JASPER WILLIAMS HIGH SCHOOL

ANNUAL EXAMINATION 2020
YEAR 12 PHYSICS

Time Allowed: 3 hours
(An extra 10 minutes is allowed for reading this paper.)

INSTRUCTIONS

1. Write your **Index Number** on the front page of the **Answer Book**.
2. Write **all** your answers in the **Answer Booklet** provided.
3. If you use extra sheets of paper, be sure to show clearly the question number(s) being answered and to tie each sheet in your Answer Booklet at the appropriate places. Ensure that your Index Number is written on the extra sheets.
4. Answer **all** the questions with black **or** blue ballpoint pen or ink pen. Do **not** use red ink. You may use a pencil **only** for drawing.
5. You may use a calculator, provided it is silent, battery-operated and non-programmable.
6. **All questions are compulsory.**

Note:

- Formulae and Physical Data which may be useful during the examination are given on page 2 of this **Question Paper.**
- Diagrams in this paper are **not** drawn to scale.

SUMMARY OF QUESTIONS

	STRAND	MARK	SUGGESTED TIME (Minutes)
1	Mechanics	40	72
2	Energy	10	18
3	Fluid statics	8	14
4	Geometrical optics and wave motion	10	18
5	Electrostatics	14	26
6	Electromagnetism	10	18
7	Atomic Physics	8	14
TOTAL		**100**	**180 Minutes**

Year 12 Physics Formulae & Constants

Mechanics

1. $s = \frac{d}{t}$
2. $v_f = v_i + at$
3. $v_f^2 = v_i^2 + 2as$
4. $s = v_i t + \frac{1}{2}at^2$
5. $\tau = F \times d_\perp$
6. $p = mv$
7. Impulse$= F.\Delta t = m.\Delta v$
8. $F = \frac{Gm_1m_2}{r^2}$
9. $T = \frac{1}{f}$, $f = \frac{1}{T}$
10. $v = \frac{2\pi r}{t}$
11. $F_c = \frac{mv^2}{r}$
12. $a_c = \frac{v^2}{r}$

Electrostatics

1. $F = \frac{kq_1q_2}{r^2}$
2. $F = Eq$
3. $E = \frac{V}{d}$
4. $W = Eqd = Vq$

Fluids and Statics

1. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
2. $\rho = \frac{m}{V}$
3. $P = \frac{F}{A}$
4. $P = \rho gh$

Light and Wave

1. $v = f\lambda$
2. $\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$
3. $pd = d\sin\theta = \frac{dx}{L} = n\lambda$

Energy

1. $W = Fd$
2. $P = \frac{W}{t}$
3. $E_K = \frac{1}{2}mv^2$
4. $E_p = mgh$
5. $E_p(\text{elastic}) = \frac{1}{2}kx^2$
6. $F_s = -kx$
7. $Q = mc\Delta T$
8. $Q = mL$

Electromagnetism

1. $F = BI\ell$
2. $V = Bv\ell$
3. $F = Bvq$
4. $\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$

Atomic Physics

1. $E_k = hf - \phi$
2. $\phi = hf_0$

Current Electricity

1. $I = \frac{q}{t}$
2. $V = \frac{W}{q}$
3. $R_{T_{series}} = R_1 + R_2 + R_3 + \ldots$
4. $\frac{1}{R_{T_{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$
5. $V = IR$
6. $P = VI = I^2R = \frac{V^2}{R}$

Constants

Gravity, g	=	$10\ ms^{-2}$
Electronic charge, e	=	$1.6\times10^{-19}\ C$
Electron mass, m_e	=	$9.1\times10^{-31}\ kg$
Speed of light, c	=	$3.0\times10^{8}\ ms^{-1}$
Mass of proton, m_p	=	$1.67\times10^{-27}\ kg$
Coulomb's Law constant, k	=	$9.0\times10^{9}\ Nm^2C^{-2}$
Gravitational Constant, G	=	$6.67\times10^{-11}\ Nm^2kg^{-2}$
Planck's Constant	=	$6.63\times10^{-34}\ Js$
Rydberg Constant, R	=	$1.097\times10^{7}\ m^{-1}$

INSTRUCTIONS FOR MULTIPLE - CHOICE QUESTIONS

Each question is worth 1 mark.

(1) In your **Answer Booklet,** circle the letter which represents the **best** answer. **If you change your mind**, put a line through your first choice and circle the letter of your next choice.

For example:

8	A	B	C	D

(2) **If you change your mind** again and like your first answer better, put a line through your second circle and tick (✓) your first answer.

For example:

8	A	B ✓	C	D

(3) **No mark** will be given if you circle more than one letter for a question.

STRAND 1 **MECHANICS** **[40 MARKS]**

- This strand has 19 Questions.
- Show necessary working for questions **8 - 19** as partial marks will be awarded for correct working.

1. The number of significant figures in 0.020 is:

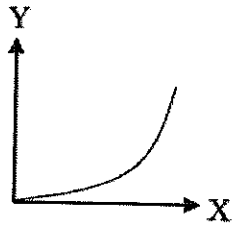
A. 4 B. 3

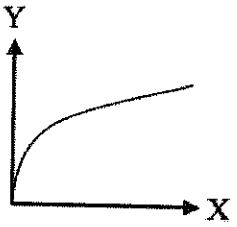
C. 2 D. 1

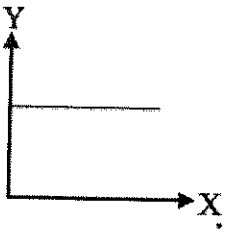
2. Precision of a Vernier Calliper

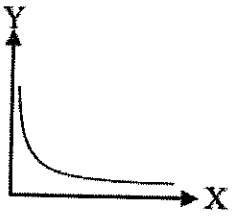
A. 0.01cm
B. 0.1cm
C. 0.01mm
D. 0.1mm

3. Which one of the following Y versus X graphs depict **inverse** relationship?

A.


C.


B.


D.


4. The **force per unit area** is known as

A. Torque
B. Energy
C. Density
D. Pressure

5. The force that keeps an object moving around a circular path without slipping is known as

A. friction force.
B. reaction force.
C. centripetal force.
D. electromotive force

6. Two objects collide inelastically. For this system of two objects,

A. only momentum is conserved.
B. only kinetic energy is conserved.
C. both momentum and kinetic energy are conserved.
D. neither momentum nor kinetic energy are conserved.

7. Which of the following pairs of statements is true about combining uncertainties?

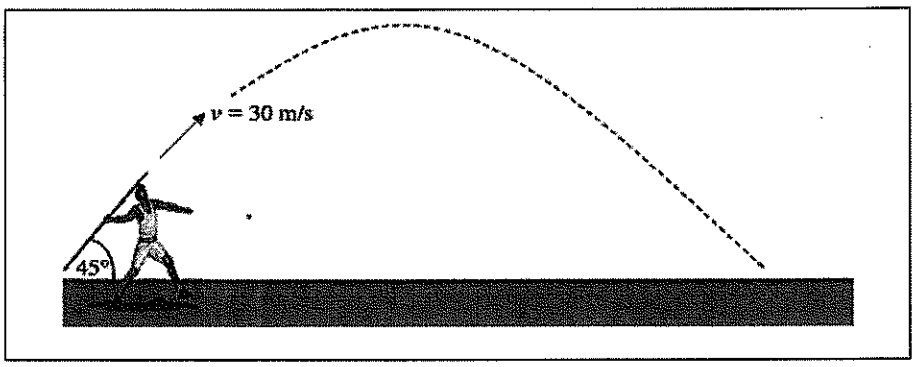
A.	Percentage uncertainties are subtracted	Absolute uncertainties are added
B.	Percentage uncertainties are added	Absolute uncertainties are subtracted
C.	Absolute uncertainties are subtracted	Percentage uncertainties are subtracted
D.	Absolute uncertainties are added	Percentage uncertainties are added

8. The dimensions of a microscopic glass slide are given as follows:

$l = (5.5 \pm 0.1)$ cm $\qquad$ $w = (1.50 \pm 0.01)$ cm

Calculate the area of the slide with its appropriate absolute uncertainty. **(2 marks)**

9. The current Olympic record for the javelin throw is 90.57 m which was set at the Beijing Olympics, 2014. Fiji's own Chrisma Dabue aims to break this record by throwing 92 m at the Rio Olympics in 2021.

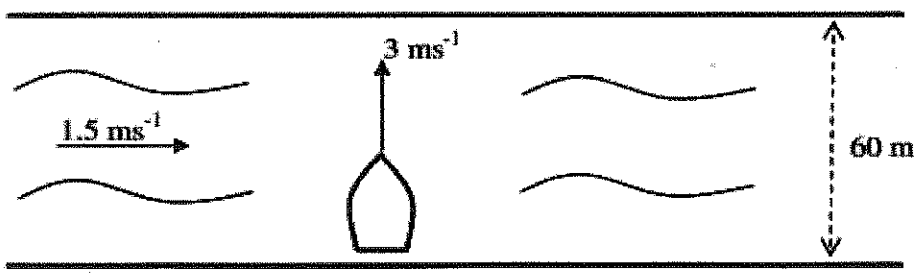


For this question, disregard the height of the thrower and assume that the bottom of the javelin is just touching the ground before release. The diagram shows his last attempt to break the record, after two unsuccessful attempts. She throws the javelin with a speed of 30 m/s at 45° to the ground as shown.

(i) Find the initial horizontal and vertical components of the javelin's velocity **(2 marks)**

(ii) Will she break the Olympic record? (Show all working for this question) **(2 marks)**

10. A punt crosses the Qalitu River with a speed of 3 ms^{-1} at a section where the river is 60 m wide. The punt tries to head directly across the river. The river flows downstream at 1.5 ms^{-1}.

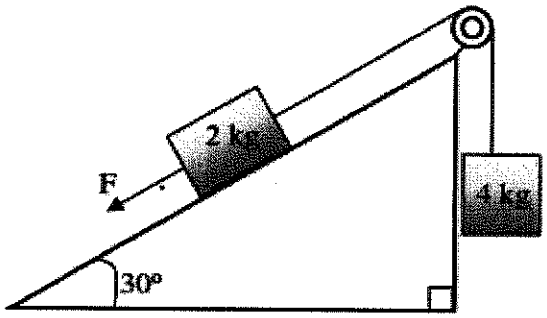


(i) How long does the punt take to cross the river? **(1 mark)**

(ii) How far downstream does the punt land on the opposite bank? **(1 mark)**

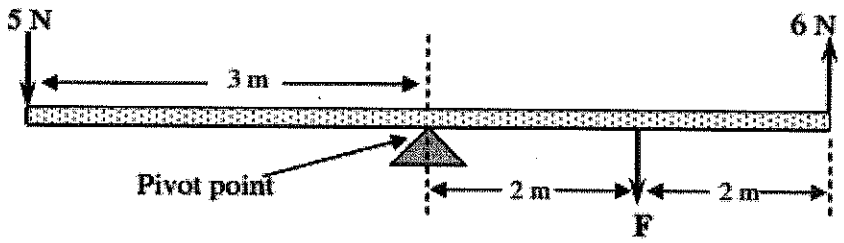
(iii) At what angle upstream, must the punt row if it wants to land at a point directly opposite to where it started? **(1 mark)**

11. The diagram given below shows a 2 kg mass on a 30° frictionless inclined plane and a 4 kg hanging mass. Both masses are connected by a light, inextensible string over a smooth pulley.



Use the information given to find the acceleration of the system. **(2 marks)**

12. Three vertical forces act to keep a pivoted bar in equilibrium as shown below.



Find the magnitude of the unknown force, **F**, needed to keep the bar in equilibrium. **(2 marks)**

13. A ball is projected vertically upwards from the ground level at v m/s and take 3 seconds to reach maximum height. Ignoring air resistance,

Calculate:

(i) The total time of flight **(2 marks)**

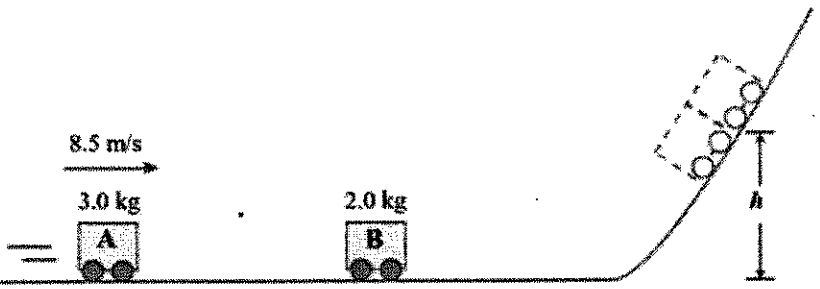
(ii) The initial velocity, v with which the ball was thrown upwards **(1 mark)**

14. A stone of mass 0.15 kg is attached to a string and whirled in a horizontal circle of radius 80cm. The period of rotation is 0.80 seconds.

(i) Calculate the velocity of the stone **(2 marks)**

(ii) Determine the tension in the string **(1 mark)**

15. A 3.0 kg car, **A** travelling at 8.5 m/s on a frictionless track collides and sticks on to a stationary 2.0 kg car **B**.

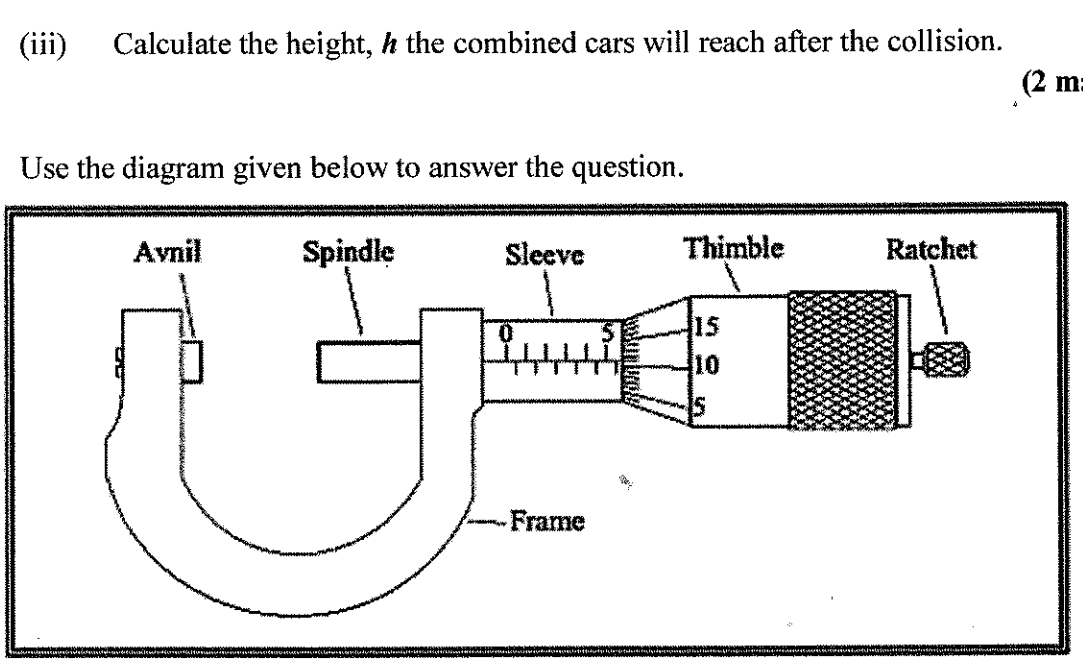


(i) Calculate the momentum of car **A** before the collision. **(1 mark)**

(ii) Calculate the combined velocity after the collision. **(1 mark)**

(iii) Calculate the height, ***h*** the combined cars will reach after the collision. **(2 marks)**

16. Use the diagram given below to answer the question.



(i) Which part of the micrometer screw gauge is used to tighten it? **(1 mark)**

(ii) If a student recorded a zero error of 0.12 mm and length reading of 5.61 mm using the same micrometer, what is the true value of the length being measured? **(1 mark)**

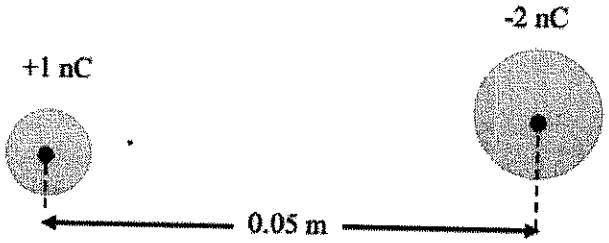
17. A bicycle starts from rest and has a uniform acceleration of $2ms^2$.

(i) What is the bicycle's initial velocity? **(1 mark)**

(ii) Determine the bicycle's velocity after 5 seconds. **(1 mark)**

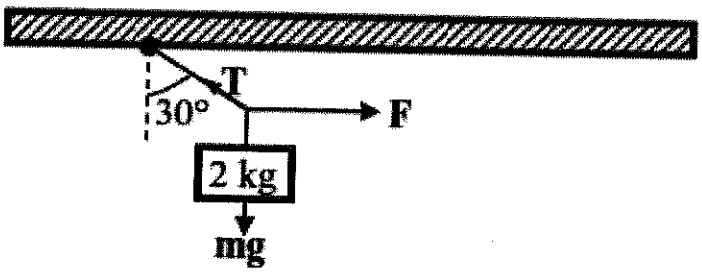
(iii) Calculate the distance travelled after 10 seconds. **(1 mark)**

18. Calculate the gravitational force between two 100 kg objects whose centres are 0.05 m apart.



(2 marks)

19. A mass of 2 kg hangs by a light string and is pulled to one side by a force **F**. The string is at an angle of 30° to the vertical axis.



(i) Determine the weight force, mg **(1 mark)**

(ii) Calculate the value of the tension, T, of the string **(2 marks)**

STRAND 2 **ENERGY** **[10 MARKS]**

- This strand has 6 Questions.
- Show necessary working for questions **3 - 6** as partial marks will be awarded for correct working.

1. Renewable energy cannot be exhausted and are non-polluting. Which of the following is **not** a renewable energy source?

   A. Geothermal energy
   B. Nuclear energy
   C. Wind energy
   D. Biomass

2. Mercury is toxic but is still used in our normal school laboratory thermometers. Alcohol is less toxic, cheaper and is used in clinical thermometers and not in school laboratory thermometers. Which of the following properties of alcohol prevents it from being used in school laboratory thermometers?

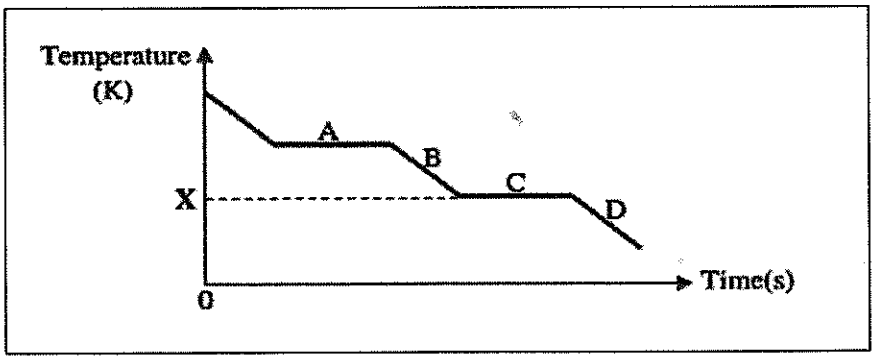
   A. its boiling point of 78°C
   B. its freezing point of −115°C
   C. its colourless nature
   D. its intoxicating ability

3. A kettle has a power rating of 3 kW. If 1.5 kg of water at 5 °C is put into the kettle and heated to boil at 100 °C:

   (i) How much energy is needed to boil the kettle? (Assuming no heat is lost.) **(2 marks)**

   (ii) How long will the kettle take to boil? **(1 mark)**

4. The graph below shows the cooling curve of water.



   (i) In which section of the graph, A, B, C or D is there a change of state from water to ice taking place? **(1 mark)**

   (ii) What is the value of temperature at point X? **(1 mark)**

5. A gas in a closed container occupies a volume of 0.5 litres at a temperature 23 °C. The gas is then heated to a temperature of 50 °C.

   Calculate the new volume of the gas if there is no change in pressure. **(2 marks)**

6. State **one** assumption of kinetic theory of gases. **(1 mark)**

STRAND 3 **FLUID STATICS** **[8 Marks]**

- This strand has 5 Questions.
- Show necessary working for questions **3 – 4** as partial marks will be awarded for correct working.

1. The lowest possible temperature is known as

   A. Kelvin.
   B. Celsius.
   C. Fahrenheit.
   D. Absolute Zero.

2. According to **Bernoulli's Principle**, fast moving air will create a region of

   A. constant pressure.
   B. varying pressure.
   C. high pressure.
   D. low pressure

3. In a hydraulic lift, a force of 60 N is applied to a piston of area 0.20 m^2. The area of the other piston is 2.0 m^2.

   (i) Calculate the pressure transmitted through the liquid. **(1 mark)**

   (ii) Calculate the force on the other piston. **(1 mark)**

   (iii) Suggest **one** possible reason why the hydraulic lift will not work properly if air is in the liquid **(1 mark)**

4. A piece of metal weighs 20 N in air, 15 N when submerged in water and 17 N when submerged in kerosene.

   (i) By comparing the apparent weights in water and kerosene, decide which liquid is more dense. Give a reason for your answer. **(1 mark)**

   (ii) Given that the density of water is 1000 kg/m^3, determine the density of the metal. **(2 marks)**

STRAND 4 GEOMETRICAL OPTICS AND WAVE MOTION [10 Marks]

- This strand has 5 Questions.
- Show necessary working for questions **3 - 5** as partial marks will be awarded for correct working.

1. In Young's double slit experiment with a monochromatic light source, the separation of the interference fringes is increased by :

   I. increasing the wavelength of the light
   II. increasing the separation of the slits
   III. decreasing the distance between the slits and the screen on which the fringes are formed

   Which of the statement(s) above is **correct** ?

   A. I
   B. I and III
   C. II and III
   D. I, II and III

2. Which of the following characteristics does **not** change when light passes from air to water ?

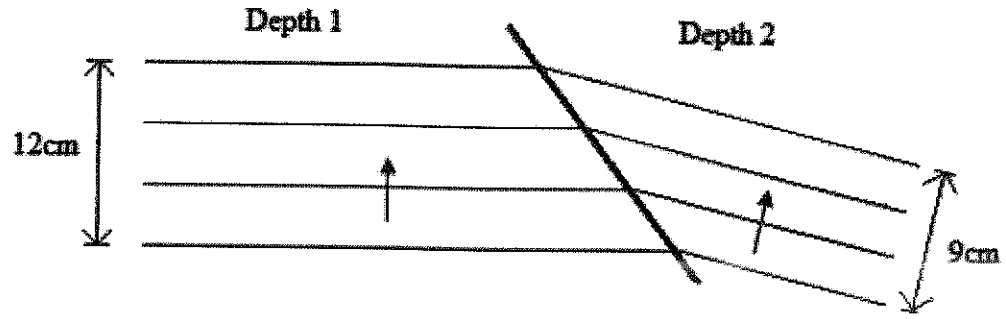
   A. speed
   B. frequency
   C. wavelength
   D. angle of incidence

3. In a Young's double slit experiment, the monochromatic light used is of wavelength 600 nm.

   (i) If the distance between the two slits is 0.50 mm and the screen distance from the double slit is 0.75 m, calculate the distance of the third bright band from the central maximum. **(2 marks)**

   (ii) What is the path difference of the light from the double slits to the second dark band? **(1 mark)**

4. Plane waves of frequency 5 Hz in a ripple tank pass from one depth of water into another across a boundary.

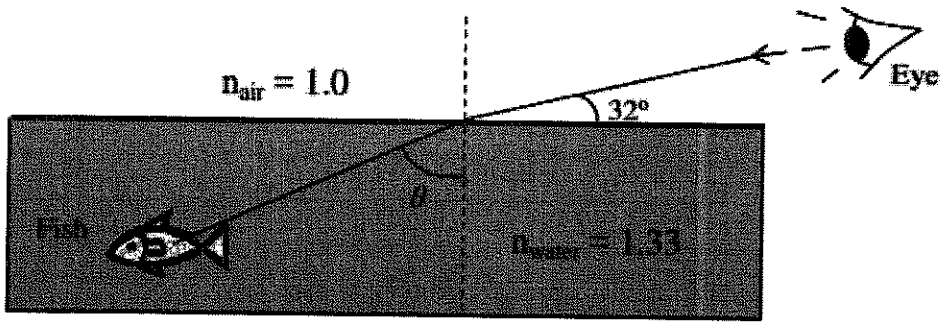


(i) Label Depth 1 and Depth 2 as shallow or deep region. **(1 mark)**

(ii) What is the wavelength of waves in Depth 1. **(1 mark)**

(iii) Calculate the speed of waves in Depth 1 **(1 mark)**

5. A fisherman notices a fish at the bottom of a lake. Refer to the diagram below to answer the question that follows.



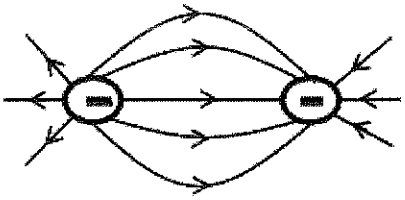
Calculate the size of the angle of refraction, θ. (Express your final answer to **three** significant figures). **(2 marks)**

STRAND 5 **ELECTROSTATICS** **[14 MARKS]**

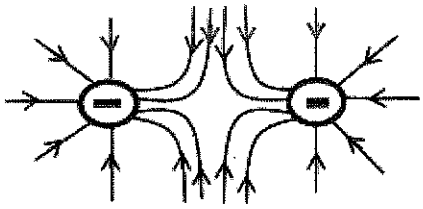
- This strand has 7 Questions.
- Show necessary working for questions **4 - 7** as partial marks will be awarded for correct working.

1. Which of these diagrams **best** shows the electric field pattern around two negative charges placed near each other?

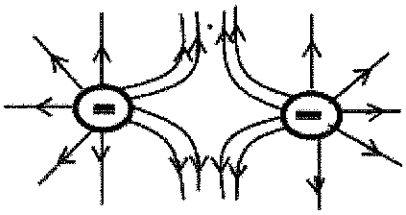
A.



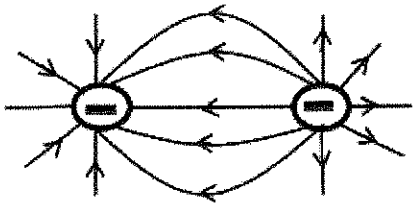
B.



C.



D.



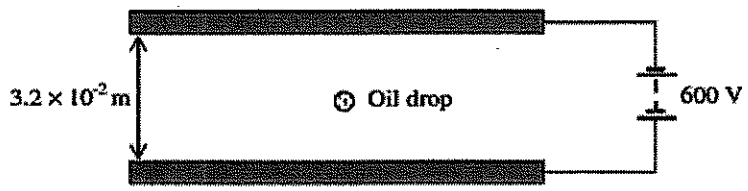
2. Which of the following conclusions **best** describe Millikan's oil drop experiment?

   A. Electrons are particles of negligible mass.
   B. All atoms contain electrons, protons and neutrons.
   C. Electrons have negative charge and of negligible mass.
   D. Charge was found to be multiples of some smallest value.

3. Which of the following devices can be connected in parallel in a circuit?

   A. Ammeter
   B. Voltmeter
   C. Manometer
   D. Micrometer

4. This question is about an experiment designed to measure the charge on an electron. In this experiment, 'Millikan's Oil Drop Experiment', two parallel metal plates, 3.2 x 10-2 m apart, are connected to a 600 V power supply.

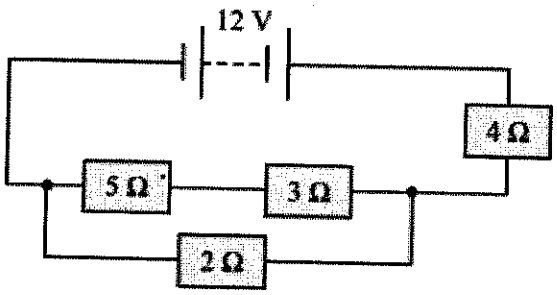


(i) Calculate the electric field strength between the two plates. **(1 mark)**

(ii) The electric field between the plates just supports the weight of an oil drop of mass 1.8×10^{15} kg, which has acquired a charge due to a few excess electrons. Given that the oil drop is stationary, calculate the charge on the oil drop. **(1 mark)**

(iii) What is the most likely number of excess electrons acquired by the oil drop? **(1 mark)**

5. Four resistors are connected to a 12 V battery, as shown in the diagram below.

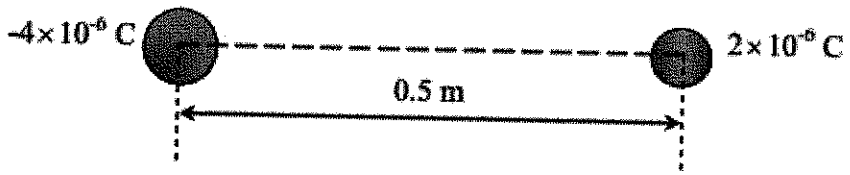


(i) Determine the total resistance of the circuit **(2 marks)**

(ii) Calculate the total current through the battery **(1 mark)**

(iii) Calculate the voltage across the 5Ω resistor **(1 mark)**

6. An object with a charge of 2×10^{-6} C is separated from the second object with a charge of -4×10^{-6} C by a distance of 0.5 m experiences an electric force between them.



(i) Calculate the force between the two objects. **(1 mark)**

(ii) State whether the force is **attractive** or **repulsive**. **(1 mark)**

7. State the function of the following safety devices in the electrical systems.

(i) Fuse **(1 mark)**

(ii) Earth wire **(1 mark)**

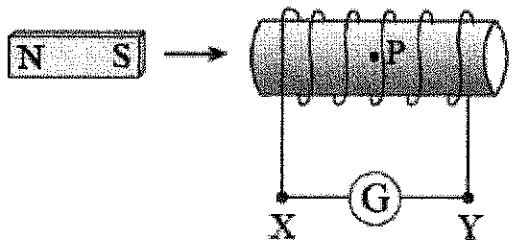
STRAND 6 **ELECTROMAGNETISM** **[10 MARKS]**

- This strand has 4 Questions.
- Show necessary working for questions **3 - 4** as partial marks will be awarded for correct working.

1. Which of the following properties makes materials suitable for use as a core in an electromagnet?

   A. easy to magnetise and easy to demagnetise
   B. difficult to magnetise and easy to demagnetise
   C. easy to magnetise and retains magnetic strength
   D. difficult to magnetise and retains magnetic strength

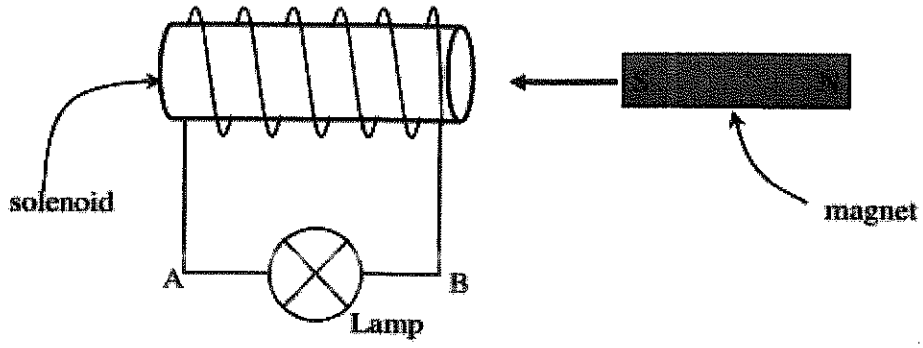
2. The diagram given below shows a bar magnet moving towards a solenoid.



Which of the pairs in the table below indicates the **direction of the current** through the galvanometer and the **direction of the magnetic field** produced by this current at location P inside the solenoid?

	Direction of the current through the Galvanometer	**Direction of the magnetic field at P**
A.	From X to Y	Right
B.	From X to Y	Left
C.	From Y to X	Right
D.	From Y to X	Left

3. Refer to the diagram below and answer the questions that follow.



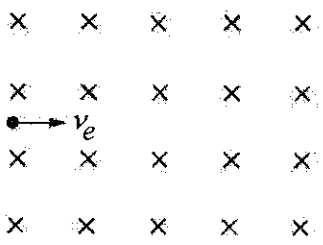
Sandy finds that she can produce electricity by moving the magnet into the solenoid, although the current produced is small.

(i) Describe one thing that she can do to make the current bigger. **(1 mark)**

(ii) Use Lenz's Law to determine the direction of the current through the lamp above **(1 mark)**

(iii) What will be the effect on the lamp if the magnet is held stationary inside the solenoid? **(1 mark)**

4. An electron enters a magnetic field with a velocity, v.
[Charge of electron = 1.6×10^{-19} C ; Mass of electron = 9.1×10^{-31} kg]



B (into the page)

(i) On the diagram in the **Answer Book**, indicate with an arrow the direction of the force on the electron due to the magnetic field. **(1 mark)**

(ii) The strength of the magnetic field is $B = 0.001$T and the electron's velocity is $v = 2 \times 10^6$ m/s. Calculate the magnitude of the magnetic force on the electron. **(2 marks)**

(iii) Calculate the radius of the circular path followed by the electron within the magnetic field. **(2 marks)**

STRAND 7 **ATOMIC PHYSICS** **[8 MARKS]**

- This strand has 5 Questions.
- Show necessary working for questions **3 - 5** as partial marks will be awarded for correct working.

1. Which of the following has the greatest penetrating power?

   A. Alpha particles
   B. Beta particles
   C. Gamma Rays
   D. X-rays

2. The maximum kinetic energy of the photoelectrons depends on light's

   A. intensity.
   B. direction.
   C. frequency.
   D. amplitude.

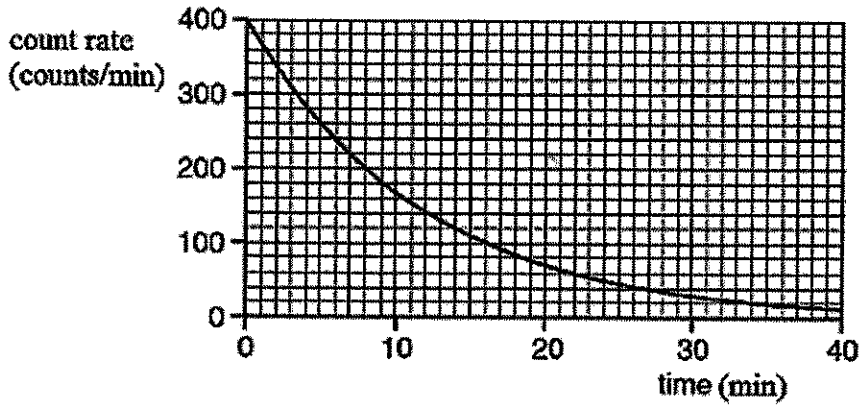
3. In a photoelectric cell, ultraviolet light of frequency 8×10^{14} Hz shines on a metal surface with a work function equal to 2×10^{-19} J.

   (i) Calculate the energy of photons of the incident ultraviolet light **(1 mark)**

   (ii) What is the maximum kinetic energy of the ejected electron **(1 mark)**

   (iii) How does the kinetic energy of the emitted electron vary with an increase in the intensity of the light? **(1 mark)**

4. Given below is the decay curve for a radioactive isotope that emits only β-particles



   Use the graph to find the value of the half-life of the isotope. **(2 marks)**

5. Define photoelectric effect **(1 mark)**

THE END