Sydney Boys High School

Student Name

Class

2016

PRELIMINARY COURSE
HALF YEAR EXAMINATION

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

Sydney Boys High School

2016

Student Name _____

STUDENT NAME:_____

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1. A car travels 50 km to the east in 45 minutes and then turns north, travelling a further 8 km in 15 minutes. The car's average speed over the trip was closest to:

(A) 120 km h^{-1}

(B) 67 km h^{-1}

(C) 80 km h^{-1}

(D) 58 km h^{-1}

2. Newton's First Law of Motion is not apparent when a shopping trolley is in motion and rolls to a stop in a car park. This is because:

(A) Newton's Laws are inaccurate.

(B) Trolley motion cannot be explained by Physics.

(C) Friction is usually ignored.

(D) Newton's third law applies to this situation.

3.

4. What would be the frequency of a light wave with a wave length of 700 nm?

(A) 4×10^{11} Hz

(B) 4.29×10^{11} Hz

(C) 4×10^{14} Hz

(D) 4.29×10^{14} Hz

5. What needs to be done to increase the volume and lower the pitch of a sound wave?

(A) Increase the frequency of the wave and decrease its amplitude

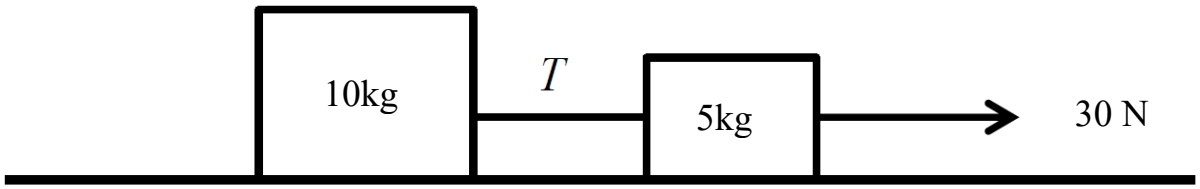
(B) Increase the frequency of the wave and increase its amplitude

(C) Decrease the frequency of the wave and increase its amplitude

(D) Decrease the frequency of the wave and decrease its amplitude

STUDENT NAME:_____

6. Two blocks of masses 10kg and 5 kg, connected by a light inextensible string are resting on a frictionless horizontal surface. A horizontal force of 30 N is applied to the right as shown in the diagram below.



Assuming the system moves to the right, what is the tension, *T* in the string between the two blocks and the acceleration, of the system?

	Tension T (N)	*Acceleration a (ms^{-2})*
(A)	4	1
(B)	6	2
(C)	15	1
(D)	20	2

Use the following information to answer Questions 7 and 8.

> In a 'drag race' the cars accelerate over a distance of 100 m, starting from zero velocity. One car travels 100 m with a constant acceleration of 12.5 ms^{-2}.

7. What is the *time* taken by the car to cover 100 m from the start?

(A) 12.0 s

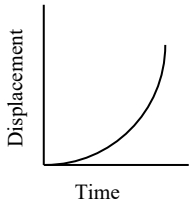
(B) 52.0 s

(C) 4.00 s

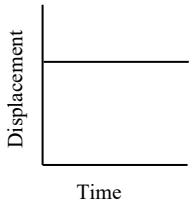
(D) 0.41 s

8. Which of the following graphs shows the motion described above?

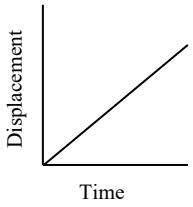
(A)



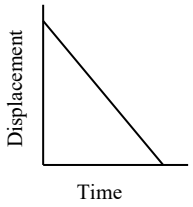
(B)



(C)



(D)



9. Astroboy is hovering motionless at a height of 20m 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 Astroboy.

(B) Astroboy's weight is zero.

(C) there is an overall upwards force on Astroboy to keep floating.

(D) the net force on the Astroboy is zero.

10. Compressions and rarefactions are characteristics of sound waves. Which statements are correct?

(I) A compression is a volume of increased air pressure.

(II) A rarefaction is a volume of reduced air pressure.

(III) Compressions and rarefactions correspond to troughs and crests respectively of a transverse wave.

(A) (I) only

(B) (II) only

(C) (I) and (II) only

(D) (I) and (III) only

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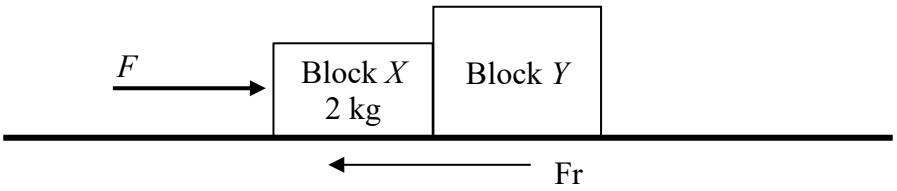
11. The diagram shows two blocks, block X and block Y, in contact with each other on a horizontal surface. A force of 21 N is applied to block X which has a mass of 2 kg. A frictional force of 3 N acts on the system which accelerates at 3 m s^{-2}.



What is the mass of block Y?

(A) 4 kg
(B) 5 kg
(C) 6 kg
(D) 7 kg

12. A student throws a stone into a pond and then counts how long each ripple takes to reach the shore. Which wave characteristic is being recorded by this student?

(A) Frequency
(B) Pitch
(C) Period
(D) Wavelength

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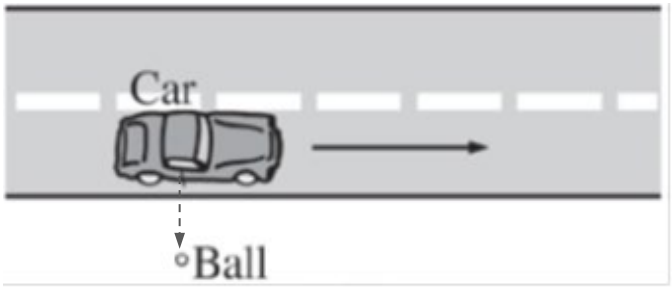
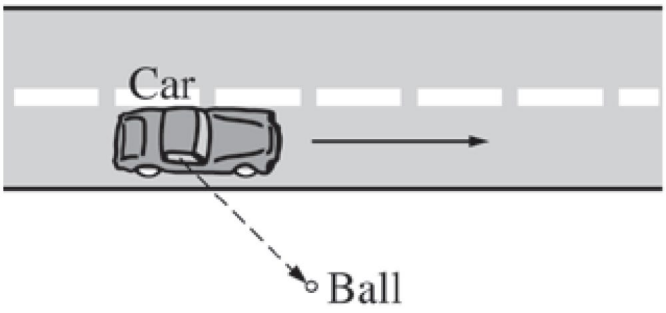
13. A ball is thrown out of the passenger window of a car moving to the right (ignore air resistance). If the ball is thrown out perpendicular to the velocity of the car, which of the following best depicts the path the ball takes, as viewed from a stationary observer above?

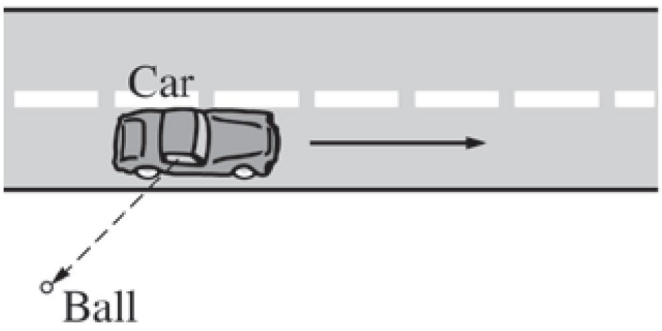
(A)



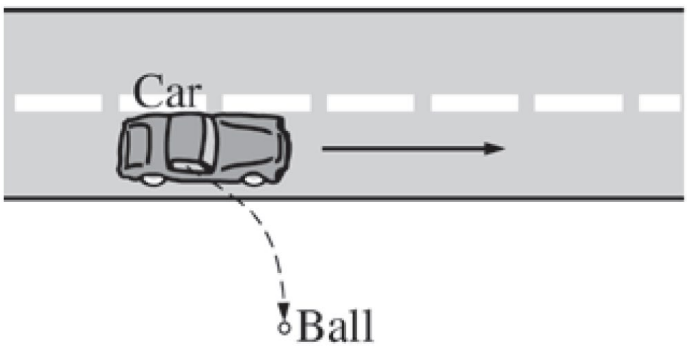
(B)



(C)



(D)



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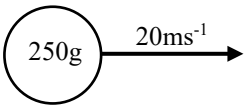
14.



A ball with a mass of 250g moves to the right with a velocity of $20ms^{-1}$. What is the impulse required to cause it to become stationary?

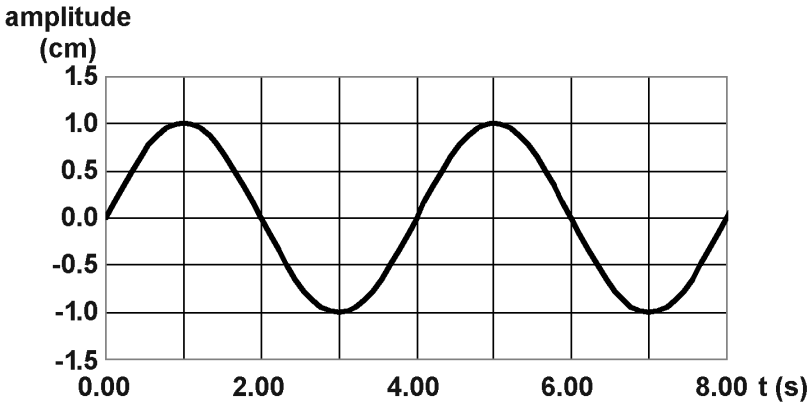
(A) 5.000×10^{0} Ns

(B) 5000×10^{-3} $kgms^{-1}$

(C) -50.00×10^{-1} Ns

(D) -5000×10^{3} $kgms^{-1}$

15. The diagram shows a mechanical wave.



The frequency of the mechanical wave is

(A) 0.125 s

(B) 0.250 Hz

(C) 0.500 s

(D) 4.000 Hz

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16. 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)		

17. A star is measured to have a light intensity of **I** at distance ***d.***

What would the light intensity be if the distance was halved?

(A) 4 I

(B) 2 I

(C) ½ I

(D) ¼ I

18. Transverse and longitudinal waves, while similar in some ways, differ in other ways.

Which set of vectors matches the respective waves?

	Direction of particle motion		**Direction of energy propagation**	
	Longitudinal	*Transverse*	*Longitudinal*	*Transverse*
(A)				
(B)				
(C)				
(D)				

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19. When comparing a stationary 2000 kg vehicle to a 90 kg bicycle rider travelling at $9ms^{-1}$, which of the following statements would be true.

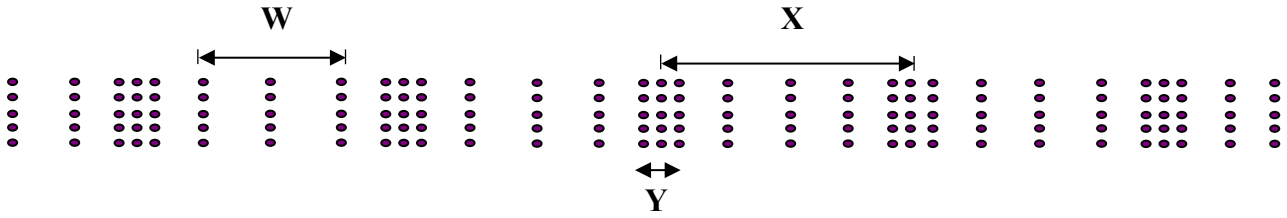
(A) The vehicle has a larger inertia than the bicycle.

(B) The bicycle rider has a smaller momentum than the vehicle.

(C) The acceleration of the bicycle is greater than the acceleration of the vehicle.

(D) None of the above.

20. The diagram represents the position of particles in a longitudinal wave at a particular instant.



Which choice shows correct data about this wave?

	W	X	Y
(A)	Rarefaction	Wave length	Compression
(B)	Wave length	Rarefaction	Compression
(C)	Rarefaction	Compression	Wave length
(D)	Compression	Wave length	Rarefaction

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Part B – 35 marks
Attempt Questions 21-29

Question 21 (5 marks)
Toy car X, mass 6 kg moving on a smooth horizontal surface at 0.25 m s^{-1} to the right collides head on with car Y, mass 4 kg, which was moving at 0.5 m s^{-1} to the left. After the collision the 6 kg car rebounds at 0.06 m s^{-1}.

a Calculate the velocity of car Y after the collision. **2**

b What impulse does car X apply to car Y? **2**

c If the collision between the cars lasted 0.3 s, what average force did car Y apply to car X? **1**

Question 22 (3 marks) **3**

Two boys are fishing in a river from their boat of mass 100 kg. The boat is drifting forward at a speed of 2ms^{-1} as measured from the bank. They decide to have a swim. One boy, who has a mass of 50 kg, dives from the front of the boat at a speed of 4 ms^{-1} relative to the boat. At exactly the same time as the second boy, who has a mass of 60 kg, dives off the other end of the boat, in the opposite direction, at 3 ms^{-1} relative to the boat.
Calculate the *kinetic energy* of the boat immediately after the boys have dived.

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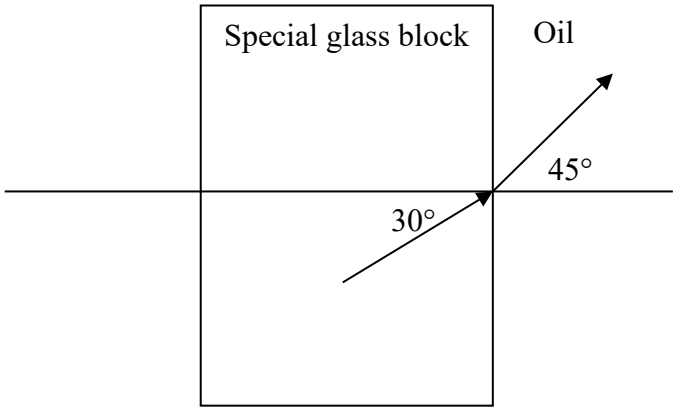
Question 23 (4 marks)

The diagram below models light being refracted as it passes out of a special glass block into oil with a refractive index *n* of 1.37.



a Determine the refractive index of the special glass. **2**

b Calculate the special block's critical angle in air **2**

Question 25 (2 marks) **2**

Standing 10m from a 5GHz WiFi router, a laptop receives ¾ signal strength.
Calculate the signal strength if the laptop moves 2.5m further away.

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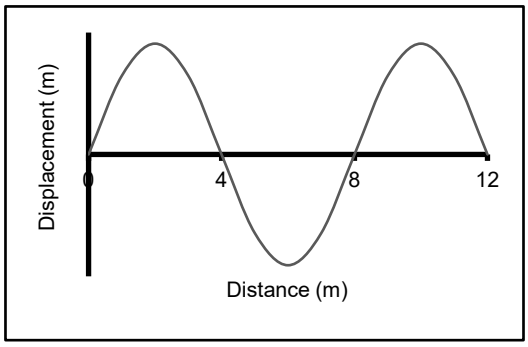
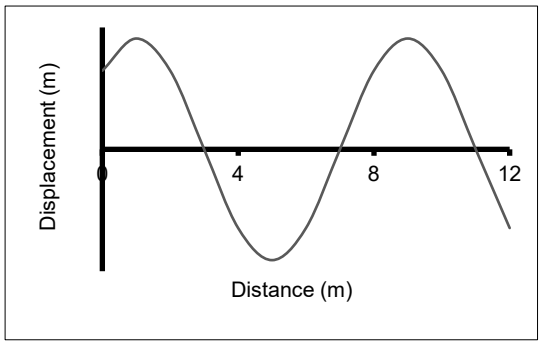
Question 24 (5 marks)

The graphs show the same wave drawn 0.35 seconds apart.



Graph 1 drawn at time t = 0.6 s



Graph 2 drawn at time 0.95 s

a Determine the maximum possible period for this wave. **3**

b What is the frequency of the wave? **1**

c Calculate the speed of the wave. **1**

PAPER CONTINUES ON NEXT PAGE

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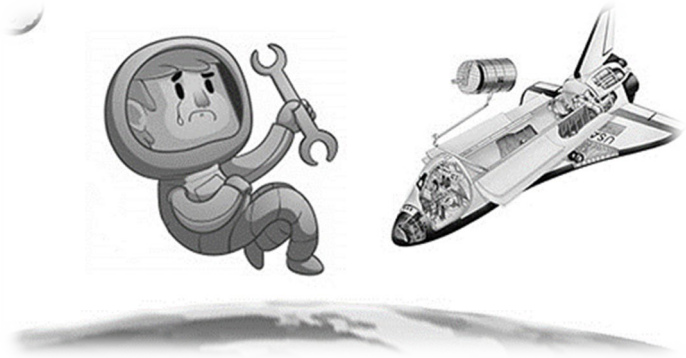
Question 26 (3 marks) **3**

An astronaut repairing a satellite finds himself some distance from the space shuttle. Both he and the space shuttle are in orbit, and he is without a jetpack or a tether. With reference to the physics involved, explain how this untethered astronaut can safely return to the space shuttle.



Question 27 (3 marks)

Two helmets of identical mass are tested for impact safety by simulating a fall from 2.5m. Helmet A is undamaged and quickly rebounds after the simulated impact; whereas Helmet B does not bounce and the shell is cracked. Both impacts take the same amount of time to complete. With reference to the physics involved, justify which is the safer helmet.

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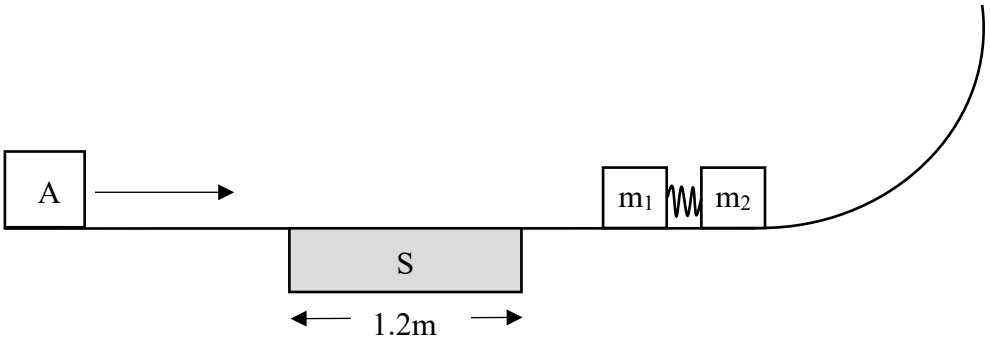
Question 28 (9 marks)

A 1.8kg block A is given an initial velocity of $6ms^{-1}$ on a frictionless surface, where it encounters a new surface, S, for 1.2m. 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 provide a frictional force of 8.25N. Calculate the velocity of block A as it leaves surface S. **3**

b Block A impacts blocks m_1 and m_2 and all of the blocks travel as one. Masses m_1 and m_2 are identical and each has a mass of 600g.

i) What is the velocity of the combined masses after the impact? **2**

ii) Calculate the energy absorbed by the spring after the collison. **2**

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

Question 29 (1 mark) **1**

A shortwave AM radio requires a larger antenna than a mobile phone that works with the microwave part of the EM spectrum. Justify why this is the case.

END OF PAPER

Y11 Physics Preliminary Half Yearly 2016 -MARKING

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

Short Answer

21.

(A) Marking Criteria	Marks
Uses law of conservation of momentum Correctly calculates velocity to 2 sig figs. Correct direction stated in words (or a statement saying whether + or – is left or right) Correct units used	**2**
3 of above correct	**1**

$p_i = u_x m_x + u_y m_y = 0.25 \times 6 - 0.5 \times 4 = -0.5 kgms^{-1}$

$p_i = p_f = v_x m_x + v_y m_y = -0.06 \times 6 + v_y \times 4$

$v_y = \frac{0.36-0.5}{4} = -0.035 ms^{-1}$ (to the left)

(B) Marking Criteria	Marks
Correct equation used Correct value calculated (1.9Ns) and direction given(to right)	**2**
1 of the above NO CARRY OVER ERRORS WERE ALLOWED HERE	**1**

$I = m_y(v_y - u_y)$

$= 4kg(-0.035 ms^{-1} + 0.5 ms^{-1}) = 1.86 Ns$ = 1.9 Ns to the right (2 sig.figs)

(C) Marking Criteria	Marks
Correct value calculated (6.2)and correct unit (N) and direction LEFT.	1

$I = Ft;\ F = \frac{I}{t} = \frac{1.86Ns}{0.3s} = 6.2\text{N}$ left

(Carry over allowed only if **equation and substitution** shown)

22. Marking Criteria	Marks
Correct use of conservation of momentum other correct technique Correct application of relative velocity (V_1=6ms^{-1}, V_2=-1ms^{-1}) Correct answer and unit	3
Same as above but wrong or missing unit	2
Some correct working **including momentum equation** and subst. line	1

$p_i = u(m_{boat} + m_{b1} + m_{b2}) = 2ms^{-1} \times (100 + 50 + 60) = 220kgms^{-1}$

$p_f = v_{boat}m_{boat} + v_{b1}m_{b1} + v_{b2}m_{b2} = p_i$

$= v_{boat}110kg + 50kg \times (4ms^{-1} + 2ms^{-1}) + 60kg \times (-3ms^{-1} + 2ms^{-1})$

$v_{boat} = \frac{p_i - 240}{110} = \frac{220-240}{110} = 1.8ms^{-1}$

$KE = \frac{1}{2}m_{boat}v^2 = \frac{100kg \times 1.8^2}{2} = 162J$

23. (A) Marking Criteria	**Marks**
Accurate use of Snell's Law Correct refractive index	**2**
One of the above	**1**

$\frac{Sin\ i}{Sin\ r} = \frac{n_2}{n_1}$

$$n_1 = \frac{n_2\ Sin\ r}{Sin\ i} = \frac{1.37\ Sin\ 45}{Sin\ 30} = 1.94 = \ 1.9\ (2\ sig\ fig)$$

(B) Marking Criteria	Marks
Correct formula to calculate critical angle and Correct angle to 2 sig figs.	2
One of the above CARRY OVER ALLOWED FOR 1 MK IF CORRECT WORKING SHOWN	1

$Sin\theta_c = \frac{n_2}{n_1}$

$\theta_c = sin^{-1}\left(\frac{1}{1.94}\right) = 31°$

24.

Marking Criteria	Marks
Correct equation line and substitution for inverse square law Correct value (0.48 or 48%)	2
One of the above	1

$I = \frac{k}{d^2}$

$0.75 = \frac{k}{10^2}$

$k = 100 \times 0.75 = 75$

$I = \frac{75}{12.5^2} = \frac{75}{156.25} = 0.48$

25.

(A)

Criteria	Marks
• Calculates the maximum period and justifies answer(T=2.8s if wave moves left)	3
• Calculates period and shows working if moves to the right (T=0.4s)	2
• Calculate wavelength correctly and gives correct unit for period	1

$\Delta t = 0.95s - 0.6s = 0.35s;\ \lambda = 8m$

$v = f\lambda;\ T = \frac{1}{f} = \frac{\lambda}{v}.\ Since\ v = \frac{d}{t},\ T = \frac{\lambda t}{d}$

$If\ wave\ moves\ left, d = 1m.\ T = \frac{8m \times 0.35s}{1m} = 2.8s$

OR

Alternative reasoning:

If wave has moved 7/8 of a wavelength to the right in 0.35 s, T = 0.35/7 × 8 = 0.4 s

If wave has moved 1/8 of a wavelength to the left in 0.35 s, T = 0.35 × 8 = 2.8 s

Therefore maximum period is 2.8 s

(B)

Criteria	Marks
Calculates the frequency and ALL WORKING SHOWN	1

$f = \frac{1}{T} = \frac{1}{2.8s} = 0.36Hz$ (2.5Hz if took wave moving the right. Carry over was only allowed if full equation and substitution shown)

(C)

Criteria	Marks
Calculates the speed with correct units	1

$v = f\lambda = 0.36Hz \times 8m = 2.9ms^{-1}$ (20m/s if took wave moving the right. Carry over was only allowed if full equation and subst shown)

26. 26.

Marking Criteria	Marks
Any 2 of the laws of physics correctly applied • Newton's 1st, 2nd, or 3rd • conservation of momentum Method involves throwing the wrench away from the space shuttle or pushing against satellite away from the space shuttle	**3**
2 of the above (or unsafe method, such as piercing his space suit)	**2**
1 of the above	**1**

The astronaut and space shuttle are both in orbit, hence have a relative velocity of 0ms-1 to each other. The astronaut should throw his wrench in the opposite direction to the space shuttle. According to Newton's Third law, this action will lead to an opposite reaction causing the astronaut to move towards the space shuttle. When the astronaut throws the wrench in the opposite direction, he gives the wrench a momentum p. By the law of conservation of momentum, the astronaut now has a momentum –p, and will move safely toward the space shuttle. he astronaut and space shuttle are both in orbit, hence have a relative velocity of $0ms^{-1}$ to each other.

27.

Marking Criteria	Marks
Correct Helmet chosen (helmet B) Correct use Newton's 2nd law or other appropriate law of physics (eg. impulse) Correct analysis of collisions (eg. inelastic preferred due to dissipation of energy)	**3**
2 of the above	**2**
1 of the above	**1**

Helmet A undergoes a much higher change of velocity than helmet B in the same time. This implies that Helmet A experiences a higher acceleration than helmet B. If we assume the helmets are of identical mass, Newton's 2nd law (F=ma) tells us that the helmet A will experience more force. In addition, helmet B cracks on impact. This reveals that it undergoes an inelastic collision, as energy is absorbed by cracking the shell. From these two reasons, it is clear that helmet B is the safer helmet.

28.

No carry on error in this question

(A)

Marking Criteria	Marks
Correct kinematic equations ($F=ma$ and $u^2=v^2+2as$) Correct application and substitution Correct answer for velocity ($5ms^{-1}$) **OR** Correct use of work energy theorem Correct calculation of kinetic energy after surface S (22.5J) Correct answer for velocity ($5ms^{-1}$)	**3**
2 of the above	**2**
1 of the above	**1**

$W = fd = \Delta KE = KE_f - KE_i$

$W = -8.25N \times 1.25m = -9.9J = KE_f - 0.5 \times 1.8kg \times (6ms^{-1})^2$

$-9.9J = KE_f - 32.4J$

$KE_f = 32.4J - 9.9J = 22.5J$

$KE_f = \frac{mv_f^2}{2}; \; v_f = \sqrt{\frac{2KE_f}{m}}$

$v_f = \sqrt{\frac{2 \times 22.5J}{1.8kg}} = 5ms^{-1}$

(B)

i)

Marking Criteria	Marks
Correct use of conservation of momentum Correct answer	2
One of the above	1

$p_i = p_f$

$1.8kg \times 5ms^{-1} = v_c(A + m_1 + m_2) = v_c(1.8kg + 0.6kg + 0.6kg)$

$9kgms^{-1} = 3kg \times v_c$

$v_c = 3ms^{-1}$

ii)

Marking Criteria	Marks
Correct application of work energy theorem Correct answer	2
One of the above	1

$KE_c = \frac{(A+m_1+m_2)v_c^2}{2} = 13.5J$

$W = KE_c - KE_f = 13.5J - 22.5J = -9J$

(C)

Marking Criteria	Marks
Correct application of conservation of energy Correct answer	2
One of the above	1

$KE_c = PE = 13.5J = mgh$

$h = \frac{PE}{mg} = \frac{13.5J}{3kg \times 9.8ms^{-2}} = 0.46m$

29.

Marking Criteria	Marks
Correctly correlates the **wavelength** of the radio wave with the size of the detector	1

Shortwave AM radio waves have a larger wavelength than microwaves. As such, they require a larger antenna to detect them.