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.

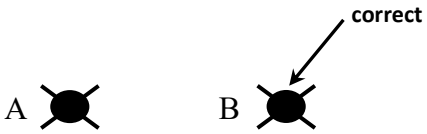
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.



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○
4.	A○	B○	C○	D○		**14.**	A○	B○	C○	D○
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○
8.	A○	B○	C○	D○		**18.**	A○	B○	C○	D○
9.	A○	B○	C○	D○		**19.**	A○	B○	C○	D○
10.	A○	B○	C○	D○		**20.**	A○	B○	C○	D○

Student name: _____ Class: _____

Sydney Boys High School

Year 11 Physics

June 2021

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

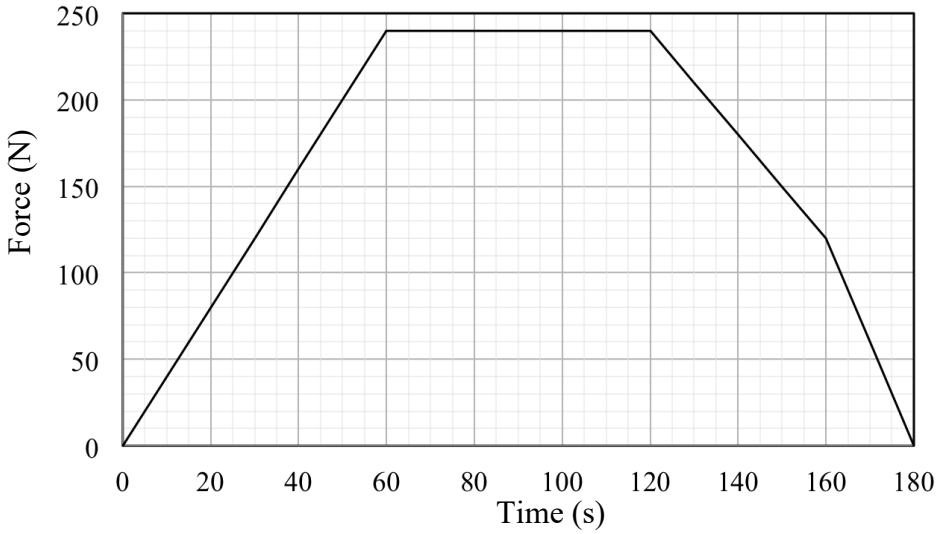
Part B – Free Response
- 30 marks

PART A – Multiple Choice (20 marks)

Choose the most correct answer.

Questions 1−3. Use the graph below.

A 150 kg motorbike (and rider) initially at rest had a force applied to it as it moved in a northward direction. The applied force changed as shown in the graph below. (assume zero friction)



1. For how many seconds was the motorbike travelling with constant velocity?

(A) 0
(B) 60
(C) 120
(D) 180

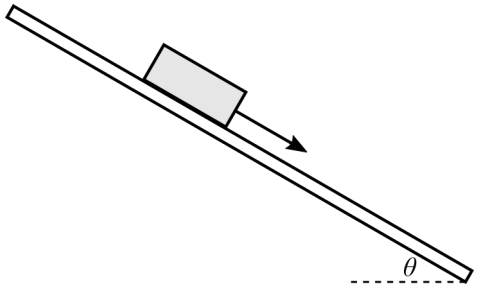
2. What change in momentum occurred during the second minute of its travel?

(A) 14400 Ns
(B) 12200 kg.m/s
(C) 14400 N/s
(D) None of the above

3. What is the motorbike's acceleration at t = 140 seconds?

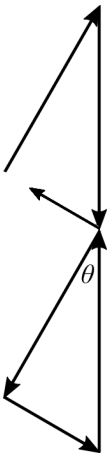
(A) 3.0 m/s^2 north
(B) 1.2 m/s^2 north
(C) 3.0 m/s^2 south
(D) 1.2 m/s^2 south

4. A brick is accelerating down a wooden plank. The plank angle Θ is then lowered until the brick slides at constant velocity down the plank.

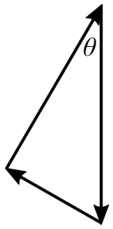


Which diagram best represents the forces of Friction, Gravity and the Normal force acting on the brick while it slides with constant velocity?

(A)

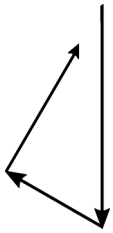


(B)



(C)

(D)



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

(A) 77
(B) 135
(C) 817
(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*
(A)	conserved	not conserved	equal but opposite
(B)	not conserved	not conserved	equal
(C)	conserved	not conserved	proportional to mass
(D)	not conserved	conserved	add to give zero

.

7. During a trip to Jupiter, a space probe's booster rocket is fired, quadrupling 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)	*4.0K*	*0.5p*
(B)	8.0*K*	*2.0p*
(C)	4.0*K*	2.0*p*
(D)	8.0*K*	0.5*p*

8. A plane flies 260 km north in 20 minutes, then turns 90 degrees to the left and flies another 260 km in 10 minutes. The average speed and average velocity are:

	Average speed (km h^{-1})	*Average velocity (km h^{-1})*
(A)	260	520 NE
(B)	735	1100 NE
(C)	37	13 NW
(D)	1120	735 NW

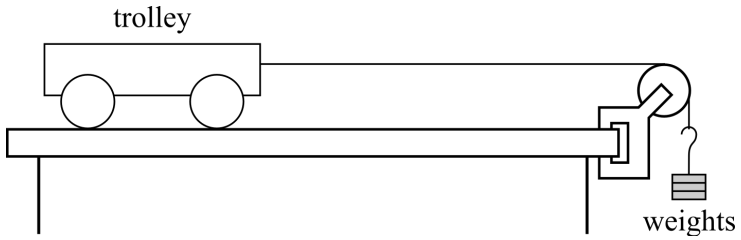
9. The women's world record for the 100 m race is 10.5 s, held by Florence Griffith-Joyner. Assume that she has a constant acceleration for the first 3 seconds and then travels at constant velocity, what is her maximum speed during the 100 m race?

(A) 13.3 m s^{-1}
(B) 11.9 m s^{-1}
(C) 12.9 m s^{-1}
(D) 11.1 m s^{-1}

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

(A) The upwards force of the floor on the chair
(B) The downwards force of the student on the chair
(C) The upwards force on the Earth due to the student
(D) The gravitational force of the chair 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. If a frictional force of 0.99 N acts on the trolley what is the acceleration of the trolley across the bench?



Choose the best answer.

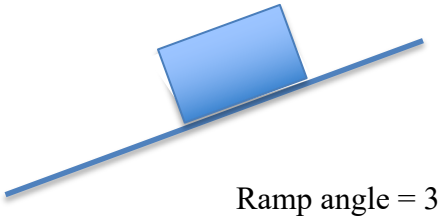
(A) 1.7 m s^{-2}
(B) 1.4 m s^{-2}
(C) 1.2 m s^{-2}
(D) 0 m s^{-2}

12. A 800 kg hot air balloon (including pilot) is rising (going up) at a constant rate of 2 m/s.

Choose the most correct statement:

(A) the hot air in the balloon is providing a net upward force.
(B) the hot air balloon's lift is greater than its weight
(C) There is no net force on the balloon
(D) the net force on the hot air balloon will be approximately 800 x 9.8 N

13. A 25 kg box sits on a 30 degree ramp. What would be the minimum coefficient of friction between the box and the ramp to stop the box sliding. ($g = 9.8$ m/s^2)



Ramp angle = 30 ° ,

Choose the closest answer.

(A) 0.102
(B) 0.31
(C) 0.45
(D) 0.58

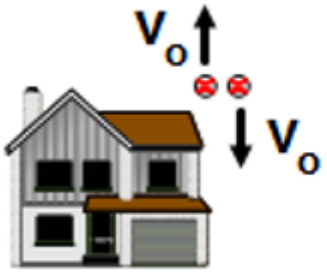
14. The first 8 rows at 5.5 m/s due north while the second 8 rows at 4.8 m/s due west, what is the velocity of the first 8 relative to the second 8?

(A) 6.9 m/s N 45°W
(B) 7.3 m/s N 41°E
(C) 7.9 m/s N 38°E
(D) 8.3 m/s S 40°W

15. In question 11 a 450g weight is connected to a 1.6 kg trolley. When the equipment is accelerating the net force on the weight is closest to:

(A) 2.24 N
(B) 15.7 N
(C) 4.4 N
(D) 0.75 N

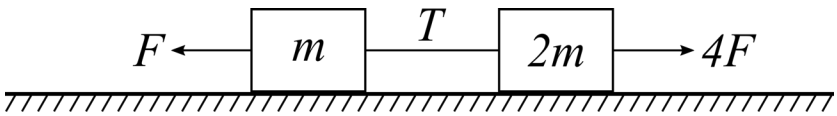
16. Two balls are thrown from the roof of a house with the same initial speed. Ball A is thrown up. Ball B is thrown down. Compare the speeds of the balls just before they hit the ground.



(A) Ball A and B will hit the ground with the same speed but at different times
(B) Ball A and B will hit the ground with the same speed at the same time
(C) Ball A will hit the ground with greater speed than Ball B
(D) Ball B will hit the ground with greater speed than Ball A

(continued over page)

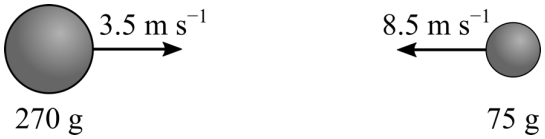
17. Two blocks of masses m and $2m$, connected by a light, inextensible string are sit on a frictionless horizontal surface. Opposing forces F and $4F$ are applied to each side of the connected blocks, as shown below.



If m=4 kg and F=2 N what is the tension T?

(A) 8 N
(B) 6 N
(C) 4 N
(D) 2 N

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



If the 75 g ball moves to the right at 1.5 m s^{-1} after the collision, what is the final velocity of the 270 g ball? (choose the closest answer from below)

(A) 1.1 m s^{-1} to the right
(B) 2.1 m s^{-1} to the left
(C) 0.72 m s^{-1} to the right
(D) 3.3 m s^{-1} to the left

19. 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 4 seconds. How much power is the man generating?

(A) 429 W
(B) 482 W
(C) 408 W
(D) 462 W

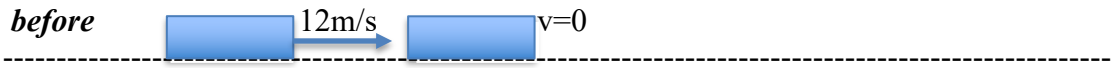
20. A ball is thrown straight up. At the highest point of its path-

(A) The net force acting on the ball is zero
(B) The ball's instantaneous acceleration is zero
(C) The ball's acceleration remains unchanged
(D) The instantaneous force acting on the ball is greater than mg.

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

Question 21 (5 marks)

A 2.0 kg block travelling at 12 m/s collides with an identical stationary block sitting on a rough surface. The first block comes to rest in the collision.



Two seconds after the impact the second block's speed is 6 m/s

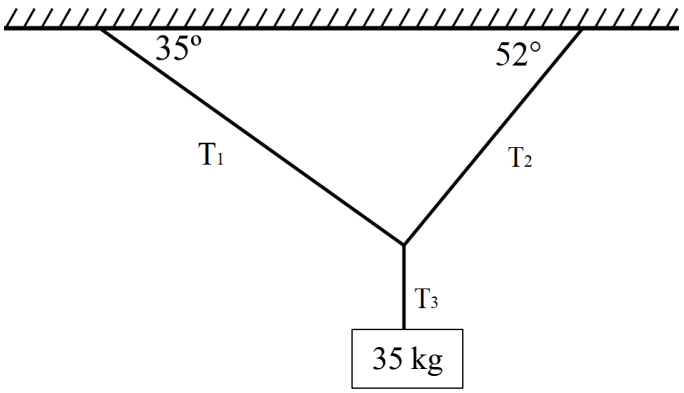
a) Calculate the velocity of the second block immediately after impact **1**

b) Show that this collision is elastic. Justify your answer **2**

c) Calculate the average frictional force acting on the second block after the collision **2**

Question 22 (4 marks)

A block of mass 35 kg hangs on two strings suspended from the ceiling of a lift travelling upwards at 2.5 m/s, as shown below. (g = 9.8m/s^2)



(a) What is the net force acting on the 35 kg mass? **1**

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

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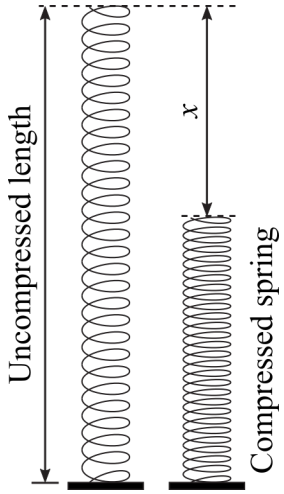
Question 23 (10 marks)

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.



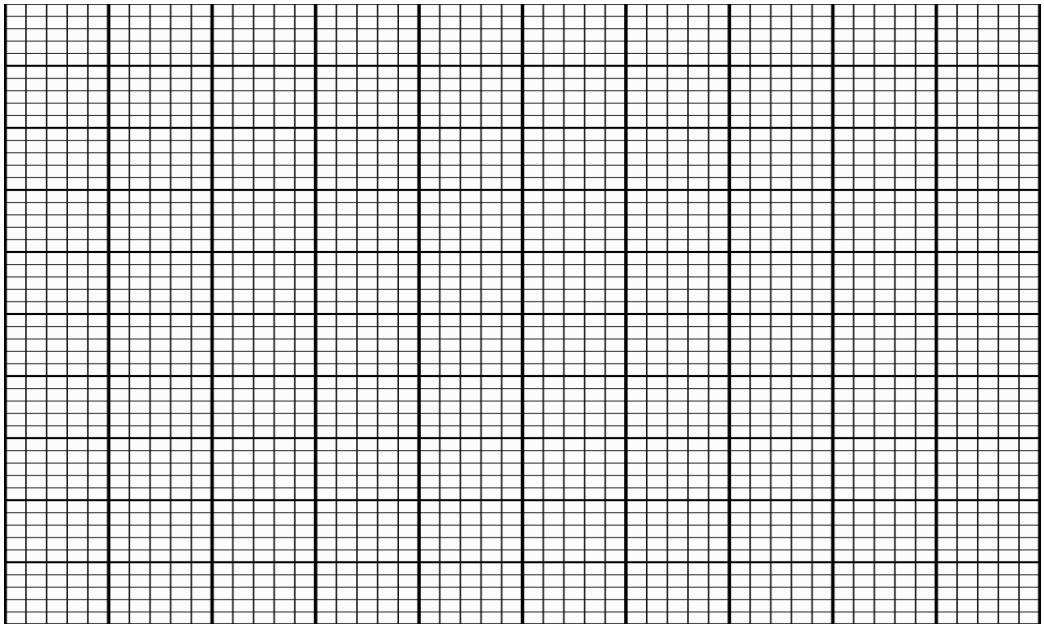
A 2.00 kg ball is placed on top of a vertically compressed spring. The spring was then released and the ball launched upwards from ground level. Launch velocities of the ball were measured for different amounts of spring compression (x). The results are shown below.

	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)					

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

(continued over page)

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



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

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(d) Using the value of k determined in (c) calculate the theoretical maximum height reached by the ball for a spring compression of 0.45m**.** **2**

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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 55 km h^{-1}.

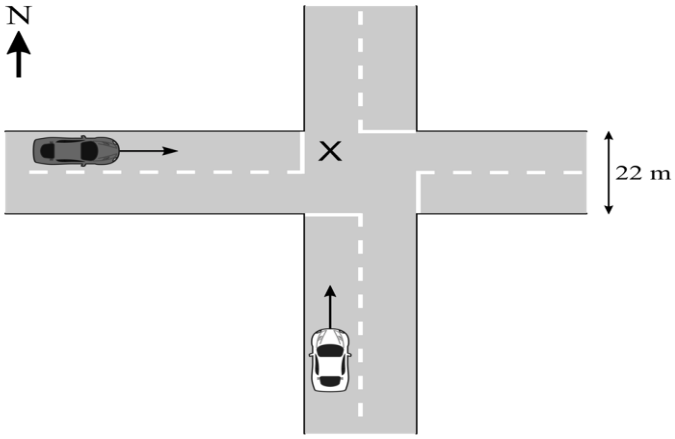

DIAGRAM DRAWN TO SCALE

The cars collide at position X. The white car comes to rest as a result of the collision.

(a) Calculate the velocity of the grey car after the collision. **2**

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(b) If the coefficient of friction between the tires of the cars and the road is 0.85, calculate the acceleration of the grey car as it skids to a stop after the collision. **2**

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(c) Draw an X on the diagram of the intersection above to show where the grey car would come to rest. (use the scale given on the diagram) **1**

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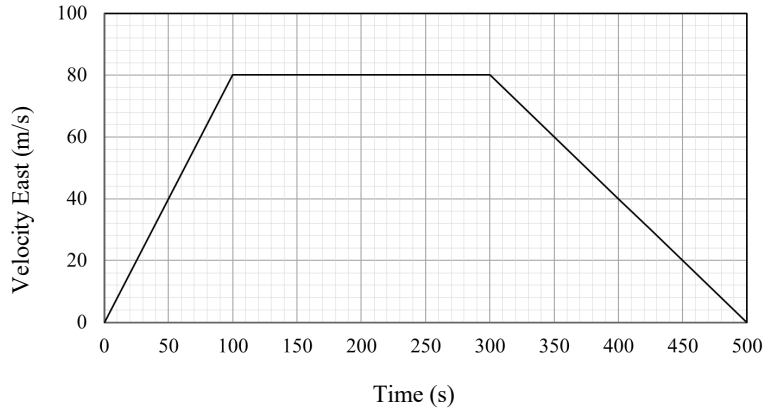
Question 25 (4 marks)

The velocity of a 1750 kg car initially travelling East was measured over a period of time. The graph below shows how the velocity of the car changed over a 500 second period.



(a) What was the car's acceleration at t = 400 seconds. **2**

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(b) Calculate the displacement of the car 2 minutes after the start. **2**

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Question 26 (2 marks) **2**

Crumple zones and airbags increase the stopping time during a car crash. With reference to a relevant law of physics explain why increasing stopping time makes cars safer.

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− End of Paper −

Student name: _____ Class: _____

Sydney Boys High School

Year 11 Physics

June 2021

Half-Yearly Cohort Assessment
Kinematics and Dynamics

General Instructions

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

Part A – Multiple Choice
- 20 marks

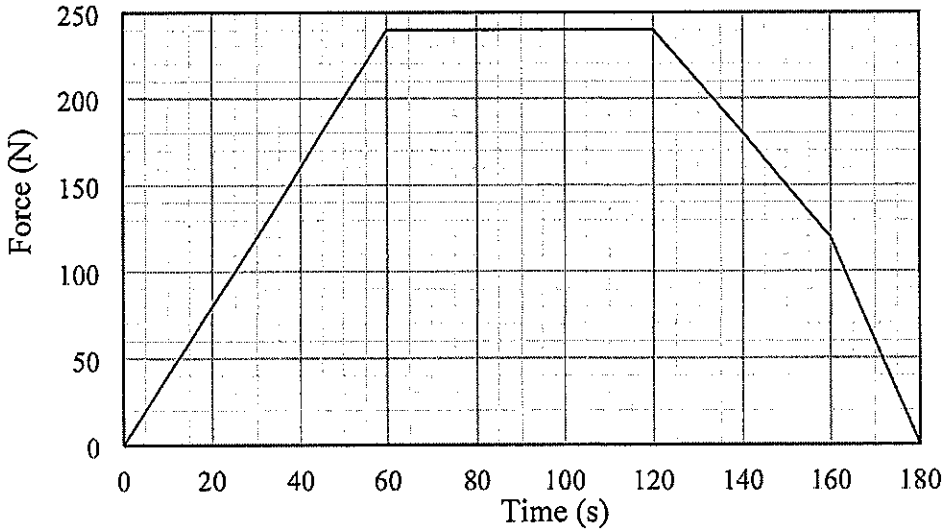
Part B – Free Response
- 30 marks

PART A – Multiple Choice (20 marks)

Choose the most correct answer.

Questions 1–3. Use the graph below.

A 150 kg motorbike (and rider) initially at rest had a force applied to it as it moved in a northward direction. The applied force changed as shown in the graph below. (assume zero friction)



1. For how many seconds was the motorbike travelling with constant velocity?

— (A) 0
(B) 60
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2. What change in momentum occurred during the second minute of its travel?

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3. What is the motorbike's acceleration at t = 140 seconds?

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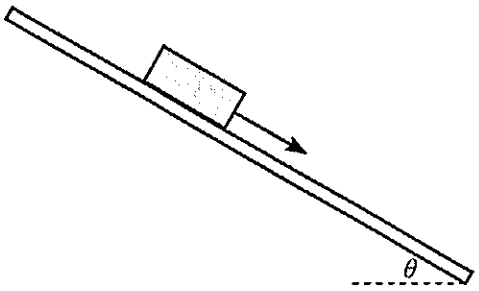
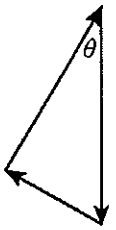


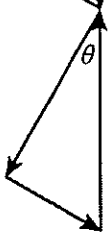
Which diagram best represents the forces of Friction, Gravity and the Normal force acting on the brick while it slides with constant velocity?

(A)

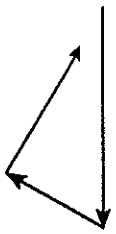
— (B)



(C)



(D)



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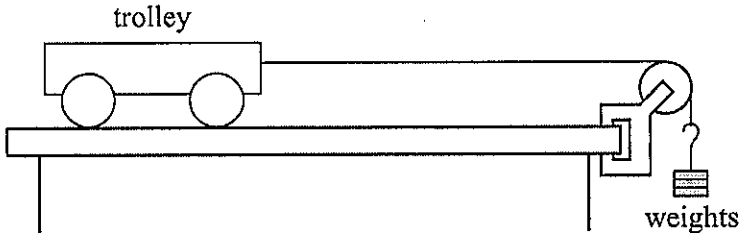

Choose the best answer.

— (A) 1.7 m s^{-2}
(B) 1.4 m s^{-2}
(C) 1.2 m s^{-2}
(D) 0 m s^{-2}

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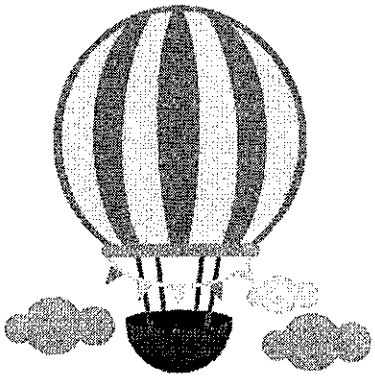
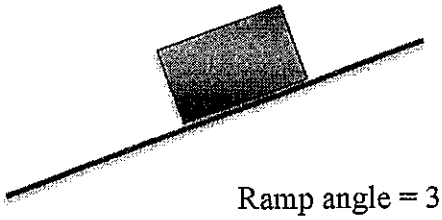


Choose the most correct statement:

(A) the hot air in the balloon is providing a net upward force.
(B) the hot air balloon's lift is greater than its weight
— (C) There is no net force on the balloon
(D) the net force on the hot air balloon will be approximately 800 x 9.8 N

13. A 25 kg box sits on a 30 degree ramp. What would be the minimum coefficient of friction between the box and the ramp to stop the box sliding. ($g = 9.8$ m/s^2)



Ramp angle = 30 °,

Choose the closest answer.

(A) 0.102
(B) 0.31
(C) 0.45
— (D) 0.58

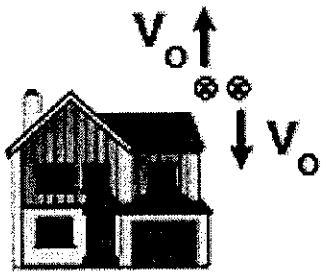
14. The first 8 rows at 5.5 m/s due north while the second 8 rows at 4.8 m/s due west, what is the velocity of the first 8 relative to the second 8?

(A) 6.9 m/s N 45°W
— (B) 7.3 m/s N 41°E
(C) 7.9 m/s N 38°E
(D) 8.3 m/s S 40°W

15. In question 11 a 450g weight is connected to a 1.6 kg trolley. When the equipment is accelerating the net force on the weight is closest to:

(A) 2.24 N
(B) 15.7 N
(C) 4.4 N
— (D) 0.75 N

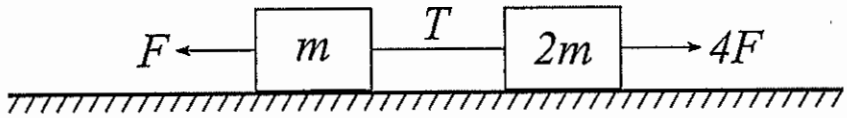
16. Two balls are thrown from the roof of a house with the same initial speed. Ball A is thrown up. Ball B is thrown down. Compare the speeds of the balls just before they hit the ground.



— (A) Ball A and B will hit the ground with the same speed but at different times
(B) Ball A and B will hit the ground with the same speed at the same time
(C) Ball A will hit the ground with greater speed than Ball B
(D) Ball B will hit the ground with greater speed than Ball A

(continued over page)

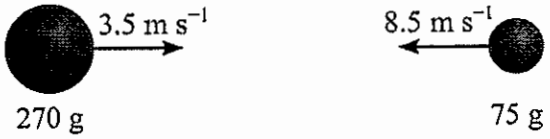
17. Two blocks of masses m and $2m$, connected by a light, inextensible string are sit on a frictionless horizontal surface. Opposing forces F and $4F$ are applied to each side of the connected blocks, as shown below.



If m=4 kg and F=2 N what is the tension T?

(A) 8 N
(B) 6 N
— (C) 4 N
(D) 2 N

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



If the 75 g ball moves to the right at 1.5 m s^{-1} after the collision, what is the final velocity of the 270 g ball? (choose the closest answer from below)

(A) 1.1 m s^{-1} to the right
(B) 2.1 m s^{-1} to the left
— (C) 0.72 m s^{-1} to the right
(D) 3.3 m s^{-1} to the left

19. 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 4 seconds. How much power is the man generating?

(A) 429 W
(B) 482 W
(C) 408 W
— (D) 462 W

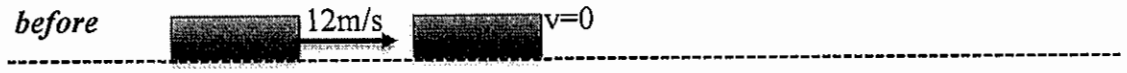
20. A ball is thrown straight up. At the highest point of its path-

(A) The net force acting on the ball is zero
(B) The ball's instantaneous acceleration is zero
— (C) The ball's acceleration remains unchanged
(D) The instantaneous force acting on the ball is greater than mg.

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

Question 21 (5 marks)

A 2.0 kg block travelling at 12 m/s collides with an identical stationary block sitting on a rough surface. The first block comes to rest in the collision.



Two seconds after the impact the second block's speed is 6 m/s

a) Calculate the velocity of the second block immediately after impact 1

$p_i = p_f$ $\quad m_1u_1 = m_2u_2$ $\quad \therefore V_2 = 12$ m/s to the right

b) Show that this collision is elastic. Justify your answer 2

$KE_i = \frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times 12^2 = 144$ J

$KE_f = \frac{1}{2}m_2v^2 = \frac{1}{2} \times 2 \times 12^2 = 144$ J

1 MARK (shows correct calcs)

KE is conserved therefore the collision is elastic

1 MARK

c) Calculate the average frictional force acting on the second block after the collision 2

$u = 12$ m/s, $v = 6$ m/s, $\Delta t = 2$ s

$a = \frac{v-u}{t} = \frac{6-12}{2}$

$a = -3$ m/s^2

$F = ma$

$= 2 \times -3$

$= -6$ N

1 MARK

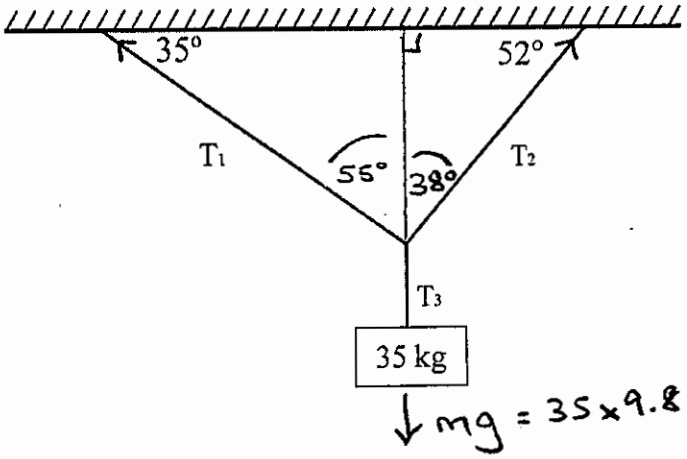
$F = 6$ N to the left

1 MARK

friction ox (or opposite to dirn of mot.)

Question 22 (4 marks)

A block of mass 35 kg hangs on two strings suspended from the ceiling of a lift travelling upwards at 2.5 m/s, as shown below. (g = 9.8m/s^2)

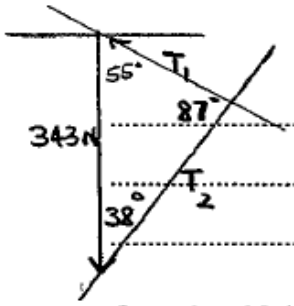


$\downarrow mg = 35 \times 9.8 = 343$ N

(a) What is the net force acting on the 35 kg mass? **1**

$F_N = ma = 35 \times 0 = 0$ N

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



$T_3 = mg = 35 \times 9.8 = 343$ N $= 340$ N (2 sf)

$\frac{343}{\sin 87} = \frac{T_1}{\sin 38}$

$T_1 = 211$ N $= 210$ N (2 sf)

$\frac{343}{\sin 87} = \frac{T_2}{\sin 55}$

$T_2 = 281$ N $= 280$ N (2 sf)

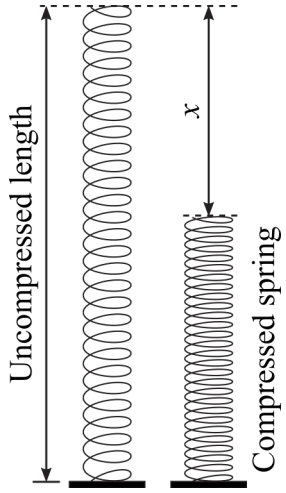
1 Mark per correct tension
- units
- 2 sig fig max

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 on top of a vertically compressed spring. The spring was then released and the ball launched upwards from ground level. 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

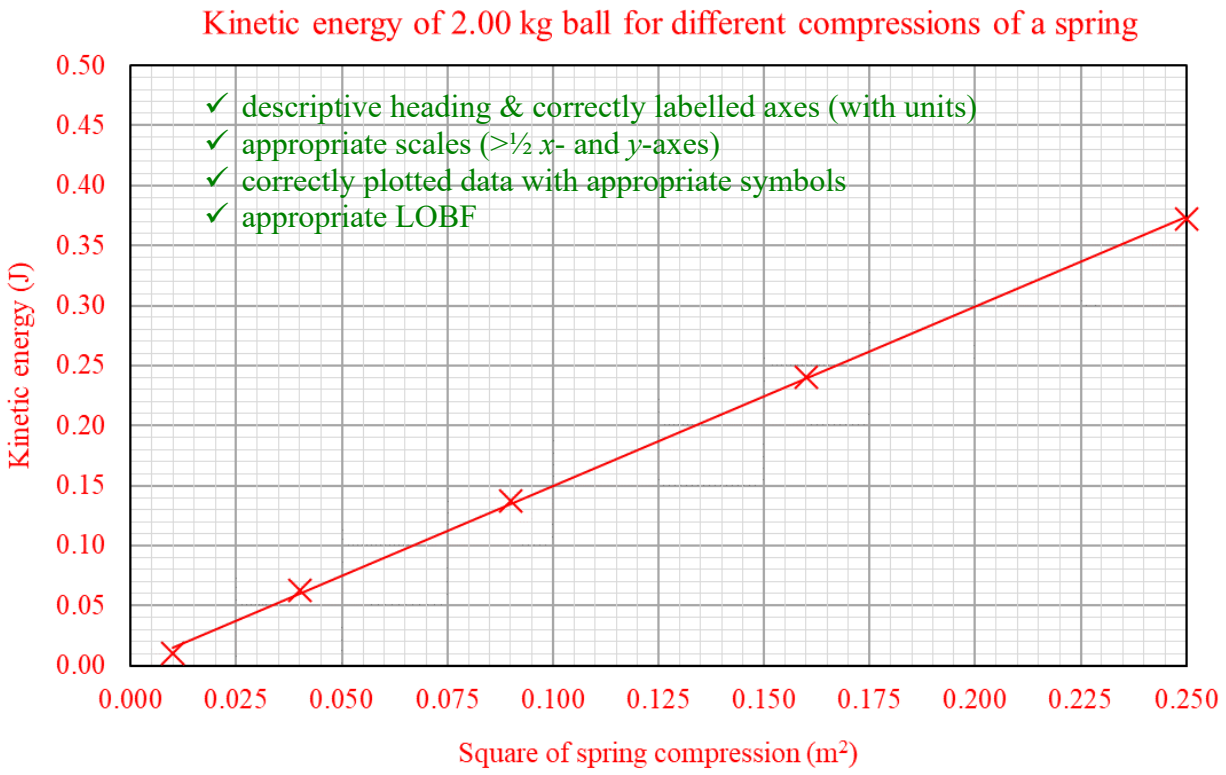
(b) Complete the kinetic energy row of the table. **1**

✓ correct values (without units)

note: values should be to 2 significant figures (due to x and v values in table)

(continued over page)

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



note: a heading that is *y*-variable vs. *x*-variable is redundant (the axes labels already show this)

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

$gradient = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.36 - 0.09}{0.235 - 0.060} = 1.543 \text{ J m}^{-2}$

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

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

Therefore, $k = 2 \times gradient = 2 \times 1.543 = 3.086 = 3.1 \text{ J m}^{-2}$ *OR* N m^{-1}

✓ gradient calculation (with working)
✓ correctly relates *gradient* to *k*
✓ answer with correct units

(d) Using the value of k determined in (c) calculate the theoretical maximum height reached by the ball for a spring compression of 0.45m**.** **2**

From the law of conservation of energy, $U_{elastic}$ at compression will be equal to U_g at the top of the flight (since $K = 0$), so that $\frac{1}{2}kx^2 = mg\Delta h$.

$\Delta h = \frac{kx^2}{2mg} = \frac{3.086 \times 0.45^2}{2 \times 2.00 \times 9.8} = 0.01594 = 0.016 \text{ m} = 16 \text{ mm}$

✓ applies $U_{elastic} = K = U_g$
✓ correctly calculates Δh (with

note: carry-over from **(c)**
(h must be correct for your value of 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 55 km h^{-1}.

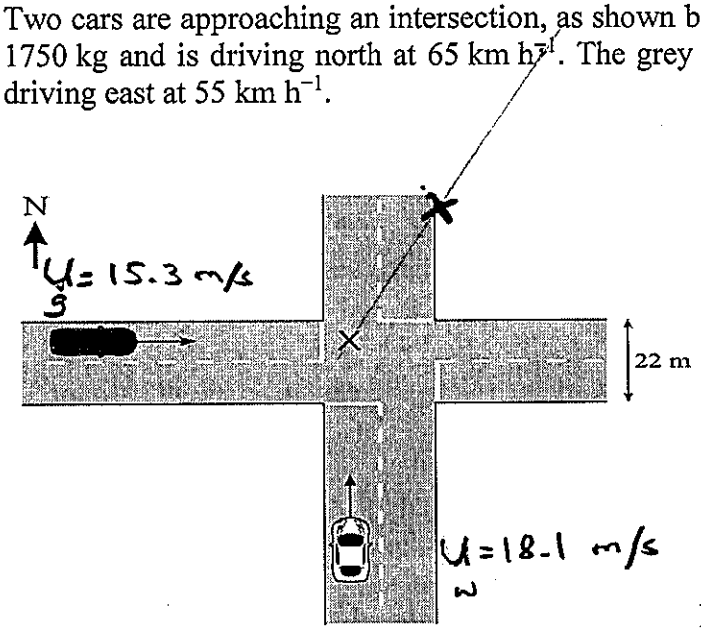


DIAGRAM DRAWN TO SCALE

The cars collide at position X. The white car comes to rest as a result of the collision.

(a) Calculate the velocity of the grey car after the collision. 2

$p_i = p_f$

$m_g u_g + m_w u_w = m_g v_g$

$(1450 \times 15.3) + (1750 \times 18.1) = m_g v_g$

22153 + 31597 = 38589 Ns, 55°

$R^2 = 38589^2 + 31597^2$, θ

$\tan\theta = \frac{22153}{31597}$

$m_g v_g = 38589$ N 35° E

$\therefore v_g = 26.6$ m/s N 35° E (3 sf)

① correct formula & uses vectors

① answer & units

(b) If the coefficient of friction between the tires of the cars and the road is 0.85, calculate the acceleration of the grey car as it skids to a stop after the collision. 2

$F_f = \mu m g = ma$

$= 0.85 \times 1450 \times 9.8$

$= 12078.5$ N

$a = \frac{12079}{1450}$

$= 8.33$ m/s² (3 sf)

① correct method

① correct answer + units

(c) Draw an X on the diagram of the intersection above to show where the grey car would come to rest. (use the scale given on the diagram) 1

$v^2 = u^2 + 2as$

$0 = 26.6^2 - 2 \times 8.33 \times s$

$s = 42.5$ m N 35° E

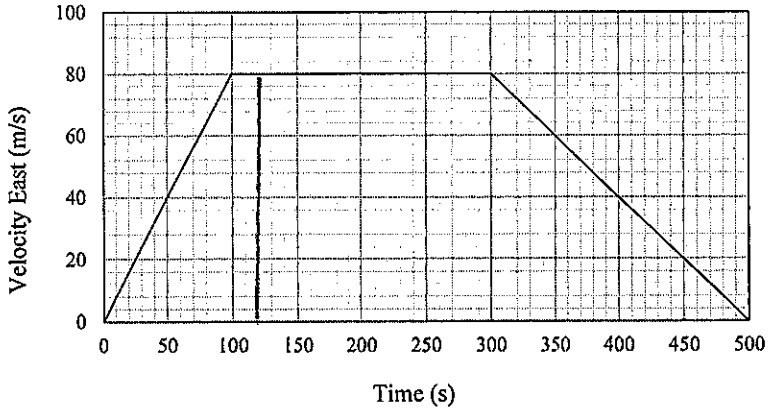
11 mm = 22 m

1 mm = 2 m

42.5 m = 21 mm

Question 25 (4 marks)

The velocity of a 1750 kg car initially travelling East was measured over a period of time. The graph below shows how the velocity of the car changed over a 500 second period.



(a) What was the car's acceleration at t = 400 seconds. 2

$a = \frac{\Delta v}{\Delta t}$

$= \frac{0 - 80}{200}$

$= -0.40 \text{ m/s}^2 = 0.40 \text{ m/s}^2$ West

Subtract 1 mark if missing:
- Correct mag *
- Correct units
- Correct dir'n

(b) Calculate the displacement of the car 2 minutes after the start. 2

Area under graph = displacement

At $t = 120$ s

$A = \left(\frac{1}{2} \times 100 \times 80\right) + (20 \times 80)$

$= 5600$ m East

* can't get any marks if magnitude incorrect

Question 26 (2 marks) 2

Crumple zones and airbags increase the stopping time during a car crash. With reference to a relevant law of physics explain why increasing stopping time makes cars safer.

1 Mark for correct law

E.G. $F = ma$ (Newton's 2nd Law)

$\therefore$ F experienced $\propto a = \frac{\Delta v}{\Delta t}$

OR

$F.t = m\Delta v$ (Law of conservation of mom)

Plus

1 Mark for explaining the safety improvement.

E.G. Newton's 2nd Law shows that if acceleration magnitude is reduced then so is the force experienced by passengers. And since $a = \frac{\Delta v}{t}$, increasing t will decrease a.

– **End of Paper** –

NB: If using Newton's 2nd law, must show how a is related to t. Not enough to just state that if t goes up, a goes down.