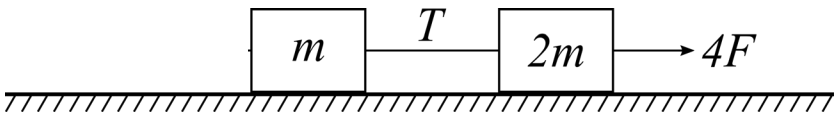
16. Airbags increase stopping time of a person's head in a car crash. Which alternative would be most useful to explain why airbags reduce the severity of injuries experienced by passengers ?

(A) The force experienced is inversely proportional to stopping time .
(B) Airbags decrease the duration(time) of 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 $2v$ so that it reaches a maximum height 4 m, at time 4 s. If the juggler throws a second ball with an initial speed of v, the time to maximum height, and the maximum height will be:

(A) 2 s and 2 m
(B) 4 s and 2 m
(C) 1 s and 2 m
(D) 2 s and 1 m .

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



If 2m=6 kg, a = 0.47m/s^2 and the coefficent of friction = 0.20, calculate the value of T ?

(A) 5.9 N
(B) 15 N
(C) 13 N
(D) 7.3 N

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, how much kinetic energy is lost from the 75 g ball in the collision? (choose the closest answer from below)

(A) 0 J
(B) 2.6 J
(C) 1.5 J
(D) 3.2 J

20. An 85 kg man runs up a 6 metre long ramp inclined at 30 degrees to the horizontal in 7 seconds. How much power is the man generating?

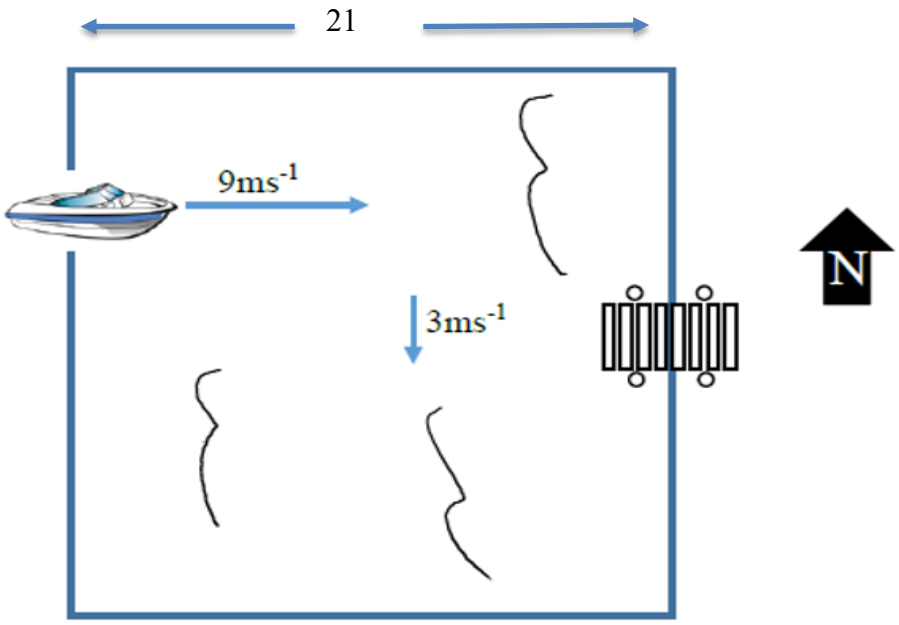
(A) 710 W
(B) 360 W
(C) 120 W
(D) 620 J

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

Question 21 (6 marks) **Teacher: . . . . . .**

A boat can move at 9 m/s relative to the water. A 21 metre wide river flows at 3 m/s. The pier on the other side of the river is 5 metres downstream of where the boat starts.

a) The boat driver points the boat perpendicular to the bank and heads off toward the other side. Will the boat be able to get to the pier on this heading? Justify your answer. **2**



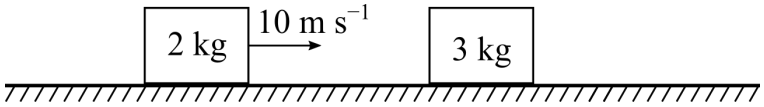
b) A person on the pier is walking west at 2.5 m/s. What is the velocity of the boat relative to the person ? **2**

c) Explain how the boat driver could get the boat to a point on the side of the river directly opposite the starting point. **2**

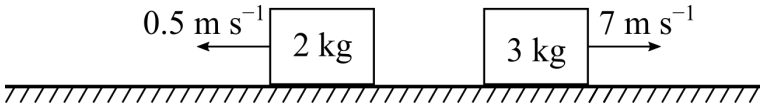
Question 22 (6 marks)

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

before collision:



after collision:



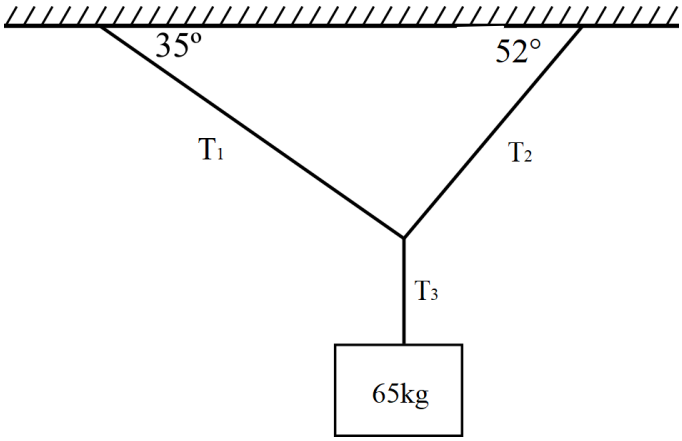
a) Identify whether the collision is consistent with the Law of Conservation of Momentum. Justify your answer. **2**

b) Determne whether this collision is elastic or inelastic. Justify your answer **2**

c) State the Law of Conservation of Energy and in relation to your findings in part b) explain how the law holds true (ie. is valid) **2**

Question 23 (5 marks)

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

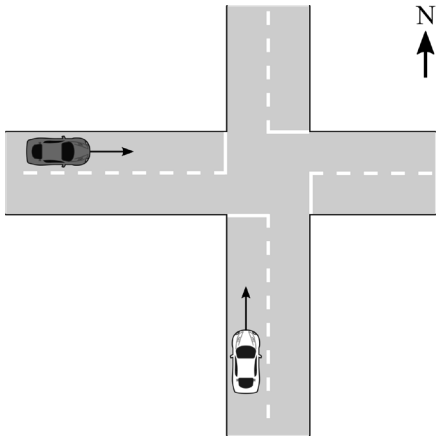


(a) On the diagram above draw and label the forces acting on the 65 kg mass and state the net force acting on the mass. **3**

(b) Calculate the magnitudes of T_1 and T_2. **2**

Question 24 (7 marks)

Two cars are approaching an intersection, as shown below. The white car has a total mass of 1750 kg and is driving north at 65 km h^{-1}. The grey car has a total 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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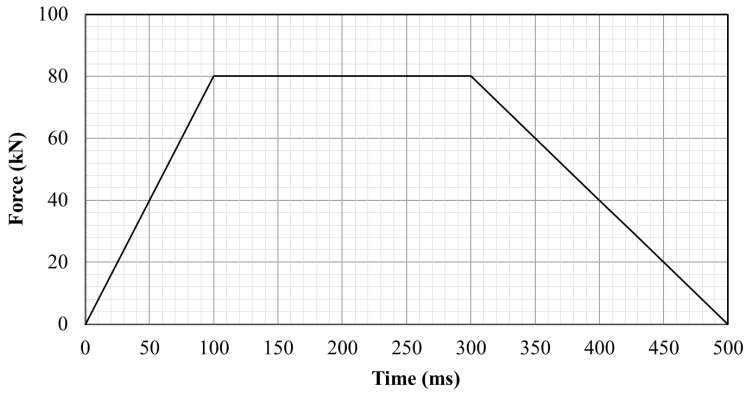
(c) Calculate the magnitude of the impulse experienced by a 65 kg passenger in the grey car <u>immediately</u> after the cars have collided and fused. **2**

.....

Question 25 (6 marks)

During a crash test, a car of mass 750 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 work done on the car between t= 100ms and t= 300ms. **2**

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(c) Calculate the impulse for this collision and explain how the quantity of impulse can be determine using the graph provided**.** **2**

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Name: . . . . . .

Teacher : . . . . . .

blank working space

End of paper

Student name: _____ Class: _____

Sydney Boys High School

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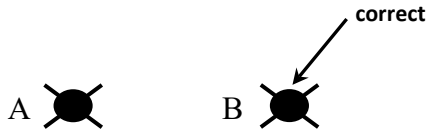

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Sydney Boys High School

2022 Year 11 Physics

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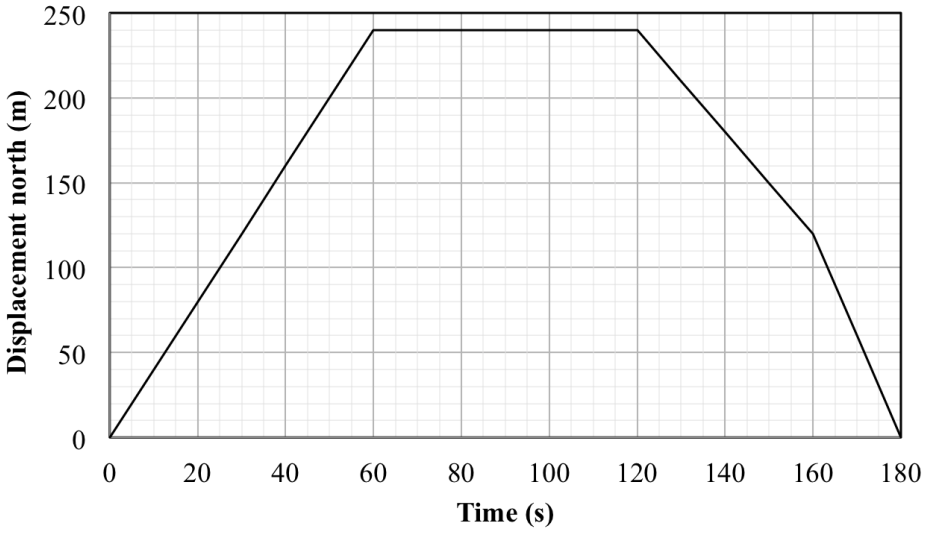

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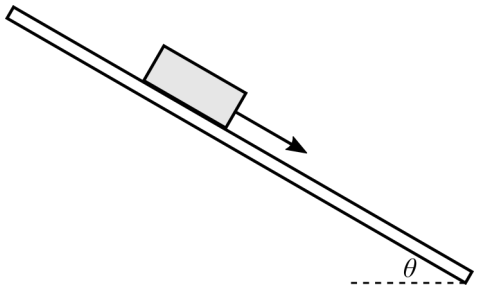

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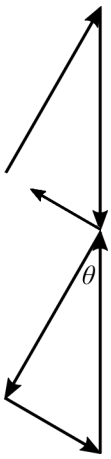
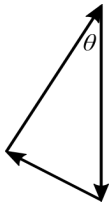


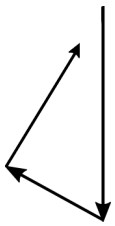
(B)



CORRECT ANSWER

(C)

(D)



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(B)	*p x 1/6*
(C)	*p*
(D)	*p x 7/5*

8. A horse walks 2.6 km north in 10 minutes, then turns right and gallops east 2.6 km in 5 minutes. The average speed and displacement for the journey are:

	Displacement (km NE)	*Average speed (m s^{-1})*
(A)	3.7 km	4.1
(B)	5.2 km	5.9
(C)	3.9 km	4.2
(D)	3.7 km	5.8

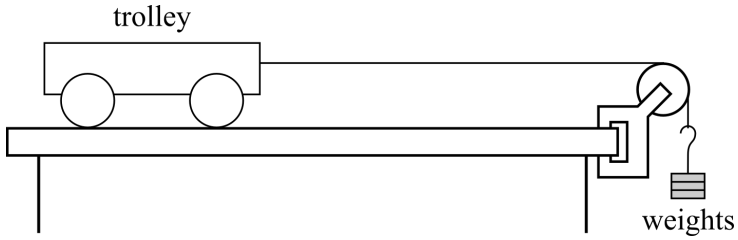
9. A boy ran a 100 m race in 12 s. Assume that he had constant acceleration for the first 4 seconds and then ran at constant velocity. What was the acceleration during the first 4 seconds?

(A) 1.9 m s^{-2}
(B) 2.5 m s^{-2}
(C) 4.5 m s^{-2}
(D) 9.4 m s^{-2}

10. You are sitting on your chair enjoying this test question. The Earth's gravity exerts a downward force on you. According to Newton's 3rd Law forces come in pairs. What is the other force in this force pair?

(A) The upwards gravitational force that you exert on the Earth
(B) The downwards force of your chair on the floor
(C) The upwards force of the chair on you
(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. There is a maximum frictional force of 6.4 N. What is the acceleration of the trolley across the bench?



Choose the best answer.

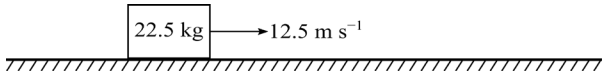
(A) 1.2 m s^{-2}
(B) 1.1 m s^{-2}
(C) 0 m s^{-2}
(D) 0.98 m s^{-2}

12. A 800 kg hot air balloon (including pilot) is descending at a constant rate of 9.8 m/s.

Choose the correct statement:

(A) There is no net force on the pilot and he will feel weightless
(B) The hot air balloon's lift is less than its weight. The pilot will feel lighter than normal
(C) There is no net force on the balloon. The pilot will feel her normal weight
(D) The net force on the hot air balloon will be approximately 7840 N

13. A 22.5 kg box is pulled along the floor with a coefficient of friction of 0.20 with an initial velocity of 12.5 m s^{-1} and an acceleration of 1.5 m/s^2. What is the pulling force being applied to the box to maintain this acceleration?



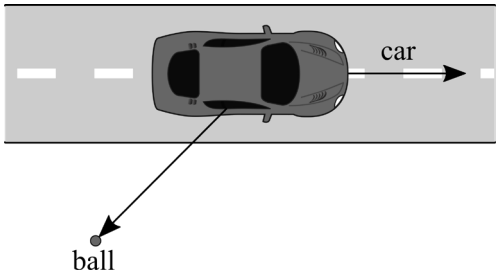
$\mu = 0.20$

Choose the closest answer.

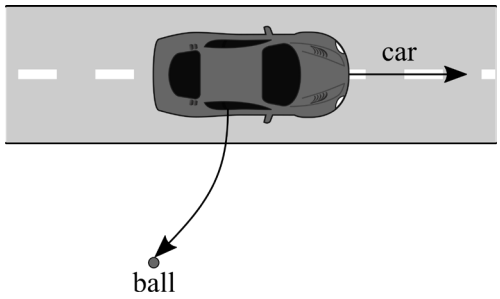
(A) 44 N
(B) 78 N
(C) 34 N
(D) 220 N

14. A ball is thrown out of the passenger window of a car travelling at constant velocity 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 the car?

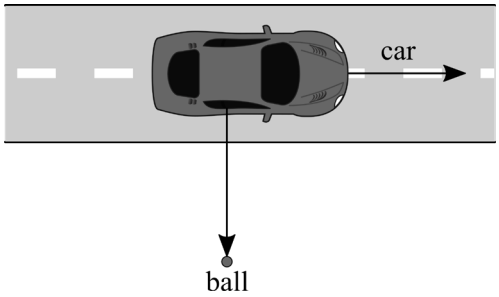
(A)



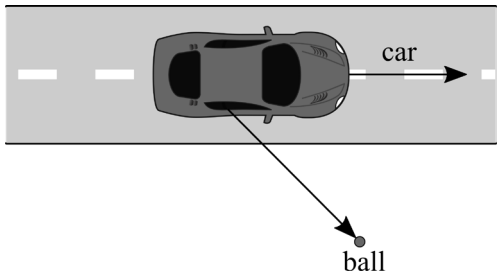
(B)



(C) CORRECT ANSWER



(D)



15. A river is 30 m wide and is flowing at 2 m/s north. A canoeist points his canoe perpendicular to the river bank (ie.east) and paddles at 2 m/s, relative to the water, across the river. How long will it take the canoe to reach the other bank and how far will the canoe have travelled from its starting point?

(A) 15 s and 42 m
(B) 21 s and 30 m
(C) 15 s and 30 m
(D) 21 s and 42 m

16. Airbags increase stopping time of a person's head in a car crash. Which alternative would be most useful to explain why airbags reduce the severity of injuries experienced by passengers ?

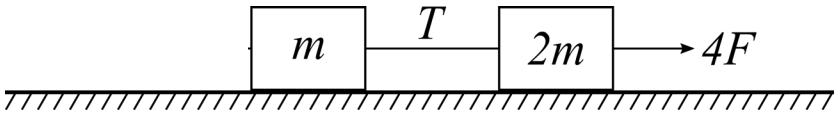
(A) The force experienced is inversely proportional to stopping time
(B) Airbags decrease the duration(time) of force experienced by occupants
(C) Newton's 3rd Law
(D) Airbags decrease the change in momentum experienced by occupants

17. A juggler throws a ball into the air with an initial speed of $2v$ so that it reaches a maximum height 4 m, at time 4 s. If the juggler throws a second ball with an initial speed of v, the time to maximum height, and the maximum height will be:

(A) 2 s and 2 m
(B) 4 s and 2 m
(C) 1 s and 2 m

(D) 2 s and 1 m

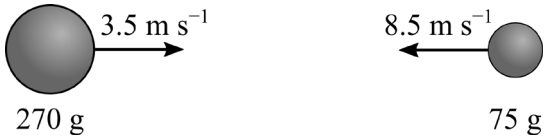
18. Two blocks of masses m and $2m$, connected by a light, inextensible string are resting on a rough horizontal surface. A force of $4F$ is applied to one side of the connected blocks, as shown below.



If 2m=6 kg, a = 0.47m/s^2 and the coefficent of friction = 0.20, calculate the value of T ?

(A) 5.9 N
(B) 15 N
(C) 13 N
(D) 7.3 N

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, how much kinetic energy is lost from the 75 g ball in the collision? (choose the closest answer from below)

(A) 0 J
(B) 2.6 J
(C) 1.5 J
(D) 3.2 J

20. An 85 kg man runs up a 6 metre long ramp inclined at 30 degrees to the horizontal in 7 seconds. How much power is the man generating?

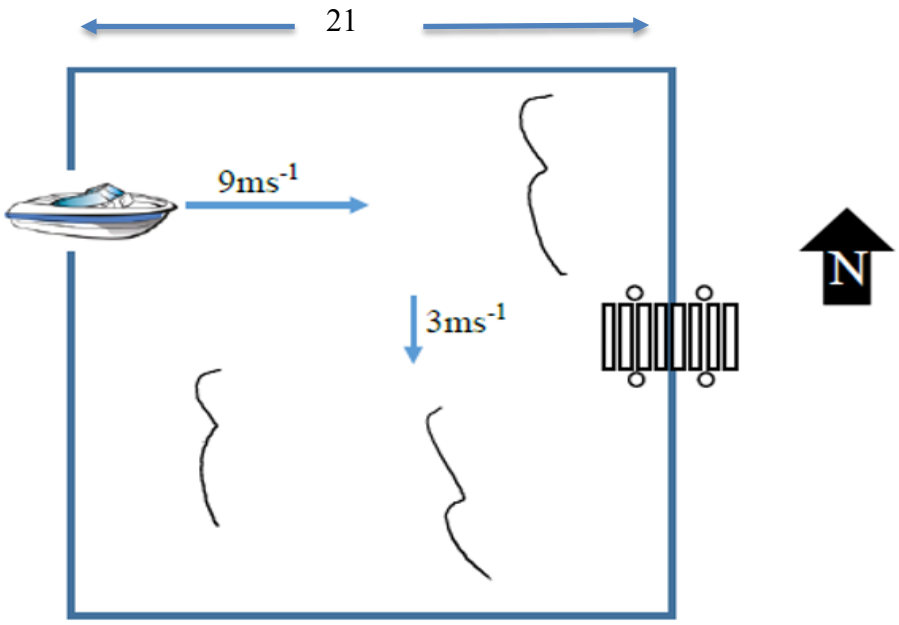
(A) 710 W
(B) 360 W
(C) 120 W
(D) 620 J

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

Question 21 (6 marks) **Teacher:** . . . . . .

A boat can move at 9 m/s relative to the water. A 21 metre wide river flows at 3 m/s. The pier on the other side of the river is 5 metres downstream of where the boat starts.

a) The boat driver points the boat perpendicular to the bank and heads off toward the other side. Will the boat be able to get to the pier on this heading? Justify your answer. **2**



1 MARK: NO. The boat will not get to the pier

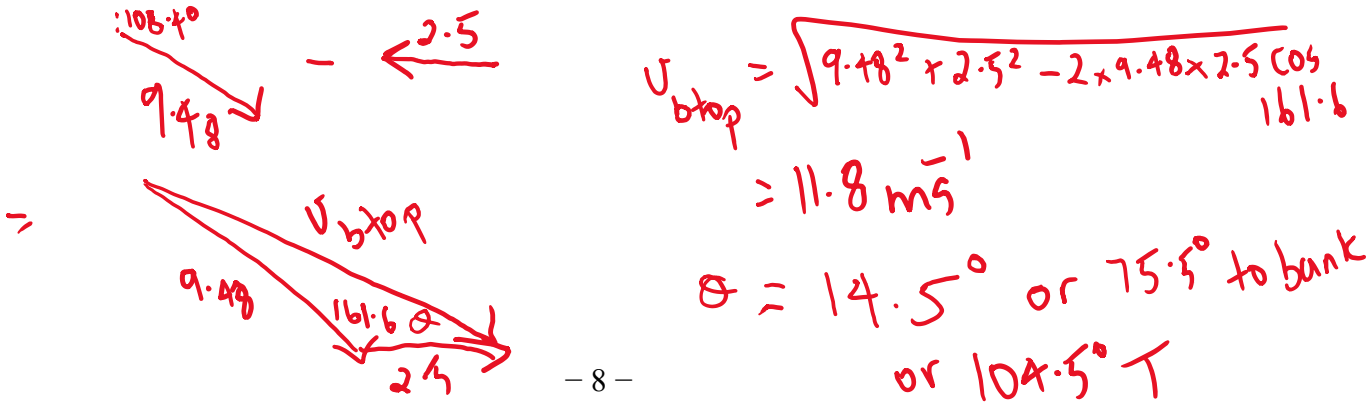
1MARK: Justification with calculations showing that the boat will miss the pier.

(a) $t = \frac{d}{v} = \frac{21}{9} = 2.33s$ (y) $d = vt = 3 \times 2.33 = 7m$

$7m > 5m$ ∴ goes past

b) A person on the pier is walking west at 2.5 m/s. What is the velocity of the boat relative to the person ? **2**

$V_{boat\ rel\ Vperson} = V_{boat} - V_{person} = V_{boat} + (-V_{person})$



c) Explain how the boat driver could get the boat to a point on the side of the river directly opposite the starting point. **2**

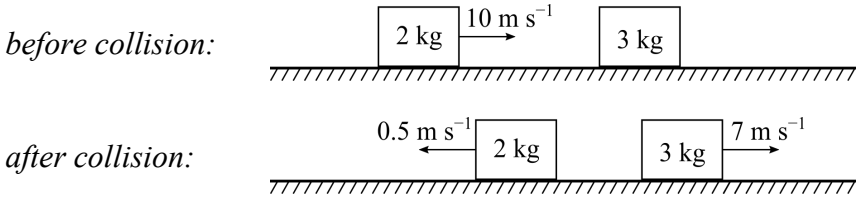
1 MARK - Explains that the boat needs to be angled upstream

$\theta = 19.5°$ or $70.5°$ T

E 19.5° N

Question 22 (6 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**

$\sum p_{before} = p_{2kg_{before}} + p_{3kg_{before}} = m_{2kg}u_{2kg} + m_{3kg}u_{3kg} = 2 \times 10 + 3 \times 0 = 20\ kg\ m\ s^{-1}$

$\sum p_{after} = p_{2kg_{after}} + p_{3kg_{after}} = m_{2kg}v_{2kg} + m_{3kg}v_{3kg} = 2 \times -0.5 + 3 \times 7 = 20\ kg\ m\ s^{-1}$

Given that $\sum p_{before} = \sum p_{after}$, the collision is consistent with the Law of Conservation of Momentum

✓ correctly compares calculations of $\sum p_{before}$ to $\sum p_{after}$
✓ correct judgement based on calculations

b) Determne whether this collision is elastic or inelastic. Justify your answer **2**

$\sum K_{before} = K_{2kg_{before}} + K_{3kg_{before}} = \frac{1}{2}m_{2kg}u_{2kg}^2 + \frac{1}{2}m_{3kg}u_{3kg}^2 = \frac{1}{2} \times 2 \times 10^2 + \frac{1}{2} \times 3 \times 0^2 = 100\ J$

$\sum K_{after} = K_{2kg_{after}} + K_{3kg_{after}} = \frac{1}{2}m_{2kg}v_{2kg}^2 + \frac{1}{2}m_{3kg}v_{3kg}^2 = \frac{1}{2} \times 2 \times -0.5^2 + \frac{1}{2} \times 3 \times 7^2 = 73.75\ J$

Given that $\sum K_{after} < \sum K_{before}$, kinetic energy has not been conserved, and the collision is inelastic.

✓ correctly compares calculations of $\sum K_{before}$ to $\sum K_{after}$
✓ correct identification based on calculations

c) State the Law of Conservation of Energy and in relation to your findings in part b) explain how the law holds true (ie. is valid) **2**

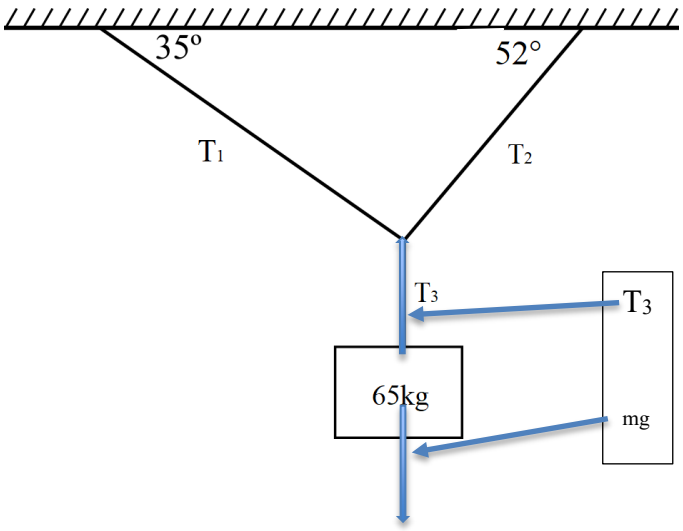
The Law of Conservation of Energy states that the total energy in an isolated system remains constant over time. That is, energy cannot be created nor destroyed, only transferred or transformed. This law is valid for the above collision, because the kinetic energy decreased when it was transformed to other types of energy (such as heat and sound) during the collision. In this way the total energy (kinetic + heat + sound) is the same before and after the collision.

✓ valid definition
✓ relates decrease in K to Law

notes: * don't say "energy cannot be lost" in the definition of the Law (particularly if you are going to immediately describe how K is *lost* as heat or sound) – energy *can* be lost from the system, but not destroyed entirely
* don't forget energy being transferred, otherwise elastic collisions wouldn't happen

Question 23 (5 marks)

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



(a) On the diagram above draw and label the forces acting on the 65 kg mass and state the net force acting on the mass. **3**

1 MARK - labelled T_3 vector shown acting on the 65kg mass with correct direction
1 MARK - labelled mg vector shown acting on the 65kg mass with correct direction

1 MARK- Since $F_{Net} = m \times a$
$F_{NET} = 65 \times 2.5 = 163$ N

(b) Calculate the magnitudes of T_1 and T_2. **2**

1 MARK FOR **EACH** CORRECT TENSION WITH UNIT and working shown

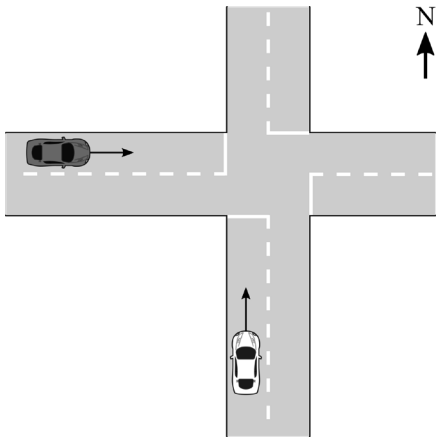
$T_1 = 490$ N (2sf)

$T_2 = 660$ N (2sf)

If answers were wrong or missing units the answer may receive 1MARK if correct working was shown (ie a vector triangle is shown and the Sin Rule is used)

Question 24 (7 marks)

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

1MARK – SOME CORRECT WORKING SHOWING MOMENTUM CALCULATIONS

1 MARK – CORRECT VELOCITY MAGNITUDE = 15.5 m/s (2sf)

1 MARK – CORRECT VELOCITY DIRECTION = East 39.5 degrees North

(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**

1 MARK – CORRECT FRICTION CALC. $F_f = U_f \times mg = 0.65 \times 3200 \times 9.8 = 20384$ N

1 MARK – CORRECT CALC OF STOPPING DISTANCE.

A=F/M=20384/3200=6.37 m/s/s

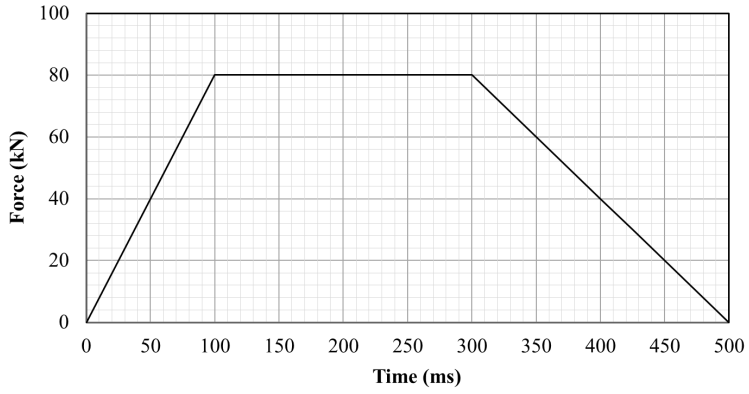
$V^2=U^2+2aS$. $0=15.5^2+2\times 6.37\times S$ $S=18.9$ m(3sf) or 19 m (2sf)

(c) Calculate the magnitude of the impulse experienced by a 65 kg passenger in the grey car immediately after the cars have collided and fused. **2**

1 MARK FOR CORRECT IMPULSE FORMULA AND SOME WORKING
2ND MARK FOR THE CORRECT ANSWER (1135 Ns) (check this)

Question 25 (6 marks)

During a crash test, a car of mass 750 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**

A= F/M = 80000/750= 107 m/s/s

1 MARK FOR CORRECT FORMULA
1 MARK FOR CORRECT ANSWER

(a) Calculate the work done on the car between t= 100ms and t= 300ms. **2**

1 MARK – SOME CORRECT WORKING. 2ND MARK – CORRECT WORKING + ANSWER
Total p = 28000 Ns therefore the initial velocity v = p/m =28000/750 = 37.3 m/s

At t = 0.1 s the change in p is 4000Ns so v has reduced by 4000/750 to 32 m/s

At t =0.3 s the velocity has reduced to 10.7 m/s.

The work done between t=0.1 and 0.3 = change in KE = ½ m (v^2-u^2) = 340 x 10^3J

(b) Calculate the impulse for this collision and explain how the quantity of impulse can be determined using the graph provided.

1MARK. The area under the graph will equal the magnitude of the impulse experienced by the car (or the total change in momentum)

1 MARK – Correctly calculates the magnitude of the impulse

Total area = area of first triangle + area of middle section + area of the end triangle

= ½ x 0. 100x80000 + 0.200 x 80000 + ½ x 0.200 x 80000 = 28000Ns

Name: . . . . . .

Teacher : . . . . . .

blank working space

End of paper