Student Name

Class

Sydney Boys High School

2018

Y11 HALF YEARLY
COHORT ASSESMENT

Physics

Total marks – 55

General Instructions

- Reading time – 5 minutes
- Working time – 75 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your student name in the space provided

This paper has two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1-20

Part B – 35 marks
- Attempt Questions 21-29

STUDENT NAME:_____

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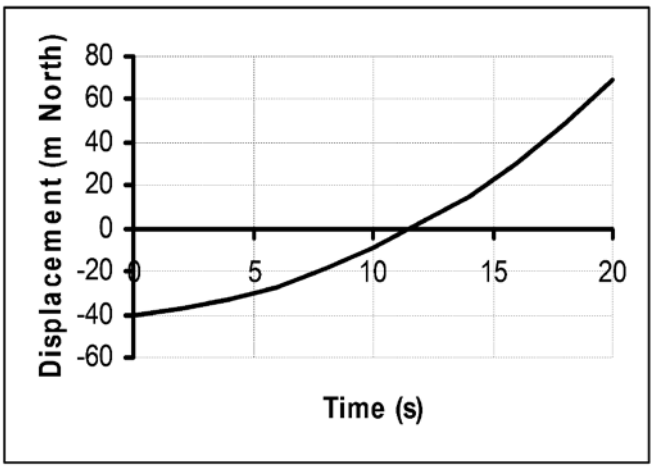
1. The graph shows how the displacement of a car changes with time.



What is the approximate speed of the object at time 10 s?

(A) 5.0 ms^{-1}

(B) 2.5 ms^{-1}

(C) 1.0 ms^{-1}

(D) 0.5 ms^{-1}

2. If a book on the dashboard of your car suddenly flies towards you, the forward velocity of the car must have

(A) decreased

(B) increased

(C) changed direction to the right

(D) changed direction to the left

3. Earth pulls downward on a pen, of mass m, which is sitting on a table; the magnitude of the force is mg. If that is called the action force, what is the reaction force?

(A) The table pushing up on the pen with a force equal to mg

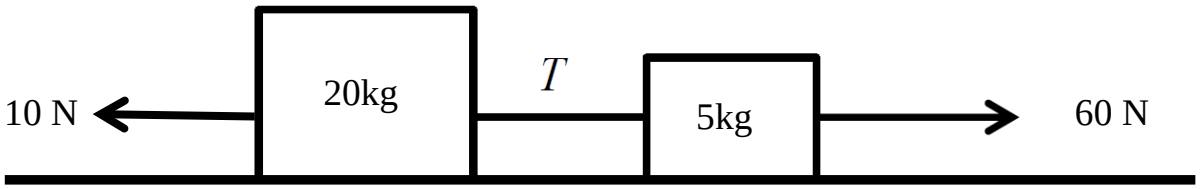
(B) The pen pushing down on the table with a force equal to mg

(C) The table pushing down on the floor with a force equal to mg

(D) The pen pulling upward on Earth with a force equal to mg

STUDENT NAME:_____

4. Two blocks of masses 20kg and 5 kg, connected by a light inextensible string are resting on a frictionless horizontal surface. A horizontal force of 60N is applied to the right and 10N to the left as shown in the diagram below.



What is the tension, *T*, in the string between the two blocks; and the magnitude of the acceleration of the system?

	Tension T (N)	*Acceleration a (ms^{-2})*
(A)	60	1
(B)	50	2
(C)	40	1
(D)	70	2

Use the following information to answer the next two questions

> In a brake test, cars are decelerated to determine the braking distance of the vehicle. One car travels 10 m with a constant acceleration of -12.5 ms^{-2} until stationary.

5. What is the *time* taken by the car to cover 10 m from the start?

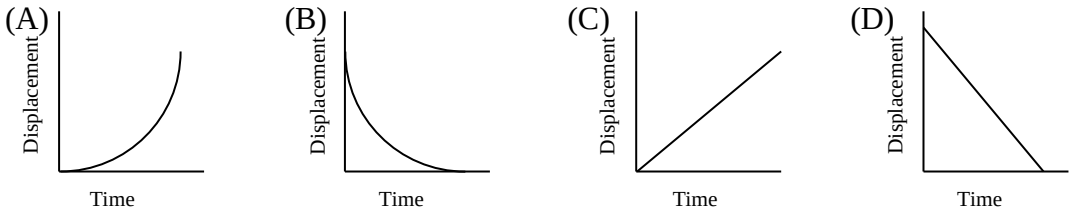
(A) 12.0 s

(B) 1.27 s

(C) 4.00 s

(D) 0.41 s

6. Which of the following graphs best describes the motion above?



STUDENT NAME:_____

7. Ironman is hovering motionless at a height of 100m above the surface of the earth.

At this point in time, it would be correct to say that:

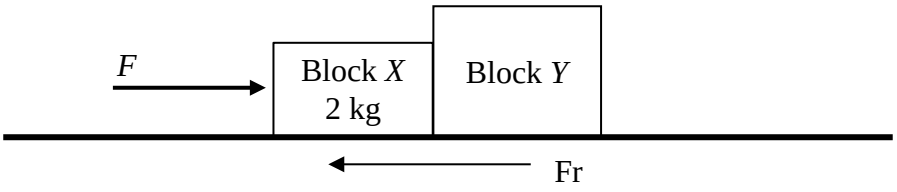
(A) there are no forces acting on the Ironman .

(B) Ironman's weight is zero.

(C) the net force on the Ironman is zero.

(D) there is an overall upwards force on Ironman to keep floating.

8. The diagram shows two blocks, block X and block Y, in contact with each other on a horizontal surface. A force of 21 N is applied to block X which has a mass of 2 kg. A frictional force of 3 N acts on the system. The system accelerates at 3 m s^{-2} to the right.



What is the mass of block Y?

(A) 7 kg

(B) 6 kg

(C) 5 kg

(D) 4 kg

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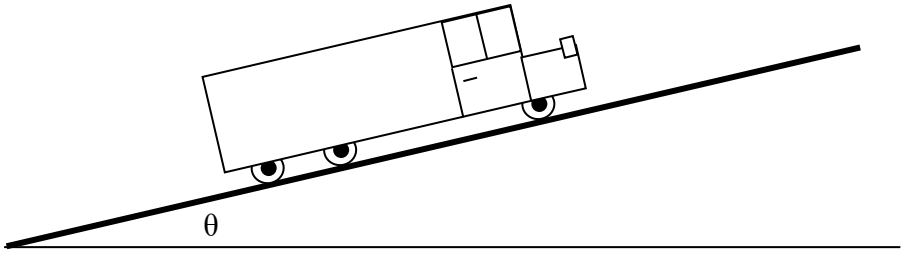
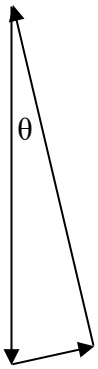
9. A truck is travelling with constant speed up an incline as shown. The angle of the incline is θ.



Ignoring friction, which diagram best represents the forces (not shown on the diagram) acting on the truck?

(A)



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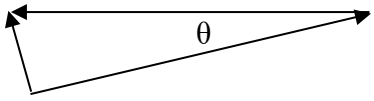

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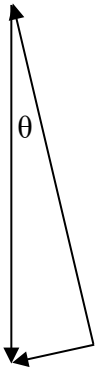

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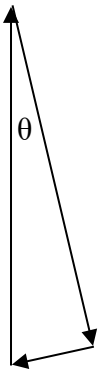

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10. Two aeroplanes sight each other in the sky. Plane A is travelling due north and plane B is travelling west.

Which set of vectors correctly represent their relative velocities?

	Velocity of plane A relative to plane B	Velocity of plane B relative to plane A
(A)		
(B)		
(C)		
(D)		

Use the following information to answer the next two questions

An explorer leaves his tent at the north pole and travels directly south for 10km, east for 10km and north for 10km, and arrives back at his tent. Each of these sections takes 2.5 hours to complete.

11. What is total *distance* travelled?

(A) 0 km

(B) 10 km

(C) 15 km

(D) 20 km

12. What is the average *velocity* of the journey?

(A) 0 kmh^{-1} S

(B) 4 kmh^{-1} W

(C) 12 kmh^{-1} N

(D) 1.1 ms^{-1} E

STUDENT NAME:_____

13. A system of two blocks is accelerated by an applied force of magnitude F on the frictionless horizontal surface. The tension in the string between the blocks is:

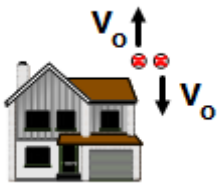
(A) 3F

(B) 5F

(C) 3/8 F

(D) 1/3 F

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



(A) Ball A moves faster because the initial velocity is up

(B) The one thrown down moves faster because the initial velocity is down

(C) They both move with the same speed

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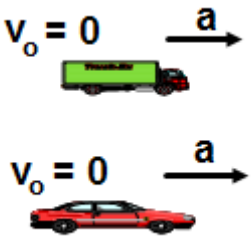
15. A car and a delivery truck both start from rest and accelerate at the same rate. However, the car accelerates for twice the amount of time as the truck. What is the final speed of the car compared to the truck?



(A) Half as much

(B) The same

(C) Twice as much

(D) Four times as much

16. The acceleration due to gravity is higher on Jupiter than on Earth. The mass and weight of a rock on Jupiter compared to that of the same rock on Earth would be

	Mass	*Weight*
(A)	Same	More
(B)	Same	Less
(C)	More	More
(D)	More	Less

17. A ball is thrown straight up. At the top of its path, the magnitude of the net force acting on it is

(A) less than zero

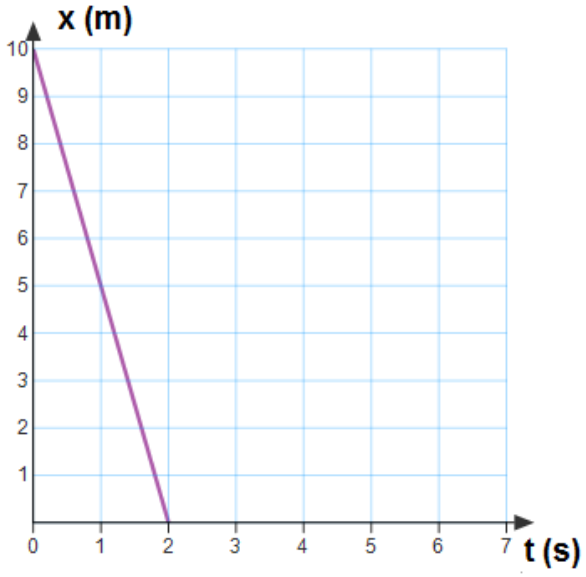
(B) between zero and mg

(C) equal to mg

(D) greater than mg

STUDENT NAME:_____

The following graph represents the position as a function of time of a moving object. Use this graph for next two questions



18. What is the initial position of the object?

(A) 4 m

(B) 6 m

(C) 8 m

(D) 10 m

19. What is the velocity of the object?

(A) 5.0 ms^{-1}

(B) -5.0 ms^{-1}

(C) 10 ms^{-1}

(D) -10 ms^{-1}

20. An archer practicing with a bow shoots an arrow straight up two times. The first time the initial speed is *u* and second time he increases the initial sped to *4u*. How would you compare the maximum height in the second trial to that in the first trial?

(A) Two times greater

(B) Four times greater

(C) Eight times greater

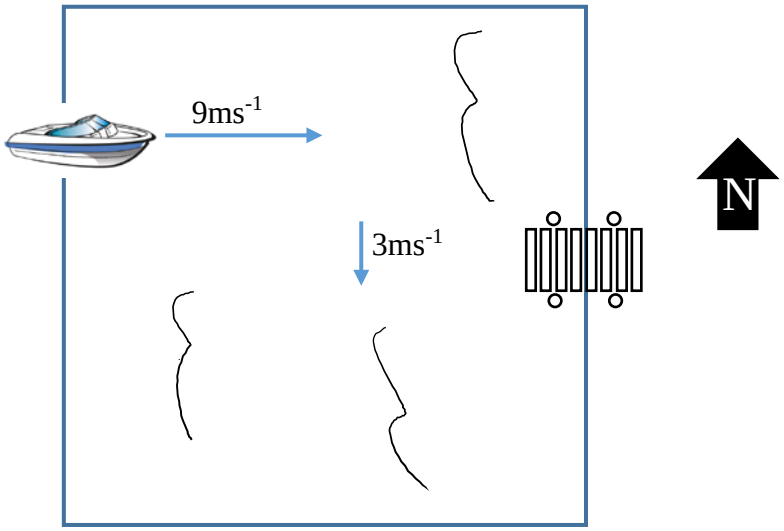
(D) Sixteen times greater

STUDENT NAME:_____

Part B – 35 marks
Attempt Questions 21-29

Question 21 (4 marks)

A boat is able to move at $9ms^{-1}$ on still water. The boat needs to get to the pier across the 15m wide river, which flows south at $3ms^{-1}$. The pier is 5m south of the boat's current position, on the opposite bank



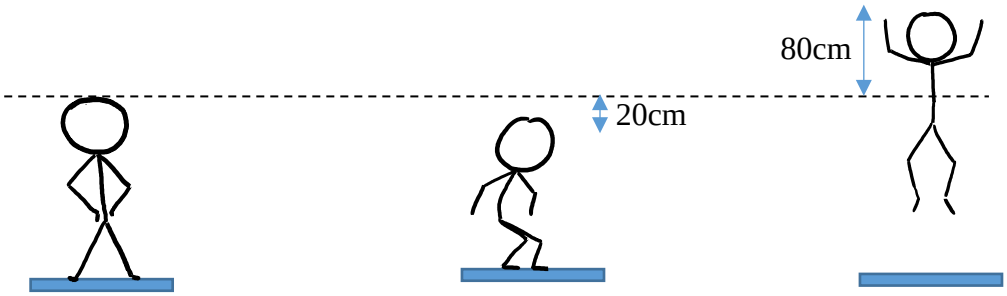
a The boat travels directly east. Will the boat reach the pier? Show all calculations **2**

b Calculate the total time of travel of the boat; were it to immediately return to the other bank, traveling directly west. **2**

STUDENT NAME:_____

Question 22 (6 marks)

A student of mass 61kg performs a standing jump. The jump was measured to lift the student 80cm off the ground. To perform this jump, the student crouched down by 20cm on a set of scales and pushed off the ground.



a Calculate the speed at which the student leaves the ground **2**

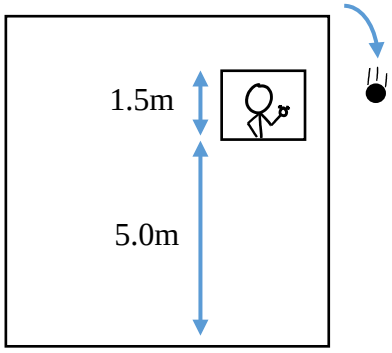
b The reading on the set of scales increased as the student jumped. Which of the laws of motion are required to explain this? **1**

c Assuming a constant force is applied, what is the maximum reading on the scale? **3**

STUDENT NAME:_____

Question 23 (3 marks) **3**

A tennis ball rolls off the roof of the Macdonald Wing building. It passes a 1.5m window that is 5.0m from the ground to the bottom of the window. The ball is measured to take 0.2s to pass from the top of the window to the bottom of the window. Calculate the height of the building.



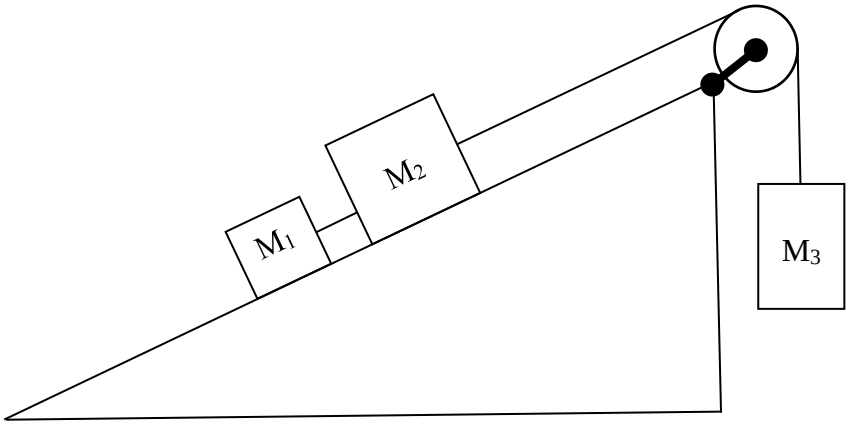
Question 24 (3 marks) **3**

A ball is thrown up with an initial velocity *u* and reaches a maximum height *h* at time *t*. What is the height the ball will achieve at time $\frac{t}{2}$?

STUDENT NAME:_____

Question 25 (8 marks)

A teacher sets up and apparatus to demonstrate dynamic motion. Two masses, M_1=3.00kg and M_2=8.00kg, are attached by an inelastic cord to each other. The masses are on a ramp with an angle of 40°, and are connected to a third mass, M_3=15.0kg, via a frictionless pulley. The ramp has a coeffecient of kinetic friction μ_k=0.251. The masses are released from a stationary position for t=0.80s



a Calculate the magnitude of the net force acting on the mass M_2 **4**

b Calculate the acceleration of mass M_1 **1**

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c The teacher states that the power of the moving objects is less than a 40W lightbulb. Assess the validity of this statement **3**

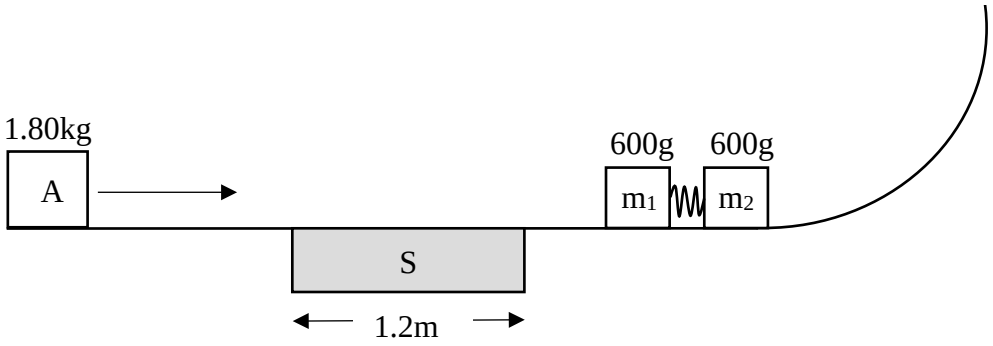
Question 26 (2 marks) **2**

A man in an elevator is holding a mass on the end of a spring balance. When the elevator is stationary, the spring balance reads 25.0 kg. The elevator starts to move and the spring balance reads 18.0 kg. What is the magnitude and direction of the elevator's acceleration?

STUDENT NAME:_____

Question 27 (9 marks)

A 1.80kg block A is given an initial velocity of $6.00ms^{-1}$ on a frictionless surface, where it encounters a new surface, S, for 1.20m. Immediately after this surface are two stationary identical masses m_1 and m_2 connected by an ideal spring on a frictionless vertical ramp.



a Surface S is found to have a $\mu_k=0.259$. Calculate the velocity of block A as it leaves surface S. **3**

b Block A impacts blocks m_1 and m_2 and compresses the spring. After the spring has reached its maximum amount of compression, all the blocks join together and travel as one with a velocity of $3.00ms^{-1}$. Masses m_1 and m_2 are identical and each has a mass of 600g.

i) Calculate the energy absorbed by the spring after the collision (i.e. change in kinetic energy of the system) **2**

The potential energy of a spring is given by the equation $U_s = \frac{1}{2}kx^2$, where k is the spring constant, and x is the change in length of the spring. **2**

ii) If the spring compresses by 12cm, determine the spring constant k.

c Given that $\Delta U = mg\Delta h$, and that the local value for g is $9.8ms^{-2}$; determine the maximum height the blocks will travel up the ramp. **2**

END OF PAPER

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Sydney Boys High School

Class: _____

2018

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	B	D	D	B	B	C	D	A	C	C	A	C	C	C	A	C	D	B	D

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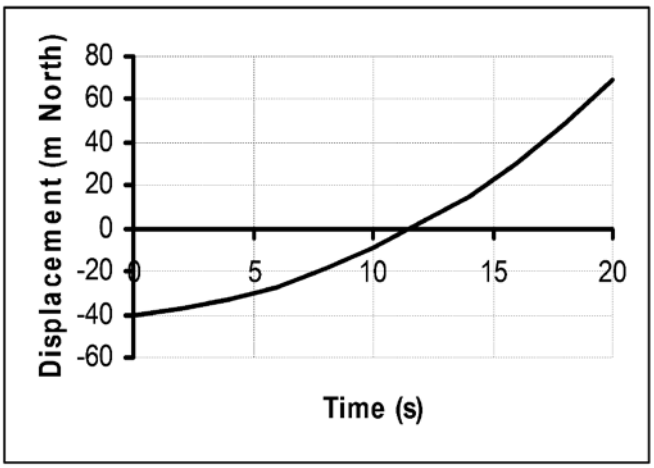

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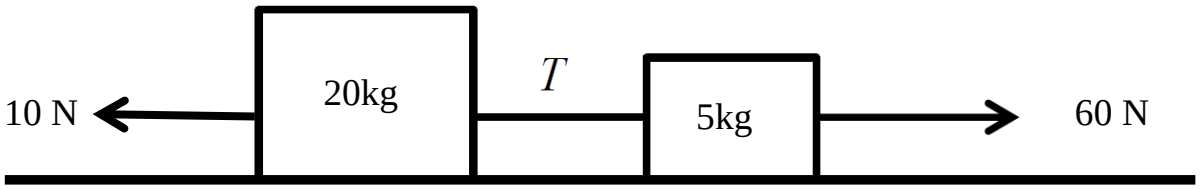

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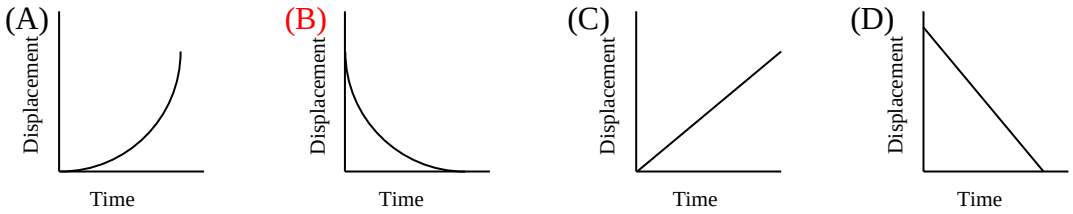

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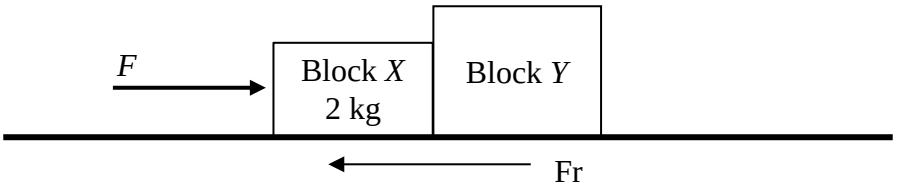

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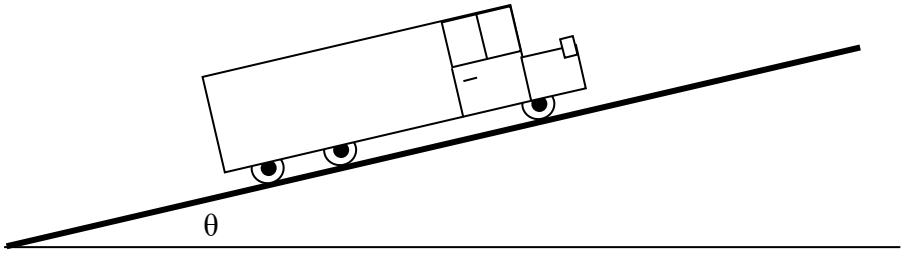

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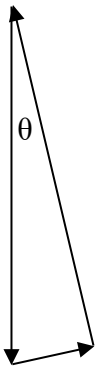

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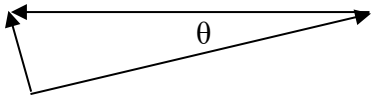

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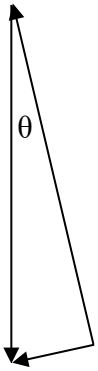

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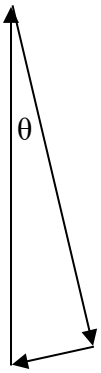

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(C) 12 kmh^{-1} N

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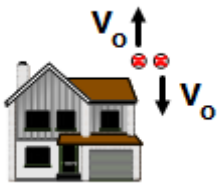

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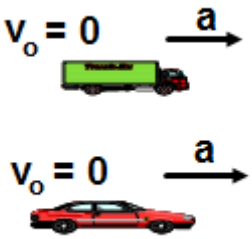

(A) Half as much

(B) The same

(C) Twice as much

(D) Four times as much

16. The acceleration due to gravity is higher on Jupiter than on Earth. The mass and weight of a rock on Jupiter compared to that of the same rock on Earth would be

	Mass	*Weight*
(A)	Same	More
(B)	Same	Less
(C)	More	More
(D)	More	Less

17. A ball is thrown straight up. At the top of its path, the magnitude of the net force acting on it is

(A) less than zero

(B) between zero and mg

(C) equal to mg

(D) greater than mg

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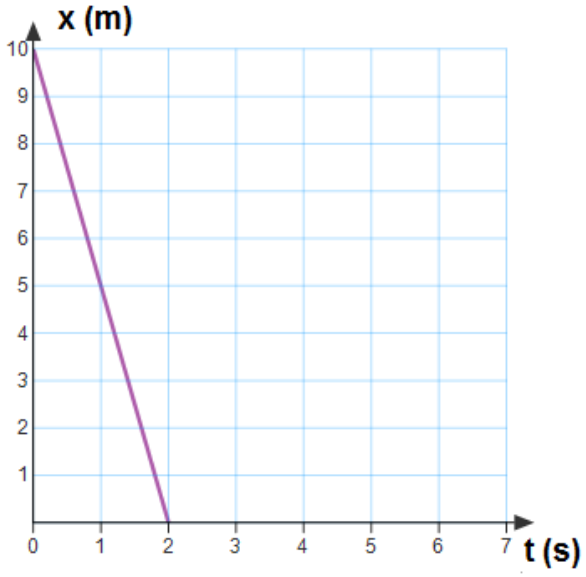
The following graph represents the position as a function of time of a moving object. Use this graph for next two questions



18. What is the initial position of the object?

(A) 4 m

(B) 6 m

(C) 8 m

(D) 10 m

19. What is the velocity of the object?

(A) 5.0 ms^{-1}

(B) -5.0 ms^{-1}

(C) 10 ms^{-1}

(D) -10 ms^{-1}

20. An archer practicing with a bow shoots an arrow straight up two times. The first time the initial speed is *u* and second time he increases the initial sped to *4u*. How would you compare the maximum height in the second trial to that in the first trial?

(A) Two times greater

(B) Four times greater

(C) Eight times greater

(D) Sixteen times greater

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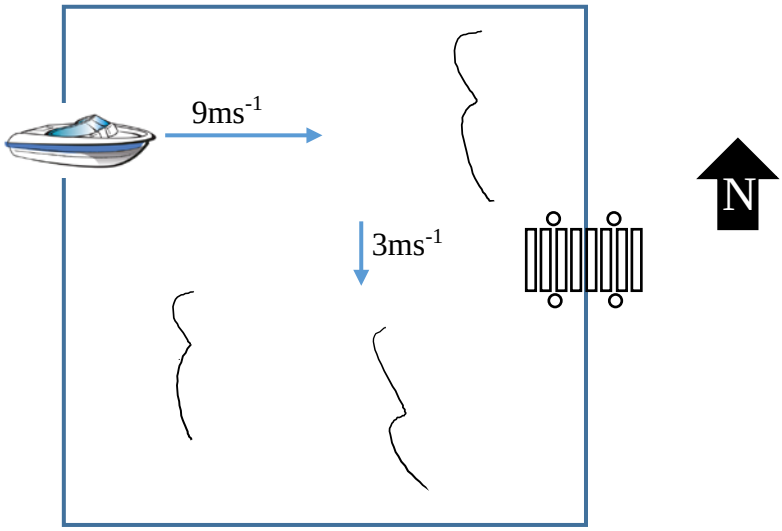
Part B – 35 marks
Attempt Questions 21-29

Question 21 (4 marks)

A boat is able to move at 9ms^{-1} on still water. The boat needs to get to the pier across the 15m wide river, which flows south at 3ms^{-1}. The pier is 5m south of the boat's current position, on the opposite bank



a The boat travels directly east. Will the boat reach the pier? Show all calculations **2**

$t_1 = \frac{s_x}{v_x} = \frac{15}{9} = 1.67s$

$s_y = v_y t = 3 \times 1.67 = 5m$

Yes, the boat will reach the pier

✓ Correct vertical distance
✓ Correct assessment; boat reaches pier

b Calculate the total time of travel of the boat; were it to immediately return to the other bank, traveling directly west with respect to the water. **2**

$t_2 = \frac{s_x}{v_x} = \frac{-15}{-9} = 1.67s$

$t_T = t_1 + t_2 = 2 \times 1.67 = 3.3s$

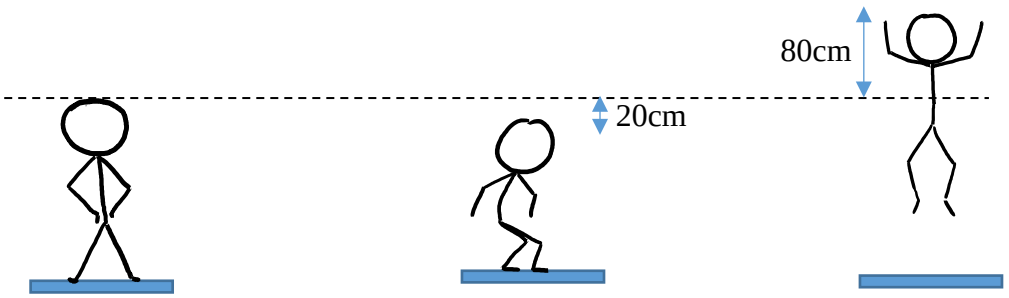
3s (1sf)

✓ Correct equations used
✓ Correct time calculated, with units and sf

FROM THE MARKER: You should be writing equations line AND substitution lines for every numerical question.

STUDENT NAME:_____

Question 22 (6 marks)
A student of mass 61kg performs a standing jump. The jump was measured to lift the student 80cm off the ground. To perform this jump, the student crouched down by 20cm on a set of scales and pushed off the ground.



a Calculate the speed at which the student leaves the ground **2**

$u = \sqrt{2as - v^2}$

$= \sqrt{2 \times 9.8 \times 0.8} = 3.95 ms^{-1}$

$= 4.0 \times 10^0 ms^{-1}\ (2sf)$

- ✓ Correct kinematic equations line.
- ✓ Correct speed calculated, with units and sf

b The reading on the set of scales increased as the student jumped. Which of the laws of motion are required to explain this? **1**

Newton's 3rd law of motion

- ✓ Newton's 3rd law (and/or Newton's 2nd Law)

c Assuming a constant force is applied, what is the maximum reading on the scale? **3**

$a = \dfrac{v^2 - u^2}{2s} = \dfrac{4.0^2}{2 \times 0.2} = 40 ms^{-2}$

$F = ma = 61 \times 40 = 2440N$

- ✓ Some correct equ and substitution
- ✓ F (2440N) or A (40m/s/s) calculated
- ✓ Mass reading 310kg to 1 or 2 s.f.

$F_{net} = F + mg = 2440 + 61 \times 9.8 = 3037.8N$

$Mass\ reading = \dfrac{F_{net}}{g} = \dfrac{3037.8}{9.8} = 310kg$

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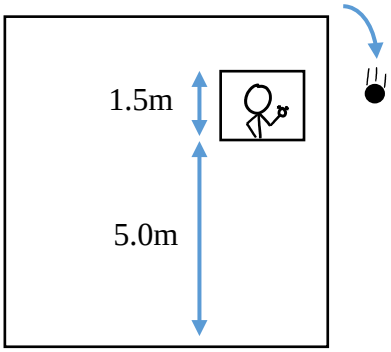
Question 23 (3 marks) **3**

A tennis ball rolls off the roof of the Macdonald Wing building. It passes a 1.5m window that is 5.0m from the ground to the bottom of the window. The ball is measured to take 0.2s to pass from the top of the window to the bottom of the window. Calculate the height of the building.



$u = \frac{s - \frac{at^2}{2}}{t} = \frac{1.5 - \frac{9.8 \times 0.2^2}{2}}{0.2} = 6.52ms^{-1}$

$s = \frac{v^2 - u^2}{2a} = \frac{6.52^2 - 0^2}{2 \times 9.8} = 2.17m$

$Height = window + s + 5m = 8.7m$

- ✓ Correct equation with substitution
- ✓ Answer has units (m) and 1 or 2 s.f.
- ✓ Total height calculated (8.7m)

Question 24 (3 marks) **3**

A ball is thrown up with an initial velocity *u* and reaches a maximum height *h* at time *t*. What is the height the ball will achieve at time $\frac{t}{2}$?

$v = u + at; v^2 = u^2 + 2as; v = 0, s = h$

$u = at;\ u^2 = 2ah$

$h = ut + \frac{at^2}{2} = at^2 + \frac{at^2}{2} = \frac{3at^2}{2}$

$u^2 = 2ah = a^2t^2$

$t^2 = \frac{2h}{a}$

$t_1 = \frac{t}{2}; h_1 = \frac{3a}{2}\frac{t^2}{4} = \frac{3at^2}{8}$

$h_1 = \frac{3a}{8}t^2 = \frac{3a}{8}\frac{2h}{a} = \frac{3}{4}h = 0.75h$

- ✓ Correct subst in 2 kinematic equations
- ✓ An equation with h the subject and a value for h.
- ✓ Height derived (3/4 h)

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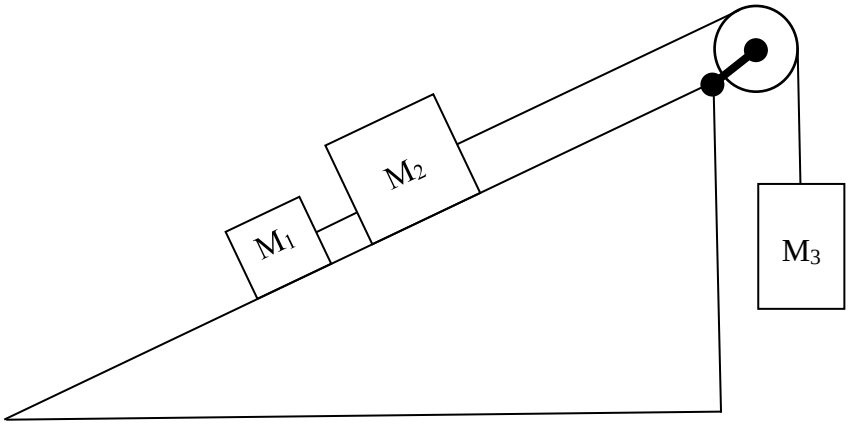
Question 25 (8 marks)

A teacher sets up and apparatus to demonstrate dynamic motion. Two masses, M_1=3.00kg and M_2=8.00kg, are attached by an inelastic cord to each other. The masses are on a ramp with an angle of 40°, and are connected to a third mass, M_3=15.0kg, via a frictionless pulley. The ramp has a coeffecient of kinetic friction μ_k=0.251. The masses are released from a stationary position for t=0.80s



a Calculate the magnitude of the net force acting on the mass M_2 **4**

$|F_{2net}| = \sum F = F_1 + F_{fr1} + F_2 + F_{fr2} + F_3$

$|F_{2net}| = m_1 g \sin 40 + \mu_k m_1 g \cos 40 + m_2 g \sin 40 + \mu_k m_2 g \cos 40 - m_3 g$

$|F_{2net}| = (m_1 + m_2) g \sin 40 + \mu_k (m_1 + m_2) g \cos 40 - m_3 g$

$|F_{2net}| = 11 \times 9.8 \sin 40 + 0.251 \times 11 \times 9.8 \cos 40 - 15 \times 9.8$

$|F_{2net}| = 69.3 + 20.7 - 147$

$|F_{2net}| = 56.98N = 57N\ (2sf)$

- ✓ F=ma used
- ✓ Fnet = sum of forces
- ✓ Frictional forces correctly factored in (cosΘ used)
- ✓ Force calculated

b Calculate the acceleration of mass M_1 **1**

$|F_{2net}| = m_T a$

$a = \frac{F}{m_T} = \frac{57.0N}{26.0kg} = 2.2ms^{-2}\ down\ the\ ramp\ (3sf)$

- ✓ Acceleration calculated

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c The teacher states that the power of the moving objects is less than a 40W lightbulb. Assess the validity of this statement **3**

$s = ut + \frac{at^2}{2}; u = 0; s = \frac{2.19 \times 0.8^2}{2} = 0.70m$

$P = \frac{Fs}{t} = \frac{57 \times 0.7}{0.8} = 49.9W$

The statement is not valid, the falling masses produce 49.9W, which is greater than 40W

or

$\bar{v} = \frac{u + v}{2}; v = u + at; \bar{v} = \frac{at}{2}$

$P = F\frac{s}{t} = F\bar{v} = \frac{57 \times 2.19 \times 0.8}{2} = 49.9W$

- ✓ Use of P=E/t or appropriate equations
- ✓ Correct power calculated
- ✓ Proper assessment of statement

Question 26 (2 marks) **2**

A man in an elevator is holding a mass on the end of a spring balance. When the elevator is stationary, the spring balance reads 25.0 kg. The elevator starts to move and the spring balance reads 18.0 kg. What is the magnitude and direction of the elevator's acceleration?

$T = F_m + F_a = 18 \times 9.8 = 176.4N$

$a = \frac{T - mg}{m} = \frac{176.4 - 25 \times 9.8}{25} = -2.74ms^{-2}$

$2.74ms^{-2}\ down$

- ✓ Magnitude of acceleration
- ✓ Correct direction

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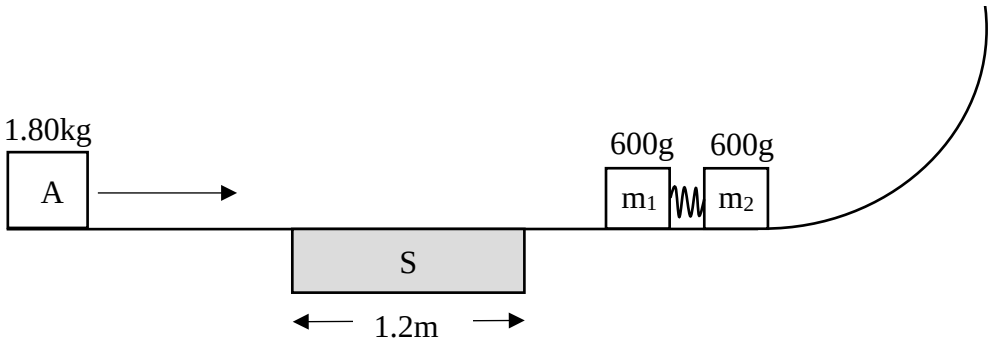
Question 27 (9 marks)

A 1.80kg block A is given an initial velocity of 6.00ms^{-1} on a frictionless surface, where it encounters a new surface, S, for 1.20m. Immediately after this surface are two stationary identical masses m_1 and m_2 connected by an ideal spring on a frictionless vertical ramp.



a Surface S is found to have a μ_k=0.259 . Calculate the velocity of block A as it leaves surface S. **3**

$W = fs = \Delta KE = KE_2 - KE_1$

$W = fs = \mu_k Ns = 0.259 \times 1.8 \times 9.8 \times 1.2 = 5.48J$

$KE_2 = KE_1 - W = \dfrac{1.8 \times 6^2}{2} - 5.48 = 26.9J$

$v = \sqrt{\dfrac{2KE_2}{m}} = \sqrt{\dfrac{2 \times 26.9}{1.8}} = 5.5ms^{-1}\ (2sf)$

- ✓ Work energy theorem used OR Frictional force used
- ✓ Work done by surface S calculated OR acceleration calculated
- ✓ Correct velocity

or

$f_f = \mu_k N = 0.259 \times 1.8 \times 9.8 = 4.57N = ma$

$a = \dfrac{f}{m} = \dfrac{4.57}{1.8} = 2.54ms^{-1}$

$v = \sqrt{u^2 + 2as} = \sqrt{6^2 + 2 \times 2.54 \times 1.2} = 5.5ms^{-1}\ (2sf)$

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b Block A impacts blocks m_1 and m_2 and compresses the spring. After the spring has reached its maximum amount of compression, all the blocks join together and travel as one with a velocity of 3.00ms^{-1}. Masses m_1 and m_2 are identical and each has a mass of 600g.

i) Calculate the energy absorbed by the spring after the collision (i.e. change in kinetic energy of the system) **2**

$$KE_3 = \frac{m_T v^2}{2} = \frac{(1.8 + 0.6 + 0.6)3^2}{2} = 13.5J$$

$$\Delta E = KE_3 - KE_2 = 26.9 - 13.5 = -13.4J$$

$13.4J\ (3sf)\ absorbed$

- ✓ Final KE calculated
- ✓ Absorbed energy correctly calculated, units

The potential energy of a spring is given by the equation $U_s = \frac{1}{2}kx^2$, where k is the spring constant, and x is the change in length of the spring. **2**

ii) If the spring compresses by 12cm, determine the spring constant k.

$$U_s = \frac{1}{2}kx^2 = 13.4J$$

$$k = \frac{2U_s}{x^2} = \frac{2 \times 13.4}{0.12^2} = 1861.11$$

$k = 1900\ (2sf)$

- ✓ Correct equations used
- ✓ Spring constant correct NB cm!

c Given that $\Delta U = mg\Delta h$, and that the local value for g is 9.8ms^{-2}; determine the maximum height the blocks will travel up the ramp. **2**

$$\Delta U = mg\Delta h = KE_3 = 13.5J$$

$$\Delta h = \frac{KE_3}{mg} = \frac{13.5}{3 \times 9.8} = 0.46m$$

- ✓ Correct equations used
- ✓ Height calculated

END OF PAPER