 Name:_____

Class:_____

Sydney Boys High School

2018

YEAR 11 YEARLY EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your name and class in the space provided
- Choose your answers carefully, no other paper will be provided

Total marks – 75

This paper has two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1-20
- Allow about 35 minutes for this part

Part B – 55 marks
- Attempt Questions 21-36
- Allow about 1 hour and 25 minutes for this part

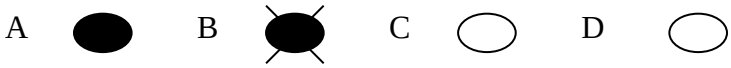
Part A – 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet.

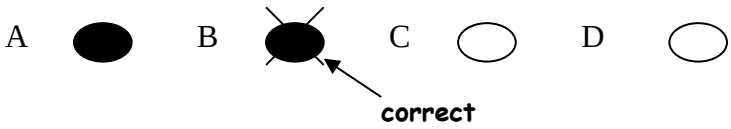
Select the alternative A,B,C or D that best answers the question. Fill in the response oval completely.

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

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

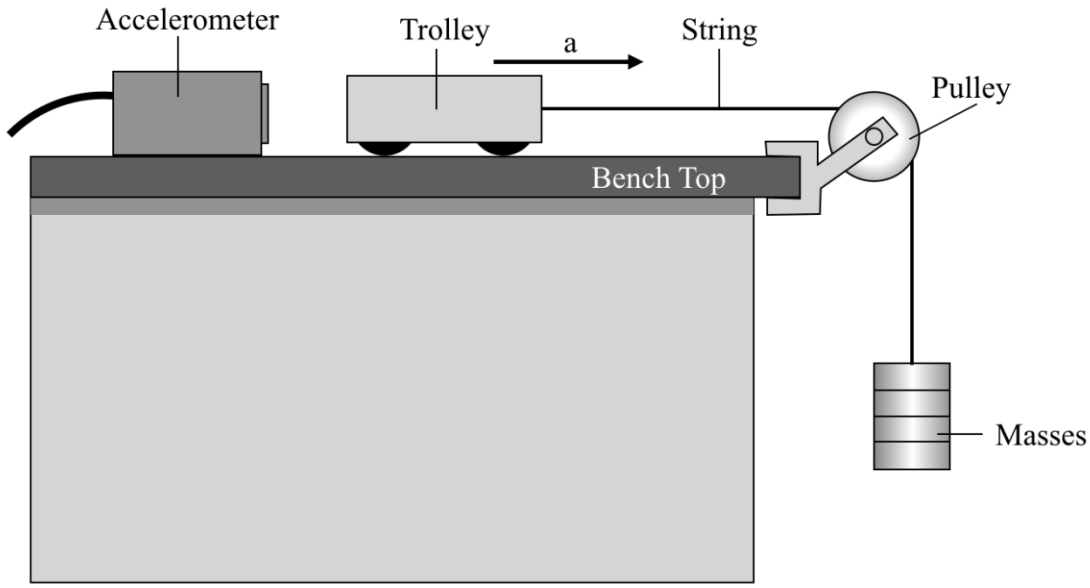


If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



1 Four students undertook an investigation to determine a relationship between the acceleration of a system and the force applied to it.

A diagram of their apparatus is shown below.



In the investigation the students added increasing masses to the mass carrier and measured the resulting acceleration of the trolley with the accelerometer.

In each of their final reports the student made a comment about the investigation. Which statement is correct.

(A) The investigation was invalid because the force applied (gravity), remained constant

(B) The investigation was reliable because it was repeated many times with different weights

(C) The investigation was valid because the experimental design enabled the aim to be tested

(D) The investigation was invalid because the mass of the system did not remain constant.

2 A heart shaped helium balloon has a mass *m*. The buoyancy force acting on the balloon is F_{Lift}

Identify the formula that would correctly determine the initial acceleration of the balloon

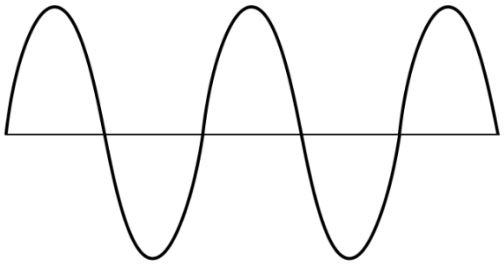
(A) $a = \frac{F}{m}$

(B) $a = \frac{F_{Lift} - mg}{m}$

(C) $a = F_{Lift} - g$

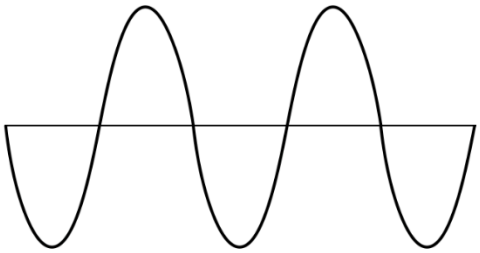
(D) $a = \frac{F_{Lift} + mg}{m}$

3 Below shows a displacement/time graph for a transverse wave.

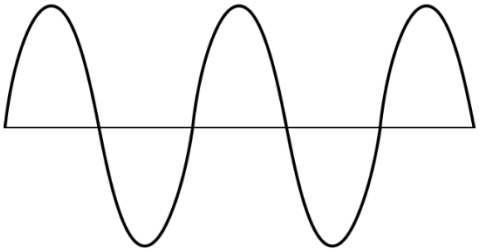


Which of the following waves, if superimposed on the one above, would result in the most deconstructive interference?

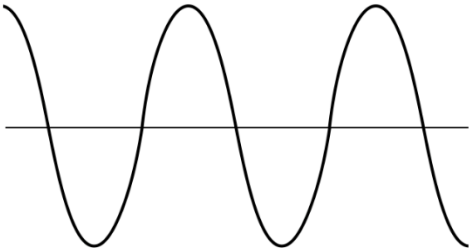
(A)



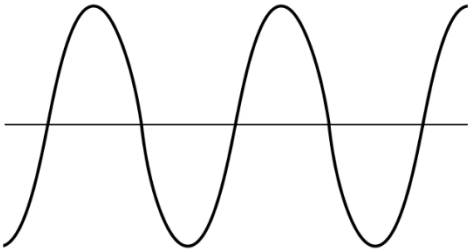
(B)



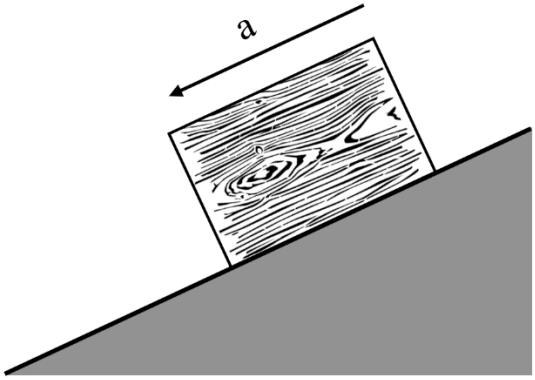
(C)



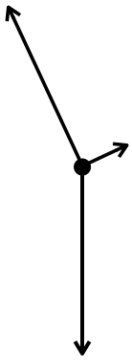
(D)

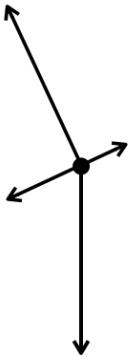


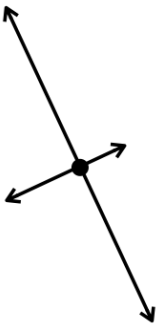
4 A block of wood is sliding down an incline as shown below.



Which of the free body diagrams below best illustrates the forces acting on the block?

(A) 

(B) 

(C) 

(D) 

5 A conductor has a current of 2.00 A passing through it. How long would it take for 1.22×10^{19} electrons to pass a single point in the conductor?

(A) 1.23 s

(B) 0.98 s

(C) 1.82 s

(D) 1.50 s

6 Calculate the wavelength of a radio-wave with a frequency of 105.7 MHz.

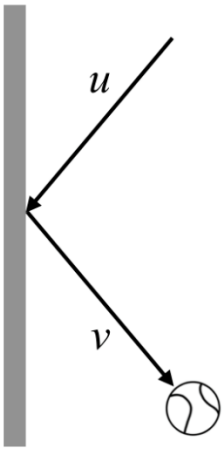
(A) 3.000 m

(B) 2.838 m

(C) 2.84 m

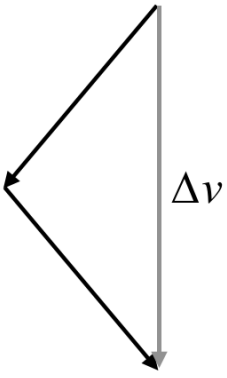
(D) 2.8 m

7 A ball hits a wall at a velocity of *u* and bounces off the wall at a velocity of *v* as shown in the diagram below.

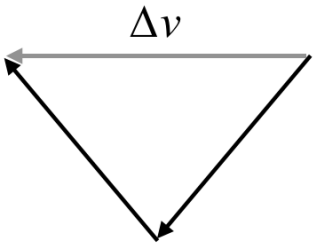


Which vector addition diagram below correctly shows the change in velocity?

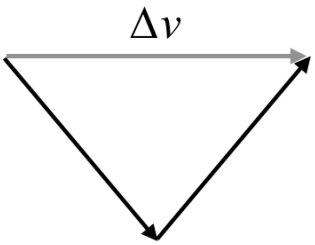
(A)



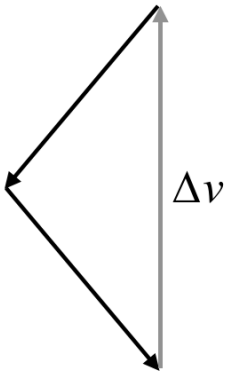
(B)



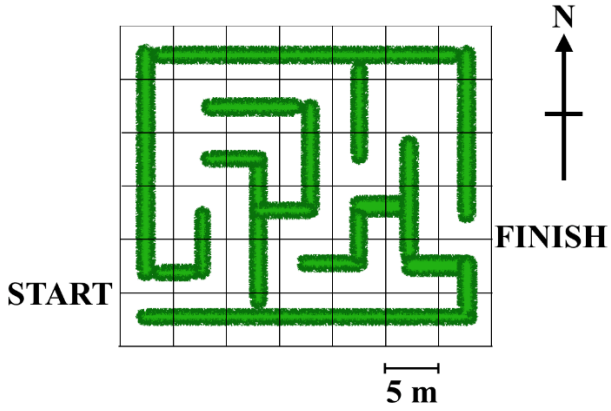
(C)



(D)

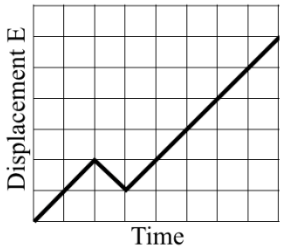


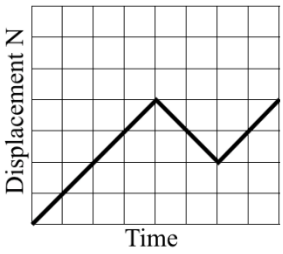
8 Bruce walks through the small hedge maze shown below at a constant speed of 2.5 m s^{-1} without taking any wrong turns.



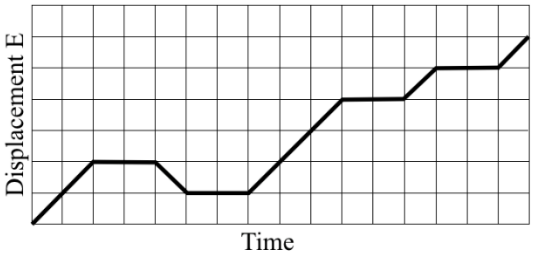
Which set of displacement/time graphs correctly illustrates the path taken by the student.

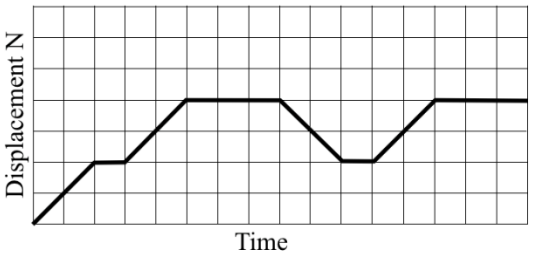
(A)



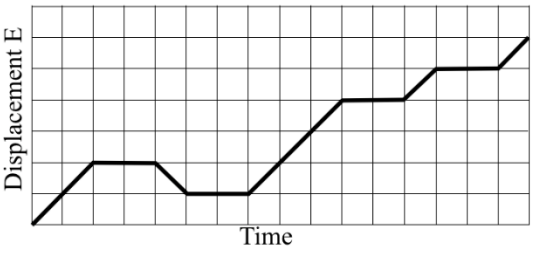


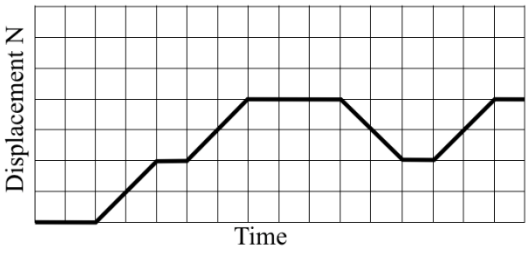
(B)



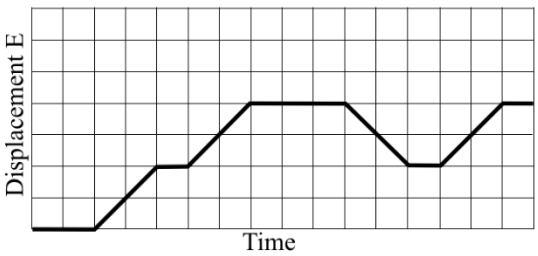


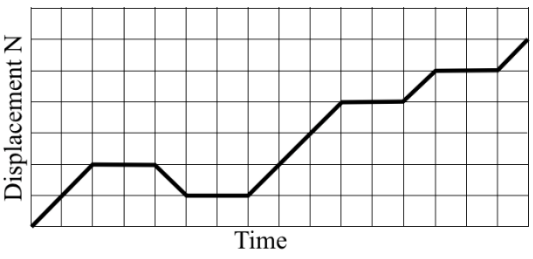
(C)





(D)

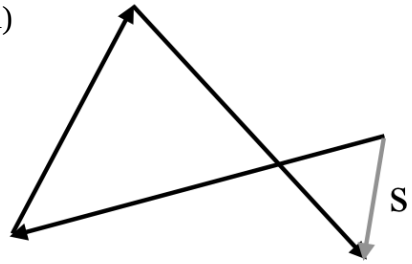




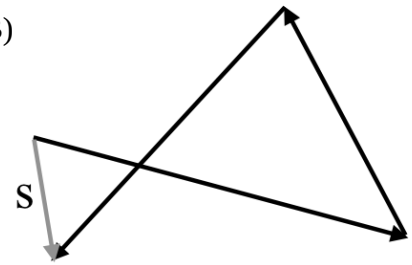
9 A concussed pigeon is walking around after flying into a glass window. It walks 45 cm at a bearing of S 75º W, 30 cm at a bearing of N 28º E, and finally 40 cm at a bearing of S 47.3º E.

Which vector addition diagram below correctly depicts the pigeons final displacement?

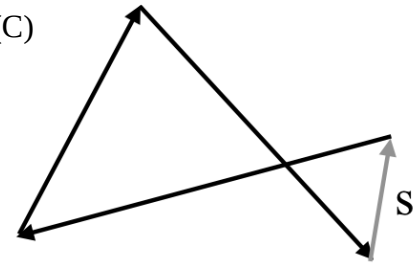
(A)



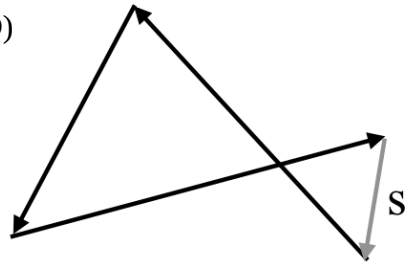
(B)



(C)



(D)



10 A space shuttle orbiting the Earth accelerates in a straight line for 10.0 s. at 12.0 m s^{-2}.

Calculate the change in velocity.

(A) 120 m s^{-2}

(B) 1200 m s^{-1}

(C) 1.2 m s^{-1}

(D) 120 m s^{-1}

11 A daredevil motorcyclist needs to achieve a velocity of 110 km h^{-1} on his motorcycle before he reaches a ramp to safely complete his stunt. What is the shortest run up he will need if his motorcycle accelerates at 15.0 m s^{-2}.

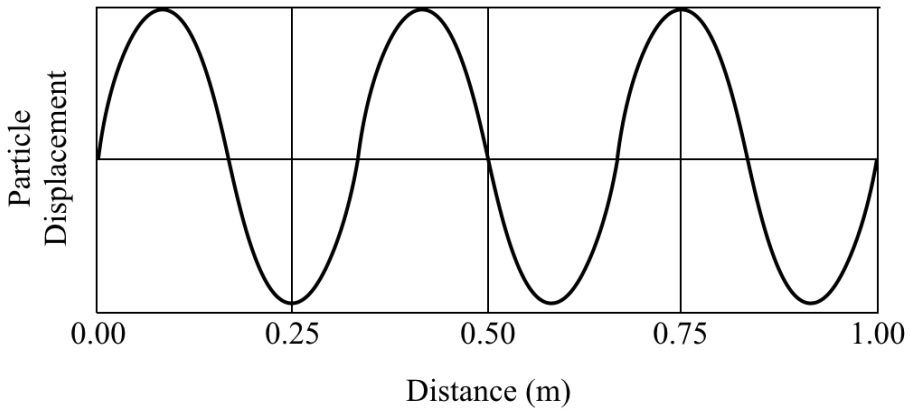
(A) 1.02 m

(B) 31.1 m

(C) 403 m

(D) 40.2 m

12 The wave shown below has a velocity of 3.00 m s^{-1}.



Calculate the period of the wave.

(A) 9.00 s

(B) 0.111 s

(C) 6.00 s

(D) 0.167 s

13 Which of the following statements in regards to thermal conduction is incorrect?

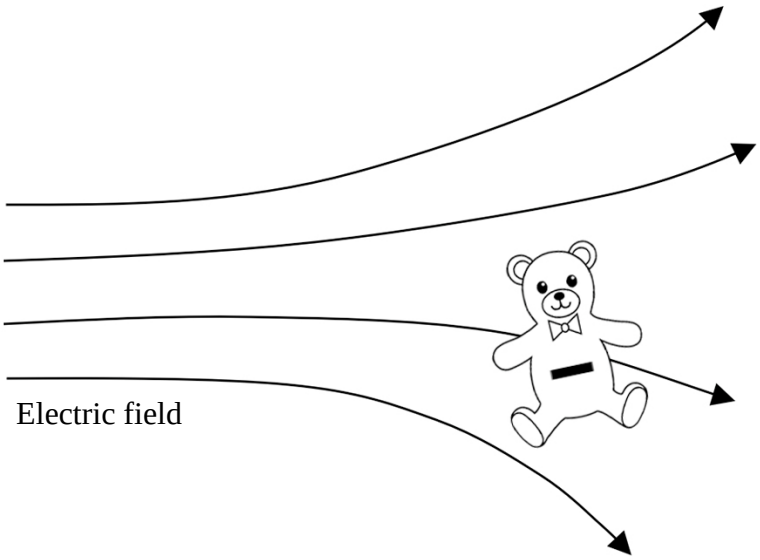
(A) Decreasing the surface area relative to the volume of a system increases the rate of conduction.

(B) Energy transfer through one side of a thick material to the other requires a greater number of collisions than for a thinner material.

(C) Smaller temperature differences result in a slower rate of energy transfer.

(D) The rate a material conducts heat energy is dependent on its thermal conductivity.

14 The diagram below shows a negatively charged teddy bear that is in an electric field.



Which of the following statements about the teddy bear is correct?

(A) The teddy bear experiences an electric force to the left and the force will decrease as it moves left.

(B) The teddy bear experiences an electric force to the left and the force will increase as it moves left.

(C) The teddy bear experiences an electric force to the right and the force will increase as it moves right.

(D) The teddy bear experiences an electric force to the right and the force will decrease as it moves right.

15 Which of the following statements correctly relates the properties of an ohmic conductor to its electrical conductivity?

(A) Increasing voltage produces a proportional increase in current.

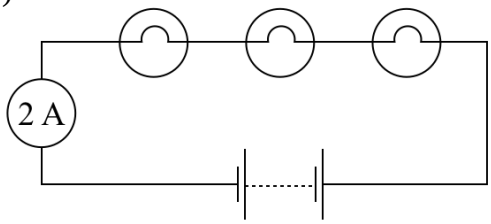
(B) Increasing resistance produces a proportional increase in voltage.

(C) Increased length of a conductor decreases conductivity.

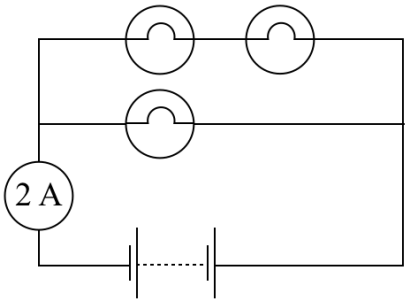
(D) Increased impurities added to a conductor increases conductivity.

16 Below are four circuits each containing identical light bulbs of 2Ω. Which of the circuits has an input voltage of 6V.

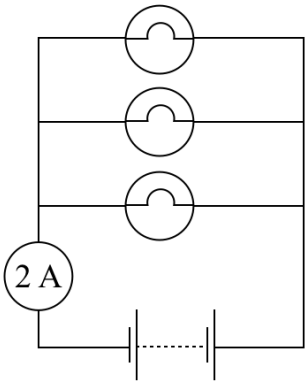
(A)



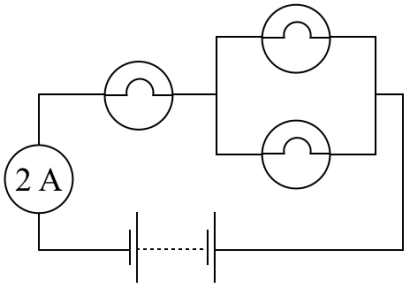
(B)



(C)



(D)



17 What effect occurs when the natural resonant frequency of an object is matched by the driving frequency?

(A) The amplitude of the oscillations within the object creating the driving frequency increases dramatically.

(B) The resulting displacement of the resonating object is the vector sum of the two individual displacements.

(C) The maximum possible energy from the source creating the forced vibration is transferred to the resonating object.

(D) The driving frequency superimposes with the resonant frequency to create deconstructive interference.

18 A 4.0 kg block, at rest, is hit by a 6.0 kg block moving at 1.5 m s^{-1} N. After the collision, the 6.0 kg block stops. What happens to the other block?

(A) It remains stationary

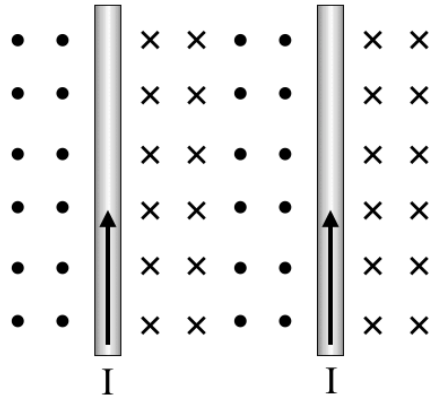
(B) It moves 1.5 m s^{-1} N

(C) It moves 2.3 m s^{-1} N

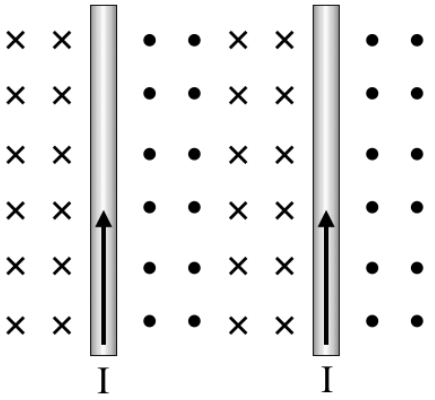
(D) It moves 1.9 m s^{-1} S

19 Which diagram below correctly represents two current carrying conductors that would produce a force of repulsion between them.

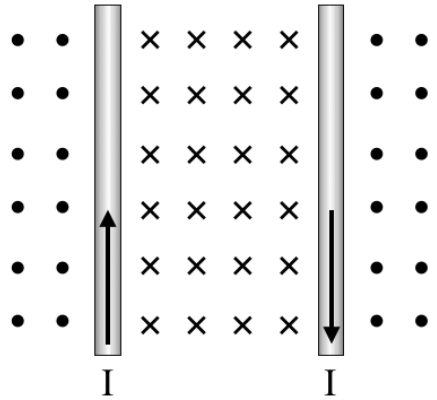
(A)



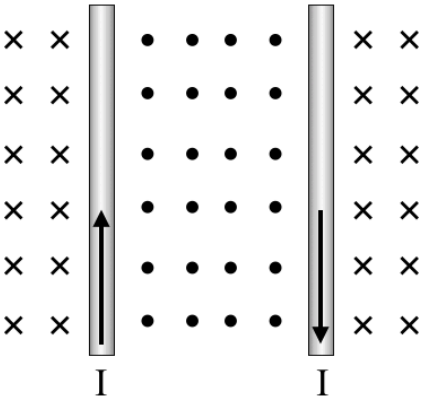
(B)



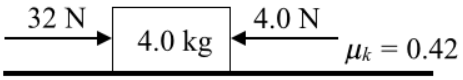
(C)



(D)



20 Two applied forces, plus friction are acting on the block below.



Calculate the acceleration of the block.

(A) 0.5 m s^{-2}

(B) 1.2 m s^{-2}

(C) 2.1 m s^{-2}

(D) 2.9 m s^{-2}

Part B – 55 marks
Attempt Questions 21-36

Allow about 1 hour and 25 minutes for this part.

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

Question 21 (3 marks)

Two helmets of identical mass are tested for impact safety by simulating a fall from 2.5m. Both impacts take the same amount of time to complete, with the results in the table below. With reference to the physics involved in the collisions, justify which is the safer helmet. **3**

	Bounce	***Damage***	***Temperature***
Helmet A	No bounce	Cracked	Warmer
Helmet B	Quickly rebounds	No damage	No change

Question 22 (3 marks)

A student being chased by an angry Ibis is running in a straight line towards the safety of a nearby building at a speed of $3.25ms^{-1}$. The building is a distance of *d* away from the child. The Ibis is 12.6m behind the child running at $4.85ms^{-1}$. What is the maximum possible value for *d* if the child reaches the building safely? **3**

Question 23 (5 marks)

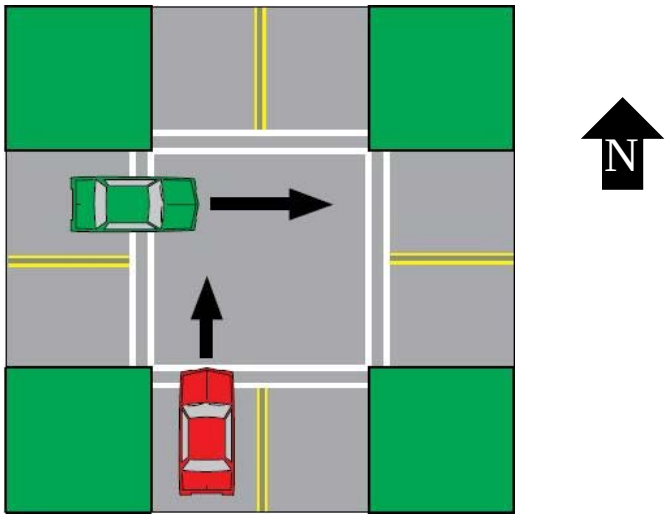
A wire coil is immersed in 250mL of water in an insulated beaker and connected to a power supply which is measured to supply 24.0V at 7.00A. The initial temperature of the water was noted to be 20.0°C. The coil is powered on for 15.0mins with adequate agitation under one atmosphere of pressure.

(a) Calculate the effective resistance of the coil **2**

(b) Given that the latent heat of vaporisation of water is 2265 Jg^{-1}, determine the mass of the water in the beaker after this experiment **3**

Question 24 (7 marks)

A large intersection experiences a traffic light failure. A 850.0kg sports car heading north collides with a 1250.0kg sedan of heading east. The sports car impacts the side of the sedan, and the combined wreck travels north east. Skid marks from the collision indicate that cars travelled a distance of 6.40m due north east from the impact until stationary. The speed limit in this area is 70.0km/h.



(a) Traffic cameras record that the sedan travelled with a constant velocity for 0.380s from the beginning of the intersection to the point of collision, a distance of 7.50m. Evaluate whether the sedan was speeding. **2**

(b) The dashcam on the sports car records the motion of the combined wreck as having an acceleration of $-21.0 ms^{-2}$ while skidding to a stop. Assume that the forces involved are constant

i. Calculate the magnitude of the force involved in this motion **2**

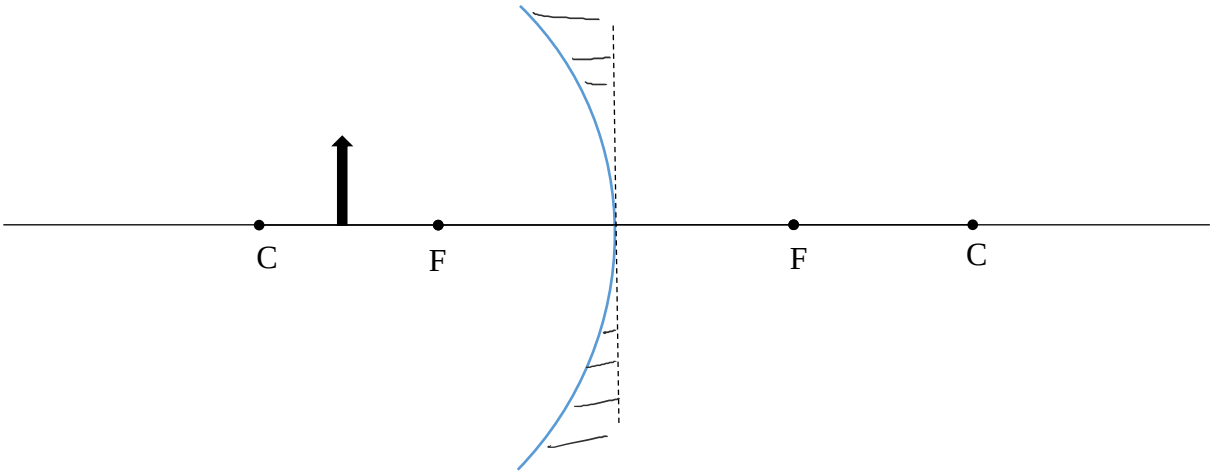
ii. Calculate the work done by friction as the wreck skids to a stop **1**

iii. With reference to the physics involved, calculate the speed of the sports car at the point of impact by analysing the momenta of the collision. **2**

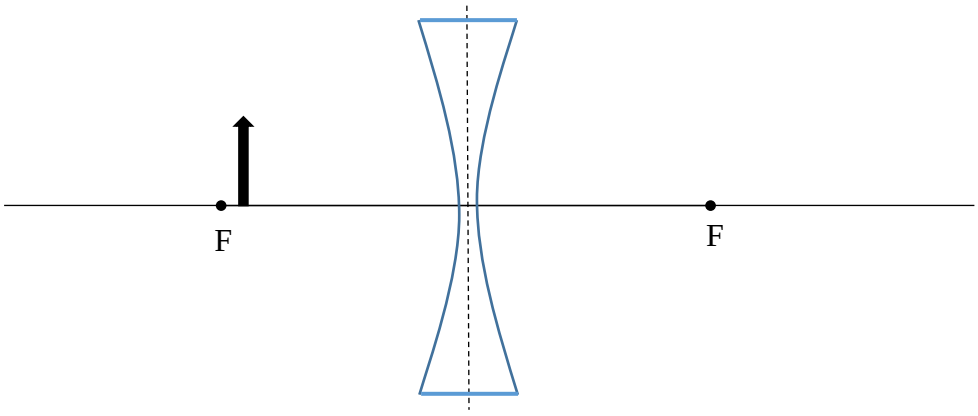
Question 25 (4 marks)

On the mirror and lens diagrams below, complete the ray trace and show the images made

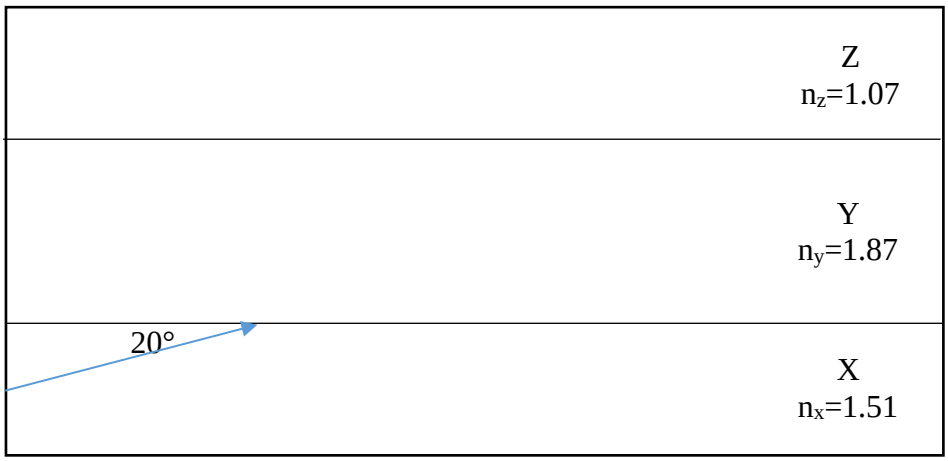
(a) **2**



(b) **2**



Question 26 (6 marks)
Three transparent materials X, Y, and Z are stacked as shown in the diagram below



A beam of light is shone into the stack, at an angle of 20° to the XY interface

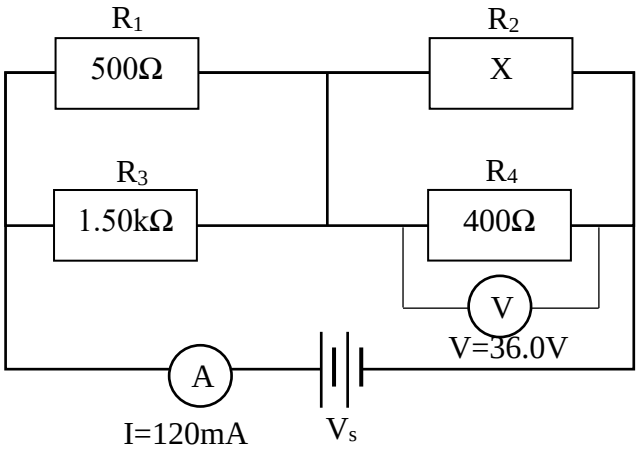
(a) Calculate the angle of refraction for the ray entering Y **2**

(b) The light beam travels through to material Z. Calculate angle the ray will make with respect to the interface YZ. Sketch the rays on the diagram above **2**

(c) Calculate the velocity of light in Y **2**

Question 27 (6 marks)

(a) A circuit is constructed according to the following circuit diagram. The value for resistor X is unknown. Calculate the current draw, voltage drop, and power draw for each circuit element and complete the table below **4**

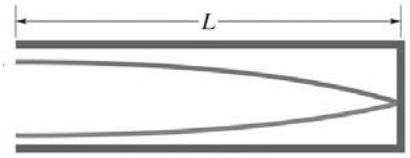


	R_1	**R_2**	**R_3**	**R_4**
Resistance (Ω)	500		1500	400
Voltage (V)				36.0
Current (A)				
Power (W)				

(b) This circuit was measured to use 1810 joules of energy. Calculate the time this circuit was operating to the nearest minute. **2**

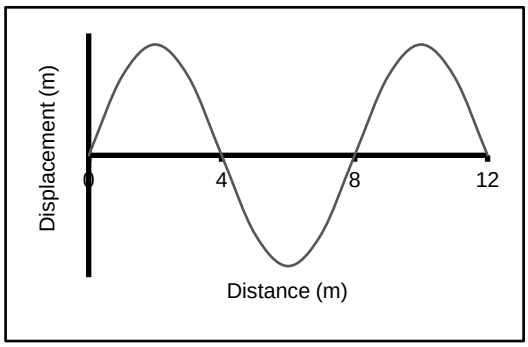
Question 28 (3 marks)

A closed ended tube of length L is designed to play a note at 440Hz in air. It resonates at the fundamental harmonic. The same tube is filled with another gas with a speed of sound of $926ms^{-1}$. Calculate the resonant frequency of the tube of gas if it resonates at the first harmonic. **3**

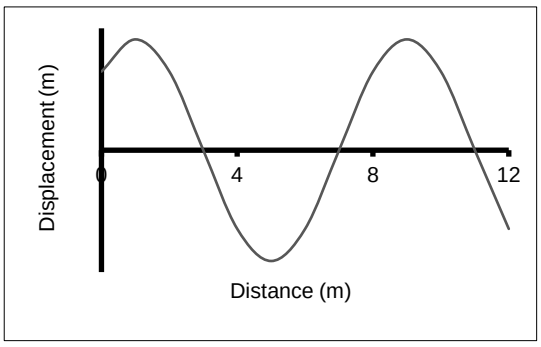


Question 29 (5 marks)

The graphs show the same wave drawn 0.25 seconds apart.



Graph 1 drawn at time t = 0.6 s



Graph 2 drawn at time 0.85 s

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

(b) Calculate the frequency of the wave. **1**

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

Question 30 (4 marks)

The space probe Juno was launched on August 2011 to investigate the planet Jupiter. Upon arrival at Jupiter in July 2016, the probe turned on all its instruments, which consumes 500W.

Intensity of sunlight at Earth's Orbit (W/m^2)	*Orbital distance for Earth (km)*	*Orbital distance for Jupiter (km)*
1366	1.50×10^{11}	7.79×10^{11}

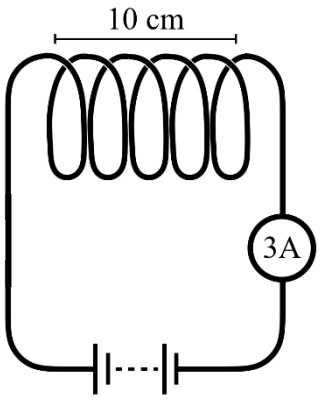
(a) Calculate the intensity of sunlight at Jupiter **2**

(b) Calculate the area of the solar cells required to power the probe, supposing the cells are 45% efficient **2**

Question 31 (4 marks)

(a) Below is a diagram of a solenoid. Draw the direction of conventional current on the diagram. **1**

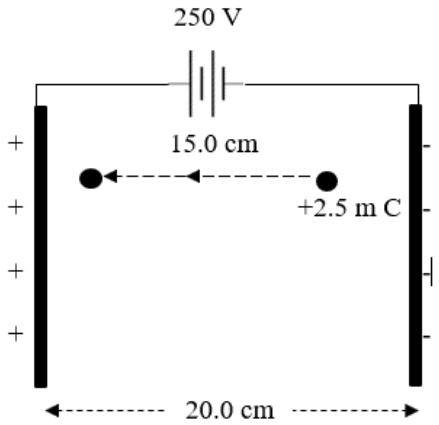
(b) Draw on the diagram below the magnetic field produced by the current. **1**



(b) Calculate the magnitude of the magnetic field created by the current at a point inside the solenoid. **2**

Question 32 (4 marks)

A charge of +2.5 mC is moved 15.0 cm within an electric field **E** between two parallel charged plates, as shown in the diagram. The plates are 20.0 cm apart and are connected to a 250 V DC power source.



(a) Calculate the force required to move the +2.5 mC charge along the direction shown. **2**

(b) Calculate by how much the charge's potential energy will change. State whether it will increase or decrease by being moved in such a way. **2**

END OF PAPER

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 Name:_____

Class:_____

Sydney Boys High School

2018

YEAR 11 YEARLY EXAMINATION

Physics

SOLUTIONS

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your name and class in the space provided
- Choose your answers carefully, no other paper will be provided

Total marks – 75

This paper has two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1-20
- Allow about 35 minutes for this part

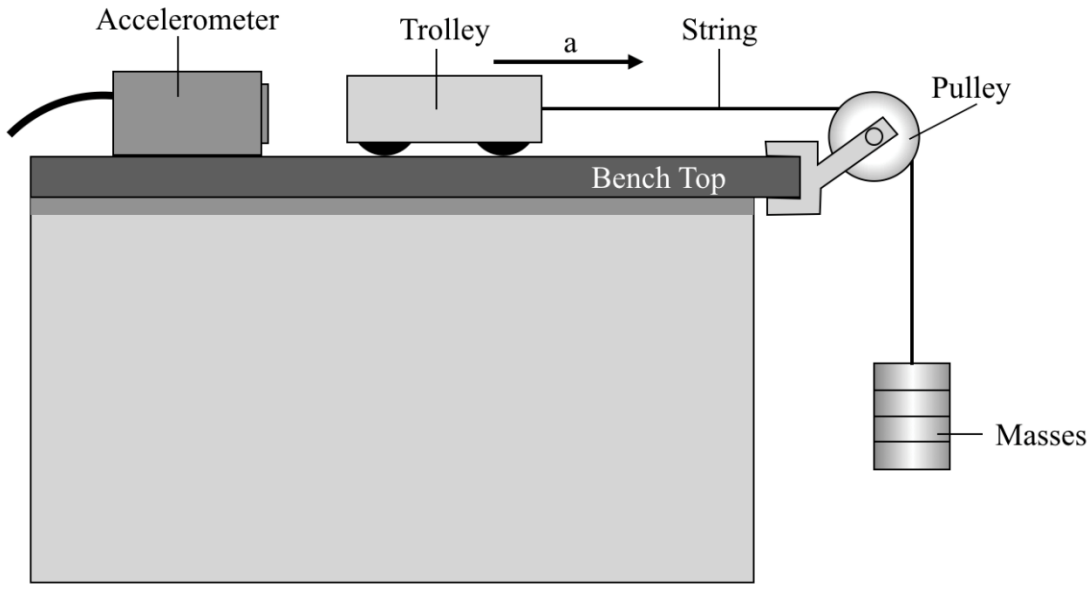
Part B – 55 marks
- Attempt Questions 21-36
- Allow about 1 hour and 25 minutes for this part

MC Answer

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

1 Four students undertook an investigation to determine a relationship between the acceleration of a system and the force applied to it.

A diagram of their apparatus is shown below.



In the investigation the students added increasing masses to the mass carrier and measured the resulting acceleration of the trolley with the accelerometer.

In each of their final reports the student made a comment about the investigation. Which statement is correct.

(A) The investigation was invalid because the force applied (gravity), remained constant

(B) The investigation was reliable because it was repeated many times with different weights

(C) The investigation was valid because the experimental design enabled the aim to be tested

(D) The investigation was invalid because the mass of the system did not remain constant.

2 A heart shaped helium balloon has a mass m. The buoyancy force acting on the balloon is F_{Lift}

Identify the formula that would correctly determine the initial acceleration of the balloon

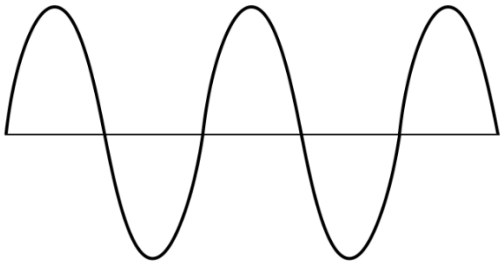
(A) $a = \frac{F}{m}$

(B) $a = \frac{F_{Lift} - mg}{m}$

(C) $a = F_{Lift} - g$

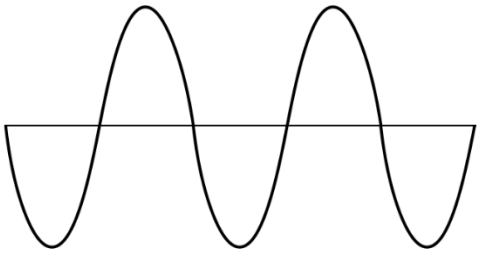
(D) $a = \frac{F_{Lift} + mg}{m}$

3 Below shows a displacement/time graph for a transverse wave.

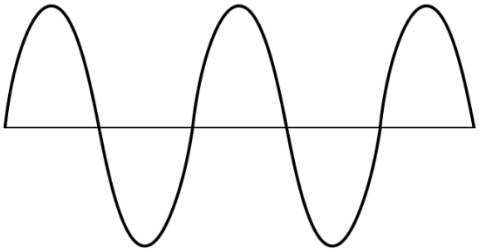


Which of the following waves, if superimposed on the one above, would result in the most deconstructive interference?

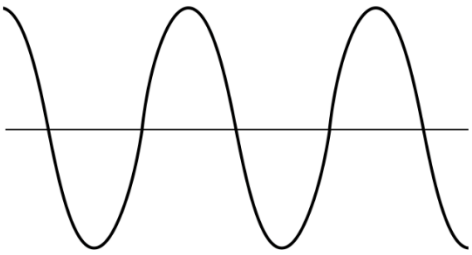
(A)



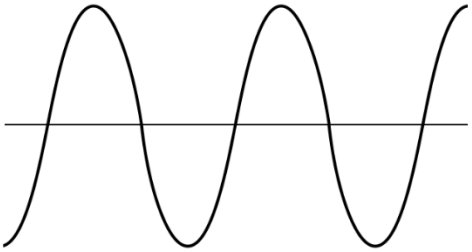
(B)



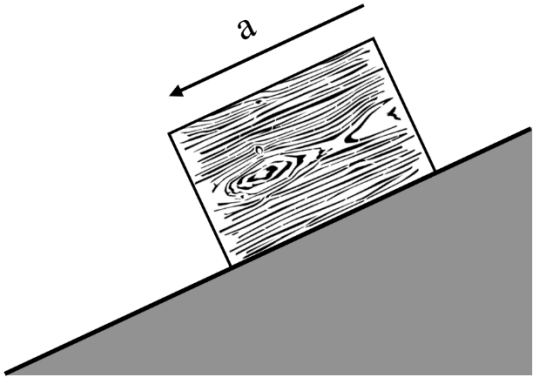
(C)



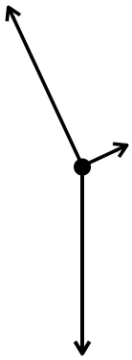
(D)

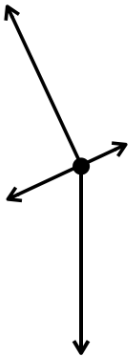


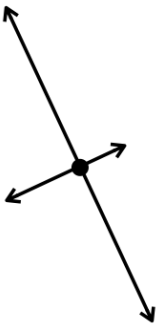
4 A block of wood is sliding down an incline as shown below.



Which of the free body diagrams below best illustrates the forces acting on the block?

(A) 

(B) 

(C) 

(D) 

5 A conductor has a current of 2.00 A passing through it. How long would it take for 1.22×10^{19} electrons to pass a single point in the conductor?

(A) 1.23 s

(B) 0.98 s

(C) 1.82 s

(D) 1.50 s

6 Calculate the wavelength of a radio-wave with a frequency of 105.7 MHz.

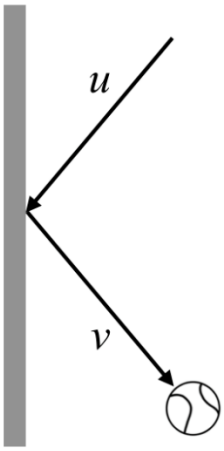
(A) 3.000 m

(B) 2.838 m

(C) 2.84 m

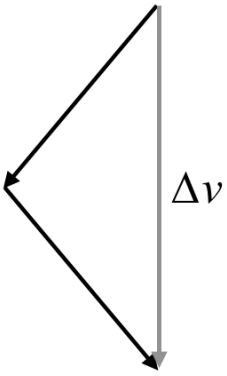
(D) 2.8 m

7 A ball hits a wall at a velocity of u and bounces off the wall at a velocity of v as shown in the diagram below.

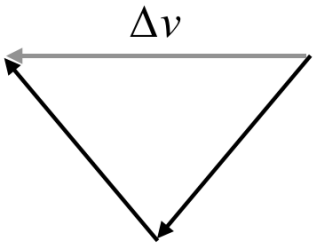


Which vector addition diagram below correctly shows the change in velocity?

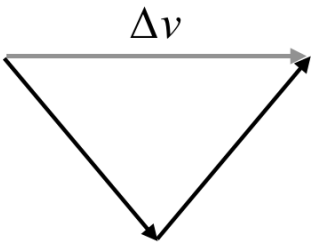
(A)



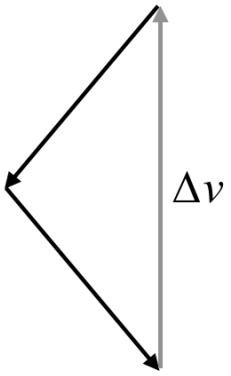
(B)



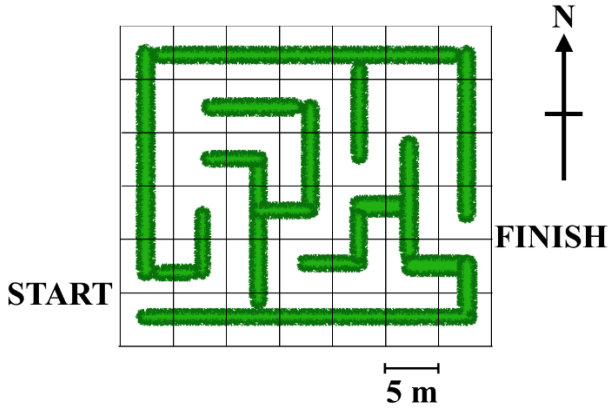
(C)



(D)

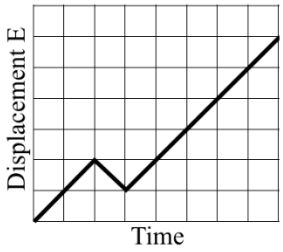


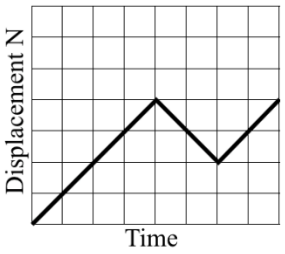
8 Bruce walks through the small hedge maze shown below at a constant speed of 2.5 m s^{-1} without taking any wrong turns.



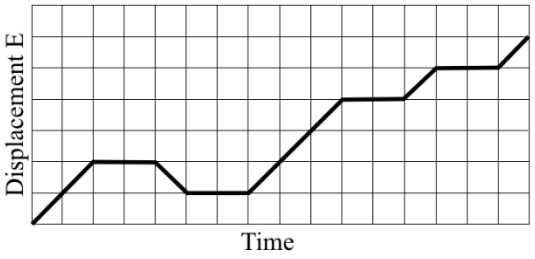
Which set of displacement/time graphs correctly illustrates the path taken by the student.

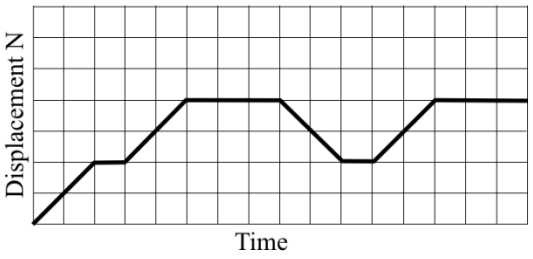
(A)



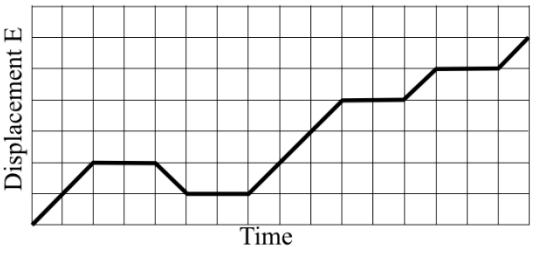


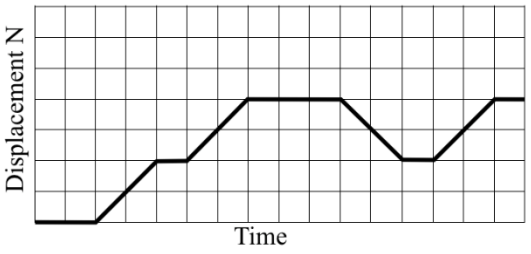
(B)



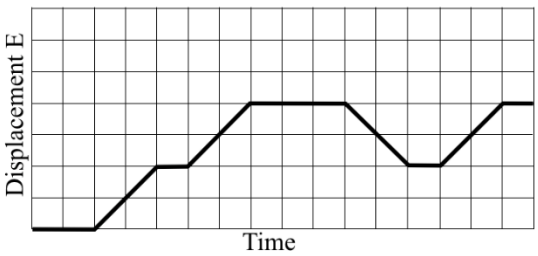


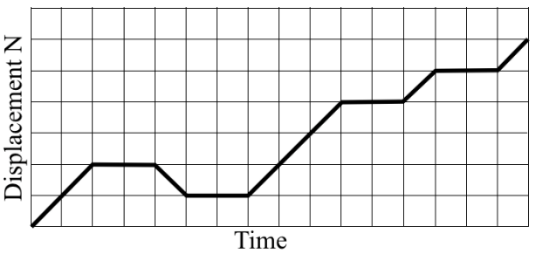
(C)





(D)

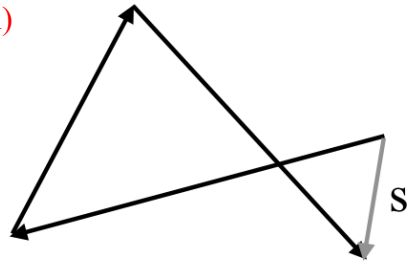




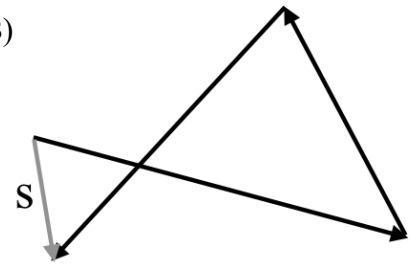
9 A concussed pigeon is walking around after flying into a glass window. It walks 45 cm at a bearing of S 75° W, 30 cm at a bearing of N 28° E, and finally 40 cm at a bearing of S 47.3° E.

Which vector addition diagram below correctly depicts the pigeons final displacement?

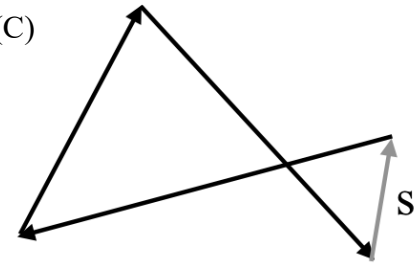
(A)



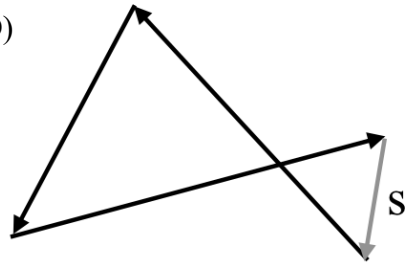
(B)



(C)



(D)



10 A space shuttle orbiting the Earth accelerates in a straight line for 10.0 s. at 12.0 m s^{-2}.

Calculate the change in velocity.

(A) 120 m s^{-2}

(B) 1200 m s^{-1}

(C) 1.2 m s^{-1}

(D) 120 m s^{-1}

11 A daredevil motorcyclist needs to achieve a velocity of 110 km h^{-1} on his motorcycle before he reaches a ramp to safely complete his stunt. What is the shortest run up he will need if his motorcycle accelerates at 15.0 m s^{-2}.

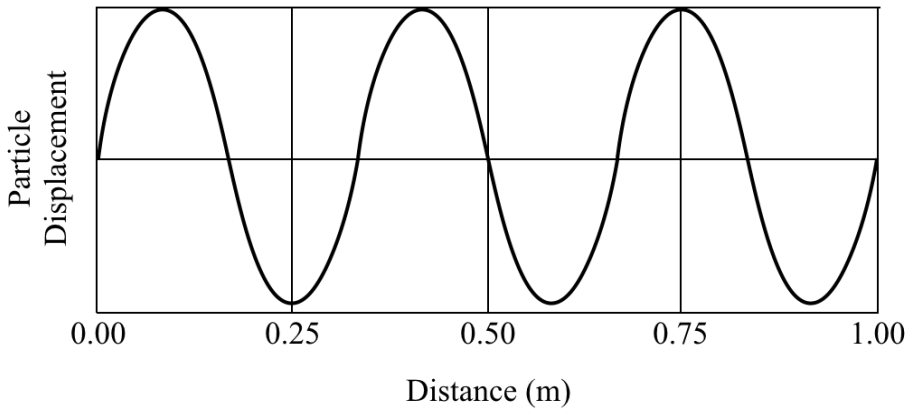
(A) 1.02 m

(B) 31.1 m

(C) 403 m

(D) 40.2 m

12 The wave shown below has a velocity of 3.00 m s^{-1}.



Calculate the period of the wave.

(A) 9.00 s

(B) 0.111 s

(C) 6.00 s

(D) 0.167 s

13 Which of the following statements in regards to thermal conduction is incorrect?

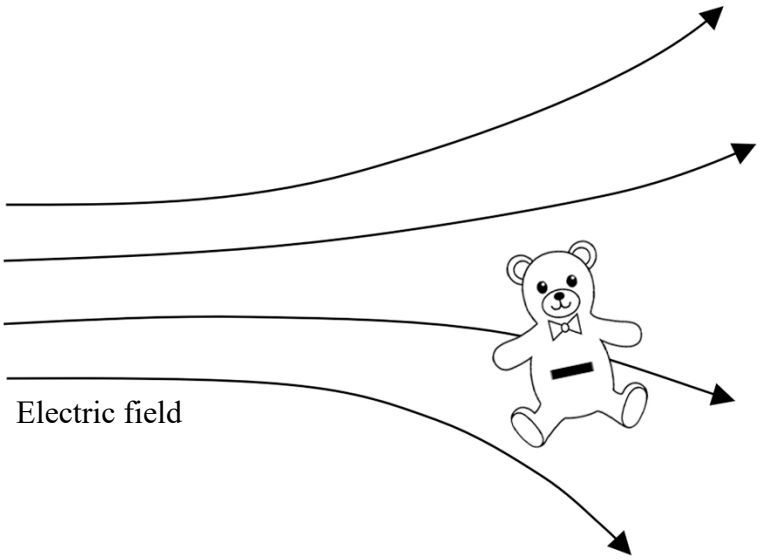
(A) Decreasing the surface area relative to the volume of a system increases the rate of conduction.

(B) Energy transfer through one side of a thick material to the other requires a greater number of collisions than for a thinner material.

(C) Smaller temperature differences result in a slower rate of energy transfer.

(D) The rate a material conducts heat energy is dependent on its thermal conductivity.

14 The diagram below shows a negatively charged teddy bear that is in an electric field.



Which of the following statements about the teddy bear is correct?

(A) The teddy bear experiences an electric force to the left and the force will decrease as it moves left.

(B) The teddy bear experiences an electric force to the left and the force will increase as it moves left.

(C) The teddy bear experiences an electric force to the right and the force will increase as it moves right.

(D) The teddy bear experiences an electric force to the right and the force will decrease as it moves right.

15 Which of the following statements correctly relates the properties of an ohmic conductor to its electrical conductivity?

(A) Increasing voltage produces a proportional increase in current.

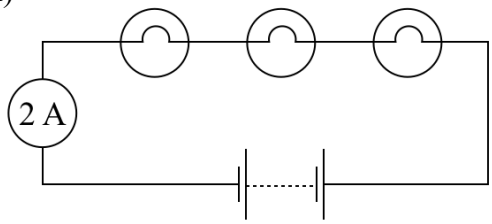
(B) Increasing resistance produces a proportional increase in voltage.

(C) Increased length of a conductor decreases conductivity.

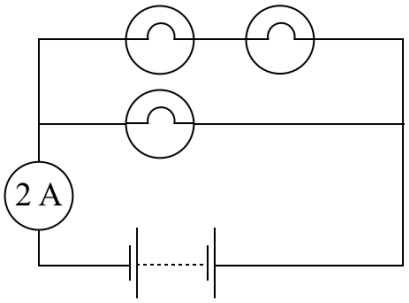
(D) Increased impurities added to a conductor increases conductivity.

16 Below are four circuits each containing identical light bulbs of 2Ω. Which of the circuits has an input voltage of 6V.

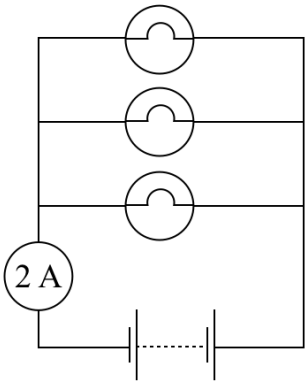
(A)



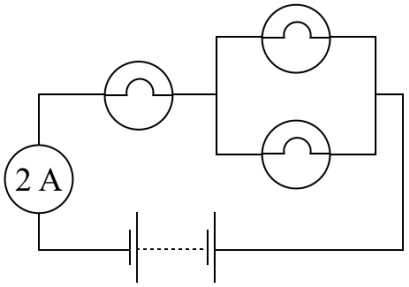
(B)



(C)



(D)



17 What effect occurs when the natural resonant frequency of an object is matched by the driving frequency?

(A) The amplitude of the oscillations within the object creating the driving frequency increases dramatically.

(B) The resulting displacement of the resonating object is the vector sum of the two individual displacements.

(C) The maximum possible energy from the source creating the forced vibration is transferred to the resonating object.

(D) The driving frequency superimposes with the resonant frequency to create deconstructive interference.

18 A 4.0 kg block, at rest, is hit by a 6.0 kg block moving at 1.5 m s^{-1} N. After the collision, the 6.0 kg block stops. What happens to the other block?

(A) It remains stationary

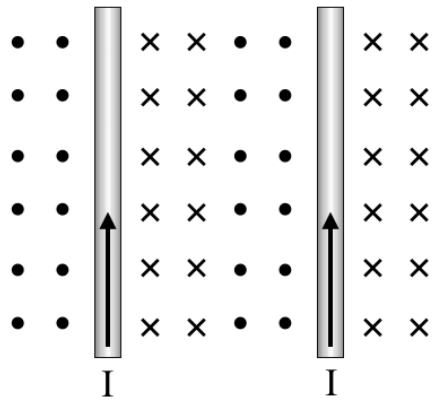
(B) It moves 1.5 m s^{-1} N

(C) It moves 2.3 m s^{-1} N

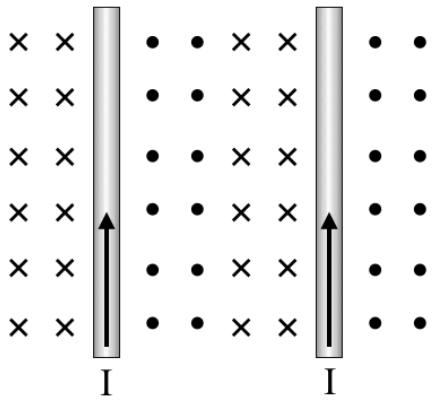
(D) It moves 1.9 m s^{-1} S

19 Which diagram below correctly represents two current carrying conductors that would produce a force of repulsion between them.

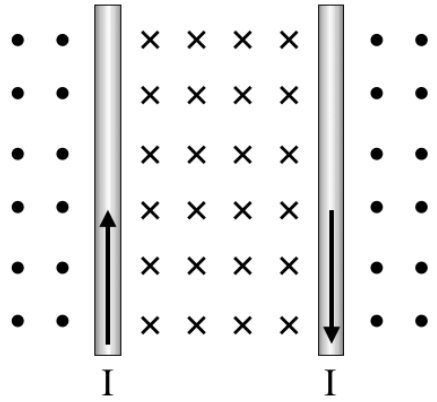
(A)



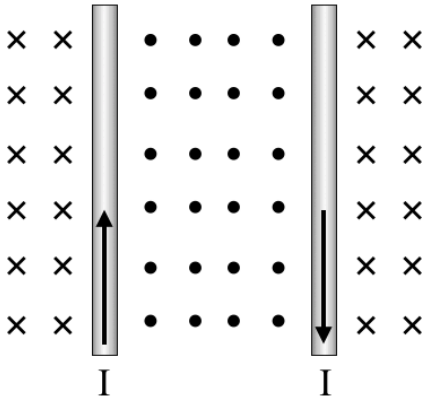
(B)



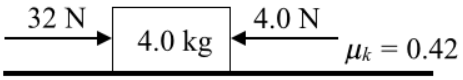
(C)



(D)



20 Two applied forces, plus friction are acting on the block below.



Calculate the acceleration of the block.

(A) 0.5 m s^{-2}

(B) 1.2 m s^{-2}

(C) 2.1 m s^{-2}

(D) 2.9 m s^{-2}

Part B – 55 marks
Attempt Questions 21-36

Allow about 1 hour and 25 minutes for this part.

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

Question 21 (3 marks)

Two helmets of identical mass are tested for impact safety by simulating a fall from 2.5m. Both impacts take the same amount of time to complete, with the results in the table below. With reference to the physics involved in the collisions, justify which is the safer helmet. **3**

	Bounce	***Damage***	***Temperature***
Helmet A	No bounce	Cracked	Warmer
Helmet B	Quickly rebounds	No damage	No change

2 OF THE FOLLOWING 3

- Both helmets have the same KE (or momentum) at impact
- B experiences greater impulse (or change in mom) therefore greater force at impact
- Helmet A dissipates forces better (absorbs energy better) as energy is used warming and cracking helmut

PLUS -

MUST HAVE

- Helmut A is safer

SUBTRACT 1 MARK FOR INCORRECT STATEMENTS/PHYSICS

Question 22 (3 marks)

A student being chased by an angry Ibis is running in a straight line towards the safety of a nearby building at a speed of 3.25ms^{-1}. The building is a distance of *d* away from the child. The Ibis is 12.6m behind the child running at 4.85ms^{-1}. What is the maximum possible value for *d* if the child reaches the building safely? **3**

1 MARK – Correct equation line and substitution line

1 MARK – 25.6

1MARK - answer given to 3 sf and has correct units (m)

Question 23 (5 marks)

A wire coil is immersed in 250mL of water in an insulated beaker and connected to a power supply which is measured to supply 24.0V at 7.00A. The initial temperature of the water was noted to be 20.0°C. The coil is powered on for 15.0mins with adequate agitation under one atmosphere of pressure.

(a) Calculate the effective resistance of the coil **2**

R=V/I

= 24/7

= 3.4 ohms 1 mark f or correct answer

1 mark for correct equation line AND correct unit

(b) Given that the latent heat of vaporisation of water is 2265 Jg^{-1}, determine the mass of the water in the beaker after this experiment **3**

E = VIt = 24x7x (15x60) = 151200 J

Q to reach 100 degrees C

Q = mcΔT

= 250 x 4.18 x 80 = 83600 J (1 mark for 83600 J)

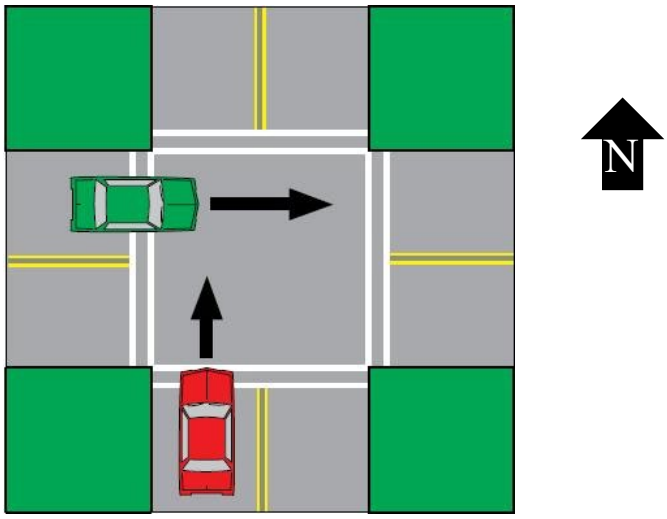
Remaining energy E =151200 – 83600 = 67600 J

This will vaporize 67600 / 2265 g of water = 29.8 g

Remaining water = 250 – 29.85 = 220 g (1 mark for correct answer, 1 mark for correct unit)

Question 24 (7 marks)

A large intersection experiences a traffic light failure. A 850.0kg sports car heading north collides with a 1250.0kg sedan of heading east. The sports car impacts the side of the sedan, and the combined wreck travels north east. Skid marks from the collision indicate that cars travelled a distance of 6.40m due north east from the impact until stationary. The speed limit in this area is 70.0km/h.



(a) Traffic cameras record that the sedan travelled with a constant velocity for 0.380s from the beginning of the intersection to the point of collision, a distance of 7.50m. Evaluate whether the sedan was speeding. **2**

$S = \frac{d}{t} = \frac{7.5m}{0.380s} = 19.7ms^{-1} = 71.1kmh^{-1}$

Yes, the sedan was speeding

✓ Correct value of 19.7ms-1

✓ Correct evaluation based on calculated value

(b) The dashcam on the sports car records the motion of the combined wreck as having an acceleration of -21.0ms^{-2} while skidding to a stop. Assume that the forces involved are constant

i. Calculate the magnitude of the force involved in this motion **2**

$F = ma = (1250kg + 850kg) \times -21ms^{-2} = -44\,100N$

✓ Correct equation used F=ma

✓ Correctly calculated value 44100N

ii. Calculate the work done by friction as the wreck skids to a stop **1**

$W = Fs = -44100N \times 6.40m = -282\,240J$

✓ Correctly calculated value 282 240J of work done

iii. With reference to the physics involved, calculate the speed of the sports car at the point of impact by analysing the momenta of the collision. **2**

$W = Fs = \Delta KE = \frac{1}{2}mv_{wreck}^2 - \frac{1}{2}mu_{wreck}^2$, $v_{wreck} = 0$

✓ Value for u_{wreck} =16.4ms^{-1}
✓ Value for u_{sport} = 28.3ms^{-1}

$282\,240J = \frac{1}{2} \times 2100kg \times mu_{wreck}^2$

$u_{wreck} = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2 \times 282240}{2100}} = 16.4ms^{-1}$

$p_{sedan} = 1250 \times 19.7 = 24625\ kgms^{-1}$; $p_{wreck} = (1250 + 850)u_{wreck} = 344298\ kgms^{-1}$

$p_{sports} = 850u_{sport}\ kgms^{-1}$

$p_{sedan}^2 + p_{sport}^2 = p_{wreck}^2$

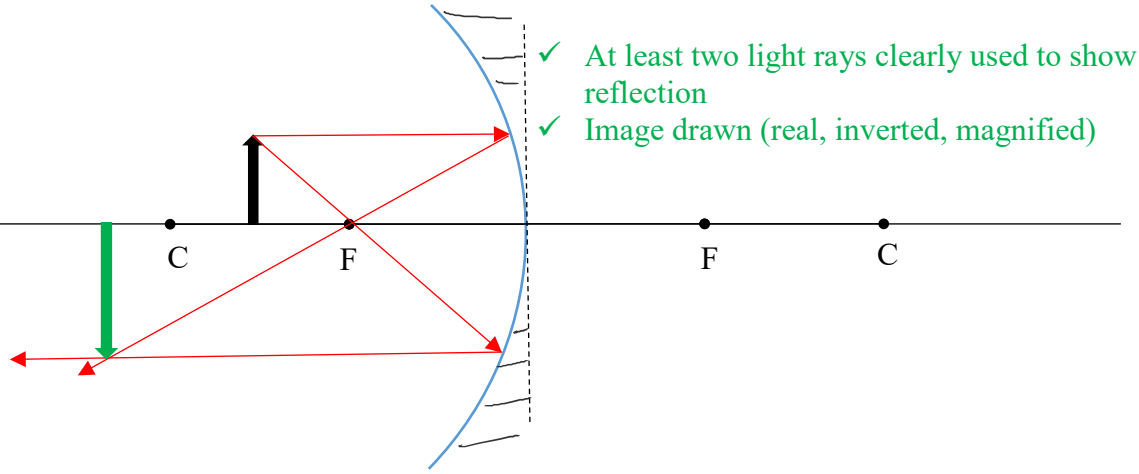
$p_{sport} = \sqrt{p_{wreck}^2 + p_{sedan}^2} = 24062.8\ kgms^{-1}$

$v = \frac{p}{m} = \frac{24062.8}{850} = 28.3ms^{-1}$

Question 25 (4 marks)

On the mirror and lens diagrams below, complete the ray trace and show the images made

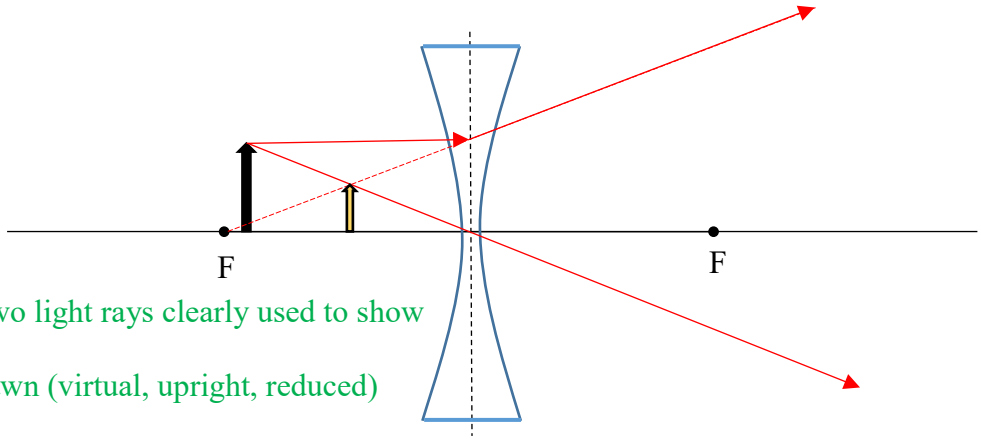
(a)



✓ At least two light rays clearly used to show reflection
✓ Image drawn (real, inverted, magnified)

2

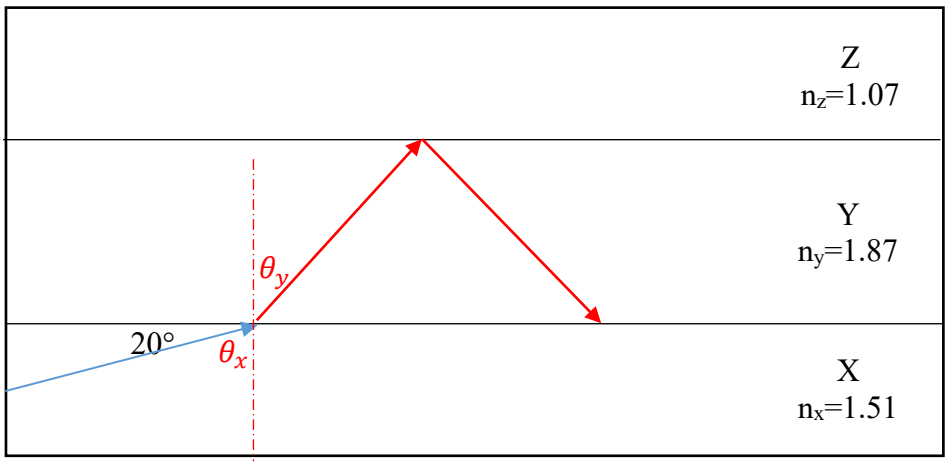
(b)



✓ At least two light rays clearly used to show refraction
✓ Image drawn (virtual, upright, reduced)

2

Question 26 (6 marks)
Three transparent materials X, Y, and Z are stacked as shown in the diagram below



A beam of light is shone into the stack, at an angle of 20° to the XY interface

(a) Calculate the angle of refraction for the ray entering Y **2**

$n_x \sin\theta_x = n_y \sin\theta_y$

$$\sin^{-1}\left(\frac{n_x \sin\theta_x}{n_y}\right) = \theta_y = \sin^{-1}\left(\frac{1.51 \sin 70°}{1.87}\right) = 49.3°$$

✓ Correctly states Snell's law
✓ Correct angle of refraction calculated 49.3°

(b) The light beam travels through to material Z. Calculate angle the ray will make with respect to the interface YZ. Sketch the rays on the diagram above **2**

$$\sin^{-1}\left(\frac{n_y \sin\theta_y}{n_z}\right) = \theta_z = \sin^{-1}\left(\frac{1.87 \sin 49.4°}{1.07}\right) = err \ \therefore TIR$$

$\theta_i = \theta_r = 40.7°$

✓ Use Snell's law to determine TIR, reflected angle to interface 41°
✓ Reflected ray sketched in the diagram

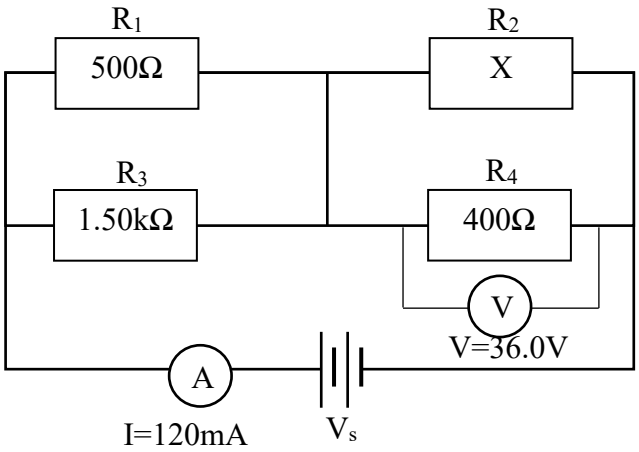
(c) Calculate the velocity of light in Y **2**

$$c_y = \frac{C}{n_y} = \frac{3.00 \times 10^8 ms^{-1}}{1.87} = 1.60 \times 10^8 ms^{-1}$$

✓ Correctly calculates speed of light in Y
✓ Correct Significant Figures (3SF) and units $1.60 \times 10^8 ms^{-1}$

Question 27 (6 marks)

(a) A circuit is constructed according to the following circuit diagram. The value for resistor X is unknown. Calculate the current draw, voltage drop, and power draw for each circuit element and complete the table below **4**



- ✓ 3-5 correct 1 Mark
- ✓ 6-8 correct 2 Marks
- ✓ 9-11 correct 3 Marks
- ✓ 12 correct 4 Marks

	R1	**R2**	**R3**	**R4**
Resistance (Ω)	500	1200	1500	400
Voltage (V)	45.0	36.0	45.0	36.0
Current (A)	0.09	0.03	0.03	0.09
Power (W)	4.05	1.08	1.35	3.24

(b) This circuit was measured to use 1810 joules of energy. Calculate the time this circuit was operating to the nearest minute. **2**

$P = 4.05 + 1.08 + 1.35 + 3.24 = 9.72W$

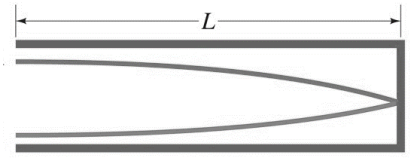
$E = Pt; t = \frac{1810J}{9.72s} = 186.2s$

$3mins\ (nearsest\ minute)$

- ✓ Correctly calculated time 186s
- ✓ Nearest minute of the above value 3 mins

Question 28 (3 marks)

A closed ended tube of length L is designed to play a note at 440Hz in air. It resonates at the fundamental harmonic. The same tube is filled with another gas with a speed of sound of 926ms^{-1}. Calculate the resonant frequency of the tube of gas if it resonates at the first harmonic.



3

$v = f\lambda$

$v_{air} = 340ms^{-1}$, $\lambda = \frac{v}{f} = \frac{340ms^{-1}}{440Hz} = 0.78m$

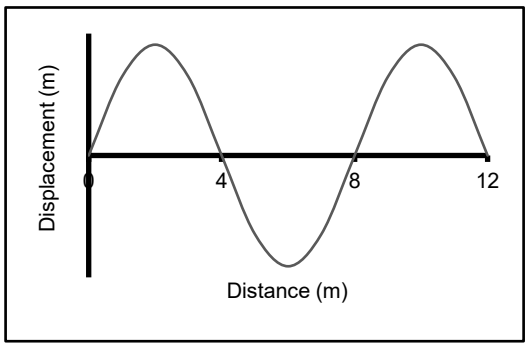
$L = \frac{\lambda}{4} = 0.19m$

$f = \frac{v}{\lambda} = \frac{926}{0.78} = 1200$ Hz

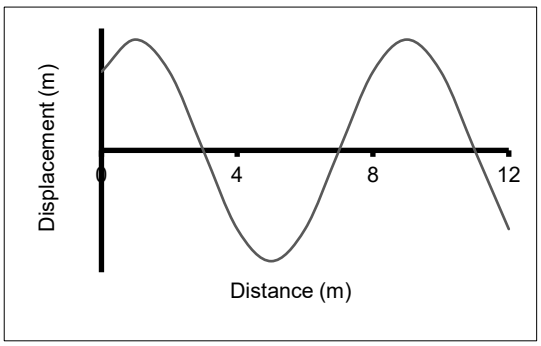
✓ v=fλ
✓ wavelength calculated 0.19m
✓ Frequency calculated to 3 S.F. 1120Hz

Question 29 (5 marks)

The graphs show the same wave drawn 0.25 seconds apart.



Graph 1 drawn at time t = 0.6 s



Graph 2 drawn at time 0.85 s

(a) Determine the maximum possible period for this wave. 3

$T = \frac{\lambda}{v} = \frac{\lambda t}{d} = \frac{8 \times 0.25}{1} = 2s$

correct value and units = 3 marks

if states wavelength = 8m then got 1 mark

(b) Calculate the frequency of the wave. 1

$f = \frac{1}{T} = \frac{1}{2} = 0.5\ Hz$

(c) Calculate the speed of the wave. 1

$v = f\lambda = 0.5 \times 8 = 4\ ms^{-1}$

Question 30 (4 marks)

The space probe Juno was launched on August 2011 to investigate the planet Jupiter. Upon arrival at Jupiter in July 2016, the probe turned on all its instruments, which consumes 500W.

Intensity of sunlight at Earth's Orbit (W/m^2)	*Orbital distance for Earth (km)*	*Orbital distance for Jupiter (km)*
1366	1.50×10^{11}	7.79×10^{11}

(a) Calculate the intensity of sunlight at Jupiter 2

$I = \frac{k}{d^2} = 1366 = \frac{k}{(1.5\times10^{11})^2}$ $k = 3.06\times10^{25}$ ← XXXX

1 mark if writes correct formula

$I_J = \frac{k}{d^2} = \frac{3.06\times10^{25}}{(7.79\times10^{11})^2} = 50.4\ Wm^{-2}$ ← XXXX

2 marks, correct answer with units
1 mark correct answer, wrong units

(b) Calculate the area of the solar cells required to power the probe, supposing the cells are 45% efficient 2

$A = \frac{P}{I} = \frac{500 \div 45\%}{50.4} = 22\ m^2$ ← XXX

XXXXX

2 marks, correct answer with units
1 mark correct answer, wrong units

correct carry on allowed

DO NOT WRITE HERE

DO NOT WRITE HERE

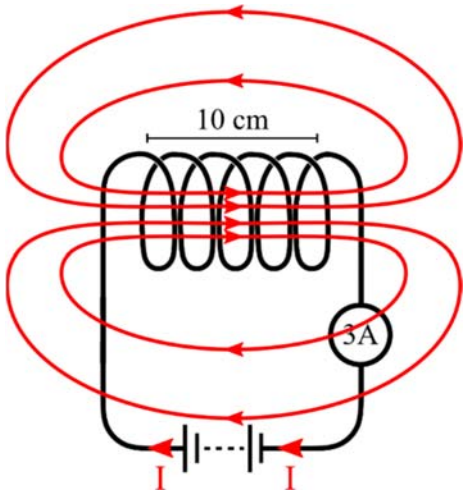
Question 31 (4 marks)

(a) Below is a diagram of a solenoid. Draw the direction of conventional current on the diagram. **1**

✓ conventional current correctly indicated

(b) Draw on the diagram below the magnetic field produced by the current. **1**

✓ magnetic field correctly indicated (at least one complete, separate loop above & below)



(b) Calculate the magnitude of the magnetic field created by the current at a point inside the solenoid. **2**

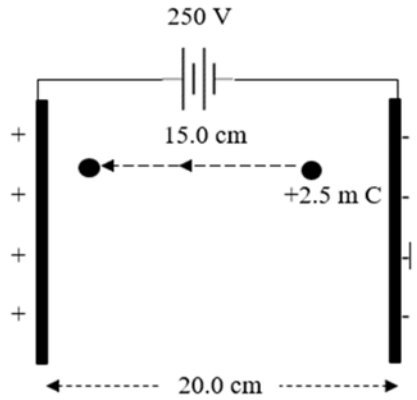
$B = \frac{\mu_0 NI}{L} = \frac{4\pi \times 10^{-7} \times 5 \times 3}{0.10} = 1.88 \times 10^{-4}\ \text{T}$ *OR* $= \frac{4\pi \times 10^{-7} \times 6 \times 3}{0.10} = 2.26 \times 10^{-4}\ \text{T}$

✓ correct answer

✓ answer with correct units

Question 32 (4 marks)

A charge of +2.5 mC is moved 15.0 cm within an electric field **E** between two parallel charged plates, as shown in the diagram. The plates are 20.0 cm apart and are connected to a 250 V DC power source.



(a) Calculate the force required to move the +2.5 mC charge along the direction shown. **2**

$$E = \frac{V}{d} = \frac{250}{0.200} = 1250$$

$$F = qE = 2.5 \times 10^{-3} \times 1250 = 3.125 = 3.1 \text{ N}$$

✓ correct answer
✓ correct units & sig figs

(b) Calculate by how much the charge's potential energy will change. State whether it will increase or decrease by being moved in such a way. **2**

$$E = \frac{V}{d} \Rightarrow V = Ed = 1250 \times 0.15 = 187.5$$

$$V = \frac{\Delta U}{q} \Rightarrow \Delta U = Vq = 187.5 \times 2.5 \times 10^{-3} = 0.469 = 0.47 \text{ J (increasing)}$$

✓ correct answer & units
✓ correct way (increases)