2008

Year 11

Yearly Science Examination

Hurlstone Agricultural High School

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet, Periodic Table, and Formulae Sheets are provided at the end of this paper
- Liquid paper must NOT be used on this exam paper

Write your student ID below.

TIC: Mr Coombes

ID number _____

Teacher ☐ Coombes ☐ Pitt ☐ Robson

Marks

Total marks (70)

This section has two parts, Part A and Part B

Part A

Total marks (10)

- Attempt Questions 1 – 10
- Allow about 20 minutes for this part

Part B

Total marks (60)

- Attempt Questions 11 – 30
- Allow about 1 hour and 40 minutes for this part

Part A

Use the multiple-choice answer sheet

Total marks (10)
Attempt Questions 1 – 10
Allow about 15 minutes for this part

1. Which of the following best describes a beta particle?

   (A) An electron ejected from a radioactive nucleus
   (B) A particle consisting of two protons and two neutrons
   (C) A radioactive particle consisting of four nucleons
   (D) An energetic form of electromagnetic radiation

2. The speed of sound in air at 21^0C is 344 m s^{-1}. Which of the following best states the frequency of a sound wave having a wavelength of 3.44 cm?

   (A) 100 Hz
   (B) 10000 Hz
   (C) 1183 Hz
   (D) 11.8 Hz

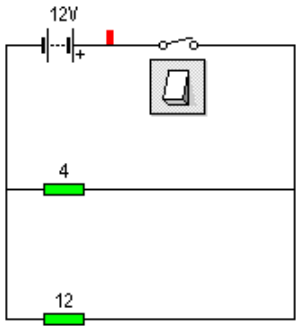
3. The light intensity from two identical stars, A and B, is measured from the Earth. Light from the star A is measured to have an intensity of 0.01 W/m^2 and has a known distance of 40 million light years. If star B has a measured intensity of 0.16 W/m^2 then how far from Earth is the star B?

   (A) 1 million light years
   (B) 10 million light years
   (C) 640 million light years
   (D) 160 million light years

4. Which of the following best describes the three major energy transformations that take place during a mobile phone call?

   (A) Sound → Electrical → Microwave → Electrical → Sound
   (B) Sound → Electrical → Radio → Electrical → Sound
   (C) Sound → Microwave → Sound
   (D) Sound → Radio → Sound

5. The following circuit diagram shows two resistors connected to a 12V power supply.



When the switch is closed, which of the following statements regarding the circuit above is FALSE?

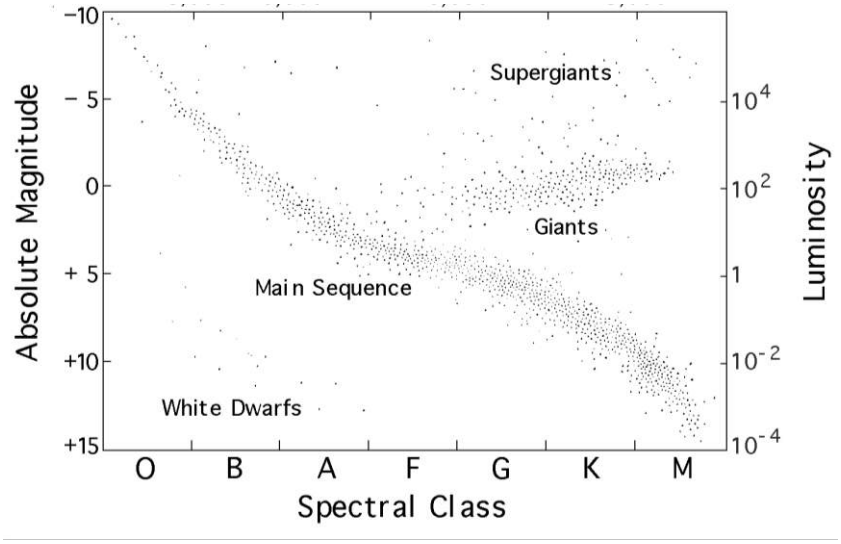
(A) Both of the resistors will have the same voltage across them.

(B) The 12 ohm resistor will have a current of 1A flowing in it.

(C) The current through the power supply will be greater than the current in the 12 ohm resistor.

(D) The four ohm resistor will have a current that is three times that in the 12 ohm resistor

6. The following is a Hertzsprung-Russell diagram.



Which of the following would be the most appropriate alternative scale for Spectral Class on the horizontal axis?

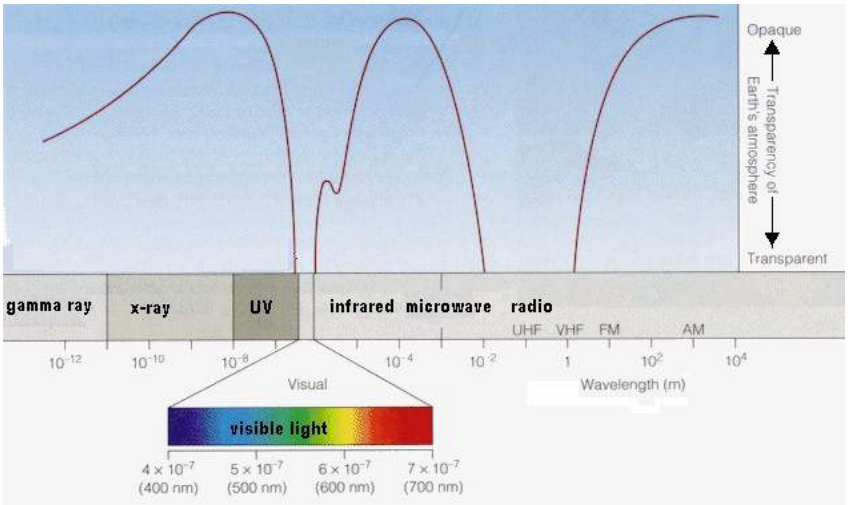
(A) Age

(B) Mass

(C) Power

(D) Temperature

7. The following image shows the transparency of the Earth's atmosphere to various types of electromagnetic waves. Use the diagram to answer the following question.



Which of the following parts of the electromagnetic spectrum would be useful in studying stars from the Earth?

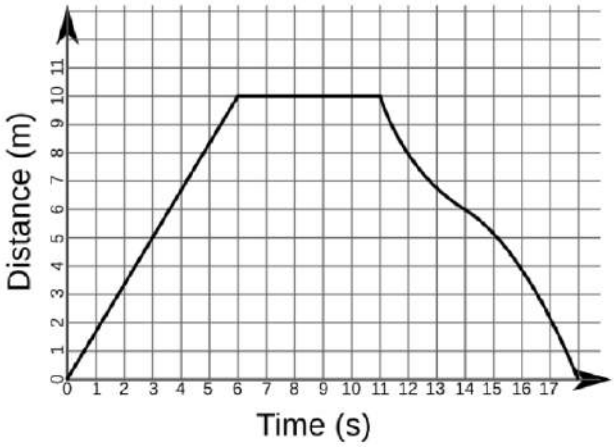
(A) Gamma rays and light

(B) X-rays and light

(C) Microwaves and light

(D) Radio waves and light

Use the displacement – time graph of a person's motion to answer the following two questions



8. The fastest speed travelled by the person in the interval shown is closest to

(A) 2.00 m/s

(B) 1.67 m/s

(C) 1.08 m/s

(D) 0.6 m/s

9. The total distance travelled by the person over the 18 second interval is closest to

   (A) 10 m
   (B) 115 m
   (C) 20 m
   (D) 36 m

10. The surface temperature of a star is most closely related to which of the following properties of the star?

   (A) Mass
   (B) Colour
   (C) Age
   (D) Composition

***** End Part A *****

Part B

Total marks (60)

Attempt Questions 11 – 28

Answer these questions in the spaces provided.

Allow about 1 h 45 m for this section of the paper.

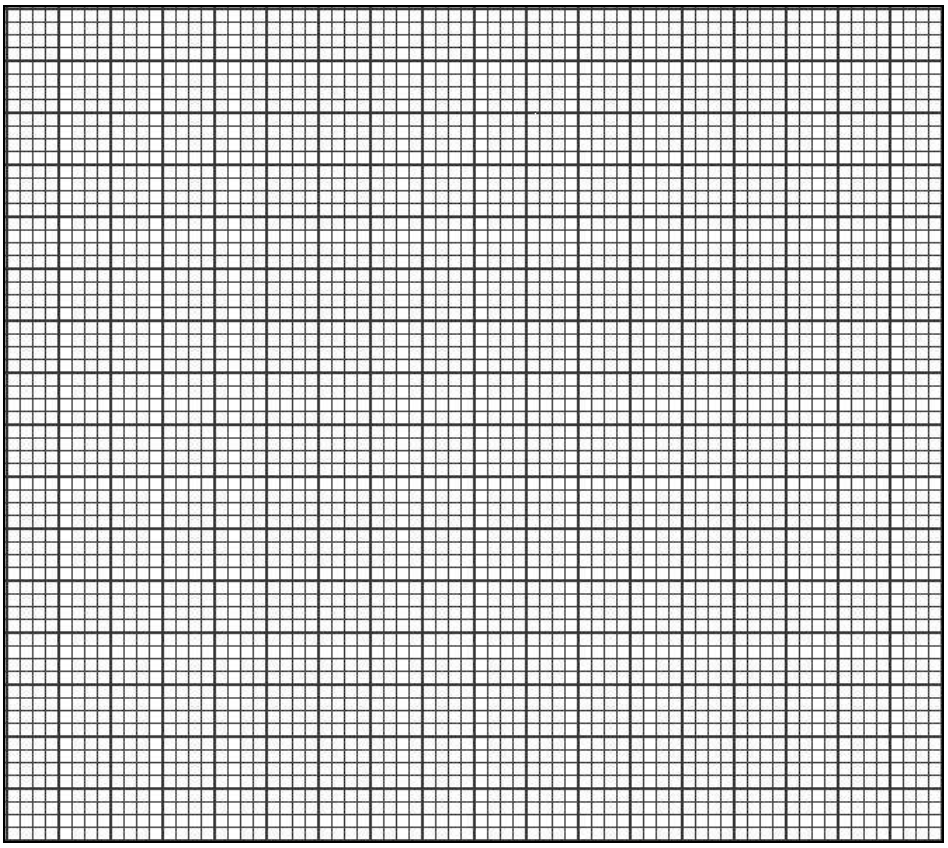
11. A group of students measured the intensity of light coming from a light globe at different distances. The table presents the values obtained by the group.

Distance (cm)	10	12	14	16	18	20
Intensity (arbitrary units)	2.00	1.38	1.02	0.78	0.62	0.5

(a) Identify the independent variable in this investigation 1M

(b) Using the graph paper below draw a graph that would enable the students to confirm the mathematical relationship shown below. Use the space in the table above to add necessary calculations if necessary.

$$I \propto \frac{1}{d^2}$$ 3M



12. Figure (a) shows two waves, a carrier and a signal, and the result of combining these to produce an FM wave output.

Figure (a)

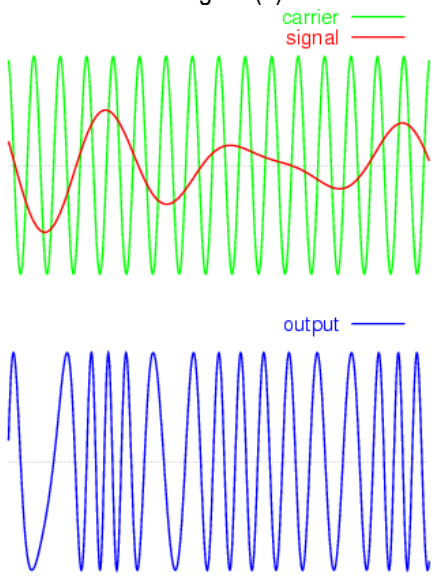
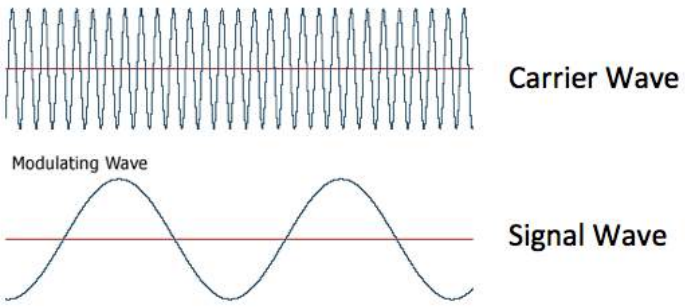


Figure (b)



(a) What does "FM" stand for? 1M

(b) Sketch the AM wave that would correspond to the addition of the signal and carrier in figure (b). Use the space below figure (b) for your answer 1M

13. (a) Outline the convention used to describe the direction of a magnetic field. 1M

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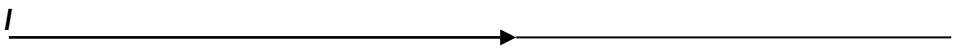
(b) Using the crosses and dots convention, sketch the magnetic field around the following current-carrying wire. 1M



14. Compare the electric field surrounding a positive charge with the field surrounding a negative charge 2M

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15. Outline the way in which an application of physics has affected both society and the environment. 2M

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16. For wires made of a given metal, the resistance is proportional to the length and inversely proportional to the cross-sectional area. A student has two wires made of the same metal. One is 10 cm long and has a diameter of 0.2 mm and its resistance is 2 ohms. The second piece of wire has a length of 50 cm and a diameter of 2 mm.

(a) Calculate the resistance of the second piece of wire. 3M

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(b) Identify another variable which affects the resistance of the same pieces of wire. 1M

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17. Compare the energy used to operate a 120 W television for 4 hours with the energy required to operate a 240 V room heater which draws a current of 10 A if it is operated for half and hour. 3M

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18. Discuss the use of microwaves in one identified communication system. 3M

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19. (a) Name the process of adding two waves together to give a resultant wave. 1M

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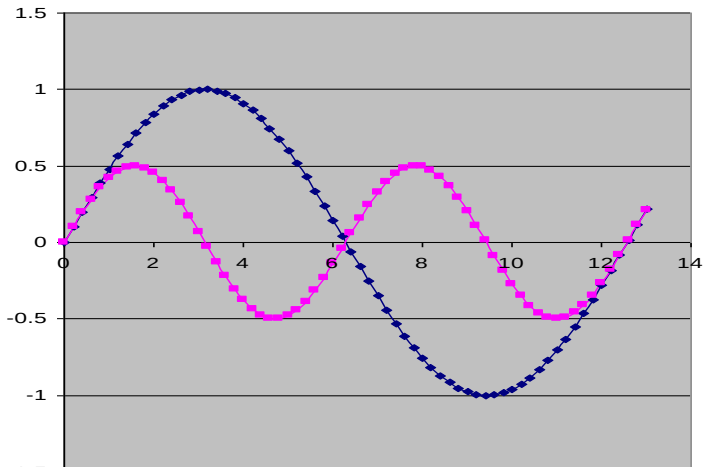
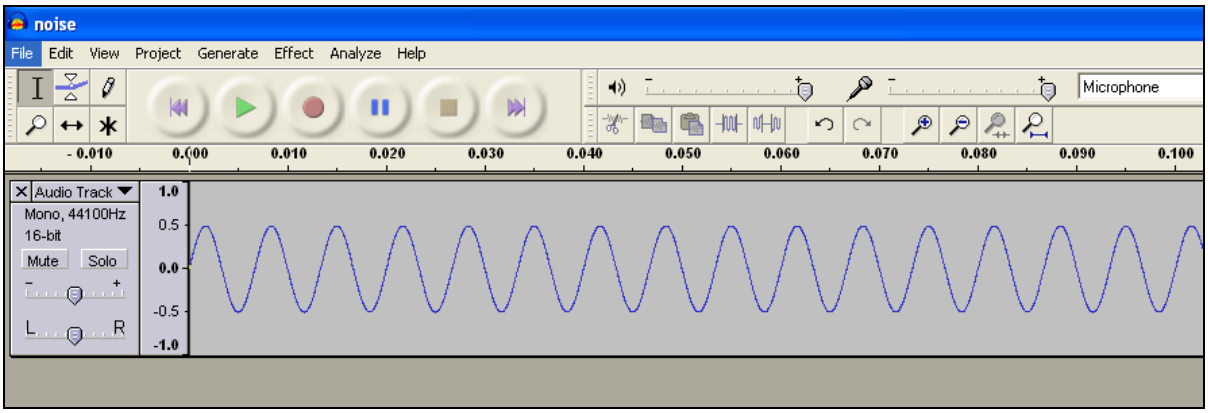
(b) On the diagram sketch the resultant wave that would result from the addition of the two waves shown. 2M



20. The following graph was made using the software called “Audacity”.



(a) Identify two other pieces of equipment required to produce such a graph. 1M

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(b) Calculate the frequency of the sound wave shown. 2M

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(c) Sketch a diagram of the sound wave and clearly label any relevant features. 2M

21. Explain how an echo could be used to reliably determine the distance from an observer to a large cliff face. 3M

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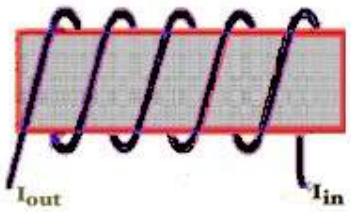
22. Draw the magnetic field surrounding the solenoid represented by the following diagram. 2M



23. (a) Explain the motion of a car travelling at a constant velocity in terms of Newton's first law.

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(b) A heavy lead ball was dropped from a height of 4 m to the ground. Outline the relevance of Newton's second and third laws to the motion of the ball.

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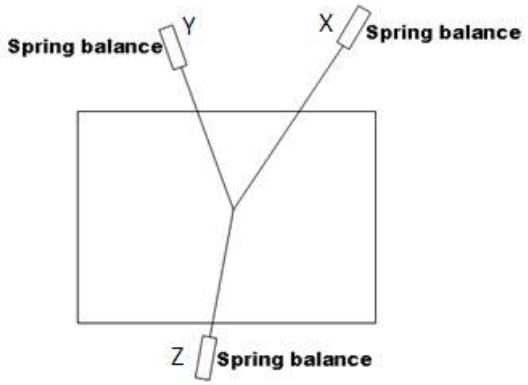
24. Students used spring balances to investigate the relationship between three forces applied in a horizontal plane as shown in the diagram below. When the measurements were taken, the strings and balances were all stationary.



Propose a reason why the forces recorded by the students are invalid. 2M

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25. A plane was flying horizontally at 200 m s^{-1} relative the air around it, heading due north according to its onboard compass. A wind was blowing towards the west at 50 m s^{-1} relative to the ground. Calculate the resultant velocity of the plane with the aid of a scale vector diagram. Show all your working. 3M

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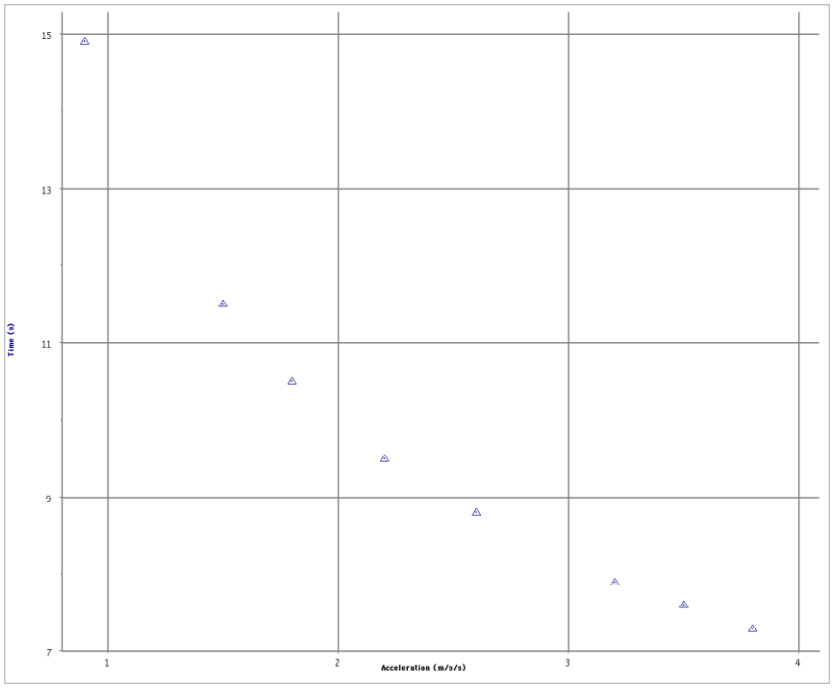
26. The time taken for an 800 kg car to travel a distance of 100 m under different at different values of its acceleration was investigated. The time was measured using a stopwatch. The average acceleration was calculated from measurements stored in a data logger connected to an accelerometer attached to the car.

The following table shows the results obtained.

Acceleration (m/s^2)	0.9	1.5	1.8	2.2	2.6	3.2	3.5	3.8
Time (s)	14.9	11.5	10.5	9.5	8.8	7.9	7.6	7.3

(a) This data has been graphed below. Draw a line of best fit for this data. 1M



3 marks

(b) Describe the relationship between these variables. 2M

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(c) Evaluate the statement "The use of an electronic data logger and accelerometer sensor ensures that the experiment is reliable" 2M

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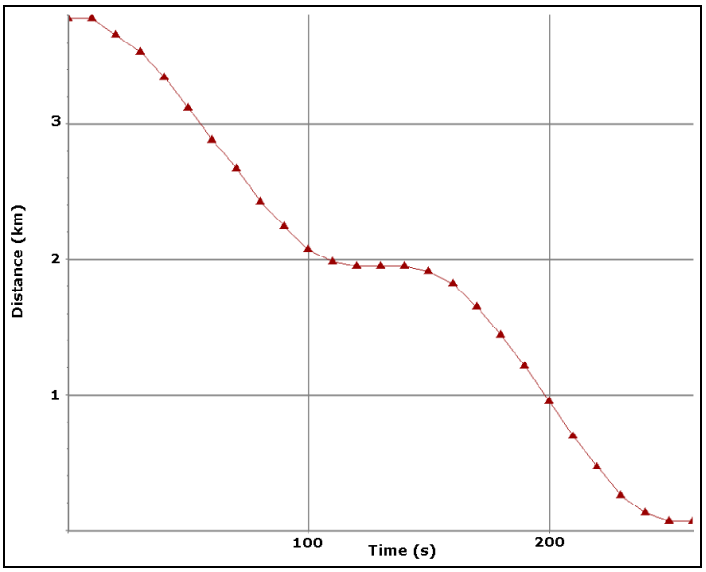
27. The following graph shows data for the motion of a train travelling from Ingleburn to Glenfield via Macquarie Fields station. A Google Earth view of the area is also provided.



Compare the maximum speed of the train between Macquarie Fields and Glenfield with the average speed of the train over the entire time interval shown on the graph. 4M

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28. The following shows data about several new types of passenger aircraft.

Below is a chart comparing the statistics of the Airbus A380 family and the Boeing 787 Dreamliner family.

	Airbus A380[34]	Airbus A380F[34]	Boeing 787-3 Dreamliner[35]	Boeing 787-8 Dreamliner[35]	Boeing 787-9 Dreamliner[35]
Capacity (seats/aircraft)	555 (max 840)	N/A	290-330	210-250	250-290
Range (km)	15,200	10,400	4,650-5,650	14,200-15,200	14,800-15,750
Flight Speed (mph)	680	680	650	650	650
Max Takeoff Weight (metric tons)	560	590	165.1	219.5	244.9
Max Fuel Capacity (Liters)[11]	310,000	310,000	126,917	126,917	138,898

(a) Use the appropriate data from this table to calculate the minimum rate at which a Boeing 787-3 uses fuel. 3M

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(b) The Airbus 380 reaches its takeoff speed of 260 km h^{-1} in 36 seconds from when it starts to move.

(i) Calculate the average acceleration during takeoff 2M

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(ii) Calculate the force required to produce this acceleration during takeoff. 2M

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DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2.0×10^{-7} N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

FORMULAE SHEET

$v = f\lambda$

$I \propto \frac{1}{d^2}$

$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$

$E = \frac{F}{q}$

$R = \frac{V}{I}$

$P = VI$

Energy $= VIt$

$v_{av} = \frac{\Delta r}{\Delta t}$

$a_{av} = \frac{\Delta v}{\Delta t}$ therefore $a_{av} = \frac{v-u}{t}$

$\Sigma F = ma$

$F = \frac{mv^2}{r}$

$E_k = \frac{1}{2}mv^2$

$W = Fs$

$p = mv$

Impulse $= Ft$

$E_p = -G\frac{m_1 m_2}{r}$

$F = mg$

$v_x^2 = u_x^2$

$v = u + at$

$v_y^2 = u_y^2 + 2a_y\Delta y$

$\Delta x = u_x t$

$\Delta y = u_y t + \frac{1}{2}a_y t^2$

$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$

$F = \frac{Gm_1 m_2}{d^2}$

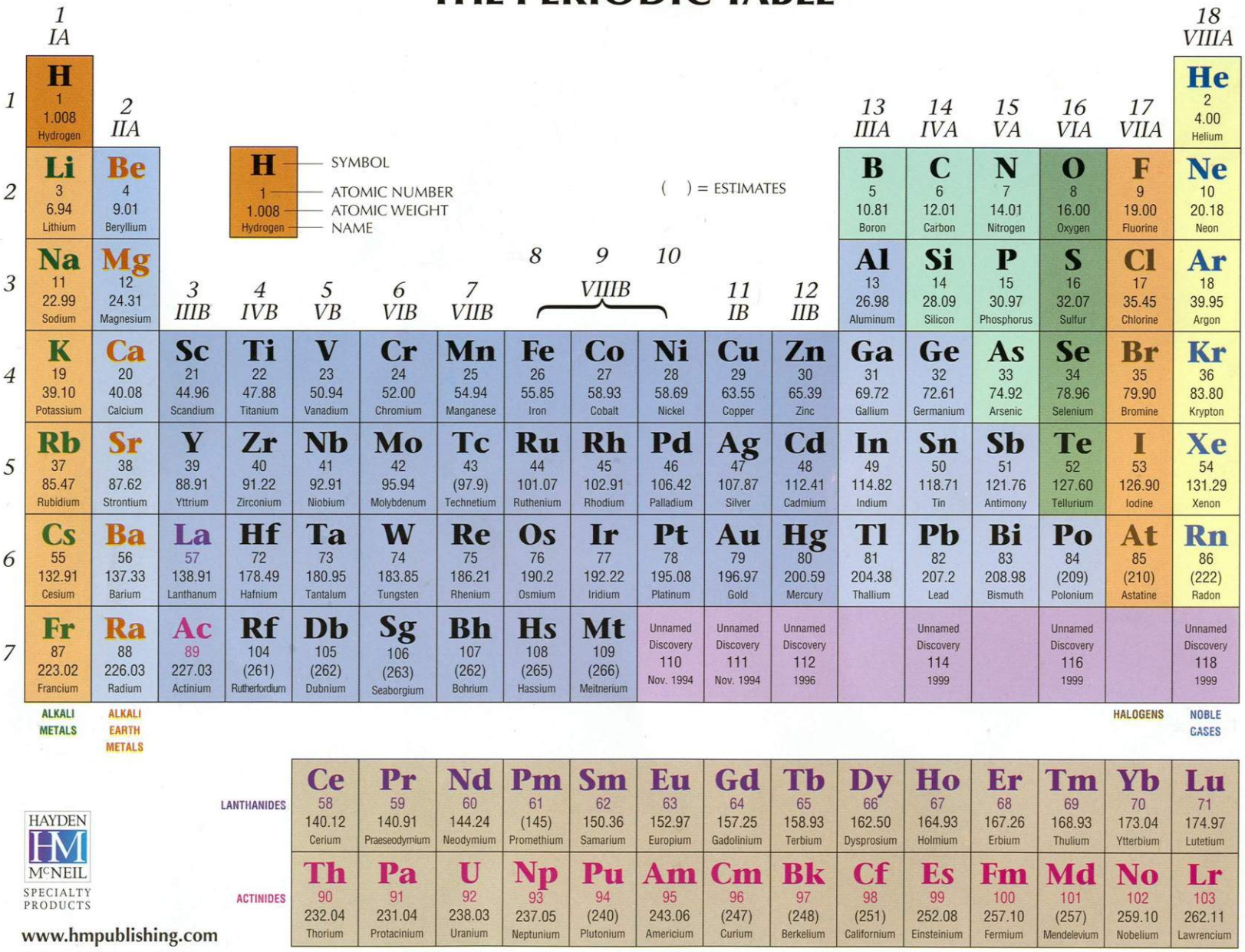
$E = mc^2$

$l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$

$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

$m_v = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$

THE PERIODIC TABLE



Section A answer sheet

Use of the multiple-choice answer sheet

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

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

(A) ⬭ (B) ⬬ (C) ⬭ (D) ⬭

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

(A) ⬬ (B) ⊗ (C) ⬭ (D) ⬭

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

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Total marks (8)
Attempt all questions 1 – 10

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) ⬭

Total ____ / 10

Yearly Exam Marking Criteria

Multiple Choice Answers 1.A 2.B 3.B 4.A 5. (ANY) 6.D 7.D 8.A 9.C 10.B

2008 Yearly Exam: .....Marking Robson 1-19, Pitt 24-28 Coombes 20-23

11a Criteria	Marks
Identifies distance as the independent variable	1

11b Criteria	Marks
Graph of I v $1/d^2$ drawn using more than half the graph paper with *appropriate labels for the axes, including units *points plotted correctly * a reasonable line of best fit	3
Graph of I v $1/d^2$ drawn but missing one of the above points (eg. a point plotted incorrectly, an incorrect or missing unit, graph too small, a poor line of best fit)	2.5
Graph of I v $1/d^2$ drawn but missing two of the above points	2
Graph of I v $1/d^2$ drawn but missing three of the above points	1.5
Graph of I v $1/d^2$ drawn but missing four of the above points OR incorrect graph drawn (eg I v d) with no errors.	1
Incorrect graph drawn (eg I v d) with one errors.	0.5

12a Criteria	Marks
Identifies FM as Frequency Modulation	1

12b Criteria	Marks
Diagram clearly shows a change in AMPLITUDE	1

13a Criteria	Marks
Correctly identifies the convention as North to South OR The direction the north pole of a compass needle points when placed in the field OR Clearly describes the use of crosses and dots to show the direction of the field into and out of the page	1

13b Criteria	Marks
Diagram clearly shows dots above the wire (field out of the page) and crosses below the wire (field into the page)	1

14 Criteria	Marks
Response clearly describes one significant similarity (eg field lines enter/leave perpendicular to the surface of the charge, shape of the field is radial) and one significant difference (eg direction of field lines is away from a positive charge but towards a negative charge)	2
Response clearly describes one significant similarity OR difference.	1

15 Criteria	Marks
Response identifies a reasonable application and clearly links the application to a significant effect on society AND a significant effect on the environment	2
Response identifies a reasonable application and clearly links the application to a significant effect on society OR a significant effect on the environment Note: Responses which identified more than one application and related them individually to society or the environment were given zero as they were not answering the question, even if the information was relevant!	1

16a Criteria	Marks
Answer shows the use of a ratio involving both length and cross-sectional area to determine the resistance as 0.1 ohms	3
Answer shows the use of a ratio involving both length and diameter to determine the resistance (1 ohm using this method)	2
Answer shows the use of a ratio	1

16b Criteria	Marks
Correctly identifies a relevant factor (eg temperature, nature of material)	1

17 Criteria	Marks
Correctly calculates the energy used by the TV as 1.728×10^6 J (or 0.48 kWh) and the heater as 4.32×10^6 J (or 1.2 kWh) and hence that the heater uses 2.5 times as much energy as the TV (statement must be quantified)	3
Correctly calculates the energy used by the TV and the heater OR Correctly calculates one of the values of energy and hence gives a statement quantifying the difference in energy usage based on the calculated figures.	2
Correctly calculates one of the values of energy	1

18 Criteria	Marks
Identifies a relevant communication technology (eg mobile phones) and presents at least two significant issues associated with the use of microwaves	3
Identifies a relevant communication technology (eg mobile phones) and presents one significant issue associated with the use of microwaves OR Describes step-by-step how microwaves are used tp transmit information using the technology	2
Identifies a relevant communication technology	1

19a Criteria	Marks
Superposition	1

19b Criteria	Marks
Resultant wave clearly sketched showing evidence of a reasonable attempt to sum the amplitudes at a number of places along the waves	2
Resultant wave clearly sketched but one significant error made in the shape of the wave.	1

20a Criteria	Marks
Two of the following microphone, source of sound, computer	1

20b Criteria	Marks
Correct answer of 150 Hz (+/- 5Hz)	2
Appropriate working but incorrect answer	1

20c Criteria	Marks
Diagram shows compressions, rarefactions and a labelled wavelength of 2.27m	2
Diagram shows compressions and rarefactions	1

21 Criteria	Marks
Appropriate method including measurement of time between sound and echo, use of speed equation and includes repetition.	3
Appropriate method including measurement of time, use of speed equation without repetition.	2
Answer shows some understanding of the concept of an echo.	1

22 Criteria	Marks
Appropriate diagram which correctly shows the direction of the field and changing magnitude of the field.	2
Appropriate diagram which correctly shows the direction **OR** changing magnitude of the field.	1

Note : Lines must not cross, must show decreasing strength of field and must touch the core of the electromagnet.

23a Criteria	Marks
Law correctly stated and applied in terms of the forces acting on the car.	2
Law correctly stated OR a correct statement regarding the forces acting on the car	1

23b Criteria	Marks
Newtons 2nd law related to the acceleration of the ball AND Newtons 3rd law related to the action/reaction pair (ie the earth attracting the ball and the ball attracting the Earth)	2
One of the above.	1

24 Criteria	Marks
States that because spring balances are designed to be used vertically, using them horizontally is invalid BECAUSE the use in this way may result in frictional forces being present which cause the reading to be incorrect.	2
States that spring balances are not designed to be used horizontally.	1

25 Criteria	Marks
Draws a scale vector diagram and uses it to measure the resultant velocity of the plane, stated as 206 km/h in a direction 14˚ W of N.	3
Calculates the correct magnitude and direction of the resultant velocity.	2
Calculates the correct magnitude of the resultant velocity.	1

26a Criteria	Marks
Draws a smooth line of best fit (curved) with approximately the same number of points evenly spaced on each side of the line.	1

26b Criteria	Marks
States that as the acceleration INCREASES the time decreases at a decreasing rate (OR an equivalent statement)	2
Identifies that as time one variable increases, the other variable decreases AND is consistent with graph drawn	1

26c Criteria	Marks
Indicates that the statement is NOT correct, supported by the reason that reliability necessitates repetition	2
Makes a correct statement related to the experimental method	1

27 Criteria	Marks
Has both speeds calculated to within an acceptable range (13.5 to 15 m/s average and 25 m/s maximum. NB 20 m/s max is TOO low) AND makes a quantitative comparison.	4
Both speed calculations correct but comparison is qualitative OR One speed calculation correct and comparison is quantitative	3
Both speed calculations correct but no comparison OR One speed comparison correct and a comparison made	2
Any comparison or speed calculation	1

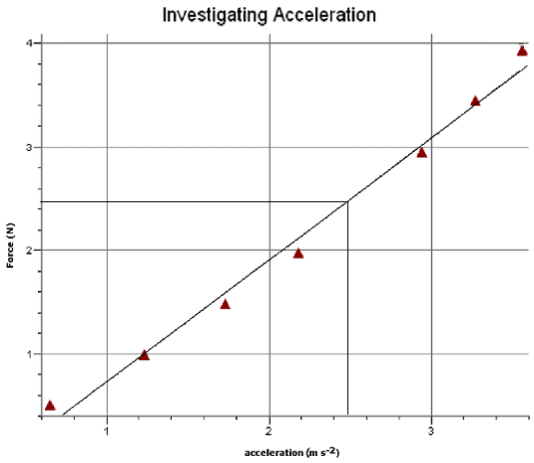
28a Criteria	Marks
Calculates the maximum time the 787-3 can fly for (5650/1094=5.165 h : 1094 km/h = 680 mph) and substitutes this into rate = fuel volume / time = 24 570 L/h OR Calculates the rate in L/km (22.4) or km/L (0.0445)	3
Correct method but no attempt to convert all units correctly	2
Any attempt at a RELEVANT calculation	1

28b Criteria	Marks
Calculates $a = \Delta v/\Delta t = 72.2/36 = 2\ m/s^2$ (converts 260 km/h)	2
Applies formula $a = \Delta v/\Delta t$ but does not convert units	1

28c Criteria	Marks
Calculates F=ma = 560000x2 = 1.12 MN	2
Applies correct formula but does not use converted units	1

Sample Answers

13(a)



To answer this question, appropriate lines should be accurately drawn on the graph to obtain the acceleration, 2.45 m s^{-2}.