JAMES RUSE AGRICULTURAL HIGH SCHOOL

2016

PHYSICS

PRELIMINARY EXAMINATION

PART A and B

THEORY

General Instructions

- Reading time - 5 minutes
- Working time - 110 minutes
- Board-approved calculators 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 pages 7 and 17

Total: 77 marks

PART A	**Theory – 15 Multiple Choice Questions**	15 marks	Allow about 20 minutes
PART B	**Theory – Extended Response Questions**	42 marks	Allow about 60 minutes
PART C	**Data Processing**	20 marks	Allow about 30 minutes

PART A 15 Multiple Choice Questions 15 marks.

1. The gradient of a graph of potential difference (vertical axis) versus current for an ohmic conductor:

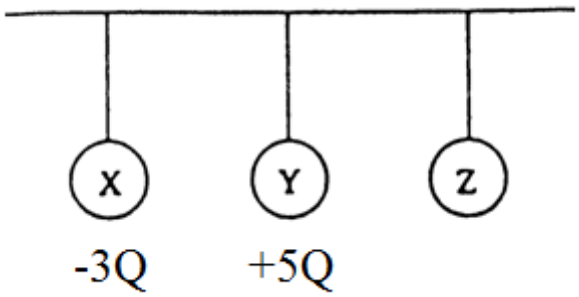
   (A) is inversely proportional to the current.
   (B) is constant and represents its resistance.
   (C) will double if the potential difference doubles.
   (D) is constant and represents the inverse of resistance.

2. A charge of -9.0 μC experiences a force of 3.0×10^{-3} N to the west when placed in an electric field.

   What is the strength and direction of this electric field?

   (A) 3.0×10^{-3} NC^{-1} East
   (B) 3.0×10^{-3} NC^{-1} West
   (C) 3.3×10^{2} NC^{-1} West
   (D) 3.3×10^{2} NC^{-1} East

3. Three identical hollow metal spheres (X, Y, and Z) are suspended vertically by thin insulating threads and carry different charges as shown. Sphere Z is initially neutral.

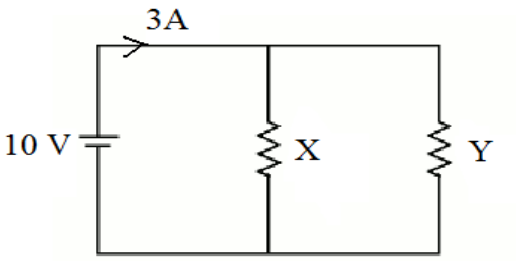


   Sphere X is touched to sphere Y and separated. Sphere Y is then touched to sphere Z and separated.

   What is the final charge on sphere Z?

   (A) –3 Q
   (B) +2 Q
   (C) +1 Q
   (D) +0.5 Q

4. Two resistors X and Y are connected as shown below.



The resistance of X is twice that of Y.
Choose the correct response

	$\frac{\text{current in X}}{\text{Current in Y}}$	$\frac{\text{Potential Difference across X}}{\text{Potential Difference across Y}}$
(A)	0.5	1.0
(B)	0.5	2.0
(C)	2.0	1.0
(D)	2.0	2.0

5. As you increase the cross-sectional area of a wire, it's resistance:

(A) increases.
(B) decreases.
(C) does not change.
(D) can't be determined without knowing the wire's temperature.

6. An electrical appliance draws 2.5 A from a 240 V power source.
How long will it take the electrical appliance to use 30 kJ of energy?

(A) 0.02 s
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7. The pictures from the Sydney Olympic Games were transmitted live to television receivers all around the world.
What is the main reason for reflecting the TV waves off orbiting satellites during the games?

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8. Total internal inflection can occur when light passes from one medium into another:

(A) at less than the critical angle.
(B) which has a higher refractive index.
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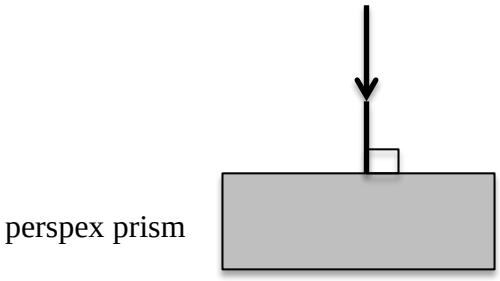
9. A ray of monochromatic light (single frequency) enters a perspex prism from air as shown.



Choose the INCORRECT response.

(A) The speed of the light will decrease.
(B) The wavelength of the light will increase.
(C) The direction of the light will remain unchanged.
(D) The frequency of the light will remain unchanged.

10. How are the frequency and volume of a sound wave affected when the pitch is decreased and the amplitude is increased.

	frequency	*volume*
(A)	decreases	decreases
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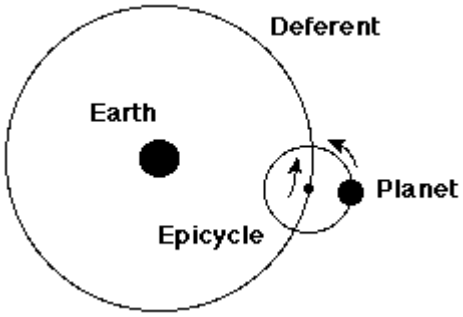
11. What observation does this model of the universe attempt to explain?



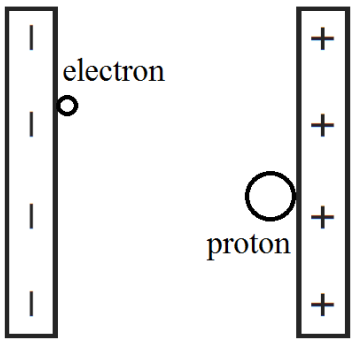
(A) Retrograde motion.
(B) Varying luminosity.
(C) Geocentric solar system.
(D) Heliocentric solar system.

12. Vega and Deneb are two stars with the same luminosity. The apparent brightness of Vega as observed from the Earth is 0.16 times the brightness of the sun, B_s.

If Deneb is located 3 times as far away from the Earth, what is its apparent brightness as observed from the Earth?

(A) 0.018 B_s
(B) 0.040 B_s
(C) 0.053 B_s
(D) 0.504 B_s

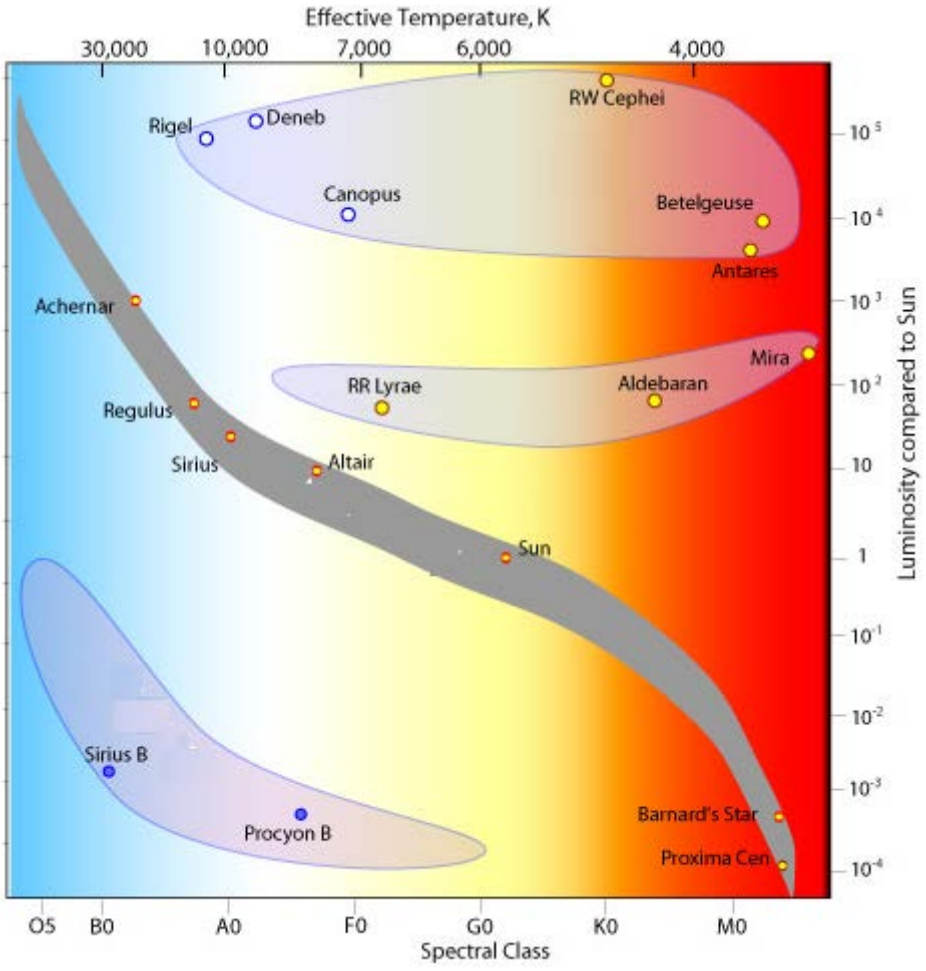
13. A proton and electron are released from rest between oppositely charged plates as shown below.



When they reach their oppositely charged plates, which will have the larger kinetic energy?

(A) The proton
(B) The electron
(C) They will have the same kinetic energy
(D) Neither one gains any kinetic energy

Use the Hertzsprung-Russell diagram below to answer questions 14 and 15.



14. Which star is most likely to be the largest?

    (A) Rigel
    (B) Betelgeuse
    (C) Aldebaran
    (D) Achernar

15. Which star does not use nuclear fusion as its energy source?

    (A) Mira
    (B) Sirius
    (C) Canopus
    (D) Procyon B

ANSWER BOOKLET

PART A Multiple Choice Answer Sheet 15 marks

Student No. …….....

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 ○

PART B 12 questions 42 marks

Attempt questions 16-27.

Allow about 60 minutes for this part.

Show all relevant working in questions involving calculations.

Question 16 (2 marks)

The metal dome on the Van der Graaff generator can produce 50 000 volts when it is charged. Why is it possible for a person to touch the charged dome without risk of serious injury? **2**

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Question 17 (2 marks)

A 240 V electric kettle has a heating element with a resistance of 20 ohms. The kettle boils a set volume of water in 2 minutes. **2**

Assume 100 % efficiency, calculate how much electrical energy is used to boil the water.

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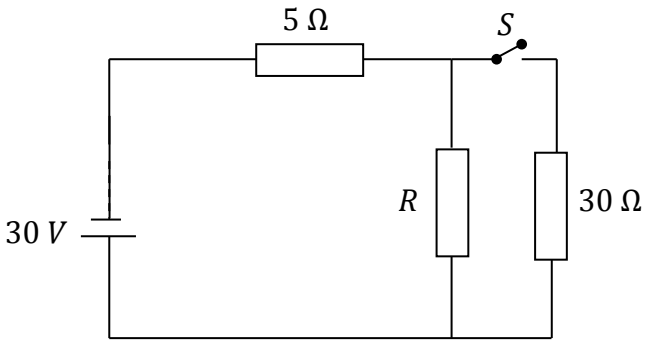
Question 18 (6 marks)

The circuit diagram shows a battery connected to three resistors and a switch, *S*.



(a) Draw on the circuit diagram a voltmeter to measure the potential difference across the 30 Ω resistor and an ammeter to measure the current flowing through the 5 Ω resistor. **2**

The current drawn from the battery when the switch S is open is 0.6 A.

(b) Calculate the value of the unknown resistance R. **2**

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(c) Explain whether the current drawn from the battery will increase, decrease or remain the same when the switch, *S*, is closed? **2**

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Question 19 (4 marks)

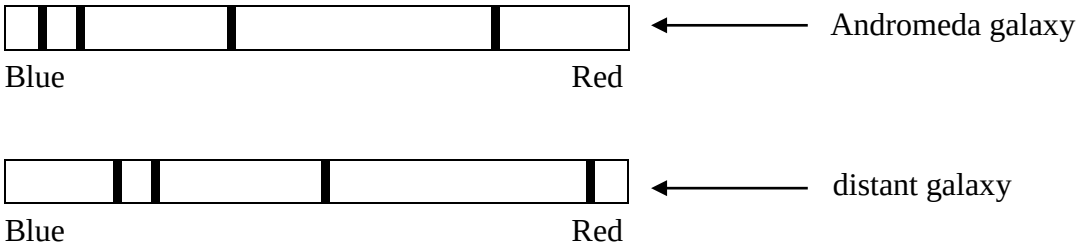
Draw magnetic field lines for the arrangements shown below.

(a) Between two magnetic poles. **2**

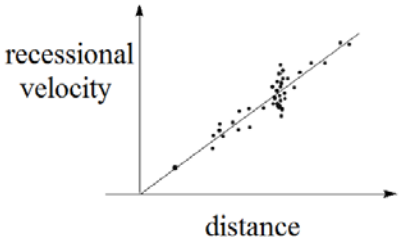
(b) Surrounding a current carrying conductor with current directed into the page. **2**

Question 20 (5 marks)

The absorption spectral lines for both our nearest galaxy Andromeda and a distant galaxy are shown in the absorption spectra below.



The graph below is often seen is astronomy.



Explain how both the absorption spectra and the graph can be used to support the Big Bang theory of an expanding universe. **5**

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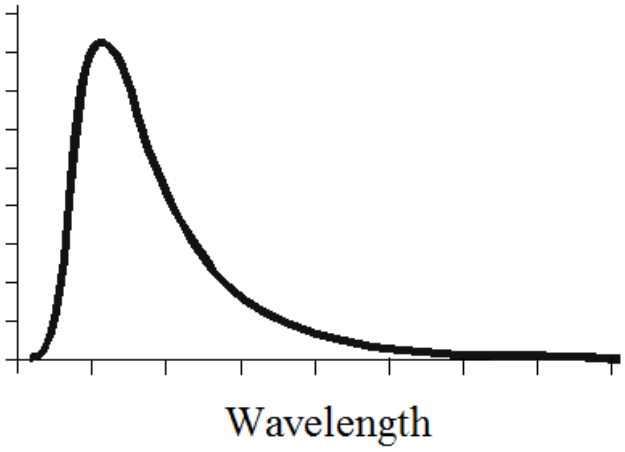
Question 21 (3 marks)

The graph below illustrates the varying intensity of radiation of different wavelengths emitted by a blue main sequence star.



(a) Sketch the curve for a red main sequence star on the image above. **1**

(b) Define the relationship between the temperature of a body and the dominant wavelength. of the radiation emitted from that body. **2**

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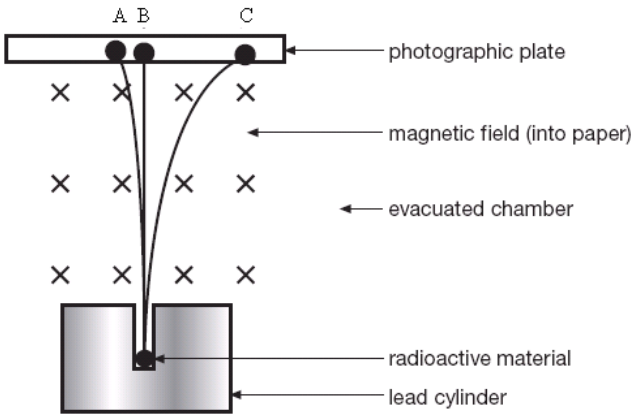
Question 22 (4 marks)

The diagram below illustrates a simple experiment designed to investigate the effect of a magnetic field on the three main types of radiation, A, B and C, that can be produced by a radioactive isotope



(a) Identify the three types of radiation A, B and C by completing the table below **2**

Name	Type of radiation
A	
B	
C	

(b) The medical image (to the right) is called a bone scan. It shows the body of a healthy person. The technique used to produce this image involves injecting a radioactive isotope into the blood. The isotope concentrates in the bones and decays producing radiation. The radiation passes through the body tissues and is detected by a ring of sensors around the body. Dark areas indicate concentrations of the radioactive isotope. **2**

Predict the type of radiation emitted from the radioactive isotope and justify your choice.

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Question 23 (3 marks)

Outline, with the aid of a diagram, how optical fibres are used in communication. **3**

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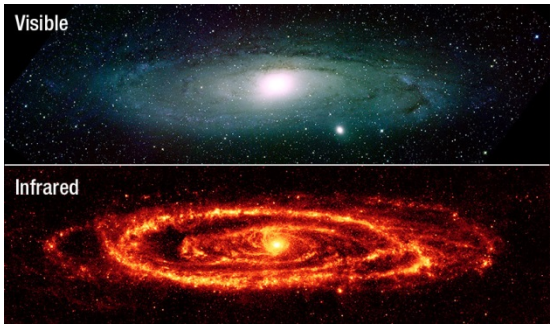
Question 24 (3 marks)

The images below were taken of the Andromeda Galaxy using both visible and infra-red light.



(a) Identify TWO differences between these light waves. **1**

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(b) Identify TWO similarities between these light waves **2**

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Question 25 (5 marks)

In your course you performed a first-hand investigation to model the inverse square law. Describe your experiment, including the following: **5**

- A clearly labelled diagram of the experimental set-up
- A graph of the results you obtained
- TWO strategies you employed to improve the reliability of your experiment
- ONE strategy you employed to ensure your experiment was valid

Diagram:

Results:

Reliability:

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Validity:

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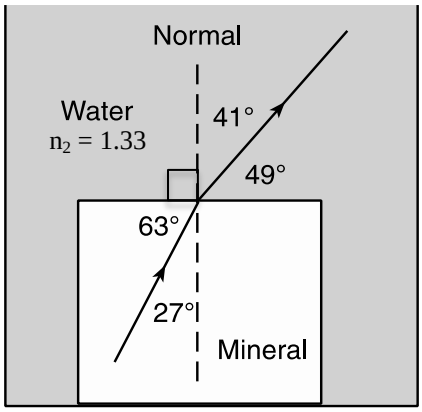
Question 26 (3 marks)

A ray of light is travelling through a mineral sample that is submerged in water. The ray refracts as it enters the water, as shown in the diagram below.



(a) Complete the table below. **1**

Angle of incidence	Angle of refraction

(b) Calculate the absolute refractive index of the mineral. **2**
Show all working, including any equations and substitution.

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Question 27 (2 marks)

Describe ONE application of reflection for a convex mirror. **2**

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End of Theory paper ☺

Student No. …….....

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PHYSICS

PART C

DATA PROCESSING

PART C Data Processing Section 20 marks Allow about 30 minutes

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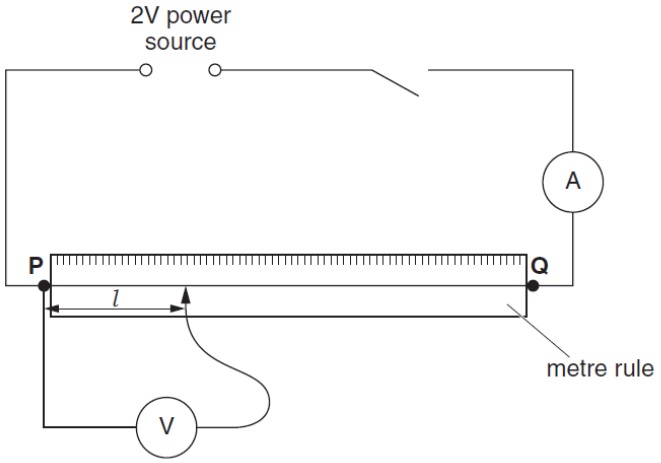
Question 28 (4 marks)

A Ruse class is investigating the effect of length on the resistance of a wire using the circuit shown.



A student measures and records in the table below the current I, flowing in the circuit and the potential difference V across a length $l = 0.25$ m of wire PQ.

The student repeats the procedure using l values of 0.50 m and 0.75 m .

length l ( )	voltage V ( )	current I ( )	resistance R ( )
0.25	0.54	3.2	
0.50	1.1	3.2	
0.75	1.6	3.2	

(a) Complete the heading for each column of the table. **1**

(b) Complete the table by calculating the resistance R of each length l of the wire using the equation $R = \frac{V}{I}$. **1**

(c) Use numbers from the table to suggest and justify a relationship between the length l of the wire and its resistance R. Show your working. **2**

relationship:

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justification:

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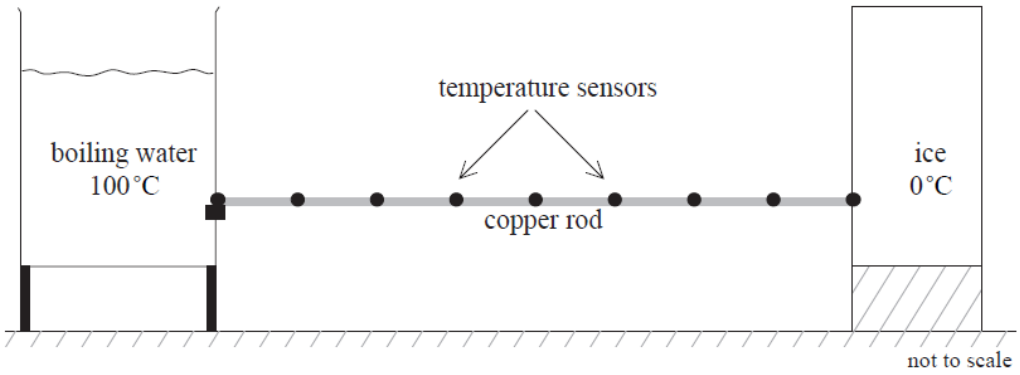
Question 29 (9 marks)

A student designed an experiment to investigate the variation of temperature along a copper rod when each end is kept at a different temperature. In the experiment, one end of the rod is placed in a container of boiling water at 100^0 C and the other end is placed in contact with a block of ice at 0.0^0 C as shown below.

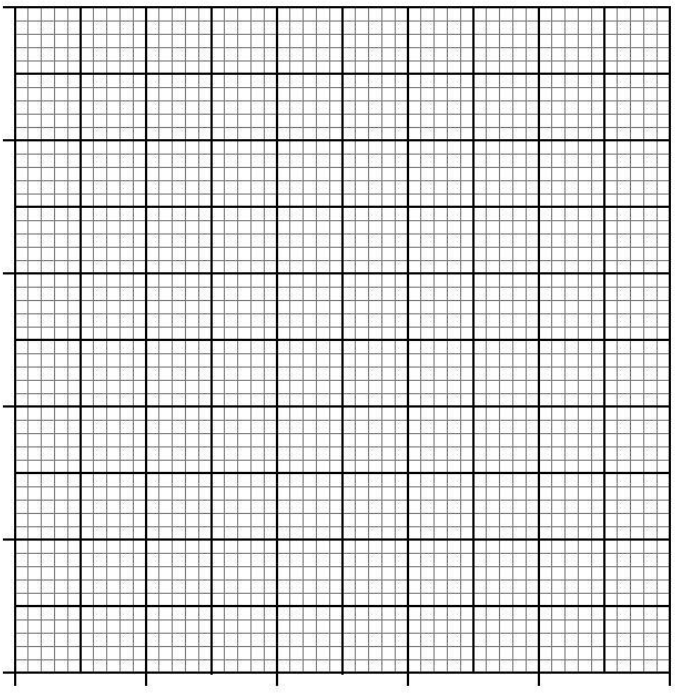


Temperature sensors are placed at 10 cm intervals along the rod. The final steady state temperature T, of each sensor is recorded, as a function of distance x of each sensor from the hot end of the rod, as shown in the table below.

T (˚C)	100	81	64	49	37	25	16	7	0
x (cm)	0	10	20	30	40	50	60	70	80

(a) Identify the independent variable in this experiment. …… **1**

(b) Plot a graph of T against x on the grid below, including a curve of best fit. **3**



Question 29 continues on the next page

Question 29 (continued)

(c) Use your graph to estimate the temperature of the rod at x = 35 cm. **1**

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(d) Determine the gradient of the curve at x = 35 cm, including units. Show all working. **4**

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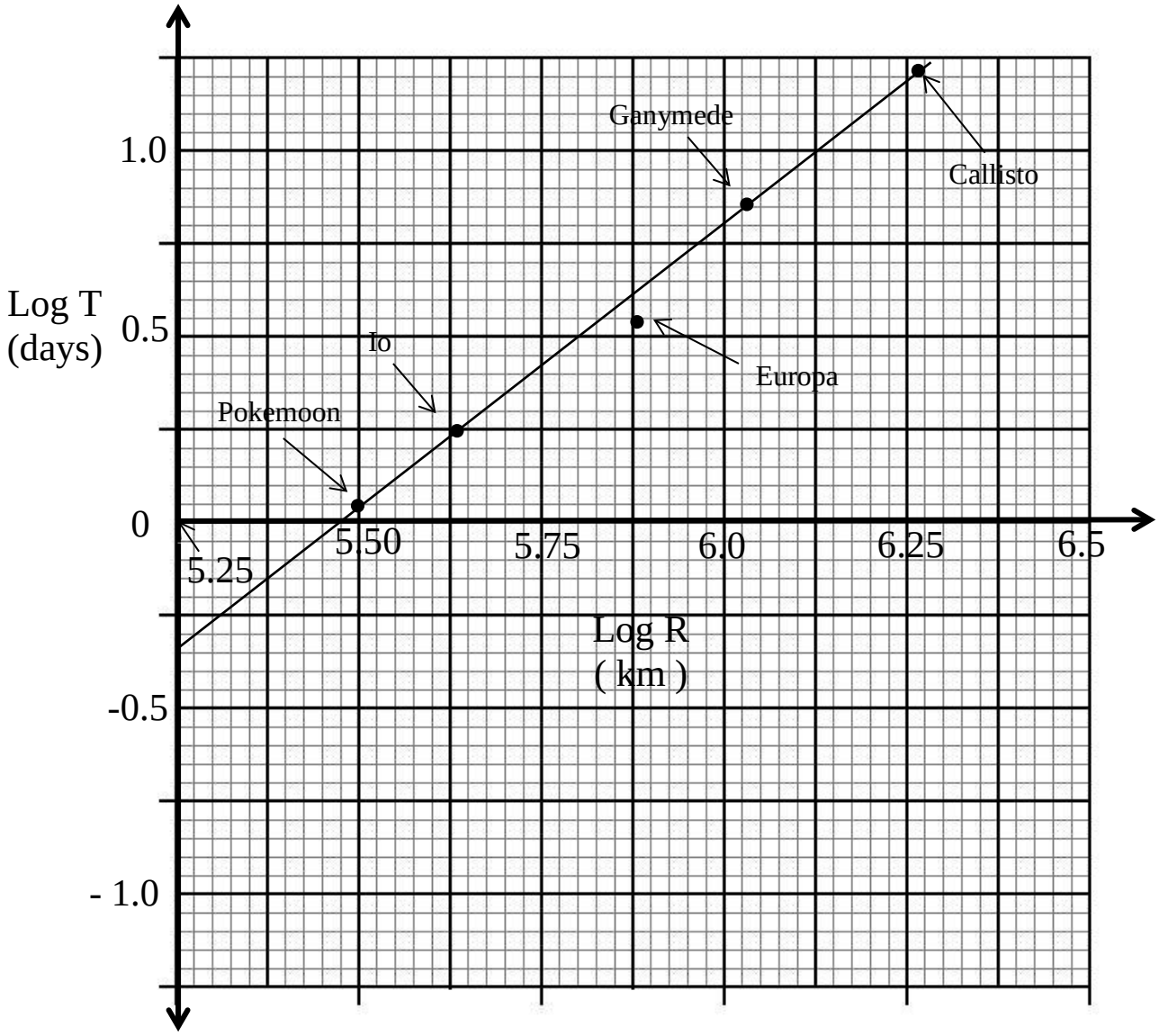
Question 30 (7 marks)

The graph and table below show orbital data for some of the moons of the planet Jupiter.



Moon	*Mean distance from planet, R* $(\times 10^5 km)$	$log\ R$ (km)	*Orbital Period, T* $(days)$	$log\ T$ $(days)$
Pokemoon			1.12	0.05
Io	4.22			
Europa	6.71	5.83	3.55	0.55
Ganymede	10.7	6.03	7.16	
Callisto	18.8	6.27	16.7	1.22

(a) Use the graph to complete the table above. **3**

Question 30 continues on the next page

Question 30 (continued)

(b) Theory predicts that the moons should obey an equation of the from **2**

$$\log T = b\,(\log R) + \log a$$

where a and b are constants.

Use the graph to find the value of b.

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(c) A recently discovered moon called Hypothetical with orbital period of 25.5 days and its mean distance from Jupiter was found to be 2 million kilometres. **2**

Assess the validity of this statement, assuming that $\log a = -8$.

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   What is the strength and direction of this electric field?

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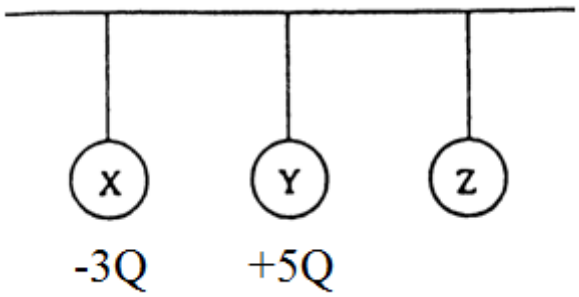
   (D) 3.3×10^{2} NC^{-1} East

3. Three identical hollow metal spheres (X, Y, and Z) are suspended vertically by thin insulating threads and carry different charges as shown. Sphere Z is initially neutral.



   Sphere X is touched to sphere Y and separated. Sphere Y is then touched to sphere Z and separated.

   What is the final charge on sphere Z?

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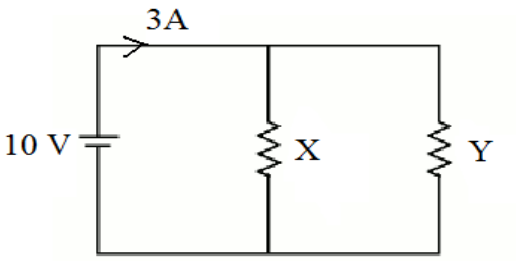
4. Two resistors X and Y are connected as shown below.



The resistance of X is twice that of Y.
Choose the correct response

	$\frac{\text{current in X}}{\text{Current in Y}}$	$\frac{\text{Potential Difference across X}}{\text{Potential Difference across Y}}$
(A)	0.5	1.0
(B)	0.5	2.0
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5. As you increase the cross-sectional area of a wire, it's resistance:

(A) increases.
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6. An electrical appliance draws 2.5 A from a 240 V power source.
How long will it take the electrical appliance to use 30 kJ of energy?

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7. The pictures from the Sydney Olympic Games were transmitted live to television receivers all around the world.
What is the main reason for reflecting the TV waves off orbiting satellites during the games?

(A) They do not travel in straight lines.
(B) They are unable to travel through the vacuum of space.
(C) They cannot follow the curved path around the Earth.
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8. Total internal inflection can occur when light passes from one medium into another:

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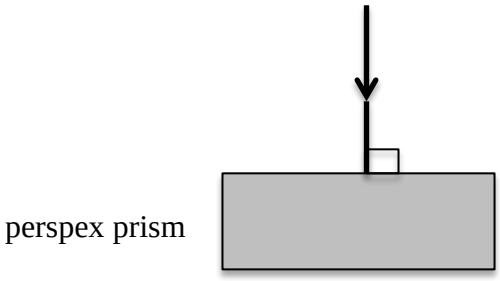

Choose the INCORRECT response.

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(C) The direction of the light will remain unchanged.
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	frequency	*volume*
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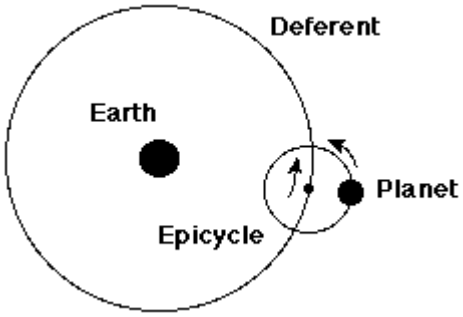
11. What observation does this model of the universe attempt to explain?

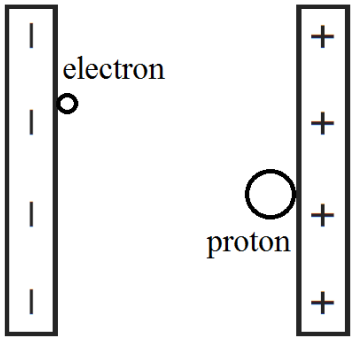


(A) Retrograde motion.
(B) Varying luminosity.
(C) Geocentric solar system.
(D) Heliocentric solar system.

12. Vega and Deneb are two stars with the same luminosity. The apparent brightness of Vega as observed from the Earth is 0.16 times the brightness of the sun, B_s.
If Deneb is located 3 times as far away from the Earth, what is its apparent brightness as observed from the Earth?

(A) 0.018 B_s
(B) 0.040 B_s
(C) 0.053 B_s
(D) 0.504 B_s

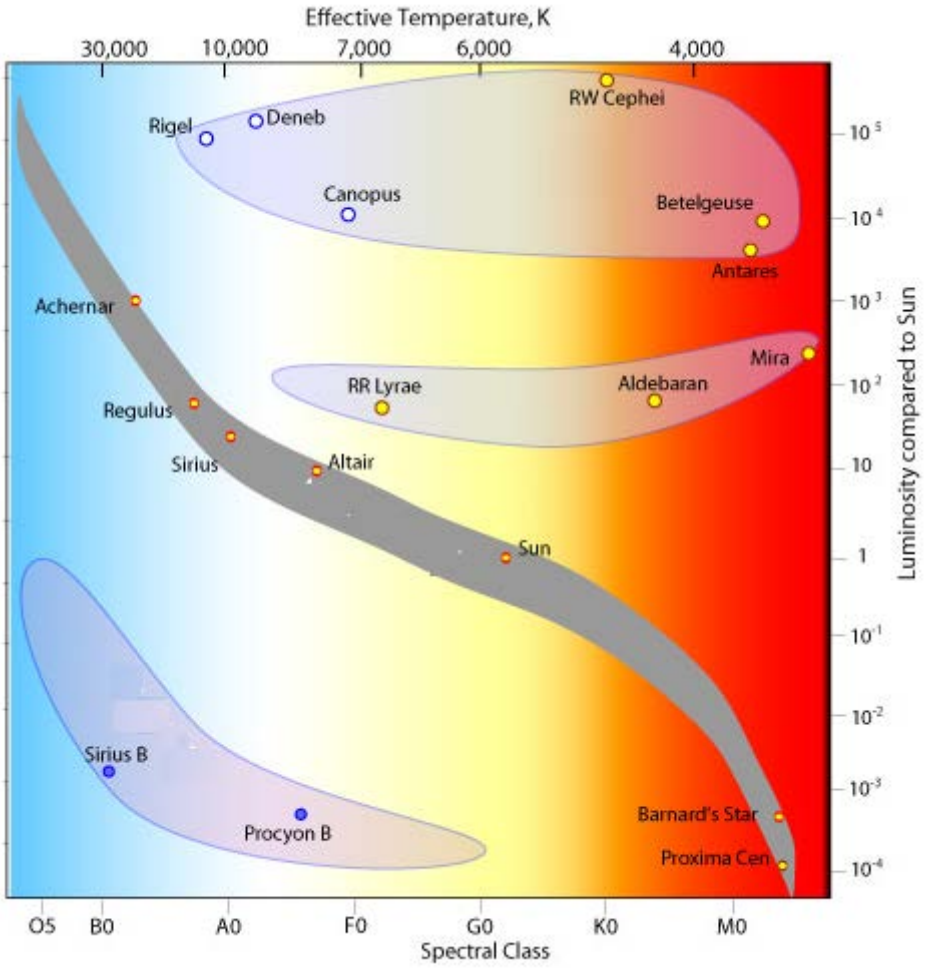
13. A proton and electron are released from rest between oppositely charged plates as shown below.



When they reach their oppositely charged plates, which will have the larger kinetic energy?

(A) The proton
(B) The electron
(C) They will have the same kinetic energy
(D) Neither one gains any kinetic energy

Use the Hertzsprung-Russell diagram below to answer questions 14 and 15.



14. Which star is most likely to be the largest?

(A) Rigel
(B) Betelgeuse
(C) Aldebaran
(D) Achernar

15. Which star does not use nuclear fusion as its energy source?

(A) Mira
(B) Sirius
(C) Canopus
(D) Procyon B

ANSWER BOOKLET

PART A Multiple Choice Answer Sheet 15 marks

Student No. …….....

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 ●

PART B 12 questions 42 marks

Attempt questions 16-27.
Allow about 60 minutes for this part.
Show all relevant working in questions involving calculations.

Question 16 (2 marks)

The metal dome on the Van der Graaff generator can produce 50 000 volts when it is charged. Why is it possible for a person to touch the charged dome without risk of serious injury? **2**

The amount of current is a lot less than 1 mA (which is considered safe??) and the electrons are spread over a large area of the dome. Discharge is instantaneous and NO CONTINUOUS CURRENT flows. Electric shocks/electrocution often involve CONTINUOUS current flowing as in electricity supplies so the van der Graaff delivers only a STATIC shock. Pathway is not through the heart also. Other answers accepted - as very high voltage not dangerous when current is extremely low.

Marking criteria	Mark
Very good description as to very low current and shock is static. Body resistance is high and prevents current flow.	2
Weak description lacking mention of low current or wrong interpretation of current flowing to earth in the wrong path.	1

Question 17 (2 marks)

A 240 V electric kettle has a heating element with a resistance of 20 ohms. The kettle boils a set volume of water in 2 minutes. **2**

Assume 100 % efficiency, calculate how much electrical energy is used to boil the water.

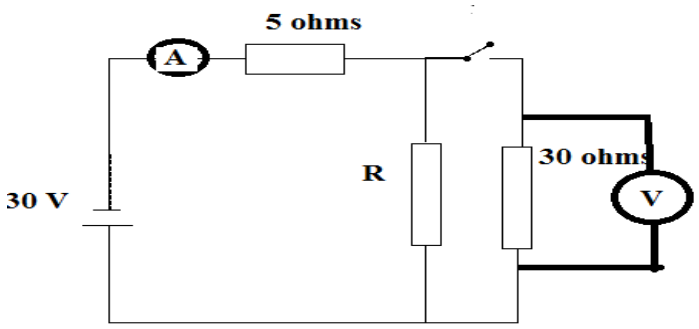
Power = $V^2/ R = (240)^2/20$ = 2880 watts (2880 J/s)

And for 120 seconds 2880J X 120s = 345600 Joules or **345.6 kJ total**

Marking criteria	Mark
Full correct workings and correct answer	2
Part correct up to power and incorrect answer Missing units	1

Question 18 (6 marks)

The circuit diagram shows a battery connected to three resistors and a switch, *S*.



Marking criteria	Mark
2 correct positions	2
1 correct position	1

(a) Draw on the circuit diagram a voltmeter to measure the potential difference across the 30 Ω resistor and an ammeter to measure the current flowing through the 5 Ω resistor. **2**

The current drawn from the battery when the switch S is open is 0.6 A.

(So voltage drop on 5 ohm resistor is 3 volts)

(b) Calculate the value of the unknown resistance *R*. **2**

R voltage is 27 volts and current is 0.6A then R =V/I = 27/0.6 = **45 Ω**

Marking criteria	Marks
Full correct working and substitutions. Correct units	2
Correct working but calculation error. No units	1

(c) Explain whether the current drawn from the battery will increase, decrease or remain the same when the switch, *S*, is closed? **2**

Adding a new pathway will reduce RESISTANCE. New resistance for parallel path is now $R_{T(p)}$ = (30X45) / (30+45) = **18 Ω** . So total resistance is R_T = 5 + 18 = **23 Ω.**

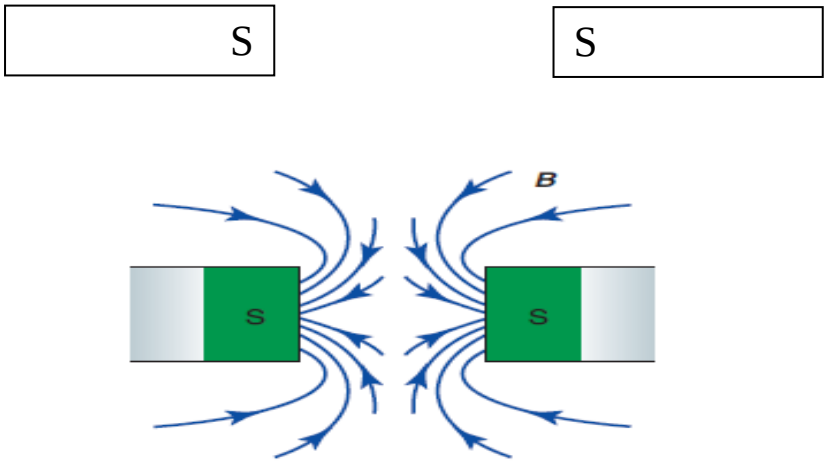
New current is I = V/R = 30 /23 = 1.30 A **so current increases.**

Marking criteria	Marks
Full working proof and explanation statement complementing correct answer	2
Statement correct no proof	1

Question 19 (4 marks)

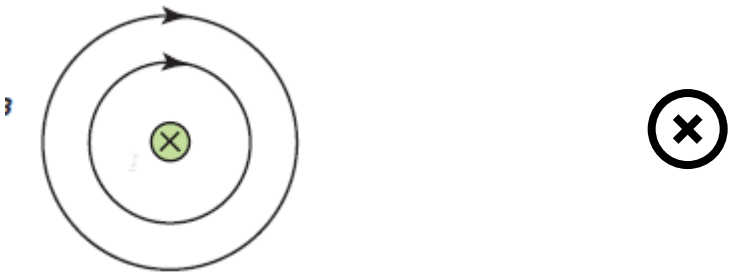
Draw magnetic field lines for the arrangements shown below.

(a) Between two magnetic poles. **2**



Marking Criteria	Mark
Correct direction and correct lines of force	2
Any one of the above	1

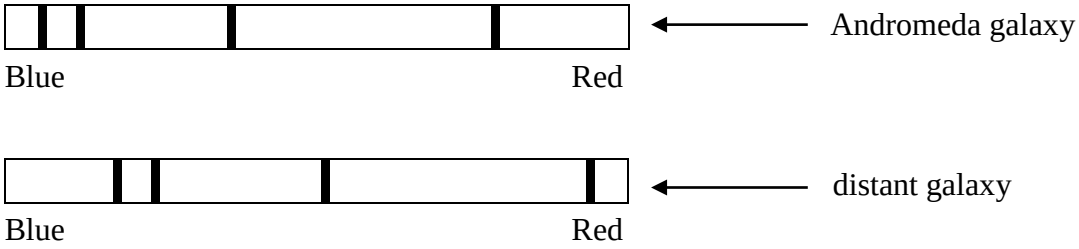
(b) Surrounding a current carrying conductor with current directed into the page. **2**



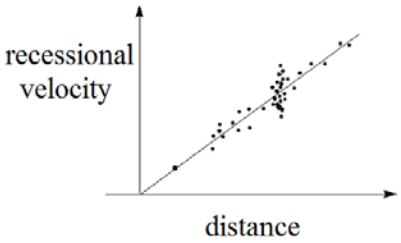
Marking Criteria	Mark
Correct direction and correct lines of force (at least 4 lines increasing in distance)	2
Any one of the above	1

Question 20 (5 marks)

The absorption spectral lines for both our nearest galaxy Andromeda and a distant galaxy are shown in the absorption spectra below.



The graph below is often seen is astronomy.



Explain how both the absorption spectra and the graph can be used to support the Big Bang theory of an expanding universe. **5**

The shift in the wavelengths of the absorption spectral lines towards the red end of the spectrum indicates the distant galaxy is moving away.

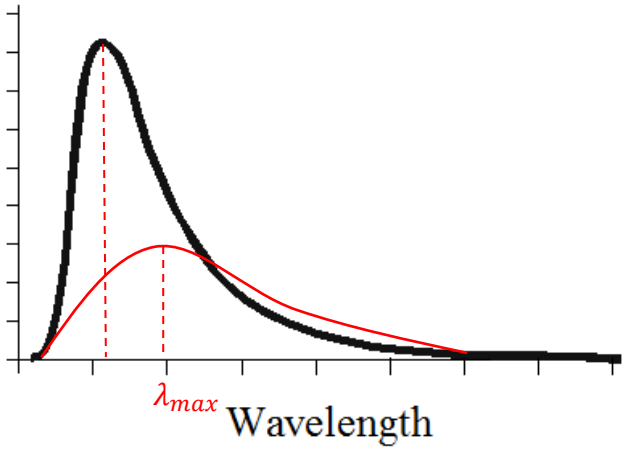
From the v-d graph it can be seen that the further away the galaxies are, the faster they are receding away which indicates that the universe is expanding.

By reversing this expansion trend, a singularity is obtained, which implies that this expansion started from a point.

Marking Criteria	Mark
(R1) Correctly explains red shift to an increase in wavelength. (R2) Correctly links cosmological red shift to galaxies moving away. (V1) Correctly uses the v-d graph to explain that the distant galaxies are moving away faster. (V2) Correctly links recessional velocity graph to universe expansion. (S) Correctly proves the existence of the big bang beginning with a singularity.	5
Any four of the above	4
Any three of the above	3
Any two of the above	2
Any one of the above	1

Question 21 (3 marks)

The graph below illustrates the varying intensity of radiation of different wavelengths emitted by a blue main sequence star



(a) Sketch the curve for a red main sequence star on the image above. **1**

Marking Criteria	Mark
Correct sketch for red main sequence	1

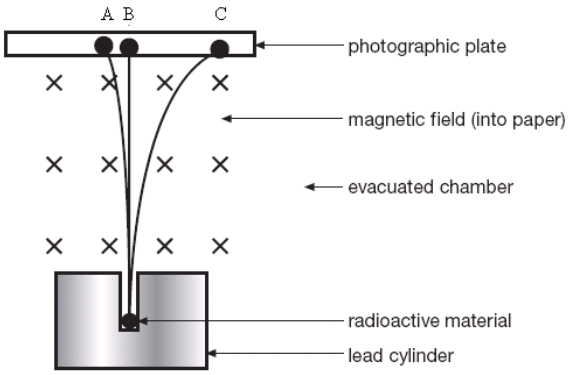
(b) Define the relationship between the temperature of a body and the dominant wavelength. of the radiation emitted from that body. **2**

As the temperature increases, the peak intensity increases with a decrease in wavelength.

Marking Criteria	Mark
Correct relationship between temperature and dominant wavelength, including a mention of the meaning of dominant wavelength	2
Any one of the above	1

Question 22 (4 marks)

The diagram below illustrates a simple experiment designed to investigate the effect of a magnetic field on the three main types of radiation, A, B and C, that can be produced by a radioactive isotope



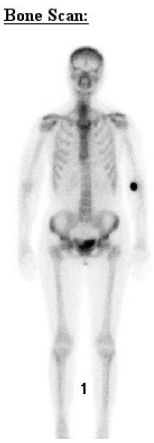
(a) Identify the three types of radiation A, B and C by completing the table below **2**

Name	Type of radiation
A	Alpha radiation
B	Gamma radiation
C	Beta radiation

Marking Criteria	Mark
Correctly identifies all three types of radiation	2
Any two correct	1

(b) The medical image (to the right) is called a bone scan. It shows the body of a healthy person. The technique used to produce this image involves injecting a radioactive isotope into the blood. The isotope concentrates in the bones and decays producing radiation. The radiation passes through the body tissues and is detected by a ring of sensors around the body. Dark areas indicate concentrations of the radioactive isotope. **2**

Predict the type of radiation emitted from the radioactive isotope and justify your choice.

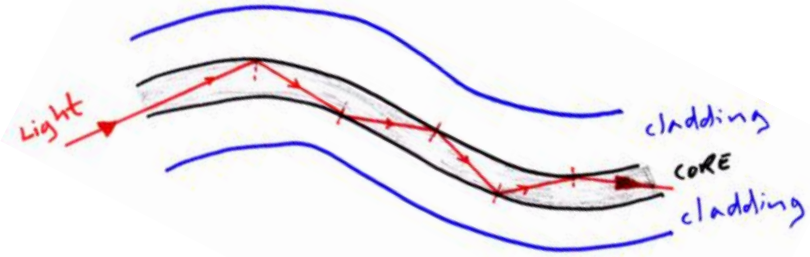


Marking Criteria	Mark
Correctly identifies gamma radiation as the preferred type with correct justification	2
Correctly identifies gamma radiation as the preferred type with incorrect or vague reasoning	1

Gamma radiation is used due to its high penetrating ability and low ionising ability. This enables the isotope to be easily detected outside of the body, without causing any tissue damage.

Question 23 (3 marks)

Outline, with the aid of a diagram, how optical fibres are used in communication. **3**



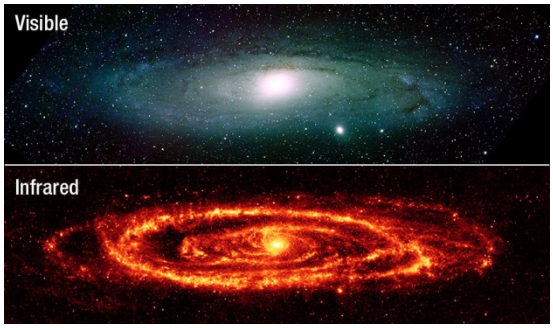
Marking Criteria	*Mark*
• Labelled diagram; TIR, correct use	3
• Any 2 of the above	2
• Any 1 of the above	1

Light entering the core experiences Totally Internally Reflection (TIR) at the core/cladding boundary (the core's refractive index is much higher than the cladding's to facilitate this).

This allows for the transmission of information over very long distances with little or no attenuation (signal loss).

Question 24 (3 marks)

The images below were taken of the Andromeda Galaxy using both visible and infra-red light.



(a) Identify TWO differences between these light waves. **1**

Marking Criteria	*Mark*
• Any 2 differences identified	1

Visible has a shorter wavelength, higher frequency, higher energy than infra-red (IR)

(b) Identify TWO similarities between these light waves. **2**

Marking Criteria	*Mark*
• Any 2 similarities identified	2
• Any 1 similarity identified	1

Both waves:
are electromagnetic in nature, transverse waves, travel at the same speed in vacuum of 3×10^{8} ms^{-1}, are self-propagating.

Question 25 (5 marks)

In your course you performed a first-hand investigation to model the inverse square law. **5**
Describe your experiment, including the following:

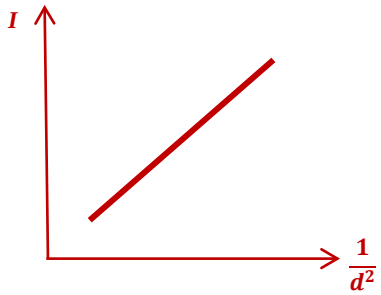
- A clearly labelled diagram of the experimental set-up.
- A graph of the results you obtained
- TWO strategies you employed to improve the reliability of your experiment.
- ONE strategy you employed to ensure your experiment was valid.

Marking Criteria	*Mark*
• A clearly labelled, correctly drawn diagram including a light source, light detector and metre ruler. • Correct graph • Two reliability strategies • One validity strategy	5
• Any 4 of the above	4
• Any 3 of the above	3
• Any 2 of the above	2
• Any 1 of the above	1

Diagram:

- A clearly labelled, correctly drawn diagram including a light source, light detector and metre ruler.

Results:



Reliability:

Any TWO correct answers. For example:

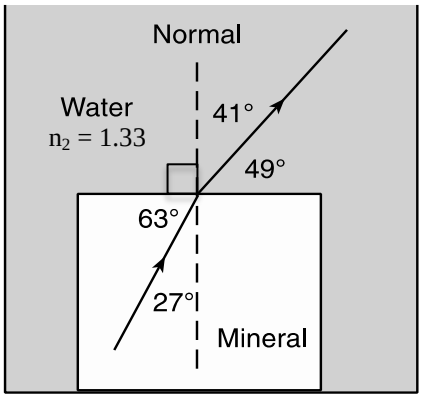
- Light reading measurements were repeated at least twice for each position, with similar results.
- More readings were taken at closer distances so as to minimize spacing between plotted points.
- Average values, when plotted, had minimal scatter from the line of best fit.
- Etc….

Validity:

- Minimize background lighting by turning off the lights.
- Aligning the light source and the light detector to the same height.
- Etc…

Question 26 (3 marks)

A ray of light is traveling through a mineral sample that is submerged in water. The ray refracts as it enters the water, as shown in the diagram below.



(a) Complete the table below. **1**

Angle of incidence	Angle of refraction
27°	**41°**

(b) Calculate the absolute refractive index of the mineral. **2**
Show all working, including any equations and substitution.

Marking Criteria	*Mark*
• Correct working and answer	2
• Any 1 of the above	1

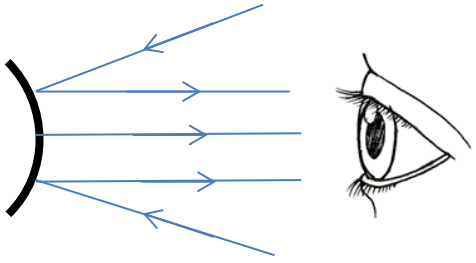
$$n_1 \sin i = n_2 \sin r$$
$$n_1 \sin 27 = 1.33 \sin 41$$
$$\therefore n_1 = \frac{1.33 \sin 41}{\sin 27}$$
$$\therefore n_1 \sim 1.92 \quad (3sf)$$

Question 27 (2 marks)

Describe ONE application of reflection for a convex mirror. **2**

Marking Criteria	*Mark*
• Detailed description of ONE application	2
• Brief description of ONE application	1

Convex mirrors are often used as side mirrors on cars as they provide a wider field of view of an image compared to a plane mirror. (albeit a diminished one).



End of Theory paper ☺

Student No. …….....

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2016

PHYSICS

PART C

DATA PROCESSING

PART C Data Processing Section 20 marks Allow about 30 minutes

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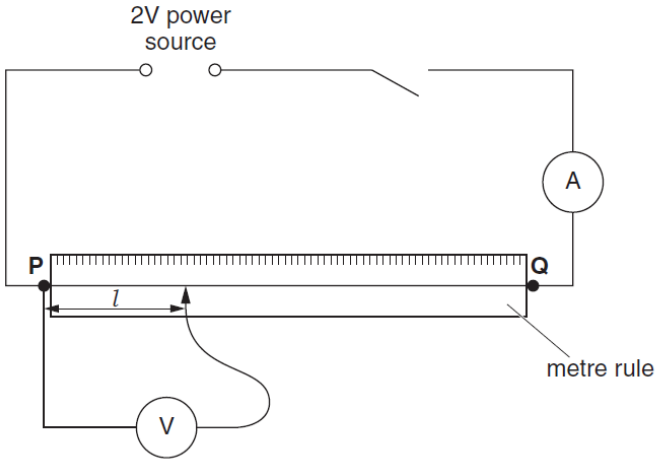
Question 28 (4 marks)

A Ruse class is investigating the effect of length on the resistance of a wire using the circuit shown.



A student measures and records in the table below the current I, flowing in the circuit and the potential difference V across a length $l = 0.25$ m of wire PQ.

The student repeats the procedure using l values of 0.50 m and 0.75 m .

length l (m)	voltage V (V)	current I (A)	resistance R (Ω)
0.25	0.54	3.2	0.17
0.50	1.1	3.2	0.34
0.75	1.6	3.2	0.50

(a) Complete the heading for each column of the table. **1**

Marking Criteria	Mark
4 correct units	1

(b) Complete the table by calculating the resistance R of each length l of the wire using the equation $R = \frac{V}{I}$. **1**

Marking Criteria	Mark
3 correct resistance values to 2 sig fig	1

(c) Use numbers from the table to suggest and justify a relationship between the length l of the wire and its resistance R. Show your working. **2**

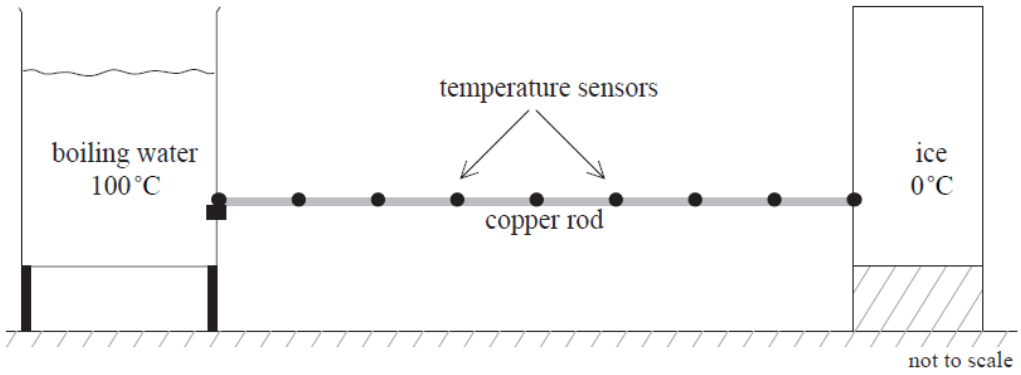
relationship:

$R \propto l$ or Resistance is proportional to length

Marking Criteria	Mark
Correct relationship	1
Correct justification	1

Question 29 (9 marks)

A student designed an experiment to investigate the variation of temperature along a copper rod when each end is kept at a different temperature. In the experiment, one end of the rod is placed in a container of boiling water at 100^0 C and the other end is placed in contact with a block of ice at 0.0^0 C as shown below.

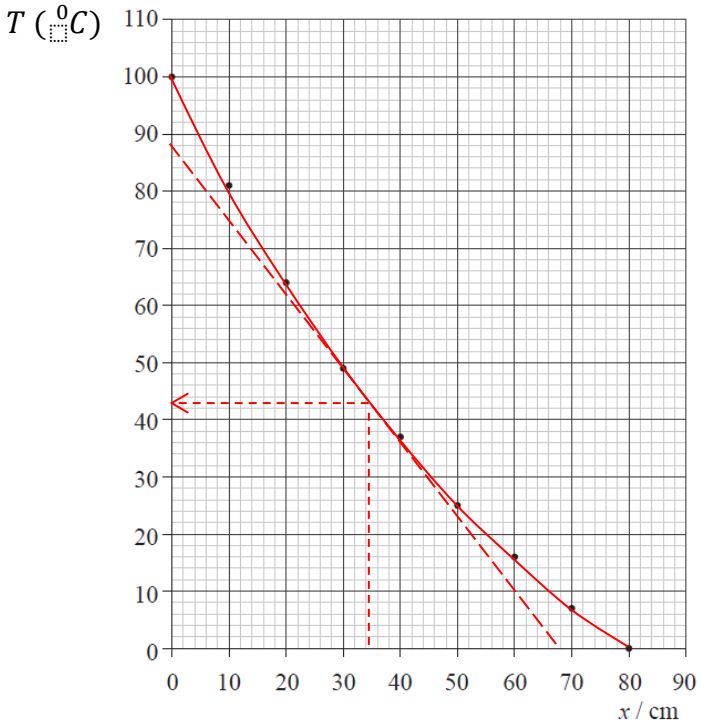


Temperature sensors are placed at 10 cm intervals along the rod. The final steady state temperature T, of each sensor is recorded, as a function of distance x of each sensor from the hot end of the rod, as shown in the table below.

T (˚C)	100	81	64	49	37	25	16	7	0
x (cm)	0	10	20	30	40	50	60	70	80

(a) Identify the independent variable in this experiment. x or the distance of sensor **1**

(b) Plot a graph of T against x on the grid below, including a curve of best fit. **3**



Marking Criteria	Mark
Correctly labelled axes, accurate plotting and line of best curve	3
Any twoof the above	2
Any one of the above	1

Question 29 (continued)

(c) Use your graph to estimate the temperature of the rod at x = 35 cm. Show all working. **1**

$$T \approx 43 \ ^0C$$

Marking Criteria	Mark
Correct interpolation	1

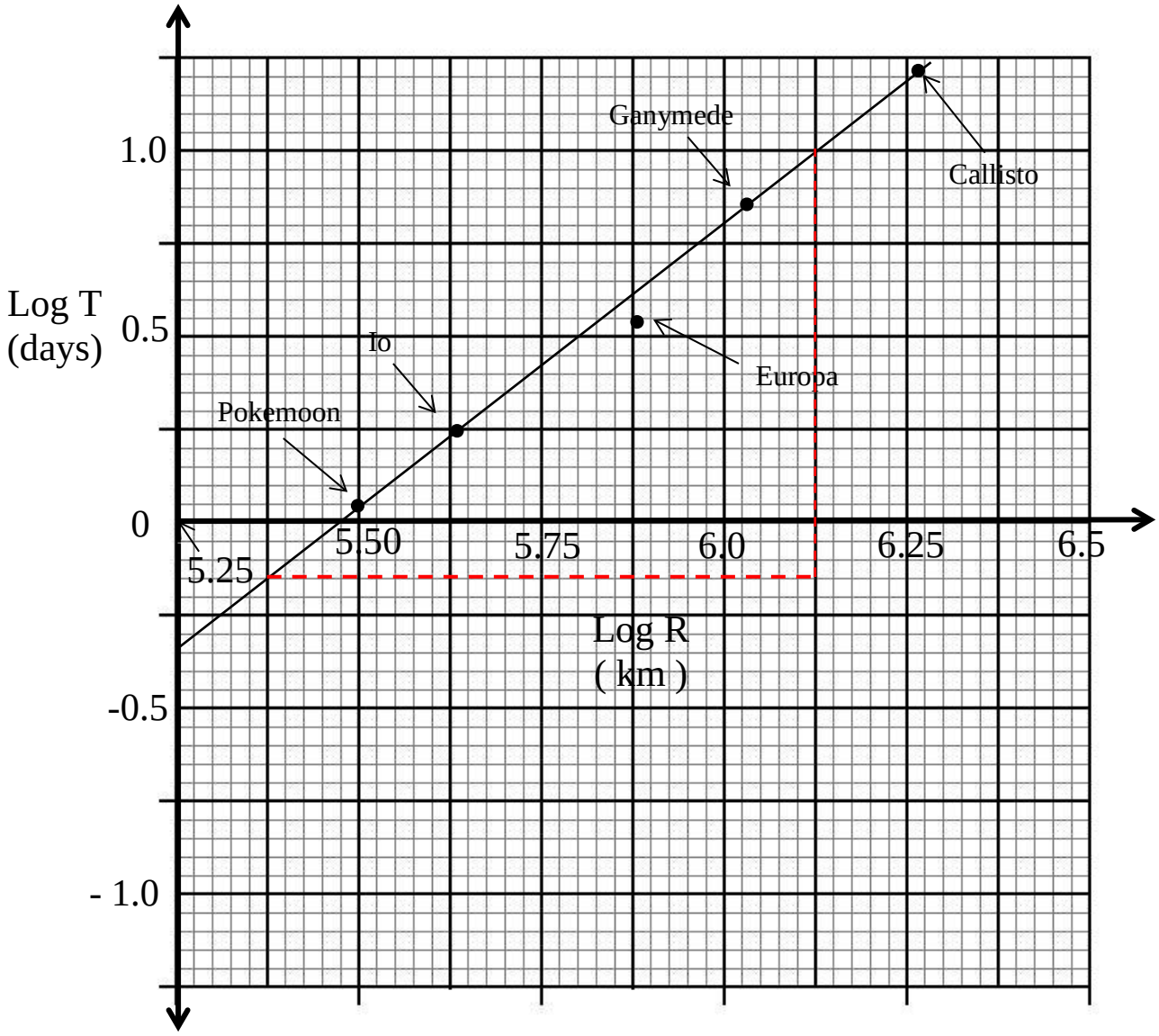
(d) Determine the gradient of the curve at x = 35 cm, including units. Show all working. **4**

$$gradient = \frac{\Delta T}{\Delta x}$$
$$= -\frac{88-0}{68-0}$$
$$= -1.3 \ ^0C \ cm^{-1}$$

Marking Criteria	Mark
Correct choice of tangent on graph; working; sign and magnitude; **units** SLOPE value range 1.2 to 1.4 accepted but **good** slope SHOWING and USING the slope line	4
Any three of the above	3
Any two of the above	2
Any one of the above	1

Question 30 (7 marks)

The graph and table below show orbital data for some of the moons of Planet Jupiter.



Moon	*Mean distance from planet, R* $(\times 10^5 km)$	*log R* (km)	*Orbital Period, T* $(days)$	*log T* $(days)$
Pokemoon	3.16	5.50	1.12	0.05
Io	4.22	5.63	1.77	0.25
Europa	6.71	5.83	3.55	0.55
Ganymede	10.7	6.03	7.16	0.86
Callisto	18.8	6.27	16.7	1.22

(a) Use the graph to complete the table above **3**

Marking Criteria	Mark
1 mark for every two correct	6

Question 30 (continued)

(b) Theory predicts that the moons should obey an equation of the from **2**

$$\log T = b\,(\log R) + \log a$$

where a and b are constants.

Use the graph to find the magnitude of b.

$$b = \frac{\Delta \log T}{\Delta \log R}$$

$$= \frac{1-(-0.15)}{6.125-5.375}$$

$$= 1.53\ days\ km^{-1}$$

Marking Criteria	Mark
Correctly identifying b to be the gradient and correct computation of gradient	2
Correctly identifying b to be the gradient	1

(c) A recently discovered moon called Hypothetical with orbital period of 25.5 days and its mean distance from Jupiter was found to be 2 million kilometres. **2**

Assess the validity of this statement, assuming that $\log a = -8$.

Substitute $R = 2 \times 10^6\ km$ into

$$\log T = 1.53\ (\log R) - 8$$

Giving $\log T = 1.53(\log 2 \times 10^6) - 8 = 1.6616$

Hence $T \approx 46\ days$

This represents an error of about 80%

Hence the statement is invalid.

Marking Criteria	Mark
Correct assessment based on verification of given data for Hypothetical using the accepted mathematical law	2
Shows some indication of verification of data	1

END OF EXAMINATION