JAMES RUSE AGRICULTURAL HIGH SCHOOL

2019

PHYSICS

YEAR 11 EXAMINATION

General Instructions

- Reading time - 5 minutes
- Working time - 2 hours
- Calculators approved by NESA may be used
- Write using black pen
- Draw diagrams using pencil
- A Data Sheet, Formulae Sheet and a Periodic Table are provided
- Write your Student Number in the space provided on the top of the first page of Part B.

Total: 80 marks

PART A 20 Multiple Choice Questions **20** marks Allow about 30 minutes

PART B Short Response Questions **60** marks Allow about 90 minutes

Part A – 20 marks

Attempt Questions 1-20

Allow about 30 minutes for this part

Use the multiple choice answer sheet on page 10.

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

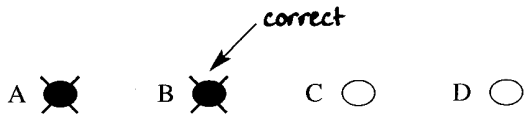
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

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

A ● B ⊗ C ○ D ○

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



PART A 20 marks.

Question 1

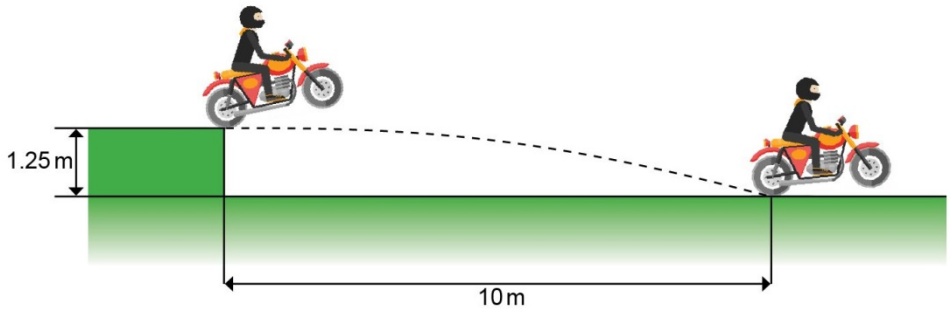
A rock is thrown vertically from the edge of a cliff. The rock reaches the maximum height of 15 m above the edge and then falls down to the bottom of the cliff 35 m below the cliff.

What is the distance travelled by the rock?

A. 30 m
B. 35 m
C. 50 m
D. 65 m

Question 2

A motorcycle stunt-rider moving horizontally, takes off from a point 1.25 m above the ground.



She lands 10 m away from the take-off point, as shown, and it takes 0.5 s to reach the ground after beginning the jump. The horizontal component of her velocity remains constant.

What was the speed at take-off, rounded to the nearest integer?

A. 5 m s^{-1}
B. 10 m s^{-1}
C. 15 m s^{-1}
D. 20 m s^{-1}

Question 3

A car was driven from a starting point a distance of 2 km east and then 6 km north, then a further 4 km east and finally 2 km south.

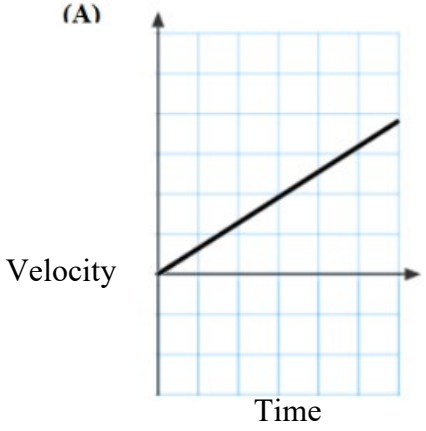
What is the magnitude, rounded to the nearest km, of the car's displacement from its starting point?

A. 6 km
B. 7 km
C. 8 km
D. 10 km

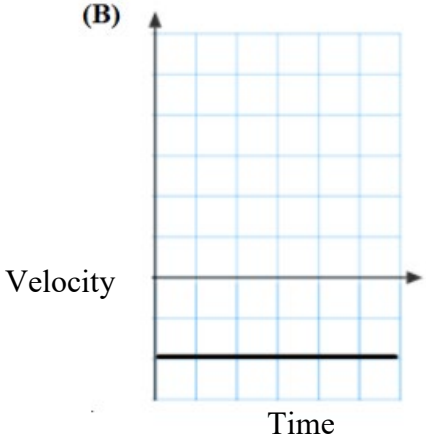
Question 4

Which of the following graphs best represents the velocity as a function of time of an object thrown vertically upwards?

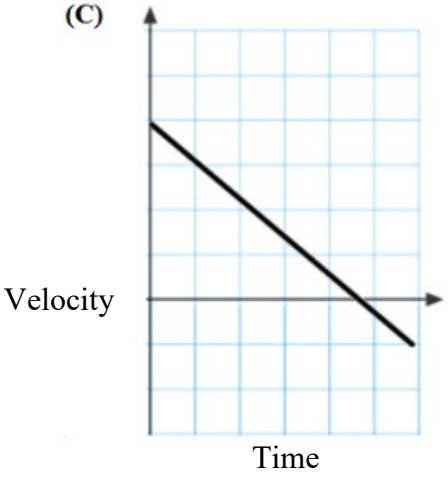
(A)



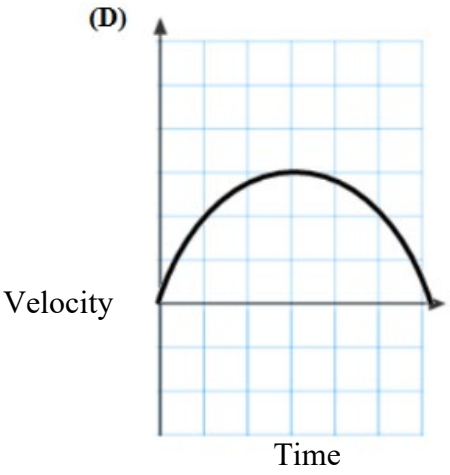
(B)



(C)



(D)



Question 5

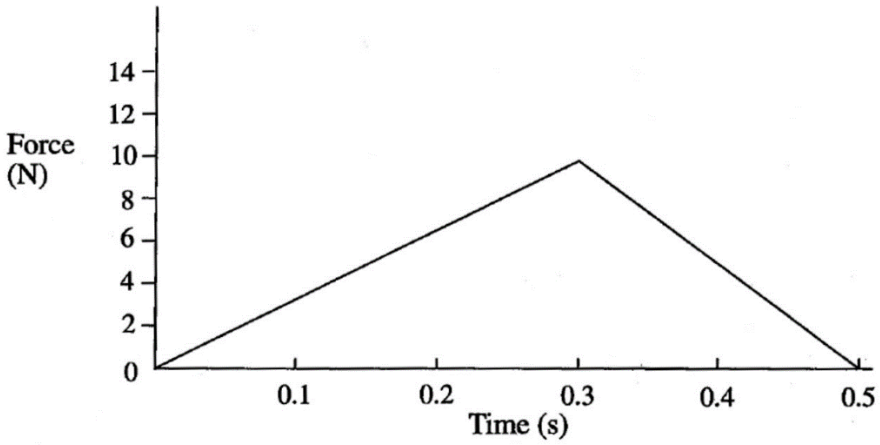
A loudspeaker mounted on a stationary car is producing a sound having a speed (v) and wavelength (λ_s). The car producing the sound then drives towards a stationary observer at a constant speed.

Which row in the table correctly shows the speed of the sound and its wavelength, as measured by the stationary observer?

	Wave speed	*Wavelength* λ_o
A.	Greater than v	Larger than λ_s
B.	Equal to v	Larger than λ_s
C.	Equal to v	Less than λ_s
D.	Greater than v	Less than λ_s

Question 6

The graph shows the net force applied to a toy car.

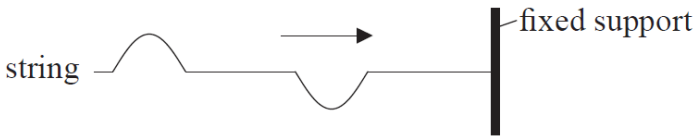


The change in momentum of the car, in kg m s^{-1}, is closest to:

A. 2.5
B. 3
C. 5
D. 10

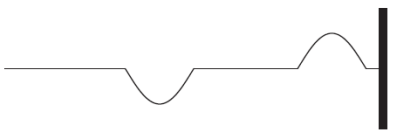
Question 7

A string is held horizontally with one end attached to a fixed support. Two pulses are created at the free end of the string. The pulses are moving towards the fixed support as shown in the diagram below.

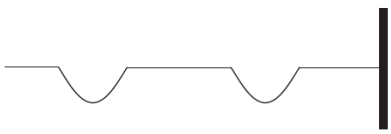


Which one of the following diagrams is a possible subsequent picture of the string?

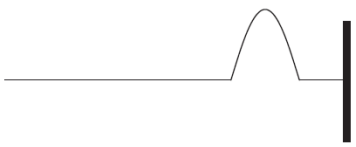
A.



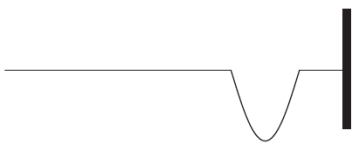
B.



C.

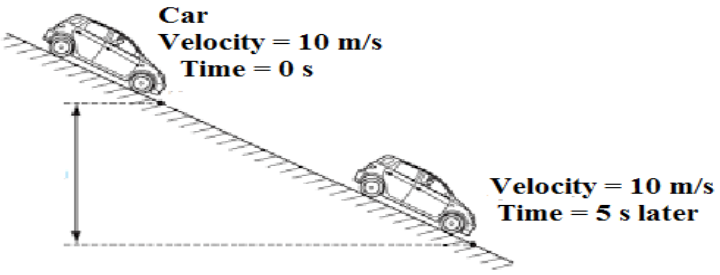


D.

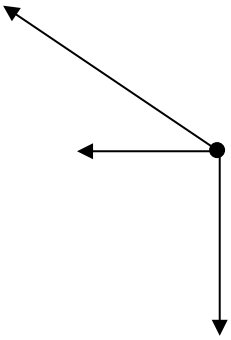


Question 8

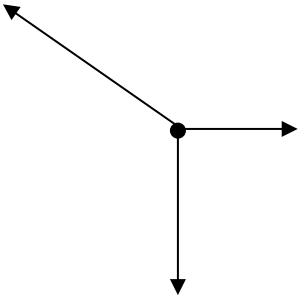
Which of the following free-body diagrams represents the car going downhill without acceleration?



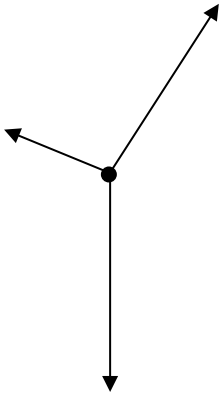
A.



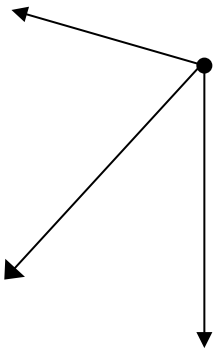
B.



C.

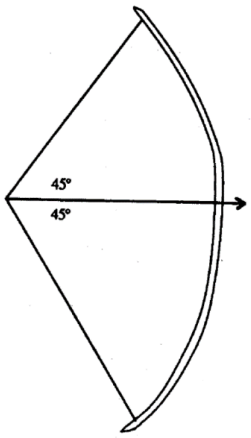


D.



Question 9

Robin Hood pulls back the string on his bow so that the string makes an angle of 45° to the arrow. The tension in the string at this instant is 200 N.



The initial acceleration of a 0.1 kg arrow released from this position would be closest to:

A. 1000 m s^{-2}
B. 1410 m s^{-2}
C. 2000 m s^{-2}
D. 2830 m s^{-2}

Question 10

A moving ball of mass 2M collides with a stationary ball of mass M.

Figure 1 shows the balls and their motions just before the collision.
Figure 2 shows the balls and their motions just after the collision.

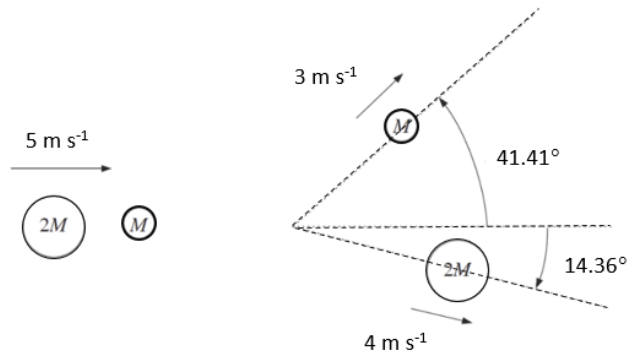


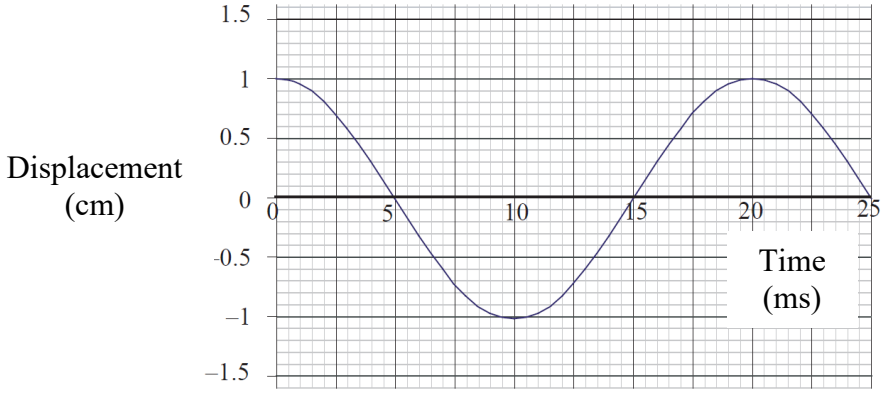
Fig. 1 Fig. 2

Which statement correctly describes the collision?

A. Momentum is conserved and the collision is elastic.
B. Momentum is not conserved and the collision is inelastic.
C. Momentum is conserved and the collision is inelastic.
D. Momentum is not conserved and the collision is elastic.

Question 11

A wave is travelling through a medium. The diagram shows the variation with time t of the displacement d of a particle of the medium from $t = 0$ to $t = 25\ ms$.



Which row of the table shows the frequency and amplitude of this wave?

	Frequency (Hz)	*Amplitude (cm)*
A.	2.0×10^{-2}	2.0
B.	2.0×10^{-2}	1.0
C.	50	2.0
D.	50	1.0

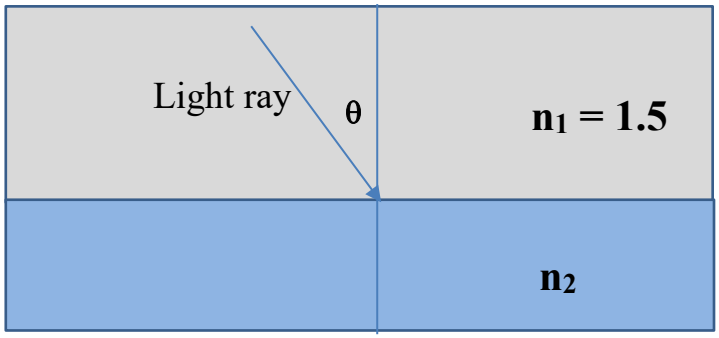
Question 12

Musicians use beats to tune their instruments. As the two notes get closer in pitch or frequency,

A. the beats sound slower and when they match perfectly, the beats disappear altogether.
B. the beats sound slower and when they match perfectly, the beats become louder.
C. the beats sound faster and when they match perfectly, the beats disappear altogether.
D. the beats sound faster and when they match perfectly, the beats become louder.

Question 13

The following diagram shows a ray of light incident on the boundary between two transparent media.

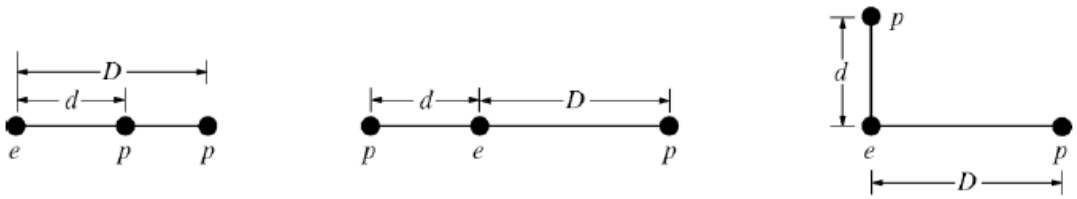


Which conditions must be satisfied for total internal reflection of this ray to occur at the boundary?

A. $n_2 < 1.5$; $\theta >$ the critical angle at the boundary
B. $n_2 < 1.5$; $\theta <$ the critical angle at the boundary
C. $n_2 > 1.5$; $\theta >$ the critical angle at the boundary
D. $n_2 > 1.5$; $\theta <$ the critical angle at the boundary

Question 14

The figure below shows an electron (e) and two protons (p) arranged in 3 different ways.



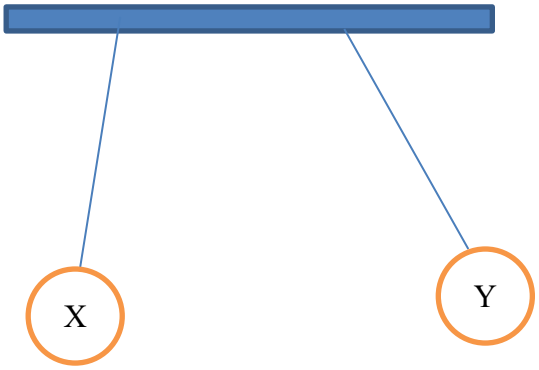
Which of the following is true about the magnitude F_1, F_2, F_3 of the net electrostatic force acting on the electron due to the two protons?

A. $F_1 > F_2 > F_3$
B. $F_2 > F_1 > F_3$
C. $F_1 > F_3 > F_2$
D. $F_3 > F_2 > F_1$

Question 15

Two charged spheres made of different non-conducting materials are suspended near each other using strings of the same length.

They behave as shown in the diagram which is drawn to scale.



Which of the following pairs of statements are correct?

A.	• The mass of X is greater than the mass of Y. • Both objects are positively charged.
B.	• The charge on X is greater than the charge on Y. • Both objects are negatively charged.
C.	• The force on Y due to the charge on X is greater than the force on X due to the charge on Y. • The force of gravity on X is greater than the force of gravity on Y.
D.	• The net force on Y is greater than the net force on X. • The electrostatic force between the spheres is greater than the force of gravity acting on either of them.

Question 16

Two cars X and Y move away from the same point. Car X moves north at 40 km h^{-1} and car Y moves east at 30 km h^{-1}.

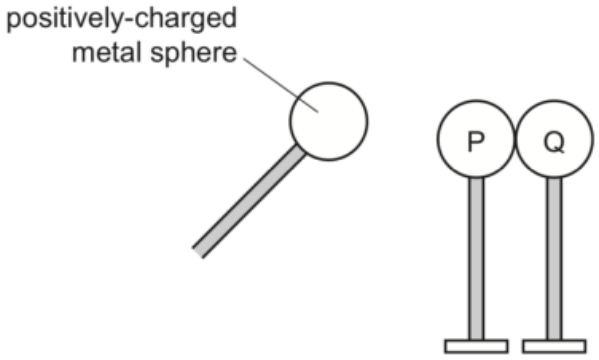
Which row of the table shows the correct information about velocity of the car X relative to the car Y?

	Speed of X relative to Y (km h^{-1})	*Direction of travel of X relative to Y*
A.	70	Remains constant
B.	70	Changes as the distance between the cars changes
C.	50	Remains constant
D.	50	Changes as the distance between the cars changes

Question 17

Two metal spheres P and Q are mounted on insulating stands and are touching each other. They are uncharged.

A positively-charged metal sphere on an insulating handle is brought close to P but does not touch it. This induces charges on P and Q.



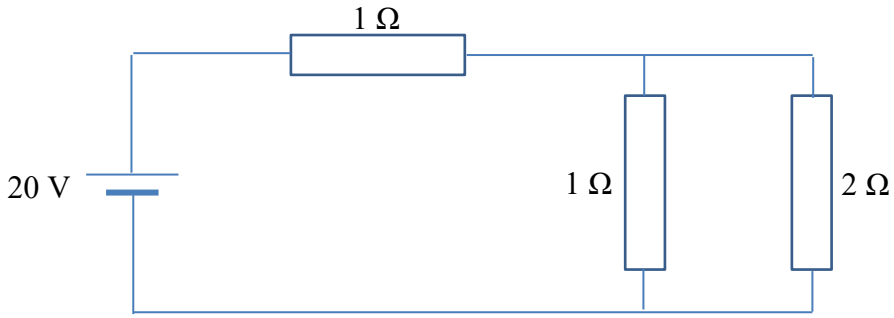
The positively-charged metal sphere is held in this position and sphere Q is moved to the right, away from sphere P.

Which row of the table shows the charge induced on P and Q and the comparison of the magnitudes of these charges?

	Charge on P	*Charge on Q*	*Magnitudes of the charges*
A.	negative	positive	equal
B.	negative	positive	unequal
C.	positive	negative	equal
D.	positive	negative	unequal

Question 18

What is the current through the 2 ohm resistor in the circuit below?



A. 2 A

B. 4 A

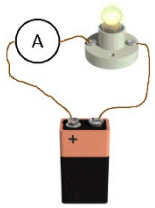
C. 5 A

D. 20 A

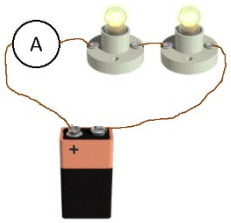
Question 19

Assuming that each of the lamps and batteries is the same, which of the following circuits has the greatest current flowing from the battery?

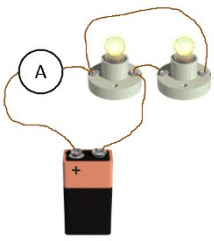
A.



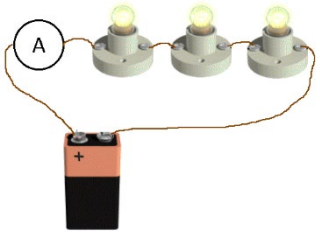
B.



C.

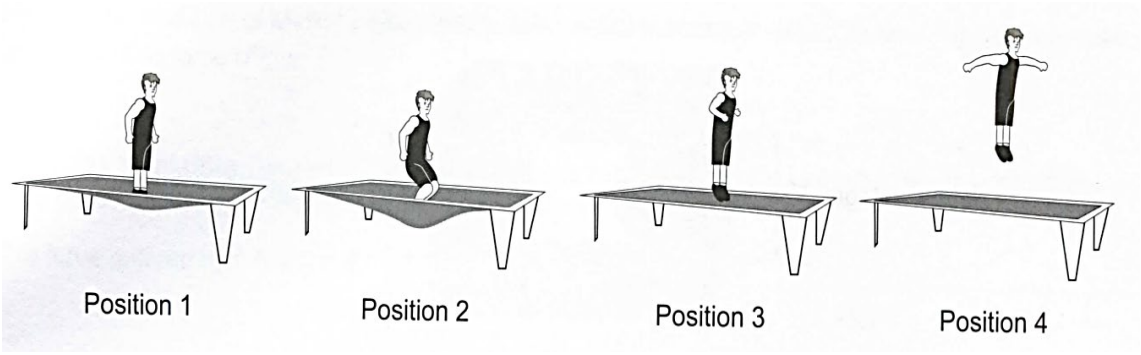


D.



Question 20

James was jumping on a trampoline as shown below. The diagrams show four successive positions during one jump.



Position 1	Position 2	Position 3	Position 4
He is moving downwards.	He is at his lowest point	His feet have just left the trampoline	He is at his highest point

Which statement correctly describes aspects of his motion?

A. At position 1 his acceleration and velocity are in the same direction.
B. At position 2 his acceleration and his velocity are both zero.
C. At positions 2 and 4 his acceleration has opposite directions.
D. At positions 1 and 3 his acceleration is in the same direction.

ANSWER BOOKLET

PART A Multiple Choice Answer Sheet

Student No. …….....

20 marks

Choose the most appropriate answer and fill in the response oval completely.

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

PART B 13 questions 60 marks

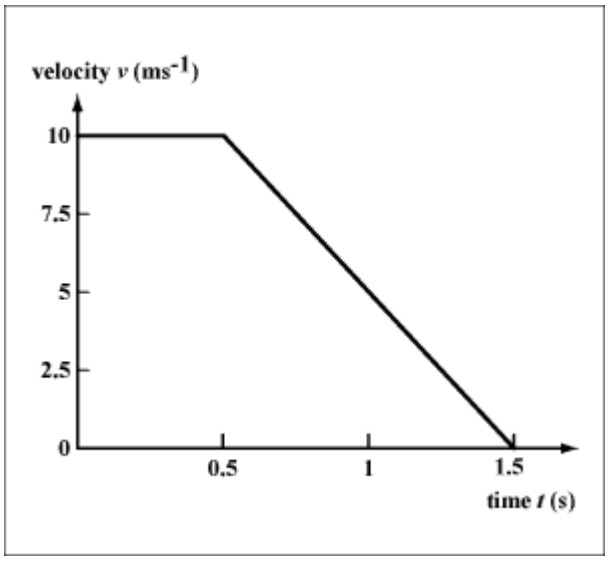
Attempt questions 21-32.

Allow about 90 minutes for this part.

Show all relevant working in questions involving calculations.

Question 21 (6 marks)

The graph shows the velocity of a car over the time interval shown.



(a) Describe the car's motion over this time interval in words. **2**

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(b) How far did the car move in the first 0.5 s? **2**

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(c) Calculate the acceleration of the car at time t = 1.0 seconds. **2**

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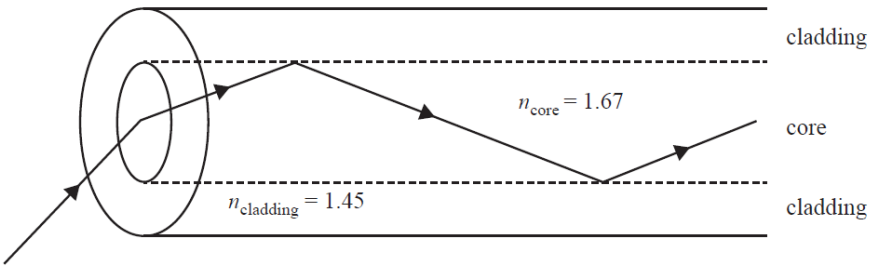
Question 22 (5 marks)

Optical fibres are constructed using transparent materials with different refractive indices. The figure below shows one type of optical fibre that has a cylindrical core and surrounding cladding. Laser light of wavelength 565 nm is shone from air into the optical fibre.



(a) Calculate the frequency of the laser before it enters the optical fibre. **2**

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(b) Calculate the critical angle for the laser light at the cladding-core boundary. Show all working. **2**

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(c) What is the frequency of the light in the fibre? **1**

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Question 23 (4 marks)

Contrast mechanical waves and electromagnetic waves. Use examples to support your answer. **4**

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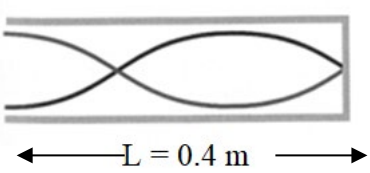
Question 24 (2 Marks)

The standing wave in a closed pipe having a length of 0.4 m is represented by the diagram below.



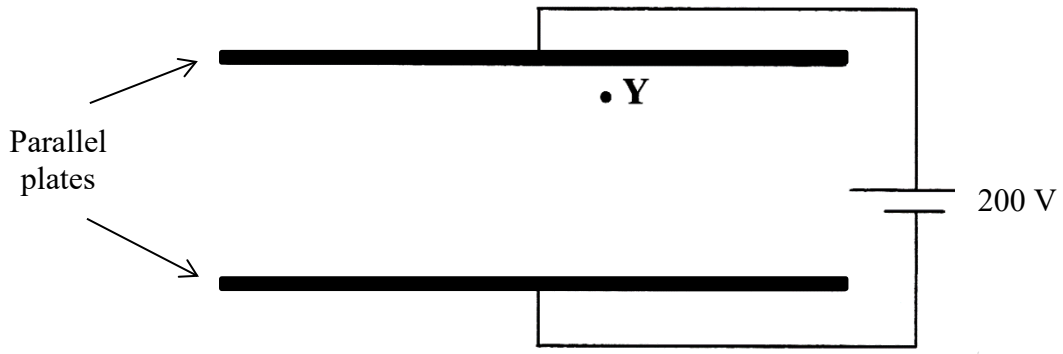
The speed of the sound wave in air is 340 $m\ s^{-1}$. **2**

Complete the table below.

Wavelength (m)	Number of antinodes

Question 25 (3 marks)

In the setup below, two parallel plates, 20 mm apart, are connected to a 200 V DC source.



(a) Draw the electric field lines between the two parallel plates **1**

(b) Calculate the force on an electron placed at Y. **2**

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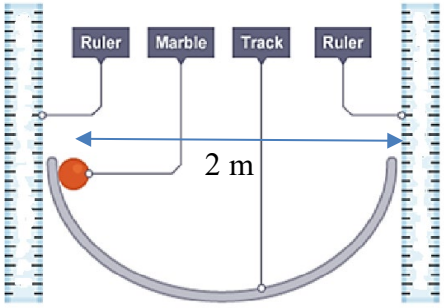
Question 26 (5 Marks)

A student investigated the motion of a marble released from different starting points on a semicircular track having a diameter of 2 metres.
The diagram shows the apparatus he used and how it was set up.



The student released the marble from different heights above the bottom of the track. He recorded the height from which the marble was released and the height that it reached on the opposite side of the track. He released the ball from the same chosen starting point three times and measured the height reached each time.

(a) What is the independent variable in this investigation? **1**

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(b) Propose a hypothesis that this investigation was set up to test. **1**

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(c) Identify a variable the student would have kept constant in this investigation. **1**

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The table shows the student's experimental results:

Release height (cm)	*Height reached (cm) Trial 1*	*Height reached (cm) Trial 2*	*Height reached (cm) Trial 3*
20	15	14	14
40	29	33	32
60	47	19	46
80	65	61	63

(d) In analysing his results, the student chose to omit some data from his calculations. Identify the data he is most likely to have omitted and state why this data was omitted in his analysis. **2**

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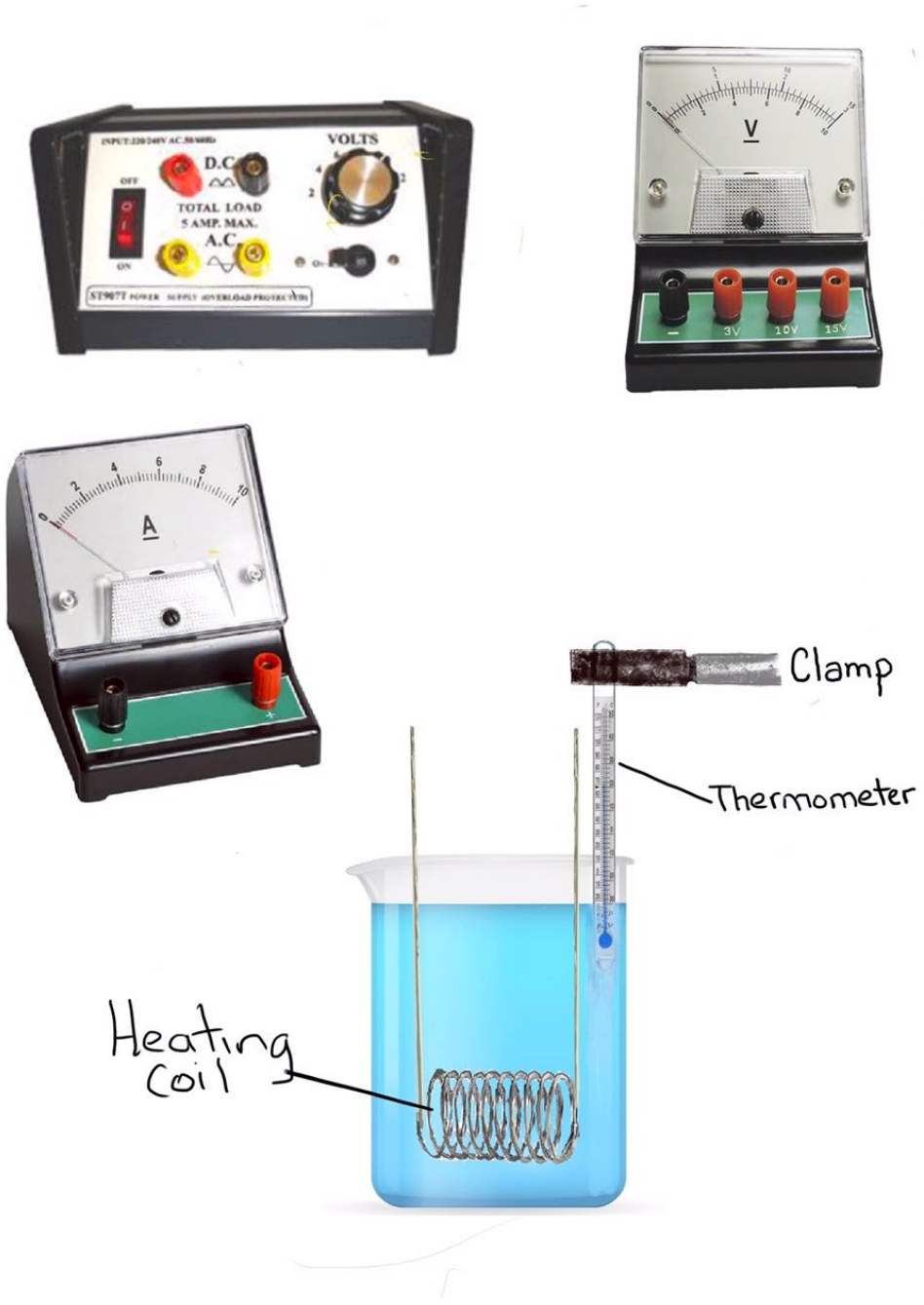
Question 27 (10 Marks)

An investigation was conducted to determine the electrical energy required to raise the temperature of 150 mL of water by 10 degrees Celsius using the electrical energy dissipated by a resistive wire coil. The apparatus used for the experiment is shown. The power pack voltage selector knob was set on 8 V and students carrying out the investigation remembered that this was not necessarily the exact output voltage. Both meters are DC meters. The voltmeter has three scales: 3 V, 10 V and 15 V.

(a) On the diagram of the apparatus show, using lines to represent connecting wires, how the components would be connected so that the current through the coil and the voltage applied to the coil could be measured simultaneously. (4 marks).



The thermometer was held in the water using a retort stand and clamp as shown, so that the bottom of the thermometer remained stationary 1 cm below the surface of the water. The heating coil was held 1 cm above the bottom of the beaker by a supporting device that is not shown on the diagram.

Five centimetres of the wire used to form the heating coil, is above the surface of the water to allow for the connection of the coil to the circuit. The submerged wire had a length of 40 cm.

The temperature of the water was measured before the current was turned on. When current was turned on, a stopwatch was used to time the duration of the heating process and the final temperature was then recorded. The students were careful not to move the thermometer during the heating process.

(b) State one source of systematic error evident in this experiment as it has been described and explain how the error would affect the results. (3 marks)

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(c) The following experimental results were obtained when 150 mL of water was heated in this investigation.

Initial temperature of water: 20ºC. Final temperature of water 30ºC.
Heating coil: Current 5 A, Voltage 3 V.
Heating time: 10 minutes.

Calculate the electrical energy produced by the heating coil. (3 marks)

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Question 28 (5 Marks)

A powerboat moves with a velocity of 12 m s^{-1} north relative to the water in a river flowing with a velocity of 5 m s^{-1} east. The river is 169 m wide.

(a) Calculate the velocity of the powerboat relative to the river bank. Include a relevant vector diagram in your answer. **3**

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(b) How long does the powerboat take to cross the river? **1**

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(c) How far downstream from its starting point on one side of the river does the powerboat travel before it reaches the opposite bank? **1**

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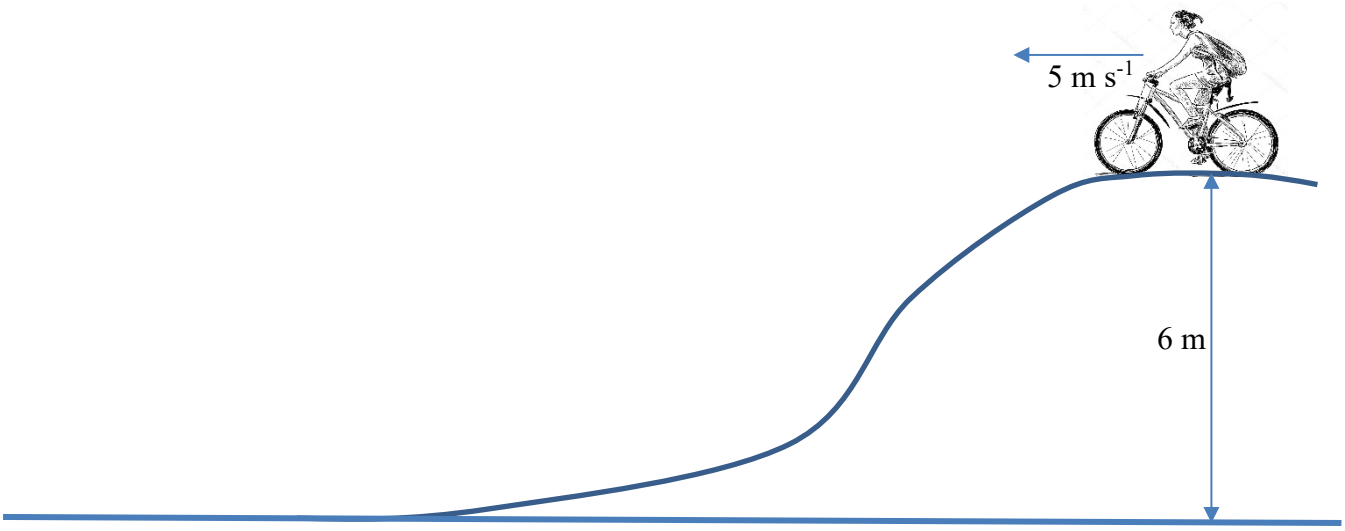
Question 29 (5 Marks)

A 58 kg girl riding on a 12 kg bike at the top of a 6 m hill, is moving at a horizontal velocity of 5 m s^{-1}.



(a) The bike then travels down the hill a vertical distance of 6 metres before reaching the horizontal ground at the bottom of the hill. Assume that no frictional forces oppose the motion of the bike as it travels down the hill.

Calculate the speed of the bike at the bottom of the hill. **3**

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(b) At the bottom of the hill she applies the brakes on the bike which skids a distance of 20 metres before coming to a stop.

Calculate the force of friction acting on the bike. **2**

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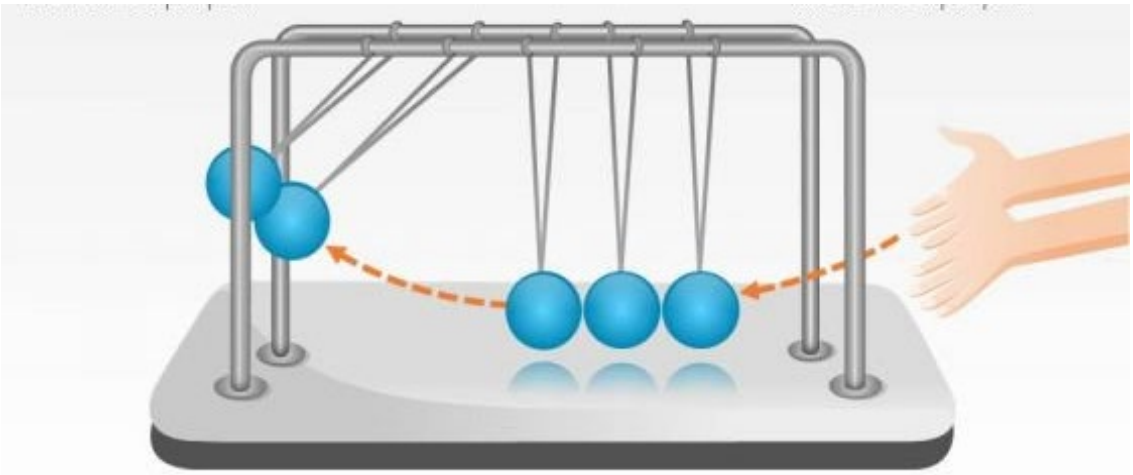
Question 30 (4 Marks)

The diagram shows a piece of apparatus sometimes called "Newton's cradle". The result of raising the rightmost two balls together and then releasing them so that they both swing down and hit the stationary three balls is shown in the diagram.



A student proposes that it should be possible to let the two balls swing down and hit the three stationary balls, resulting in only one ball moving away from the line of stationary balls, but at twice the velocity with which the two swinging balls were moving.

Evaluate the student's proposal with reference to the relevant laws of physics. **4**

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Question 31 (7 Marks)

(a) X and Y are two lamps. X is rated at 12 V 36 W and Y at 4.5 V 2.0 W. Calculate the current through the lamps X and Y when it is operated at its correct (nominal) working voltage.

X .....

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Y .....

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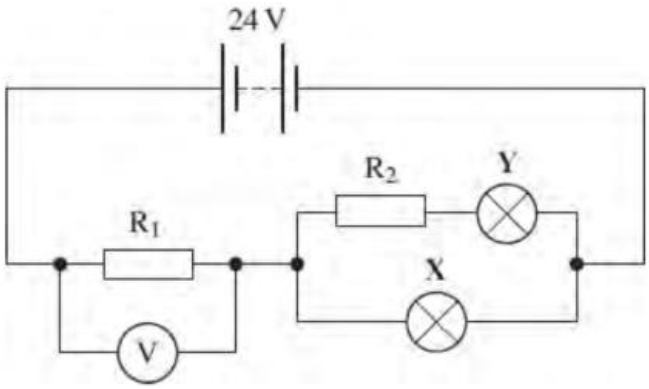
(b) The two lamps are then connected in the circuit shown in the circuit diagram below. The battery has an emf of 24 V and negligible internal resistance. The resistors, R_1 and R_2 are chosen so that the lamps are operating at their correct working voltage.



(i) Calculate the potential difference across R_1 **2**

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(ii) Calculate the current in R_1 **2**

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(iii) What deduction can be made about the sum of the voltage drops across R1 and X? **1**

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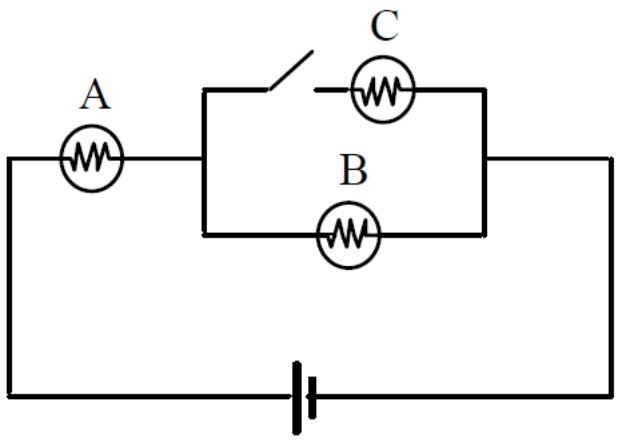
Question 32 (4 Marks)

Three identical light bulbs A, B and C, are connected to a battery as shown in the circuit diagram below.



What happens to the brightness of bulbs A and B if the switch is closed? Justify your answer using physics principles. **4**

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END OF EXAMINATION ☺

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2019

PHYSICS

YEAR 11 EXAMINATION

General Instructions

- Reading time - 5 minutes
- Working time - 2 hours
- Calculators approved by NESA may be used
- Write using black pen
- Draw diagrams using pencil
- A Data Sheet, Formulae Sheet and a Periodic Table are provided
- Write your Student Number in the space provided on the top of the first page of Part B.

Total: 80 marks

PART A 20 Multiple Choice Questions **20** marks Allow about 30 minutes

PART B Short Response Questions **60** marks Allow about 90 minutes

Part A – 20 marks

Attempt Questions 1-20

Allow about 30 minutes for this part

Use the multiple choice answer sheet on page 10.

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

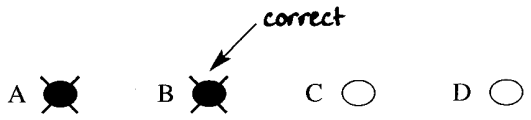
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

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

A ● B ⊗ C ○ D ○

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



PART A 20 marks.

Question 1

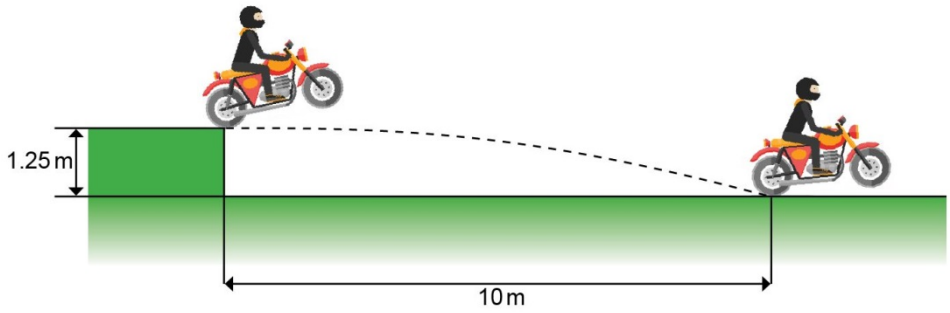
A rock is thrown vertically from the edge of a cliff. The rock reaches the maximum height of 15 m above the edge and then falls down to the bottom of the cliff 35 m below the cliff.

What is the distance travelled by the rock?

A. 30 m
B. 35 m
C. 50 m
D. 65 m

Question 2

A motorcycle stunt-rider moving horizontally, takes off from a point 1.25 m above the ground.



She lands 10 m away from the take-off point, as shown, and it takes 0.5 s to reach the ground after beginning the jump. The horizontal component of her velocity remains constant.

What was the speed at take-off, rounded to the nearest integer?

A. 5 m s^{-1}
B. 10 m s^{-1}
C. 15 m s^{-1}
D. 20 m s^{-1}

Question 3

A car was driven from a starting point a distance of 2 km east and then 6 km north, then a further 4 km east and finally 2 km south.

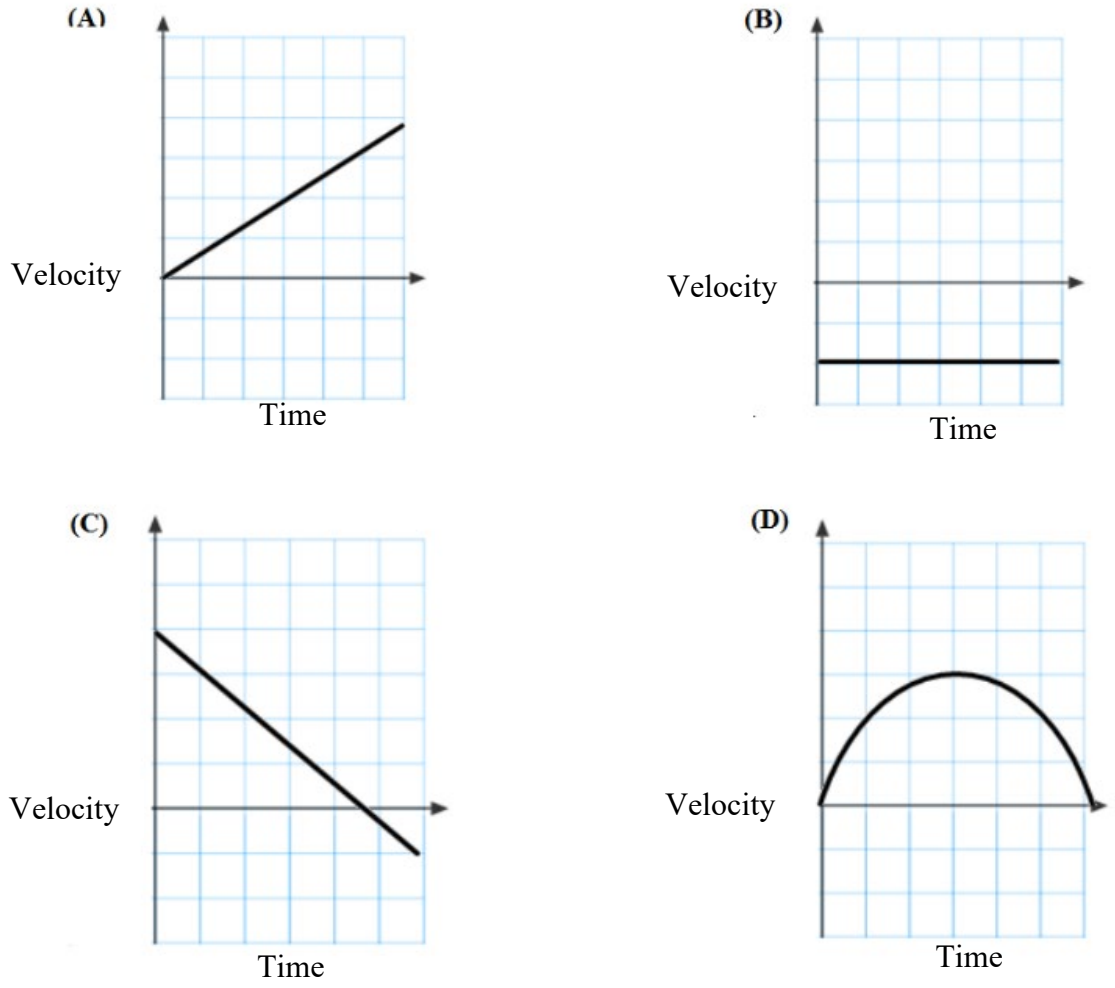
What is the magnitude, rounded to the nearest km, of the car's displacement from its starting point?

A. 6 km
B. 7 km
C. 8 km
D. 10 km

Question 4

Which of the following graphs best represents the velocity as a function of time of an object thrown vertically upwards?

C



Question 5

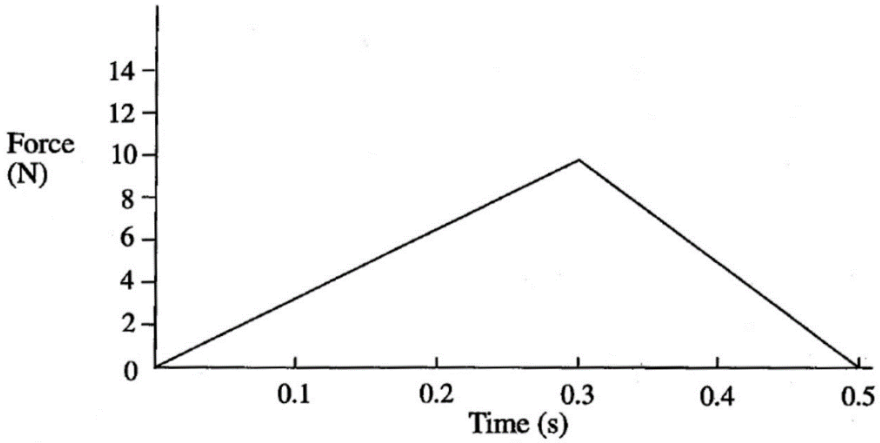
A loudspeaker mounted on a stationary car is producing a sound having a speed (v) and wavelength (λ_s). The car producing the sound then drives towards a stationary observer at a constant speed.

Which row in the table correctly shows the speed of the sound and its wavelength, as measured by the stationary observer?

	Wave speed	*Wavelength* λ_o
A.	Greater than v	Larger than λ_s
B.	Equal to v	Larger than λ_s
C.	Equal to v	Less than λ_s
D.	Greater than v	Less than λ_s

Question 6

The graph shows the net force applied to a toy car.

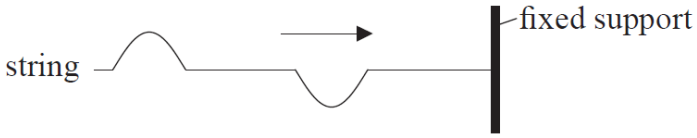


The change in momentum of the car, in kg m s^{-1}, is closest to:

A. 2.5
B. 3
C. 5
D. 10

Question 7

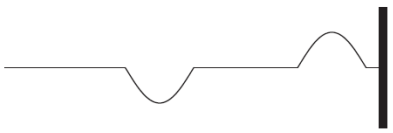
A string is held horizontally with one end attached to a fixed support. Two pulses are created at the free end of the string. The pulses are moving towards the fixed support as shown in the diagram below.



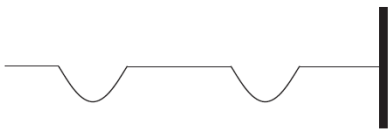
Which one of the following diagrams is a possible subsequent picture of the string?

C

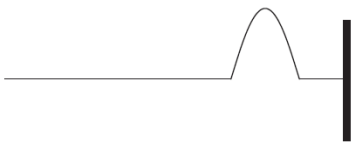
A.



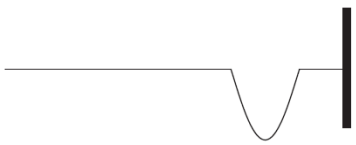
B.



C.

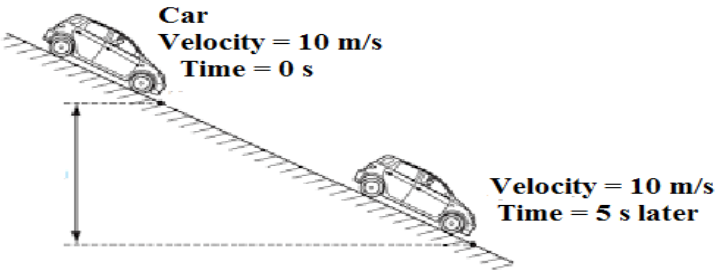


D.

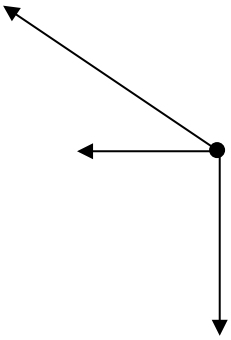


Question 8

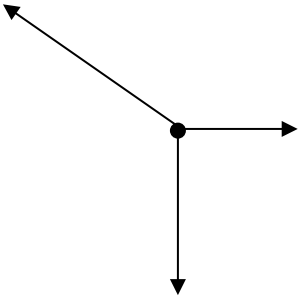
Which of the following free-body diagrams represents the car going downhill without acceleration?



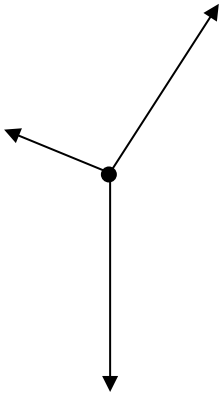
A.



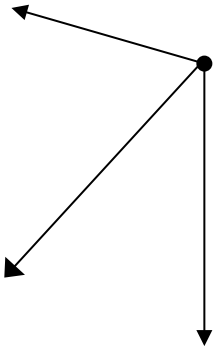
B.



C.

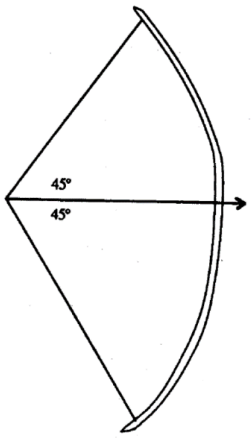


D.



Question 9

Robin Hood pulls back the string on his bow so that the string makes an angle of 45° to the arrow. The tension in the string at this instant is 200 N.



The initial acceleration of a 0.1 kg arrow released from this position would be closest to:

A. 1000 m s^{-2}
B. 1410 m s^{-2}
C. 2000 m s^{-2}
D. 2830 m s^{-2}

Question 10

A moving ball of mass 2M collides with a stationary ball of mass M.

Figure 1 shows the balls and their motions just before the collision.
Figure 2 shows the balls and their motions just after the collision.

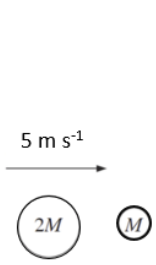


Fig. 1

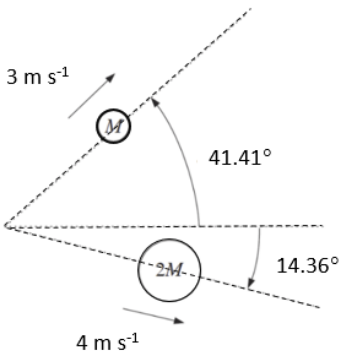


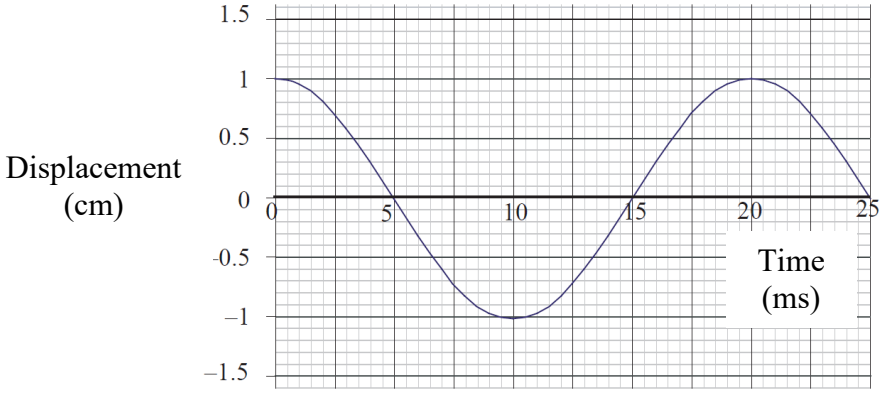
Fig. 2

Which statement correctly describes the collision?

A. Momentum is conserved and the collision is elastic.
B. Momentum is not conserved and the collision is inelastic.
C. Momentum is conserved and the collision is inelastic.
D. Momentum is not conserved and the collision is elastic.

Question 11

A wave is travelling through a medium. The diagram shows the variation with time t of the displacement d of a particle of the medium from $t = 0$ to $t = 25\ ms$.



Which row of the table shows the frequency and amplitude of this wave?

	Frequency (Hz)	*Amplitude (cm)*
A.	2.0×10^{-2}	2.0
B.	2.0×10^{-2}	1.0
C.	50	2.0
D.	50	1.0

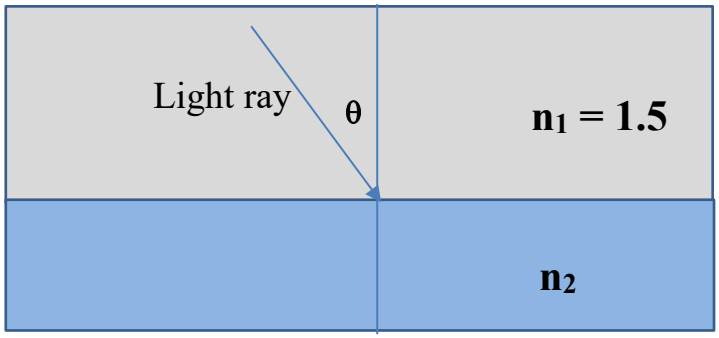
Question 12

Musicians use beats to tune their instruments. As the two notes get closer in pitch or frequency,

A. the beats sound slower and when they match perfectly, the beats disappear altogether.
B. the beats sound slower and when they match perfectly, the beats become louder.
C. the beats sound faster and when they match perfectly, the beats disappear altogether.
D. the beats sound faster and when they match perfectly, the beats become louder.

Question 13

The following diagram shows a ray of light incident on the boundary between two transparent media.

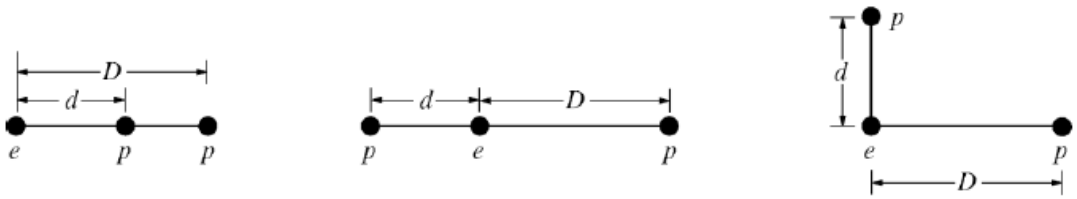


Which conditions must be satisfied for total internal reflection of this ray to occur at the boundary?

A. $n_2 < 1.5$; $\theta >$ the critical angle at the boundary
B. $n_2 < 1.5$; $\theta <$ the critical angle at the boundary
C. $n_2 > 1.5$; $\theta >$ the critical angle at the boundary
D. $n_2 > 1.5$; $\theta <$ the critical angle at the boundary

Question 14

The figure below shows an electron (e) and two protons (p) arranged in 3 different ways.



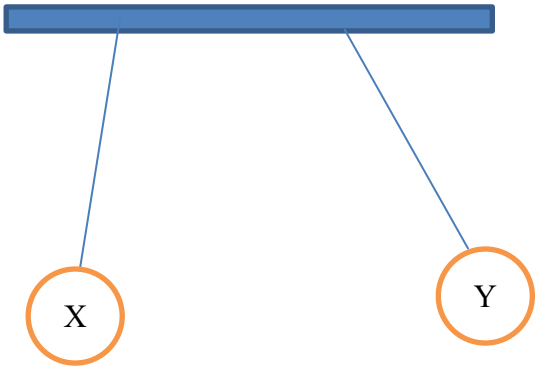
Which of the following is true about the magnitude F_1, F_2, F_3 of the net electrostatic force acting on the electron due to the two protons?

A. $F_1 > F_2 > F_3$
B. $F_2 > F_1 > F_3$
C. $F_1 > F_3 > F_2$
D. $F_3 > F_2 > F_1$

Question 15

Two charged spheres made of different non-conducting materials are suspended near each other using strings of the same length.

They behave as shown in the diagram which is drawn to scale.



Which of the following pairs of statements are correct?

A.	• The mass of X is greater than the mass of Y. • Both objects are positively charged.
B.	• The charge on X is greater than the charge on Y. • Both objects are negatively charged.
C.	• The force on Y due to the charge on X is greater than the force on X due to the charge on Y. • The force of gravity on X is greater than the force of gravity on Y.
D.	• The net force on Y is greater than the net force on X. • The electrostatic force between the spheres is greater than the force of gravity acting on either of them.

Question 16

Two cars X and Y move away from the same point. Car X moves north at 40 km h^{-1} and car Y moves east at 30 km h^{-1}.

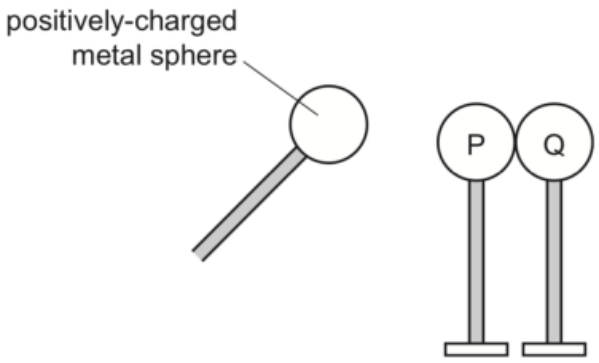
Which row of the table shows the correct information about velocity of the car X relative to the car Y?

	Speed of X relative to Y (km h^{-1})	*Direction of travel of X relative to Y*
A.	70	Remains constant
B.	70	Changes as the distance between the cars changes
C.	50	Remains constant
D.	50	Changes as the distance between the cars changes

Question 17

Two metal spheres P and Q are mounted on insulating stands and are touching each other. They are uncharged.

A positively-charged metal sphere on an insulating handle is brought close to P but does not touch it. This induces charges on P and Q.



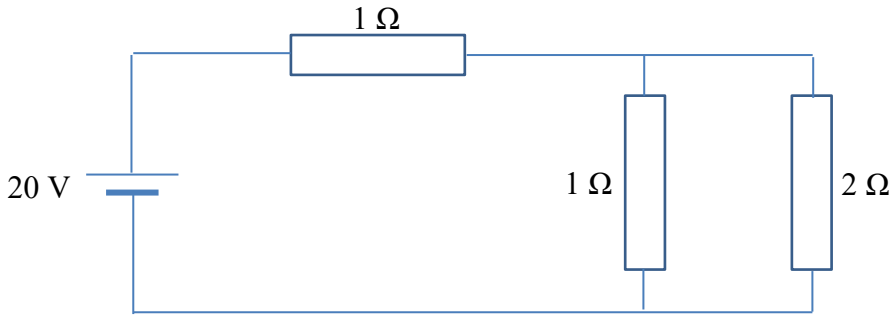
The positively-charged metal sphere is held in this position and sphere Q is moved to the right, away from sphere P.

Which row of the table shows the charge induced on P and Q and the comparison of the magnitudes of these charges?

	Charge on P	*Charge on Q*	*Magnitudes of the charges*
A.	negative	positive	Equal
B.	negative	positive	Unequal
C.	positive	negative	Equal
D.	positive	negative	Unequal

Question 18

What is the current through the 2 ohm resistor in the circuit below?



A. 2 A

B. 4 A

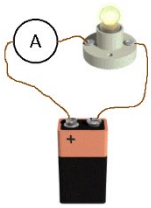
C. 5 A

D. 20 A

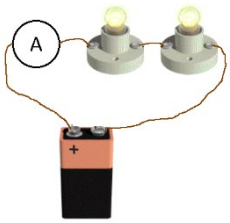
Question 19

Assuming that each of the lamps and batteries is the same, which of the following circuits has the greatest current flowing from the battery?

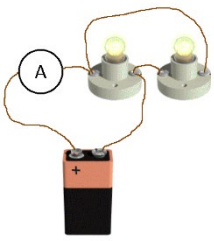
A.



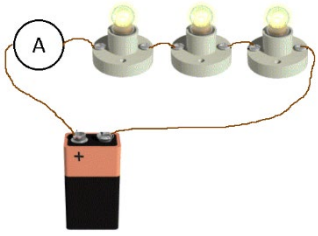
B.



C.

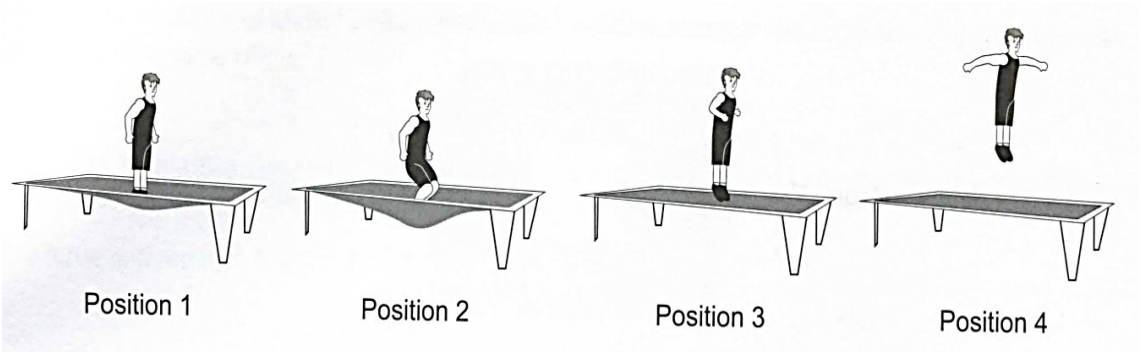


D.



Question 20

James was jumping on a trampoline as shown below. The diagrams show four successive positions during one jump.



Position 1	Position 2	Position 3	Position 4
He is moving downwards.	He is at his lowest point	His feet have just left the trampoline	He is at his highest point

Which statement correctly describes aspects of his motion?

A. At position 1 his acceleration and velocity are in the same direction.
B. At position 2 his acceleration and his velocity are both zero.
C. At positions 2 and 4 his acceleration has opposite directions.
D. At positions 1 and 3 his acceleration is in the same direction.

ANSWER BOOKLET

PART A Multiple Choice Answer Sheet

Student No. …….....

20 marks

Choose the most appropriate answer and fill in the response oval completely.

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

PART B 13 questions 60 marks

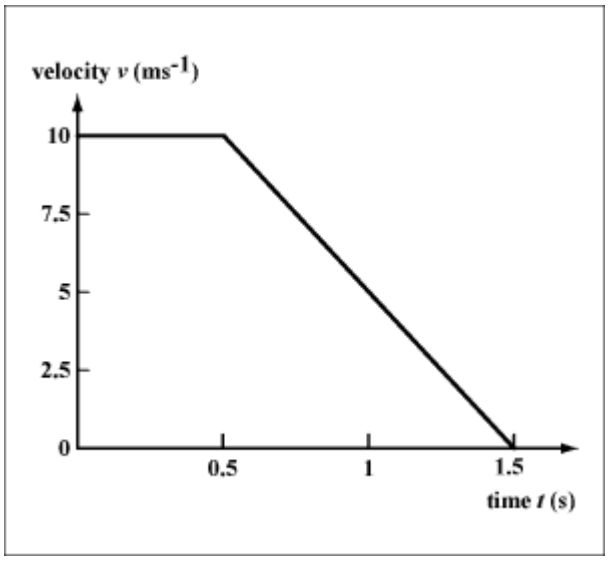
Attempt questions 21-32.

Allow about 90 minutes for this part.

Show all relevant working in questions involving calculations.

Question 21 (6 marks)

The graph shows the velocity of a car over the time interval shown.



(a) Describe the car's motion over this time interval in words. **2**

Criteria	Mark
Correct and complete description of the motion (uniform speed, uniform acceleration, stops)	2
Any two of the above (uniform speed, uniform acceleration and stops)	1

The car travels at a uniform speed and then it slows down with a uniform acceleration before coming to a stop.

(b) How far did the car move in the first 0.5 s? **2**

Criteria	Mark
Correctly relates the area under graph to displacement, and computes distance correctly, with units	2
Any one of the above, with units	1

Displacement = area under curve for motion in one direction.

Hence $s = 10 \times 0.5 = 5\ m$

i.e. the car travels 5 m in the first 0.5 s.

(c) Calculate the acceleration of the car at time t = 1.0 seconds. **2**

Criteria	Mark
Correctly relates the slope to the acceleration and computes the acceleration correctly with correct units	2
Relates the slope to acceleration OR calculates acceleration	1

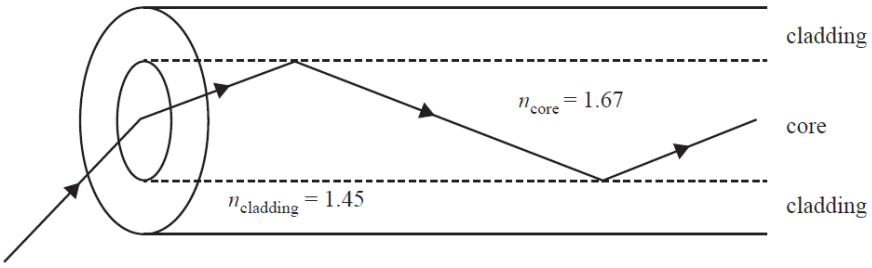
Sample Answer:

Acceleration = slope of v-t graph

i.e. $a = \frac{\Delta v}{\Delta t} = \frac{10-0}{1.5-0.5} = 10\ m\ s^{-2}$

Question 22 (5 marks)

Optical fibres are constructed using transparent materials with different refractive indices. The figure below shows one type of optical fibre that has a cylindrical core and surrounding cladding. Laser light of wavelength 565 nm is shone from air into the optical fibre.



(a) Calculate the frequency of the laser before it enters the optical fibre. **2**

Criteria	Mark
Correct substitution into correct formulae (with correct units)	2
Any one of the above	1

Sample answer:

$$f = \frac{c}{\lambda}$$

$$= \frac{3 \times 10^8}{565 \times 10^{-9}}$$

$$= 5.3 \times 10^{14}\ Hz$$

(b) Calculate the critical angle for the laser light at the cladding-core boundary. Show all working. **2**

Criteria	Mark
Correct substitution into correct formula and correct critical angle computed.	2
Any one of the above	1

Sample Answer:

$$\sin\theta_c = \frac{n_{cladding}}{n_{core}}$$

$$= \frac{1.45}{1.67}$$

$$\therefore \theta_c = 60.3^{\circ}$$

(c) What is the frequency of the light in the fibre? **1**

Criteria	Mark
Correct frequency	1

Sample Answer

The frequency is source dependent, hence does not change i.e. $5.3 \times 10^{14}\ Hz$

Question 23 (4 marks)

Contrast mechanical waves and electromagnetic waves. Use examples to support your answers.

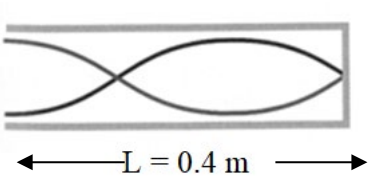
Mechanical waves such as ocean waves, sound waves, string waves etc. all require a physical medium through which to propagate. This occurs either as a result of oscillation of the particles perpendicular to the direction of propagation of energy in the case of transverse waves such as a surface water wave or the oscillation of the particles parallel to the direction of energy propagation in the case of longitudinal waves such as sound waves. The energy of the wave is transmitted with this type of motion. The speed of mechanical waves is dependent on properties of the medium through which the wave is travelling, such as its elasticity and density.

Electromagnetic waves do not require a medium to travel through to transmit its energy. The waves are transverse and are electric and magnetic in nature, moving at the speed of light in a vacuum. They travel more slowly in any medium, --such as water, glass and oil--than they do in a vacuum. The refractive index of a material is a measure of how much the electromagnetic wave is slowed by the medium, compared to its velocity in a vacuum. Electromagnetic waves differ in properties because of differences in their frequencies, which range from radio waves to gamma rays.

Criteria	Marks
• Both types of waves mechanical and electromagnetic fully contrasted in high quality detail.	4
• Detail is good but not fully explaining 2 examples for each type of wave.	3
• Only weaker responses of each one of the wave types.	2
• One response only or ordinary lacking detail.	1

Question 24 (2 Marks)

The standing wave in a closed pipe having a length of 0.4 m is represented by the diagram below.



The speed of the sound wave in air is 340 $m\ s^{-1}$. **2**

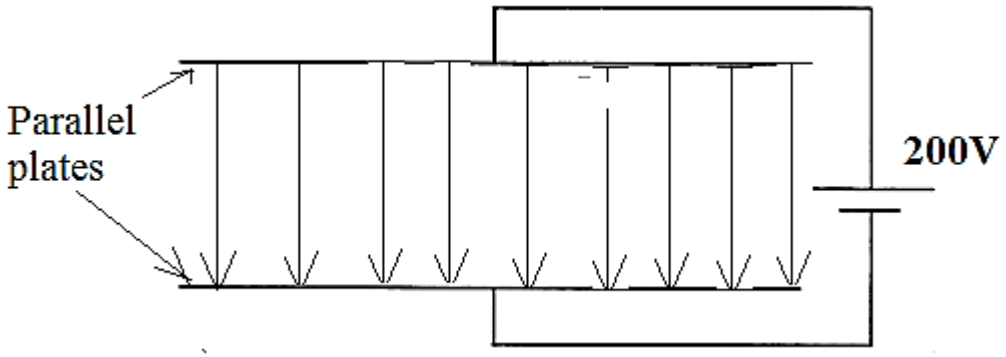
Complete the table below.

Wavelength (m)	Number of antinodes
¾ λ = 0.4 λ = $\frac{0.4 \times 4}{3} = \frac{1.6}{3} = 0.53$ m	2

Criteria	Marks
• Both responses fully correct	2
• One response box correct	1

Question 25 (3 marks)

In the setup below, two parallel plates, 20 mm apart, are connected to a 200 V DC source.



Criteria	Marks
• Direction of arrows down	1

(a) Draw the electric field lines between the two parallel plates **1**

(b) Calculate the force on an electron placed at Y. **2**

$$F = qE = q\left(\frac{V}{d}\right)$$

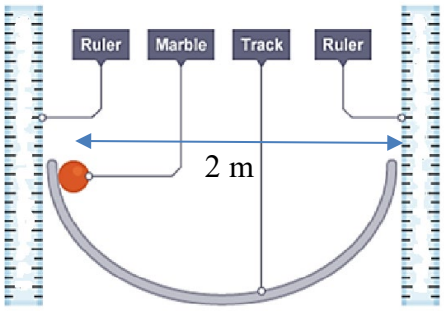
$$= 1.602 \times 10^{-19} \times \left(\frac{200}{0.02}\right)$$

$$= 1.6 \times 10^{-15}\ N$$

Criteria	Marks
• Full substitutions in formula correctly used an d correct answer with units	2
• Correct equations but wrong calculations with wrong answer	1

Question 26 (5 Marks)

A student investigated the motion of a marble released from different starting points on a semicircular track having a diameter of 2 metres.
The diagram shows the apparatus he used and how it was set up.



The student released the marble from different heights above the bottom of the track. He recorded the height from which the marble was released and the height that it reached on the opposite side of the track. He released the ball from the same chosen starting point three times and measured the height reached each time.

(a) What is the independent variable in this investigation? **1**

Height of the ball release point

Criteria	Marks
• Fully explained answer	1

(b) Propose a hypothesis that this investigation was set up to test. **1**

Various answers – Typical ball rolls to same height, ball rolls to less height, ……

Criteria	Marks
• Fully explained answer	1

(c) Identify a variable the student would have kept constant in this investigation. **1**

Use the same ball, use the same exact height,…

Criteria	Marks
• Fully explained answer	1

The table shows the student's experimental results:

Release height (cm)	*Height reached (cm) Trial 1*	*Height reached (cm) Trial 2*	*Height reached (cm) Trial 3*
20	15	14	14
40	29	33	32
60	47	19	46
80	65	61	63

(d) In analysing his results, the student chose to omit some data from his calculations. Identify the data he is most likely to have omitted and state why this data was omitted in his analysis. **2**

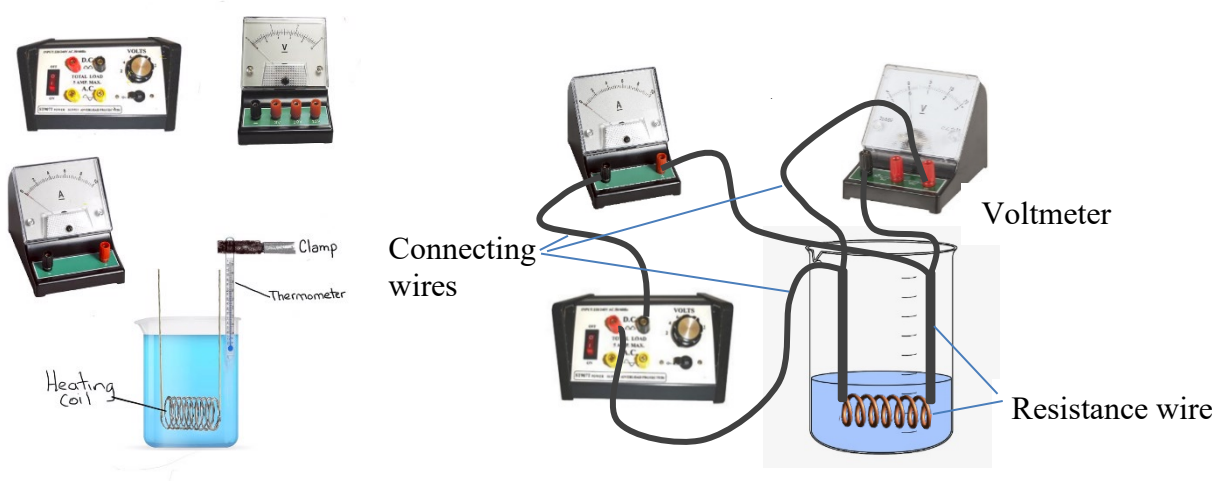
The 60 cm release height trial 2 was the likely omitted results. It is clearly an outliner result and would be not acceptable. Other results conform more accuracy and are acceptable.

Criteria	Marks
• Both responses 60 cm trail height and trial 2 included in explanation.	2
• Insufficient in trial 2 and height not well linked.	1

Question 27 (10 Marks)

An investigation was conducted to determine the electrical energy required to raise the temperature of 150 mL of water by 10 degrees Celsius using the electrical energy dissipated by a resistive wire coil. The apparatus used for the experiment is shown. The power pack voltage selector knob was set on 8 V and students carrying out the investigation remembered that this was not necessarily the exact output voltage. Both meters are DC meters. The voltmeter has three scales: 3 V, 10 V and 15 V.

(a) On the diagram of the apparatus show, using lines to represent connecting wires, how the components would be connected so that the current through the coil and the voltage applied to the coil could be measured simultaneously. (4 marks).



Marking Criteria	Marks
• shows the ammeter connected in series with the coil • shows the voltmeter connected in parallel across the heating coil (or across the voltage supply) • shows the correct polarity of meters connected to DC voltage supply (Red/Red and Black/Black) • shows the use of the correct scale used on the voltmeter (either the 10V or 15V scales are suitable).	4
• three correctly connected components	3
• two correctly connected components	2
• one correctly connected component	1

The thermometer was held in the water using a retort stand and clamp as shown, so that the bottom of the thermometer remained stationary 1 cm below the surface of the water. The heating coil was held 1 cm above the bottom of the beaker by a supporting device that is not shown on the diagram. Five centimetres of the wire used to form the heating coil, is above the surface of the water to allow for the connection of the coil to the circuit. The submerged wire had a length of 40 cm.

The temperature of the water was measured before the current was turned on. When current was turned on, a stopwatch was used to time the duration of the heating process and the final

temperature was then recorded. The students were careful not to move the thermometer during the heating process.

(b) State one source of systematic error evident in this experiment as it has been described and explain how the error would affect the results. (3 marks)

Sample answer

Systematic error: The fixed position of the thermometer. Due to convection, heated water from the coil rises to the top, causing the thermometer to give a consistently higher reading than the average temperature of the water. This results in the calculated heat energy absorbed by the water being HIGHER than the true quantity of heat.

Other systematic errors include not stirring the water to distribute the heat energy (the effect is the same as described above); Part of the heating coil resistance wire being out of the water (the effect is to reduce the proportion of the energy produced by the heating coil that is absorbed by the water. This results in the calculated energy from the coil that is assumed to have been absorbed by the water being too high).

Marking Criteria	Marks
• Identifies a systematic error • Relates the systematic error to its effect on the results	3
• Identifies a systematic error • Outlines an effect of the systematic error	2
• Identifies a systematic error	1

(c) The following experimental results were obtained when 150 mL of water was heated in this investigation.

Initial temperature of water: 20ºC. Final temperature of water 30ºC. Heating coil: Current 5 A, Voltage 3 V. Heating time: 10 minutes.

Calculate the electrical energy produced by the heating coil. (3 marks)

$P = VI$

$E = Pt = VIt = 3 \times 5 \times (10 \times 60) = 9000$ J

A mark was awarded if only the equation $P = VI$ was used; a second mark for the application of $E=Pt$ and a mark for the final answer (and unit).

Marking Criteria	Marks
• Applies P = VI • Applies E = VIt • Correct answer and units	3
• Two correct processes applied	2
• One correct process applied	1

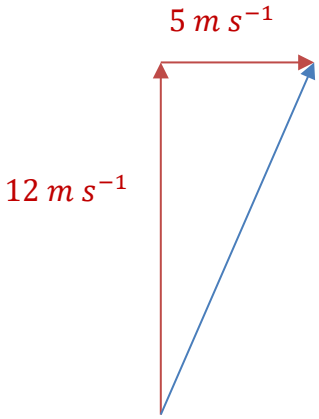
Question 28 (5 Marks)

A powerboat moves with a velocity of 12 m s^{-1} north relative to the water in a river flowing with a velocity of 5 m s^{-1} east. The river is 169 m wide.

(a) Calculate the velocity of the powerboat relative to the river bank. Include a relevant vector diagram in your answer. **3**

$v = \sqrt{12^2 + 5^2}$
$= 13\ m\ s^{-1}$

$\theta = tan^{-1}\frac{5}{12}$
$= N\ 22°\ 37'E\ OR\ 67°\ 23'to\ the\ river\ bank$



Marking Criteria	*Marks*
• Correctly drawn vector diagram. • Calculated the speed of the powerboat relative to the river bank. • Determined the angle correctly.	3

(b) How long does the powerboat take to cross the river? **1**

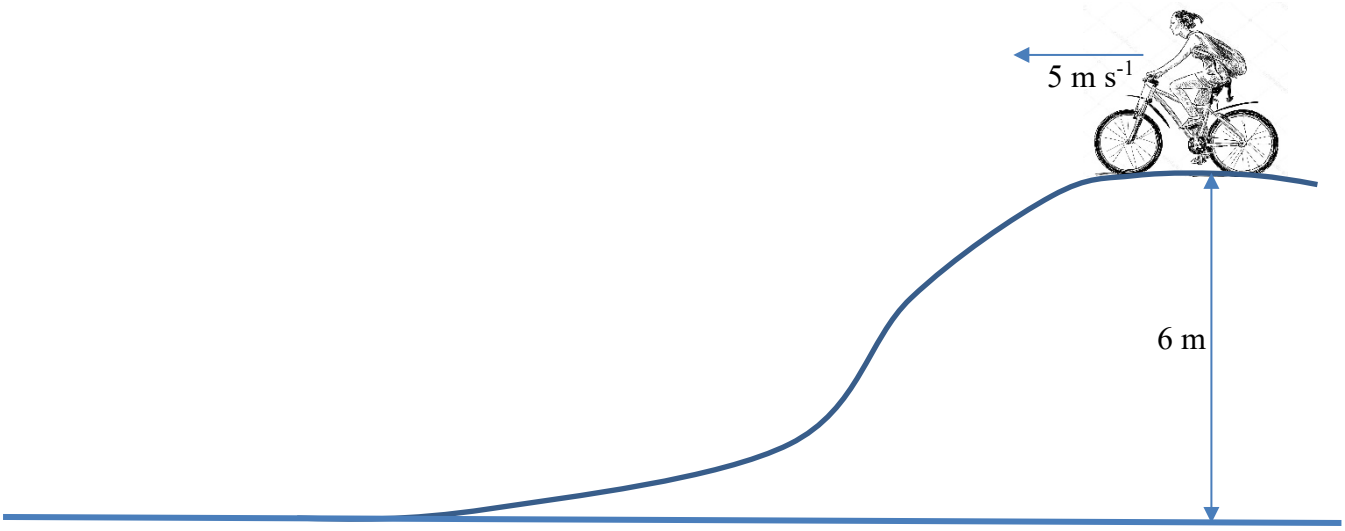
$t = \frac{169}{12}$
$= 14.1\ s$

(c) How far downstream from its starting point on one side of the river does the powerboat travel before it reaches the opposite bank? **1**

$d = 5\ \times 14.1$
$= 70.4\ m$

Question 29 (5 Marks)

A 58 kg girl riding on a 12 kg bike at the top of a 6 m hill, is moving at a horizontal velocity of 5 m s^{-1}.



(a) The bike then travels down the hill a vertical distance of 6 metres before reaching the horizontal ground at the bottom of the hill. Assume that no frictional forces oppose the motion of the bike as it travels down the hill.

Calculate the speed of the bike at the bottom of the hill. **3**

$$\frac{1}{2}mv^2 = mgh + \frac{1}{2}mu^2$$
$$v^2 = 2gh + u^2$$
$$v = \sqrt{2 \times 9.81 \times 6 + 5^2}$$
$$= 11.9\ m\ s^{-1}$$

Marking Criteria	*Marks*
• Correctly applied the conservation of energy. • Used the correct mass (70 kg) OR cancelled the mass variable. • Calculated the correct velocity.	3

(b) At the bottom of the hill she applies the brakes on the bike which skids a distance of 20 metres before coming to a stop.

Calculate the force of friction acting on the bike. **2**

$$W = \Delta KE$$
$$F \times 20 = \frac{1}{2} \times (58 + 12) \times 0^2 - \frac{1}{2} \times (58 + 12) \times 11.9^2$$
$$F \times 20 = -4995.2$$
$$F = -249.76 \text{ N OR } 249.7 \text{ N to the right of the page}$$

OR

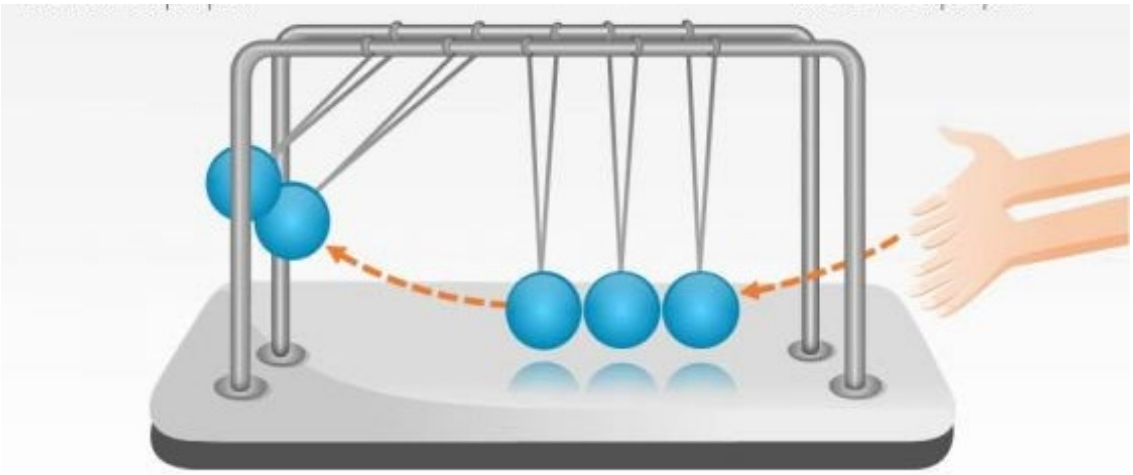
$v^2 = u^2 + 2as$
$0 = 11.9^2 + 2 \times a \times 20$
$a = -\frac{11.9^2}{40}$
$= -3.568\ m\ s^{-2}$

$F = ma$
$F = 70 \times -3.568$
$= -249.76$ N

Marking Criteria	*Marks*
• Correctly calculated the force due to friction. • Stated the direction which friction is applied.	2

Question 30 (4 Marks)

The diagram shows a piece of apparatus sometimes called "Newton's cradle". The result of raising the rightmost two balls together and then releasing them so that they both swing down and hit the stationary three balls is shown in the diagram.



A student proposes that it should be possible to let the two balls swing down and hit the three stationary balls, resulting in only one ball moving away from the line of stationary balls, but at twice the velocity with which the two swinging balls were moving.

Evaluate the student's proposal with reference to the relevant laws of physics. **4**

Sample answer:

Two relevant laws of physics must be considered.

The law of conservation of momentum: In a closed system the total initial momentum is equal to the total final momentum. Considering the student's proposal. Just before the moving two balls collide with the stationary balls, their total momentum is 2mv (assuming a velocity of v). The proposal is consistent with the law of conservation of momentum because one ball moving at twice the velocity would have a momentum m(2v) = 2mv.

The law of conservation of energy: Initially $K = 0.5(2m)v^2 = mv^2$

The final $K = 0.5(m)(2v)^2 = 2v^2$

Since there is no source of energy in the system that could account for this doubling of the kinetic energy, the proposal violates the law of conservation of energy and hence the proposed behaviour of the system is not possible.

Marking Criteria	Marks
• Analyses the proposed interaction using relevant equations and reference to the law of conservation of momentum and the law of conservation of energy • Shows that the interaction is consistent with one law but not the other	4

• Concludes that the student's proposal is not possible.	
• Analyses the proposed interaction using relevant equations and reference to the law of conservation of energy • Shows that the interaction is inconsistent with this law • Concludes that the student's proposal is not possible.	3
• Analyses aspects of the proposed interaction with reference to the laws of conservation of energy and momentum	2
• Applies the law of conservation of momentum to the proposed interaction OR • Applies the law of conservation of energy to the interaction	1

NOTE: A significant number of responses attempted to apply (inappropriately) Newton's laws of motion to the proposed interaction. Typically these answers reflected a poor understanding of Newton's laws e.g. in applying the trite statement "action and reaction are equal and opposite", forces were not discussed and the necessity for two bodies and the direction in which the forces act on them was unclear. Students who attempted to apply these laws generally showed a poor understanding of them.

Question 31 (7 Marks)

(a) X and Y are two lamps. X is rated at 12 V 36 W and Y at 4.5 V 2.0 W. Calculate the current through lamps X and Y when it is operated at its correct (nominal) working voltage.

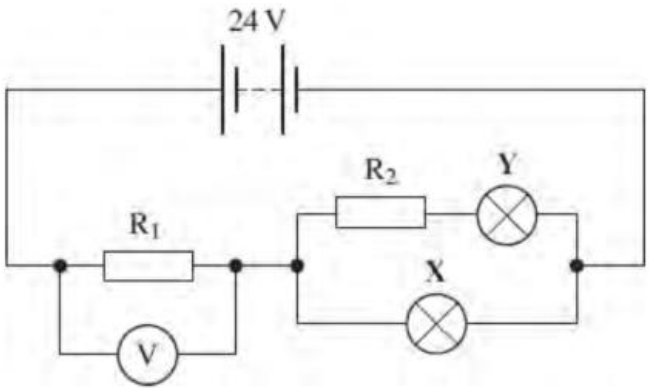
Marking Criteria	Marks
Correct current through each lamp, with correct units	1

Sample Answer:

X: $I = \frac{36}{12} = 3\ A$ 1

Y: $I = \frac{2}{4.5} = \frac{4}{9}\ A\ or\ 0.44\ A$ 1

(b) The two lamps are then connected in the circuit shown in the circuit diagram below. The battery has an emf of 24 V and negligible internal resistance. The resistors, R_1 and R_2 are chosen so that the lamps are operating at their correct working voltage.



(i) Calculate the potential difference across R_1 **2**

Marking Criteria	Marks
Correctly calculates the voltage across R_1, with correct reasoning	2
Calculates a voltage across R_1, with incorrect reasoning	1

Sample Answer:

From given information, voltage across X is $12\ V$.

Voltage across the parallel branch is also $12\ V$.

Hence Voltage across $R_1\ is\ 24\ V - 12\ V$ (by Kirchhoff's voltage/loop rule)

(ii) Calculate the current in R_1 **2**

Marking Criteria	Marks
Correctly calculates the current flowing through R_1, with correct reasoning	2
Calculates a current through R_1, with incorrect reasoning	1

Sample Answer:

$$I_{main} = I_X + I_{R_2} \quad \text{.....Kirchhoffs current rule}$$

$$= 3\ A + \frac{4}{9}\ A$$

$$= \frac{31}{9}\ A$$

Hence current through R_1 is $3.44\ A$

(iii) What deduction can be made about the sum of the voltage drops across R1 and X? **1**

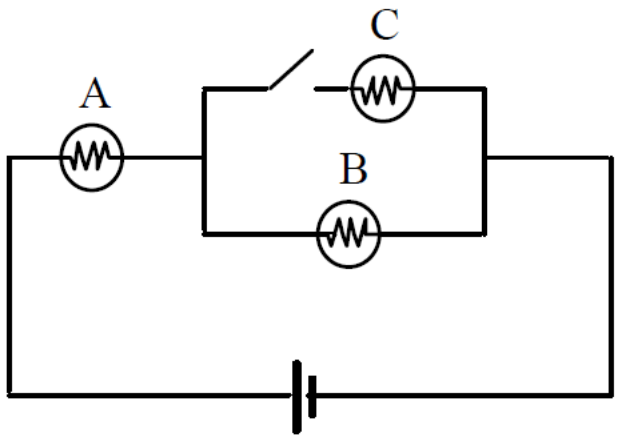
Marking Criteria	Marks
Correct deduction	1

Sample Answer:

The sum of the voltage drops across R_1 and X equals the supply voltage $(24\ V)$

Question 32 (4 Marks)

Three identical light bulbs A, B and C, are connected to a battery as shown in the circuit diagram below.



What happens to the brightness of bulbs A and B if the switch is closed? Justify your answer using physics principles. **4**

Marking Criteria	Marks
Correctly • describes the brightness of Lamps A and B, • mentions with switch closed, overall resistance decreases with a corresponding increase in current, • Uses Physics principles (power equations to denote brightness) to correctly justify the brightness of the lamps • Answers the question by describing the brightness of each lamp before and after the switch is closed.	4
Any three of the above	3
Any two of the above	2
Any one of the above or some relevant information	1

Sample Answer

Assuming power dissipated in the lamps is an indicator of the brightness of the lamps (See later)

If the switch is closed, the equivalent resistance of the circuit decreases which results in the main current being greater (than when the switch was open). From $P = I^2R$, the brightness of lamp A increases.

Since the resistance of the parallel branch now decreases, the voltage drop across this branch decreases, with a corresponding decrease in the voltage across lamp B (than when the switch was open). From $P = \frac{V^2}{R}$, the brightness of lamp B decreases.

Remember in general, this is NOT true i.e. Power ≠ brightness ……..here is a convincing argument: Consider 2 bulbs which are rated as $240\ V, 60\ W$ and $240\ V, 100\ W$. Which is brighter?

END OF EXAMINATION ☺