Name: _____

Class: _____

# Sydney Boys High School

## 2019

### 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

**Section I – 20 marks**

**Attempt Questions 1-20**

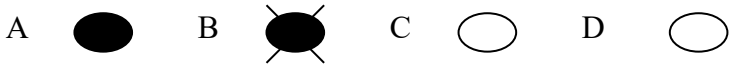
**Allow about 35 minutes for this section**

Use the multiple-choice answer sheet.

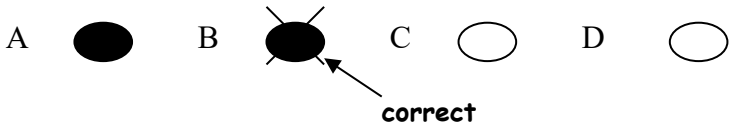
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

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.** A pipe that is open at one end can produce a range of standing wave vibrations in the air space inside the pipe.
The longest wavelength (called the fundamental vibration) will have a wavelength of:


(A) L/2

(B) L

(C) *2L*

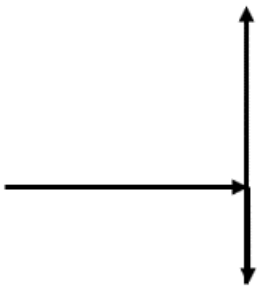
(D) 4L

**2.** A drone is flown 500 m to the east. It turns to the south and flies for 300 m before turning north, flying for 800 m and landing again.

The drone's displacement vector is best represented by:

(A)

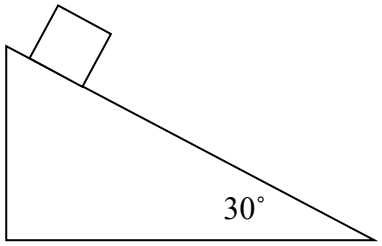
(B)



(C)

(D)

**3.** A smooth block with a mass of 2kg is placed on a smooth 30° slope with negligible friction. The block will most likely:



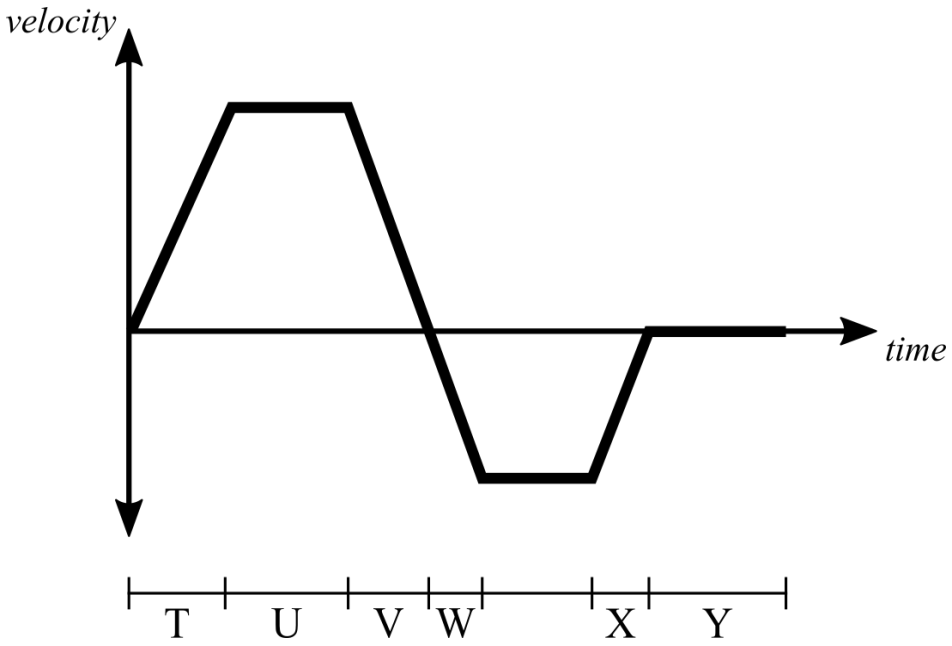

(A) remain stationary.

(B) travel down the slope at a constant velocity.

(C) travel down the slope with a constant acceleration .

(D) travel down the slope with increasing acceleration.

**4.** A car moving down a straight road has its motion analysed and plotted on a graph, shown below.




Which description most accurately describes the car's motion during the times T, U, V, W, X and Y?

| | T | U | V | W | X | Y |
|---|---|---|---|---|---|---|
| (A) | positive acceleration | zero acceleration | negative acceleration | negative acceleration | negative velocity | stopped |
| (B) | positive acceleration | stopped | negative acceleration | negative velocity | negative velocity | stopped |
| (C) | positive velocity | stopped | negative velocity | negative velocity | positive velocity | stopped |
| (D) | positive velocity | zero acceleration | negative velocity | negative velocity | negative velocity | stopped |

**5.** A mechanical wave travelling on a long spring is found to have a period of 0.5 seconds and a wavelength of 3 metres. Which of the following is a correct statement about the wave?

(A) It has a speed of 6 $ms^{-1}$.

(B) It has a speed of 2 $ms^{-1}$.

(C) It has a speed of 1.5 $ms^{-1}$.

(D) Its speed cannot be determined from the data provided.

**6.** A current, **I**, flows through the coils of a solenoid with ***N*** turns and length ***L***.

A student wishes to double the magnetic field produced near the ends of this solenoid. Which combination of changes would achieve this result?

| | Change to **I** | Change to ***N*** | Change to ***L*** |
|---|---|---|---|
| (A) | no change | no change | double |
| (B) | double | double | no change |
| (C) | no change | double | halve |
| (D) | double | double | double |

**7.** A plane can fly through still air at 300 km $h^{-1}$. It wishes to fly directly north over the ground but a crosswind of 100 km $h^{-1}$ is blowing from the east.

In which direction must the pilot head the plane so that its course is directly north?

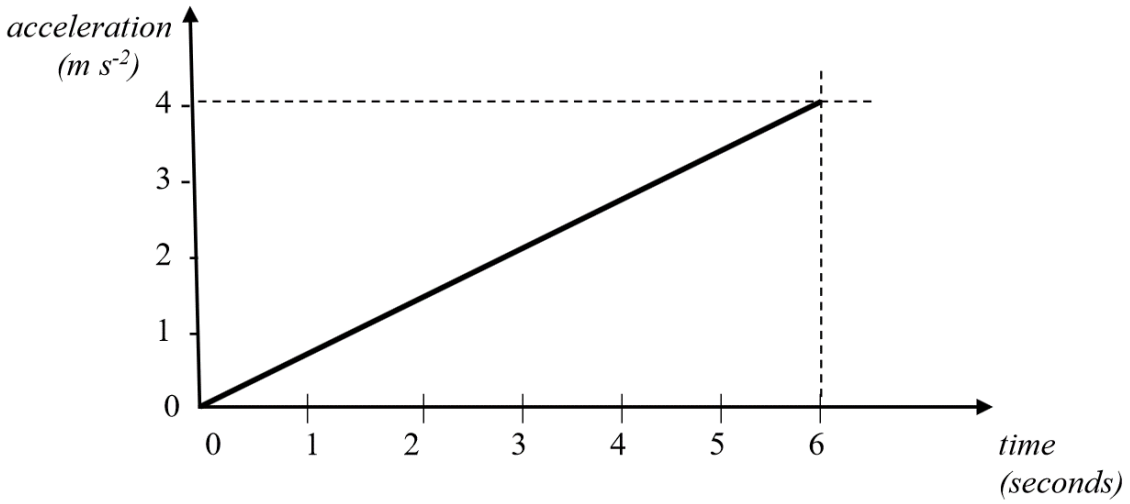
(A) N19.5°E

(B) N19.5°W

(C) N18.4°E

(D) N18.4°W

**8.** A car is moving along a straight road at a constant 15 m $s^{-1}$. The car then begins to accelerate for 6.0 s. The car's acceleration versus time is recorded on the axes below.




The speed of the car after it has accelerated for 6 seconds is closest to:

(A) 19 m $s^{-1}$

(B) 21 m $s^{-1}$

(C) 27 m $s^{-1}$

(D) 39 m $s^{-1}$

**9.** Before starting a game, squash players must hit the small hollow rubber ball against the wall a number of times in order to heat the ball and cause the gas inside it to expand. Only then will the ball bounce properly.

Which statement best explains this?

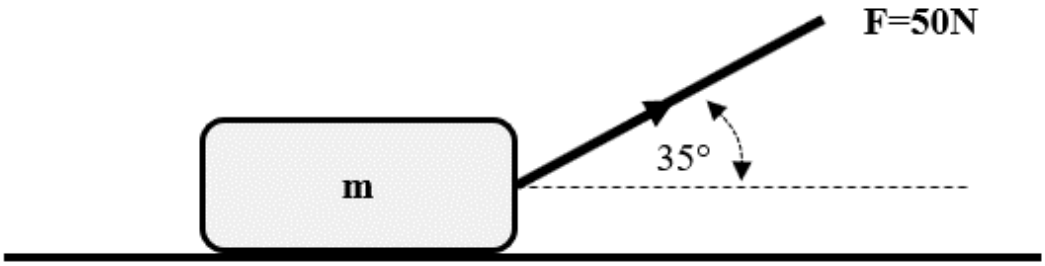
(A) When the ball rebounds off the wall, some of its momentum is transformed into heat energy.

(B) When the ball hits the wall, some of its kinetic energy is transformed into heat energy.

(C) When the ball flies through the air, the air friction causes it to gain heat energy.

(D) When the ball hits the wall, the sound it makes is transformed into heat energy.

**10.** A box with mass **m** is being dragged along a surface by a rope with a tension of 50N, as shown.




The acceleration of the box can be expressed as:

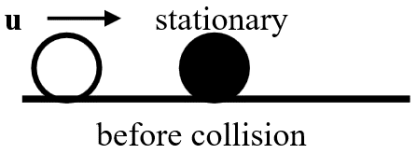
(A) $\frac{50\sin 35°}{m}$

(B) $\frac{50\cos 35°}{m}$

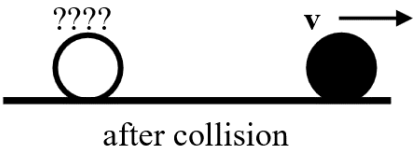
(C) $\frac{m}{50\cos 35°}$

(D) 50m x cos35°

**11.** A white ball with mass **m** and an initial speed **u** collides with a stationary black ball, also with mass **m**. After the collision, the black ball moves off with a speed **v**.




before collision




after collision

This collision is known to be elastic.

What is the speed of the white ball after the collision?

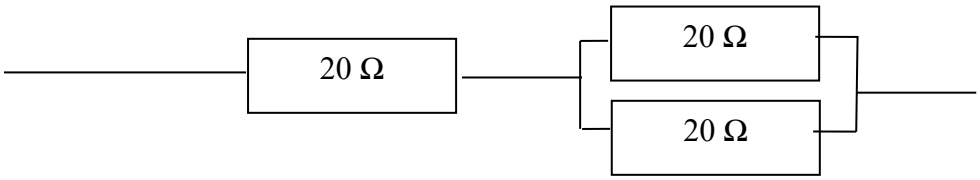
(A) zero

(B) u

(C) v

(D) v/2

**12.** Consider the resistors in the following diagram:




To have an equivalent resistance, the above arrangement of resistors could be replaced by a single resistor with a value of:

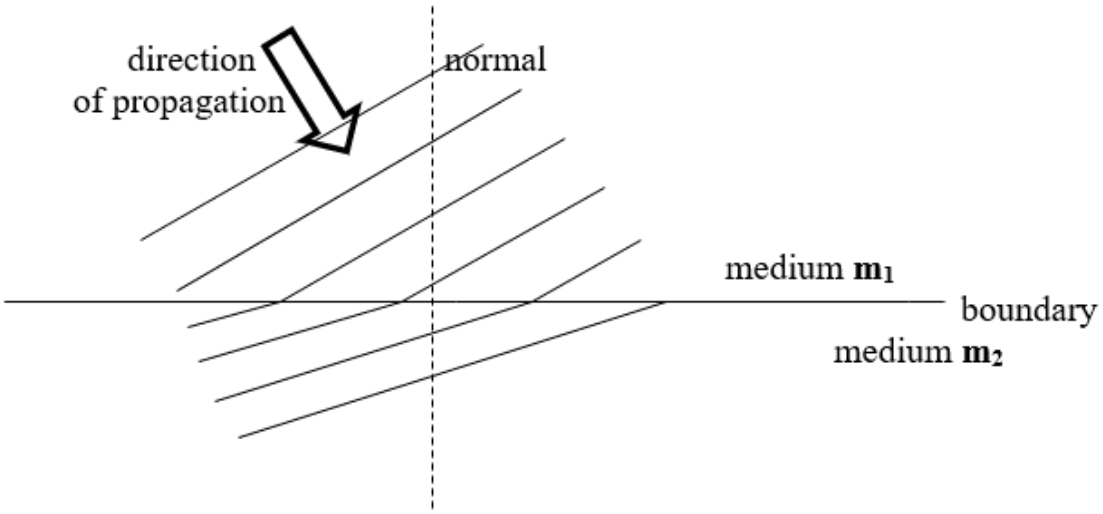
(A) 20 Ω

(B) 30 Ω

(C) 40 Ω

(D) 60 Ω.

**13.** As it enters a second medium, $\mathbf{m_2}$, a wave refracts as shown in the diagram.




Which statement can be made about the wave as it enters medium $\mathbf{m_2}$?

(A) Its frequency increases.

(B) Its frequency decreases.

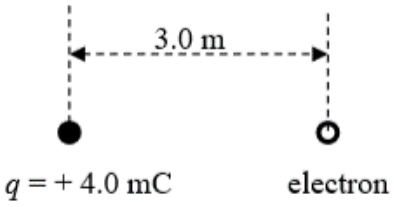
(C) The wavelength increases.

(D) The wavelength decreases.

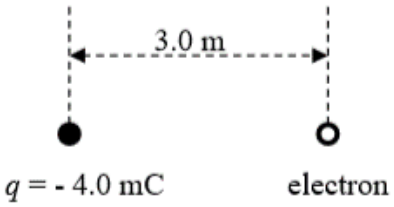
**14.** An electron has a force of 6.4 x $10^{-13}$ N acting on it in a westerly direction.

Which arrangement could produce this force?

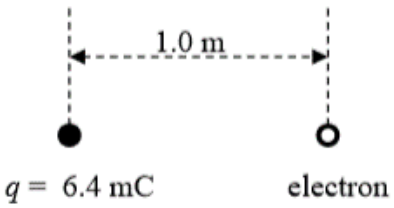

(A)



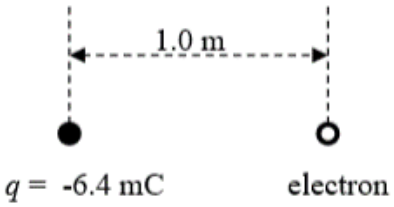

(B)




(C)




(D)



**15.** A crane has an electric motor with a power rating of 5.0 kW, which is 80% efficient at lifting loads vertically.

What is the maximum speed at which the crane can lift a 200 kg load?

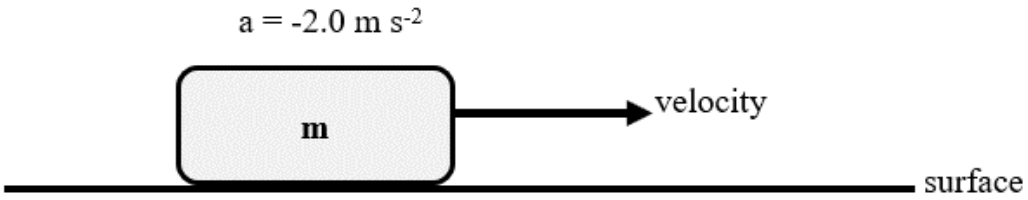
(A) 19.6 m $s^{-1}$

(B) 40 m $s^{-1}$

(C) 2.6 m $s^{-1}$

(D) 2.0 m $s^{-1}$

**16.** A box with mass **m** is sliding on a horizontal surface. It is decelerating at a constant 2.0 m $s^{-2}$, as shown.




The coefficient of kinetic friction, μ, is closest to:

(A) 19.6

(B) 2.0

(C) 0.20

(D) 0.10

**17.** Which of the following correctly identifies the magnetic field direction at the point M directly above the current carrying conductor?

(A) →

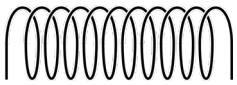
(B) ←

(C) ⊗

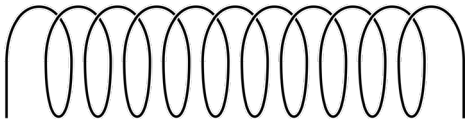
(D) ⊙

**18.** Each of the diagrams below represent a solenoid. The numbers of windings, lengths and diameters for the solenoids are not all the same. In which solenoid would the magnetic field strength be the greatest when a current of 1 Ampere is flowing through its coils?

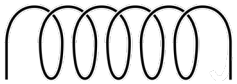
(A)



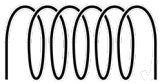
(B)



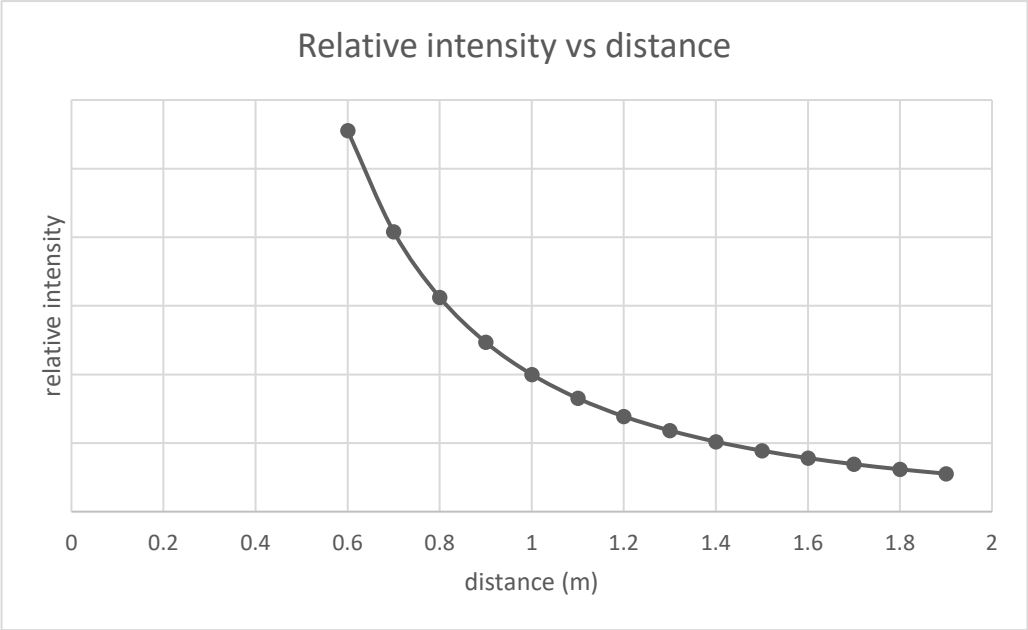
(C)



(D)



**19.** The intensity of light coming from a point source as the distance from the source was varied was plotted on a set of axes, as shown.




At which distance would it be expected that the intensity will be 1/200$^{th}$ that at a distance of 1 m?

(A) 2 m

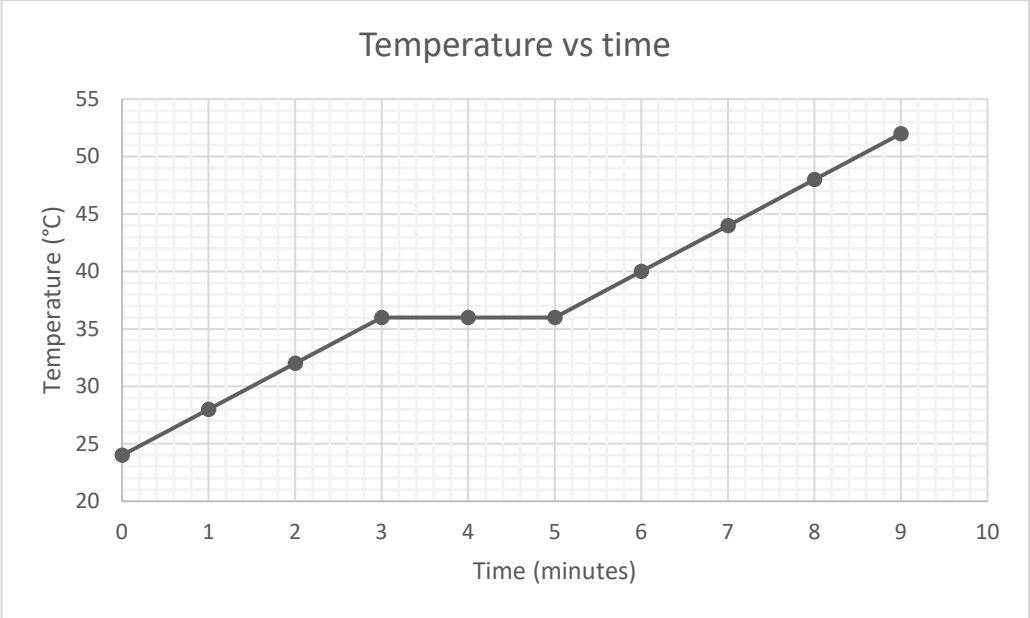
(B) 14 m

(C) 20 m

(D) 200 m

**20.** A 100 mL sample of a liquid substance was heated at a constant rate. The sample of this substance has a mass of 200 g. The specific heat capacity of the substance, c, is 0.40 $JK^{-1}g^{-1}$.

The heating curve obtained is shown below.




The latent heat absorbed by the sample when it vaporises is closest to:

(A) 24 J

(B) 320 J

(C) 640 J

(D) 1.5 kJ

**Part B 55 marks**
**Attempt Questions 21 – 34**

**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.

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**Marks**

**Question 21** (6 marks)

Describe a procedure for a practical investigation that could find the acceleration of a dropped steel ball. Include all measurements that need to be recorded and what calculations would need to be performed to find the acceleration. Identify any sources of error in the investigation. **6**

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**Question 22** (6 marks) **Marks**

A small plane is flying with a constant ground speed of 200 km $h^{-1}$ due north.
There is a constant cross wind of 50 km $h^{-1}$ blowing from the west.

(a) Draw a scaled vector diagram to show the plane's air speed and direction and state the values of this speed and direction. **1**

(b) Calculate how long it will take the plane to travel to its destination, 1000 km north from its starting point. **1**

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(c) On arrival at its destination, the wind changes to a constant breeze of 20 km $h^{-1}$ from the north. **2**
Calculate the time taken for the return journey of 1000 km, if the pilot flies the plane directly south with a constant air speed of 200 km $h^{-1}$

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(d) Determine the average acceleration of the plane when it lands if it touches down with a ground speed of 50 $ms^{-1}$ and takes 400 m to stop **2**

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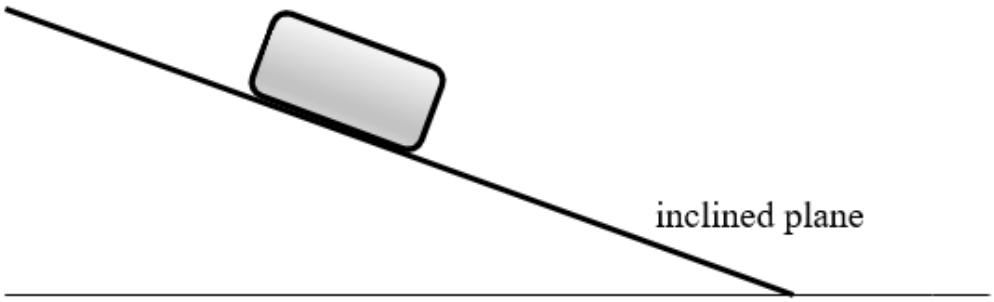
**Question 23** (4 marks) **Marks**

A box is resting motionless on an inclined plane, as shown.




(a) On the diagram, show all the forces acting on the box as labelled vectors. **2**

(b) The inclined plane is now slowly tilted more until the box just begins to slide. **2**

Explain why the box begins to accelerate down the plane.

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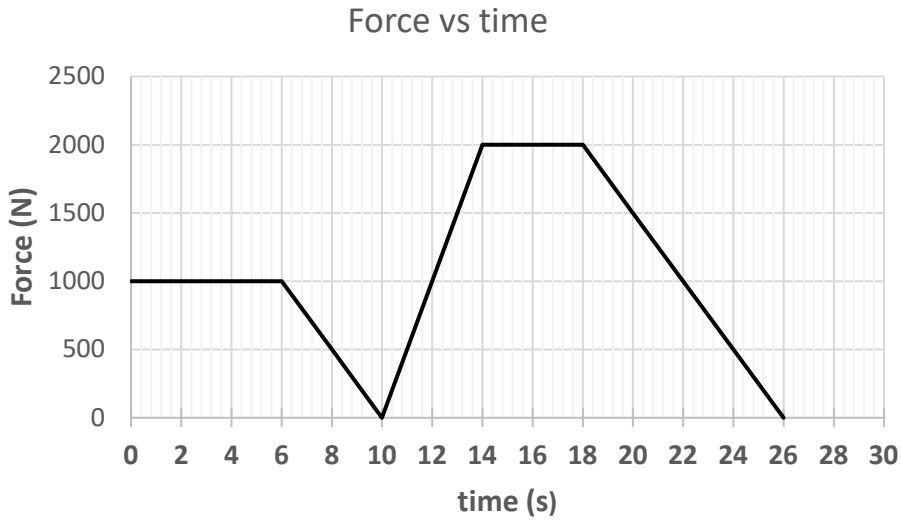
**Question 24** (4 marks) **Marks**

The net force acting on a 1400 kg vehicle is shown in the graph below.




(a) Find the total impulse acting on the vehicle during the 26 second duration. **2**

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(b) Assuming the vehicle started from rest, what is its final speed? **2**

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**Question 25** (6 marks) **Marks**

This question is about what happens when a light beam enters a glass prism with a refractive index (RI) =1.55.

(a) What will happen to the speed of the light as it enters the prism? **1**

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(b) Determine the wavelength of red light with a frequency of $4.3 \times 10^{14}$ Hz while it is inside the glass prism. **1**

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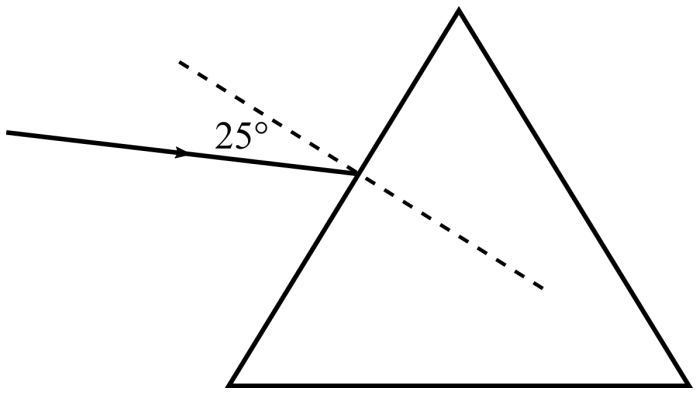
(c) If the beam strikes the edge of the prism at 25° as shown below, calculate the angle of refraction for the beam of red light and draw a line on the diagram to show the path of the beam as it travels into the prism. **2**

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d) Define the term ***critical angle*** and calculate the critical angle for the glass/air interface for the prism. **2**

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**Question 26** (4 marks) **Marks**

(a) When an ambulance with its siren blaring passes an observer, the Doppler effect is observed. This effect is not perceived with the light from a car's headlight as it passes by. Explain why this is so. **2**

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(b) Calculate the observed frequency when an ambulance moving at 30 m $s^{-1}$ towards a stationary observer emits a sound with a frequency of 400 Hz. **2**

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**Question 27** (3 marks)

Explain how Kirchoff's voltage law relates to the conservation of energy. **3**

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**Question 28** (5 marks) **Marks**

An electric heating coil is connected to a 12V power source and draws a constant current of 3.0A. It is immersed into an insulated container with 250 mL water, originally at 15.0 °C.

(a) Calculate how many joules of heat energy are being added to the water every second. Assume all energy transformations are 100% efficient. **3**

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(b) Find the time it takes to heat the water to 30.0°C **2**

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**Question 29** (5 marks) **Marks**

Three identical 144 W globes are to be placed into a 231 V circuit.

(a) Determine the difference in total energy usage over 1 hr if they are placed in series or in parallel. **3**

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(b) How many globes can be placed in the same circuit in parallel before the 8A limit on the wire is exceeded? **2**

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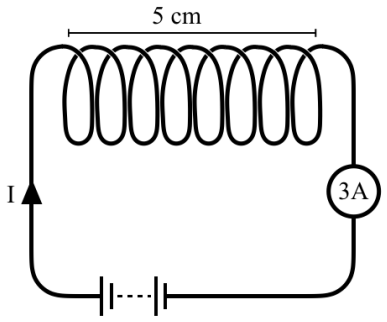
**Question 30** (2 marks)

Calculate the magnitude of the magnetic field inside the solenoid shown below. **2**

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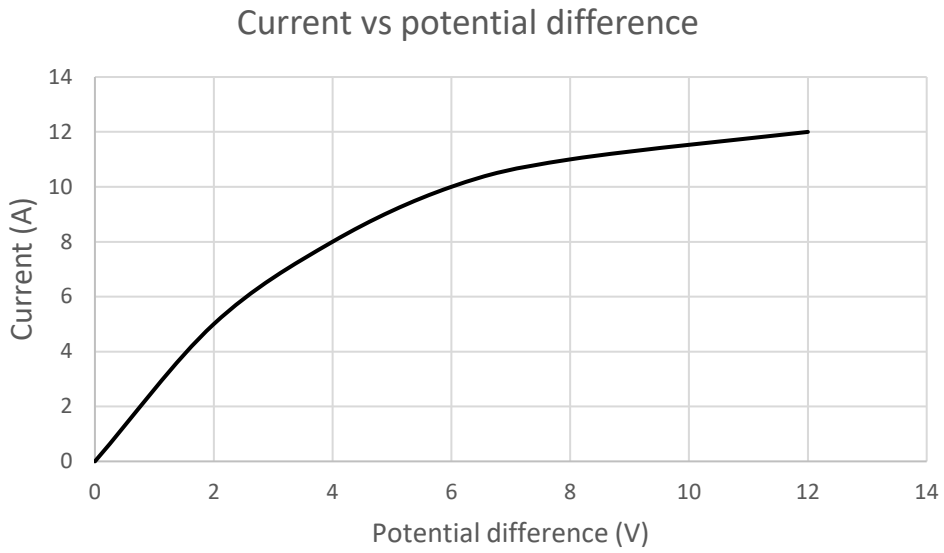
**Question 31** (4 marks) **Marks**

A small light globe has the potential difference across it and the current flowing through it measured as the voltage of the power source is varied.

The results are plotted on the axes shown below.




**2**

(a) State whether this globe is an ohmic or a non-ohmic resistance and give your reasons.

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**2**

(b) What is the value of the globe's resistance when a potential difference of 4.0 V is applied?

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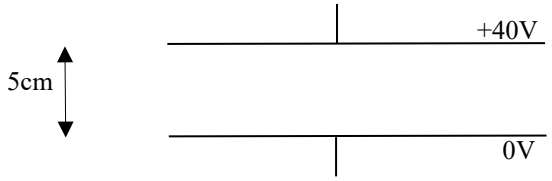
**Question 32** (6 marks) **Marks**

(a) The diagram below represents parallel electric plates. ***Draw lines on the diagram***, to show the nature of the electric field between the plates. **2**




(b) If the distance between the plates, is 5 cm, calculate the magnitude of the electric field between the plates. **1**

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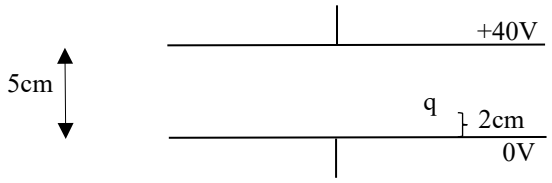
(c) Calculate the direction and magnitude of the acceleration of a particle with mass $2.7 \times 10^{-20}$ kg and a charge, $q = +160.2 \times 10^{-19}$ C, placed in the field, 2 cm above the bottom plate. **3**

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**2019 Physics Year 11 Yearly Examination**.

Marking Guidelines and Model Answers.

**Section I Multiple Choice**

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

## Section II

### 21

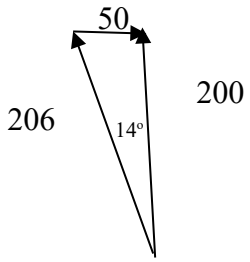
| Marking Criteria | Marks |
|---|---|
| ✓ States to measure time and height<br>✓ States how to measure time and height<br>✓ Uses appropriate method to correctly find a<br>✓ 1st source of error<br>✓ 2nd source or error<br>✓ Addresses reliability (either repetition with consistency or refers to plotting graph and data points) | **1 mark per tick** |

**e.g.** A vertical height of 2.0 m above the ground is measured with metre rulers.
A steel ball is dropped from the 2.0m height, making sure the ball is dropped from rest.
The time taken for the ball to fall is measured using a stopwatch by several people (or electronic timing gate is used)
The ball is dropped 4 more times and the average of the times taken calculated.
The acceleration of the ball is calculated using $s = ut + 1/2at^2$ with u=0, s=2.0m
Sources of error include timing (human error) or the ball not being dropped exactly from rest or the ball not being dropped from an exact height of 2.0 m measured from bottom of the ball.

### 22 (a)

| Criteria | Marks |
|---|---|
| • Correct vector diagram drawn to scale showing the plane's air speed and direction (206km/h 14° west of north) | 1 |
| • | |

**Sample answer**




### 22 (b)

| Criteria | Mark |
|---|---|
| • Calculates the correct time | 1 |

**Sample answer**
t = s/v = 1000/200 = 5 hrs

## 22 (c)

| Criteria | Marks |
|---|---|
| • Determines the relative ground speed and correctly determines the time taken | 2 |
| • Calculates time is distance / velocity | 1 |

**Sample answer**

Relative ground speed = 200 + 20 = 220 km/h
Time = distance/speed = 1000/220 = 4.55 hours (4 hours 33 minutes)

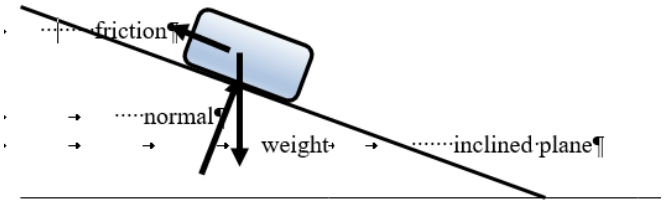
## 22 (d)

| Criteria | Marks |
|---|---|
| • Correctly determines the magnitude and direction of the acceleration | 2 |
| • Determines the magnitude but fails to recognise it as being negative | 1 |

**Sample answer**
$v^2-u^2 = 2as$
Hence $a = v^2-u^2/2s = 0 – 50^2/2x400 = -3.1\ ms^{-2}$

## 23.a.

| Marking Criteria | Marks |
|---|---|
| • All forces labelled correctly | **2** |
| • 1 force incorrect | **1** |
| • 2 or more forces incorrect | **0** |




## 23.b.

| Marking Criteria | Marks |
|---|---|
| • Thorough explanation provided | **2** |
| • Incomplete explanation provided | **1** |

Before sliding, the box is being prevented from moving by static friction between it and the surface of the inclined plane. As the ramp is tilted, the component of the force of gravity acting down the slope exceeds the static friction force, so the box begins to accelerate down the ramp. Once it begins to move, the friction becomes dynamic friction, which is less than static friction so the net force on the box down the incline increases, resulting in continued acceleration of the box.

## 24.a.

| Marking Criteria | Marks |
|---|---|
| • Impulse found correctly **with correct unit** | **2** |
| • Correct method attempted for finding impulse but error or errors made | **1** |

I = area under the F vs t graph = 6000+2000+4000+8000+8000=28000 N s = 28 kN s

## 24.b.

| Marking Criteria | Marks |
|---|---|
| • Correct answer provided | **2** |
| • Calculation attempted using appropriate formula | **1** |

$I = \Delta p = m\Delta v$ where $\Delta v = v_f - v_i$

$28 \times 10^3 = 1400 \times \Delta v$

$\Delta v = 28 \times 10^3 / 1400$

$= 20 \text{ m s}^{-1}$

## 25 (a)

| Criteria | Mark |
|---|---|
| • Identifies that the light will slow down | 1 |

**Sample answer**

The light's speed will be slower.

(An answer that identifies the speed to be approximately $1.94 \times 10^8 \text{ ms}^{-1}$ is also correct).

## 25 (b)

| Criteria | Mark |
|---|---|
| • Correctly calculates the wavelength | 1 |

**Sample answer**

$v = f\lambda$

$\lambda = v/f = c/(1.55 \times 4.3 \times 10^{14}) = 4.5 \times 10^{-7} \text{ m}$

## 25 (c)

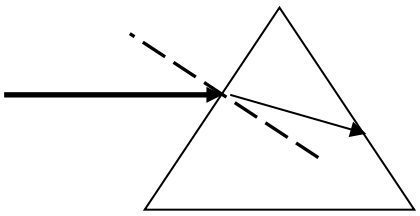
| Criteria | Marks |
|---|---|
| • Calculates the correct angle AND shows an appropriate line on the diagram (closer to the normal) | 2 |
| • Calculates the correct angle OR shows a line closer to the normal | 1 |

**Sample answer**

$\sin i / \sin r = 1.55$

$r = \sin^{-1}(\sin 25/1.55)$

$= 15.8^o$



## 25 (d)

| Criteria | Marks |
|---|---|
| • Provides an adequate definition AND calculates the angle | 2 |
| • Provides and adequate definition OR calculates the angle | 1 |

**Sample answer**
The critical angle is the angle of incidence at which light that strikes the boundary will be refracted by 90 degrees, or will travel along the boundary. Hence, no light will escape the boundary for any angle at or beyond the critical angle.
Sin c = 1/RI
Critical angle = $\sin^{-1}$ (1/1.55) = 40.18º

## 26.a.

| Marking Criteria | Marks |
|---|---|
| • Provided explanation is complete | **2** |
| • Partial explanation provided | **1** |

A speeding ambulance is the source of sound waves. This speed is a considerable fraction of the speed of sound (~10%) and thus the observed frequency of emitted sound is observably Doppler shifted. A car, even if travelling quickly, has a tiny fraction of the speed of light (~0.00001%) which is too small to noticeably affect the observed frequency of the light from the headlights.

## 26.b.

| Marking Criteria | Marks |
|---|---|
| • Correct calculation performed | **2** |
| • Correct formula selected but subsequent error made | **1** |

$$f' = f\frac{(v_{wave} + v_{observer})}{(v_{wave} - v_{observer})}$$
$$= 400\frac{(340)}{(340-30)}$$
$$= 439 \text{ Hz}$$

## 27.

| Marking Criteria | Marks |
|---|---|
| • Kirchoff's voltage law described<br>• Relationship to conservation of energy clearly explained | **3** |
| • Kirchoff's voltage law outlined<br>• Conservation of energy linked | **2** |
| • Kirchoff's voltage law identified | **1** |

Kirchoff's voltage law states that the sum of all the potential differences around a closed circuit equals zero. That is, the energy transformed into other forms of energy in all of the devices in a circuit is equal to the energy provided by the battery or source of EMF. Hence energy is conserved in any electrical circuit.

**28.a.**

| Marking Criteria | Marks |
|---|---|
| • Correct answer provided | **2** |
| • Correct method identified with error made | **1** |

P=VI = 12 x 3.0 = 36 J every second

**28.b.**

| Marking Criteria | Marks |
|---|---|
| • Correct answer calculated | **3** |
| • Answer is calculated but an error made | **2** |
| • A correct step is performed | **1** |

Energy required: $Q = mc\Delta T$
$= 250\ g \times 4.18\ J\ g^{-1}\ K^{-1} \times 15.0\ K$
$= 15675\ J$

time = $15675\ J / 36\ J\ s^{-1}$
$= 435\ s$

## 29(a)

| Criteria |
|---|
| ✓ uses correct globe resistance to calculate correct energy difference |
| ✓ correctly uses $E = Pt$ |
| ✓ uses $\Delta P = P_{parallel} - P_{series}$ or $\Delta E = E_{parallel} - E_{series}$ |

***Sample answer:***

Power rating of 144 W for a light globe corresponds to an applied voltage of 231 V. Therefore:

$$P = VI = \frac{V^2}{R} \quad \Rightarrow \quad R = \frac{V^2}{P} = \frac{231^2}{144} = 370.6\Omega$$

**Series**

$$R_{total} = 3R_{globe} = 3 \times 370.6 = 1111.7\Omega$$

$$V = I_{circuit} R_{total} \quad \Rightarrow \quad I_{circuit} = \frac{V}{R_{total}} = \frac{321}{1111.7} = 0.2078 \text{ A}$$

$$P = VI = 231 \times 0.2078 = 48 \text{ W}$$

$$E = Pt = 48 \times (60 \times 60) = 172800 \text{ J}$$

**Parallel**

$$\frac{1}{R_{total}} = \frac{1}{R_{globe}} + \frac{1}{R_{globe}} + \frac{1}{R_{globe}}$$

$$\Rightarrow R_{total} = \frac{R_{globe}}{3} = \frac{370.6}{3} = 123.5\Omega$$

$$V = I_{circuit} R_{total} \quad \Rightarrow \quad I_{circuit} = \frac{V}{R_{total}} = \frac{231}{123.5} = 1.87 \text{ A}$$

$$P = VI = 231 \times 1.87 = 432 \text{ W}$$

$$E = Pt = 432 \times (60 \times 60) = 1555200 \text{ J}$$

$$\Delta E = E_{parallel} - E_{series} = 1555200 - 172800 = 1382400 = 1.38 \times 10^6 \text{ J}$$

## 29(b)

| Criteria |
|---|
| ✓ correct use of $V = IR$ or $P = VI$ |
| ✓ correct number of globes |

***Sample answer:***

For each globe:

$$P = VI \quad \Rightarrow \quad I = \frac{P}{V} = \frac{144}{231} = 0.623 \text{ A}$$

$$\Rightarrow \quad n = \frac{8}{0.623} = 12.8$$

Therefore, a maximum of 12 globes can be placed in parallel.

## Q30

| Criteria |
|---|
| ✓ use of correct solenoid formula |
| ✓ correct value & units |

***Sample answer:***

$$B = \frac{\mu_o NI}{L} = \frac{4\pi \times 10^{-7} \times 8 \times 3}{0.05} = 6.0 \times 10^{-4} \text{ T} \quad \text{or} \quad \text{N A}^{-1} \text{ m}^{-1}$$

## 31.a.

| Criteria |
|---|
| ✓ correct type (non-ohmic) |
| ✓ appropriate justification (based on deviation from linearity predicted by Ohm's Law) |

***Sample answer:***

The globe is non-ohmic. Ohm's Law states that the voltage and current are directly proportional, according to $V = IR$. The non-linearity of the graph indicates that the voltage and current are not directly proportional for this globe. Thus, the globe does not obey Ohm's Law and is considered non-ohmic.

## 31.b.

| Criteria |
|---|
| ✓ use of Ohm's Law equation |
| ✓ correct value & units |

***Sample answer:***

From the graph, the current is 8.0 A at 4.0 V. Therefore:

$$V = IR \quad \Rightarrow \quad R = \frac{V}{I} = \frac{4.0}{8.0} = 0.50\Omega$$

***Marker's note:***

Do not leave answers as fractions – they are considered incomplete calculations. Use decimal form.

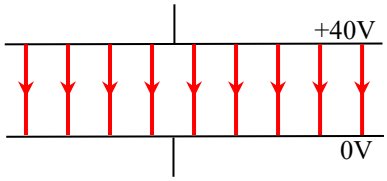
The resistance of a non-ohmic component is <u>not</u> related to the gradient of the curve. This would mean that you could not determine the resistance of the light globe at a given voltage without also measuring the current for values above and below the voltage of interest … and then having the graph them!

However, given that Jacaranda textbook states (incorrectly!) that the resistance is related to the gradient, that calculation will be accepted for this exam. Thus, the resistance from the gradient is 0.85±0.05Ω.

## 32 (a)

| Criteria |
|---|
| ✓ parallel lines between plates that are vertical, evenly spaced and just touch both plates |
| ✓ downward arrows on all lines |

**Sample answer**




## 32 (b)

| Criteria |
|---|
| ✓ correct value & units |

**Sample answer**

$$E = \frac{V}{d} = \frac{40}{0.05} = 800 \text{ V m}^{-1} \quad \text{or} \quad \text{N C}^{-1}$$

## 32 (c)

| Criteria |
|---|
| ✓ uses relevant equation(s) correctly |
| ✓ correct value & units |
| ✓ correct direction |

**Sample answer**

$$F = qE = 160.2 \times 10^{-19} \times 800 = 1.2816 \times 10^{-14} \text{ C}$$

$$F = ma \quad \Rightarrow \quad a = \frac{F}{m} = \frac{1.2816 \times 10^{-14}}{2.7 \times 10^{-20}} = 4.75 \times 10^{5} \text{ m s}^{-2} \text{ downwards}$$

***Marker's note:***

The convention that North is up the page applies to navigation or maps. This question involves neither.