SYDNEY GRAMMAR SCHOOL

2014

FORM V
EXAMINATION

Physics

Working Time: 2 hours

Thursday 28th August 8.40AM

General Instructions

- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet, Formula Sheet and Periodic Table are provided at the back of this paper
- Write your name at the top of the Multiple Choice Answer Sheet & all pages of Part B
- Hand in your Multiple Choice Sheet and all of Part B in one bundle. (Do not staple together)

Total marks (97)

This paper has two parts: Part A and Part B.

Part A
Total marks **(14)**
- Attempt ALL Questions
- Allow about 20 minutes for this Part

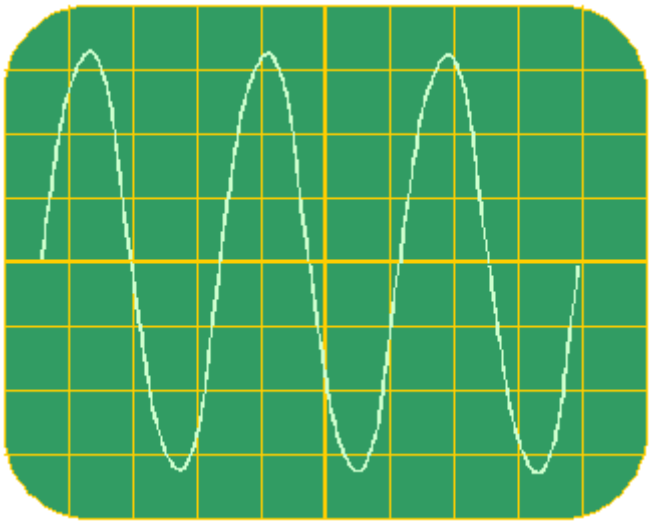
Part B
Total marks **(83)**
- Attempt ALL Questions
- Allow about 1 hour 40 minutes for this Part

CHECKLIST	
Each boy should have the following:	
1 Question Paper	
1 Multiple Choice Answer Sheet	

1 – PCK	3 – AAH	5 – AAH	7 – PCK
2 – MTK	4 – SRW	6 – MRW	

EXAMINERS:
MRW/AAH/PCK/SRW/MTK

1 The cathode ray oscilloscope is a device that displays a graph of voltage (on the y-axis) versus time (on the x axis). In the diagram below, a cathode ray oscilloscope is used to measure the output of a microphone.



The screen scale is set to the following settings:-

- the y-scale is 2 V per division
- the x-scale is 5 x 10^{-4} s/division.

The frequency of the sound is closest to:

(A) 1.4 x 10^{-3} Hz
(B) 340 Hz
(C) 357 Hz
(D) 714 Hz

2 Which of the following choices correctly lists components of the electromagnetic spectrum from the shortest to longest wavelength respectively?

(A) Infrared, visible light, ultraviolet
(B) Infrared, microwave, radio waves
(C) Infrared, visible light, X-rays
(D) Gamma rays, ultraviolet, X-rays

3 When a water wave travels from deep water to shallow water, the wave slows down.

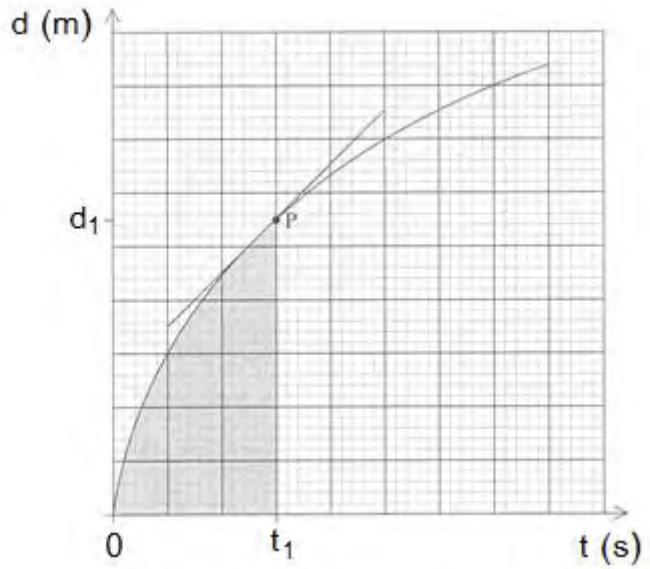
This means:

(A) frequency of the wave decreases and wavelength remains the same.
(B) both wavelength and frequency decrease.
(C) wavelength of the wave decreases and frequency remains the same.
(D) wavelength and frequency remain the same.

4 The time taken for an object dropped from rest to fall vertically through 16 m is 2.0 s. **Based on these measurements**, what is the best estimate for the magnitude of the acceleration of the object?

(A) $4.0\ ms^{-2}$
(B) $8.0\ ms^{-2}$
(C) $9.8\ ms^{-2}$
(D) $10\ ms^{-2}$

5 The graph below shows how the displacement, d, of an object varies with time, t. The tangent to the curve at time t_1 is also shown.



Which of the following gives the instantaneous speed of the object at time t_1?

(A) The gradient at P

(B) The shaded area

(C) $\dfrac{1}{\text{gradient at P}}$

(D) $\dfrac{d_1}{t_1}$

6 A person of weight 600 N is standing on a set of bathroom scales in a lift. The lift is accelerating upwards at 1.0 ms^{-2}.
The reading on the scales is closest to:-

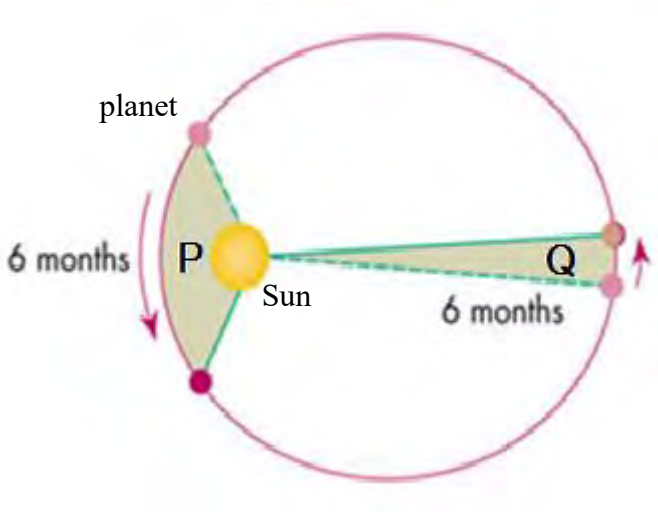
(A) 0 N
(B) 540 N
(C) 600 N
(D) 660 N

7 Two objects undergo an inelastic collision in which no external forces are acting.

Which of the following describes the Conservation of Momentum and the Conservation of Kinetic Energy of the system?

	Total Momentum	**Total Kinetic Energy**
(A)	conserved	not conserved
(B)	conserved	conserved
(C)	not conserved	not conserved
(D)	not conserved	conserved

8 The diagram below depicts the motion of a planet around the Sun.



What is the ratio of the area on the left, P, to the area on the right, Q?

(A) 1:1
(B) 1.5:1
(C) 2:1
(D) π:1

9 Who was the scientist that introduced the concept of "epicycles" into a model of the Universe?

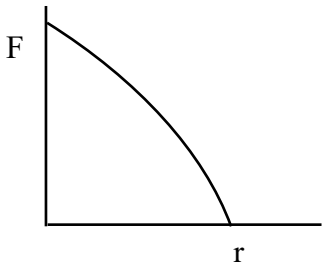
(A) Newton
(B) Copernicus
(C) Ptolemy
(D) Kepler

10 Why is Copernicus's model of the Solar System now considered wrong?

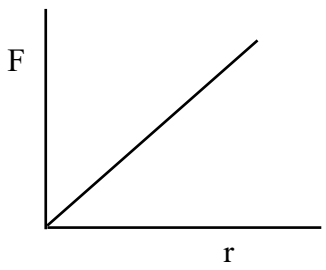
(A) He placed the Earth at the centre of the Solar System.
(B) He had nine planets rather than eight planets.
(C) He could not explain the phases of Venus.
(D) He showed the planets orbiting the Sun in circles.

11 The electrical force, F, between two small identical point charges is measured at different distances of separation, r.
Which of the following graphs correctly shows how the electrical force, F, varies with separation, r?

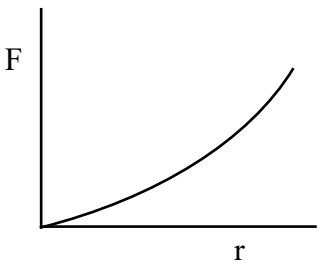
(A)



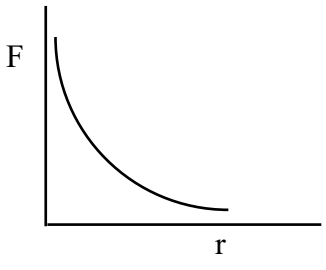
(B)



(C)



(D)



12 When drawing magnetic field lines, the stronger the magnetic field:

(A) the closer together the magnetic field lines are.
(B) the more nearly parallel the magnetic field lines are.
(C) the further apart the magnetic field lines are.
(D) the more divergent the magnetic field lines are.

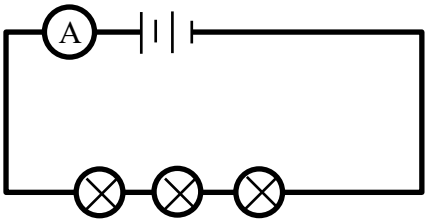
13 A uniform electric field exists between two parallel plates separated by 0.20 m. A force of 4.5×10^{-9} N acts on a particle of charge 2.5×10^{-12} C between the plates.

What is the potential difference between the plates?

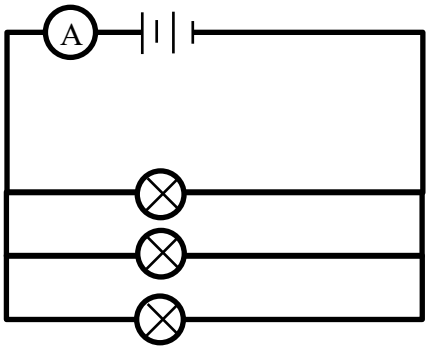
(A) 360 V
(B) 450 V
(C) 1800 V
(D) 4500 V

14 Which of the following arrangements of three identical light globes connected to the same battery would give the highest reading on the ammeter, A?

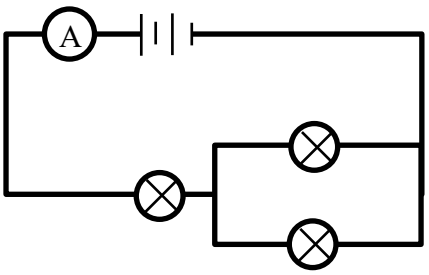
(A)



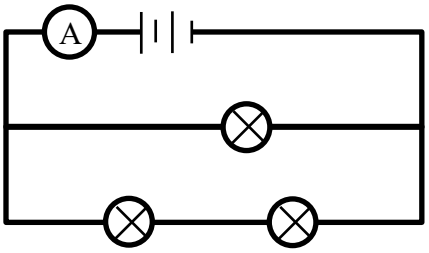
(B)



(C)



(D)



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Class

Name

Part B

Total marks (83)
Attempt ALL Questions
Allow about 1 hour and 40 minutes for this Part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 15 (2 marks) **Marks**

The intensity of a point source of light is 10 Wm^{-2} at a distance of 2 m.

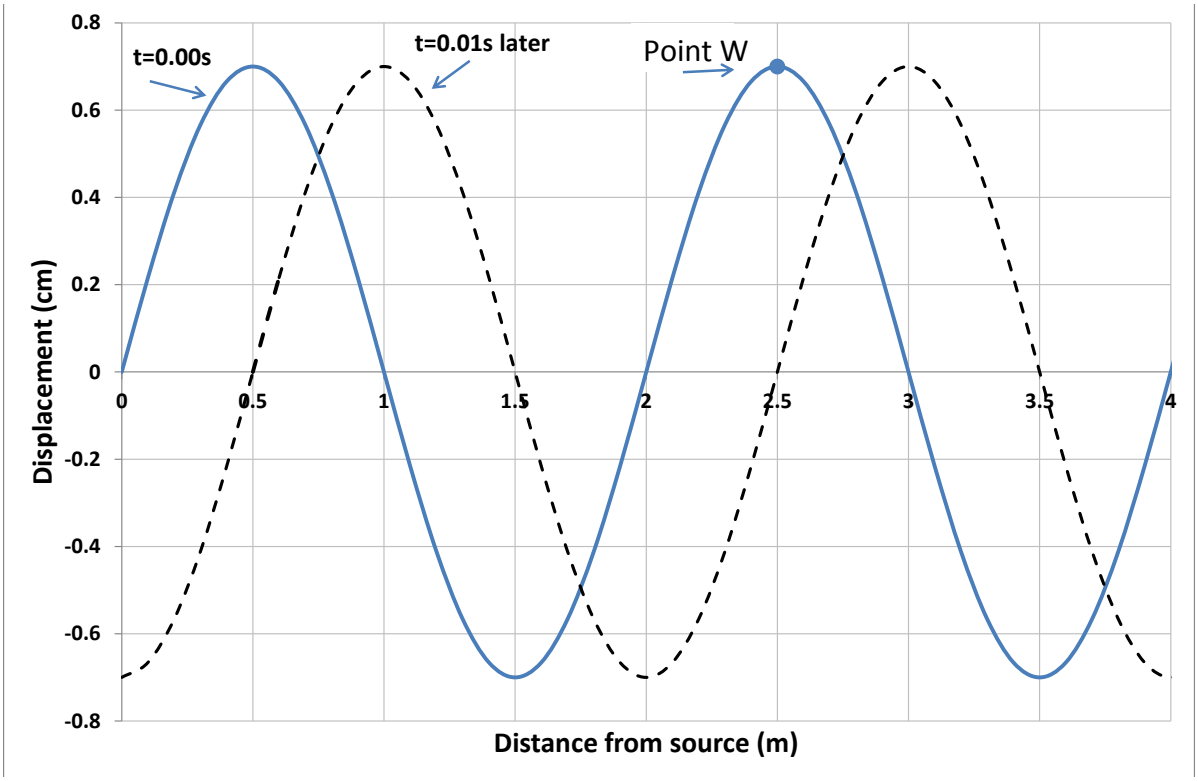
Calculate the intensity at a distance of 5 m away from the point source. 2

Class

Name

Question 16 (6 marks) **Marks**

The following diagram shows the displacement versus distance graph for a transverse wave moving to the right at two instants of time: t = 0.0 s and 0.01 s later.



(a) Use the graphs above to determine:-

(i) the amplitude of the wave. 1

(ii) the wavelength of the wave. 1

Question 16 continued on next page.

Class

Name

Question 16 continued. **Marks**

(iii) the speed of the wave. 1

(iv) the frequency of the wave. 1

(v) the period of the wave. 1

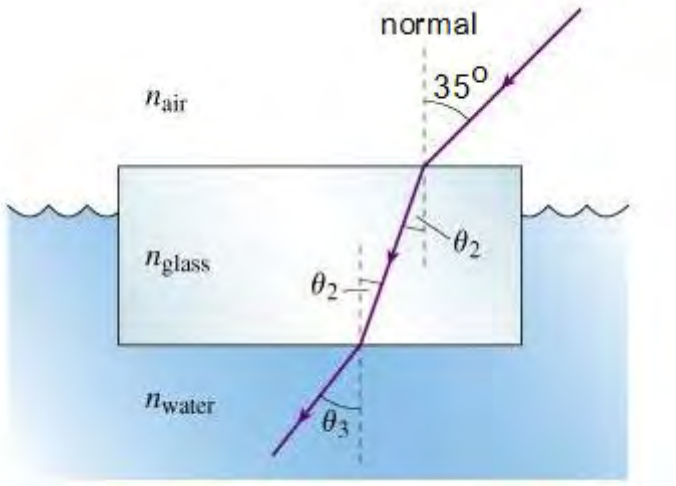
(vi) the direction of motion of the particle at point W between t = 0.0 s and t = 0.01 s. 1

Class

Name

Question 17 (5 marks) **Marks**

A light ray is shone from air (n_{air}=1.0) through glass (n_{glass}= 1.49) to water (n_{water}=1.33). The angle of incidence is 35°



(a) Calculate the angle of refraction, θ_2, as the light passes from air to glass. 2

(b) Calculate the angle of refraction into the water θ_3, as the light passes from glass to water. 2

Question 17 continued on next page.

Class

Name

Question 17 continued. **Marks**

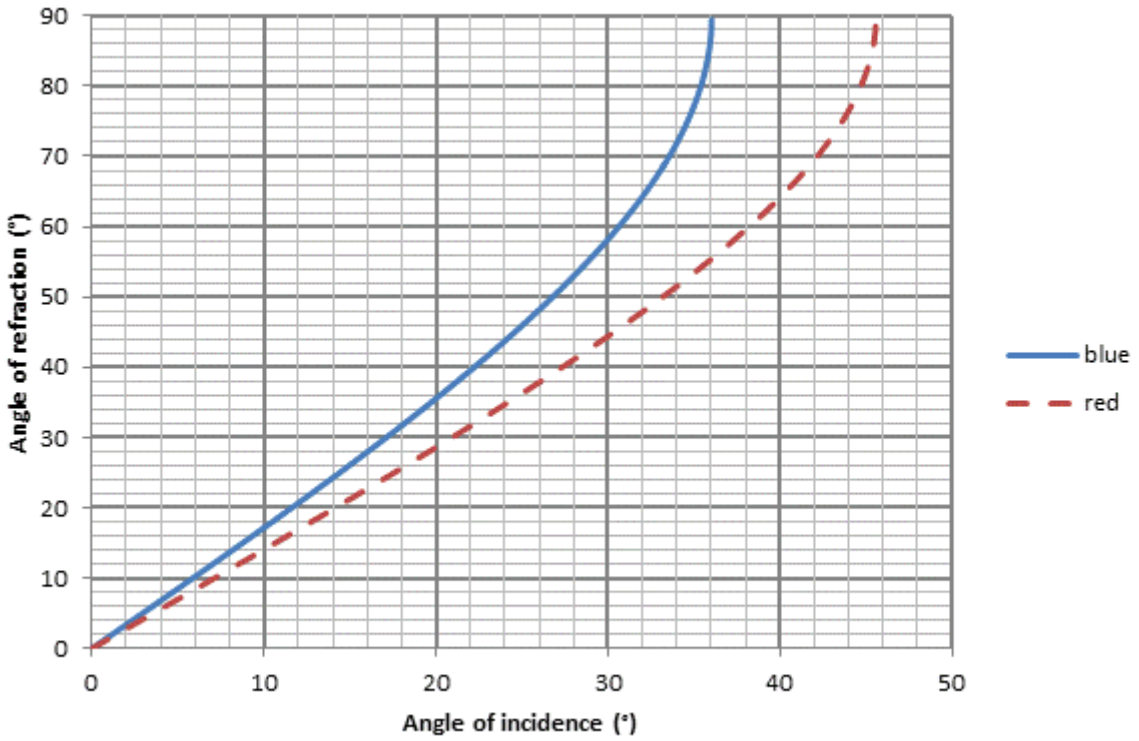
(c) Calculate the speed of light in the water. 1

Class

Name

Question 18 (7 marks) **Marks**

The refractive index of Medium X varies depending on the wavelength of the light entering it. The graph below shows how the angle of refraction varies depending on the angle of incidence when blue and red light travel **from Medium X to air**.



(a) Use the graph to determine the critical angle for blue light in Medium X. 2

Question 18 continued on next page.

Class

Name

Question 18 continued. **Marks**

(b) Determine the refractive index for blue light in Medium X. 2

(c) What would the angle of incidence have to be for there to be a 16 degree difference in the angle of refraction between blue and red light when the light travels from Medium X to air? 1

(d) Identify which colour of light slows down the most in Medium X.
Explain your answer. 2

Class

Name

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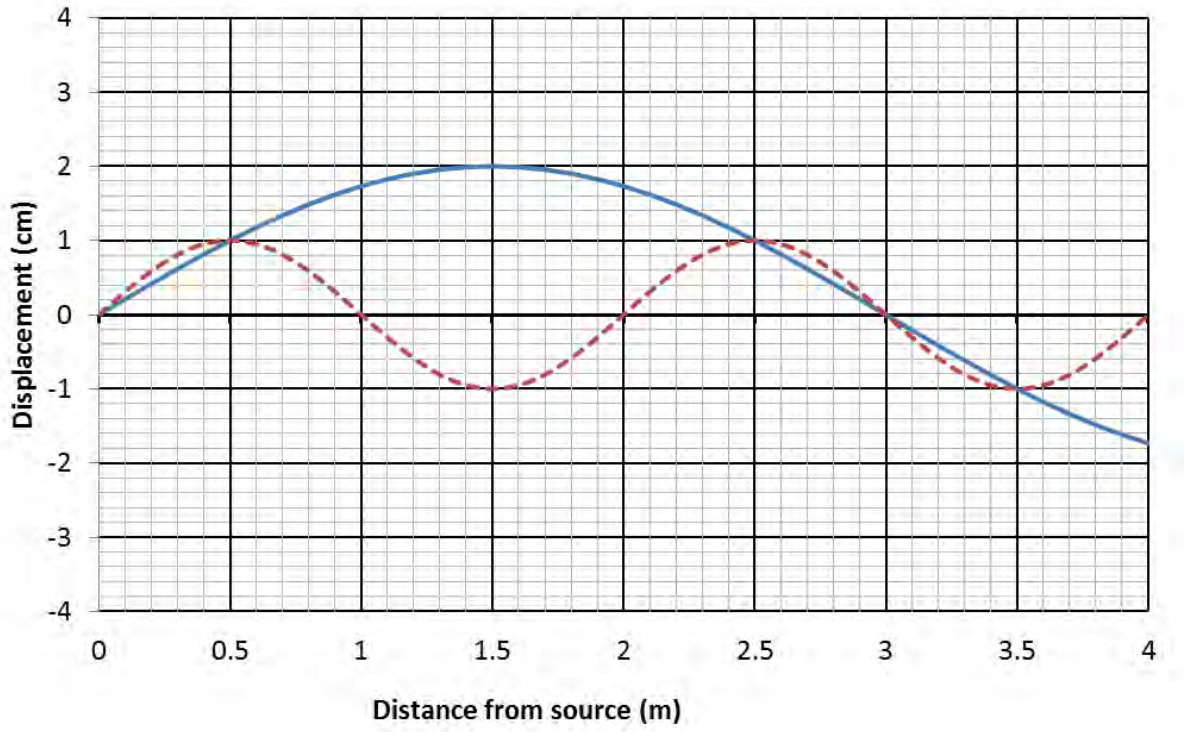
Class

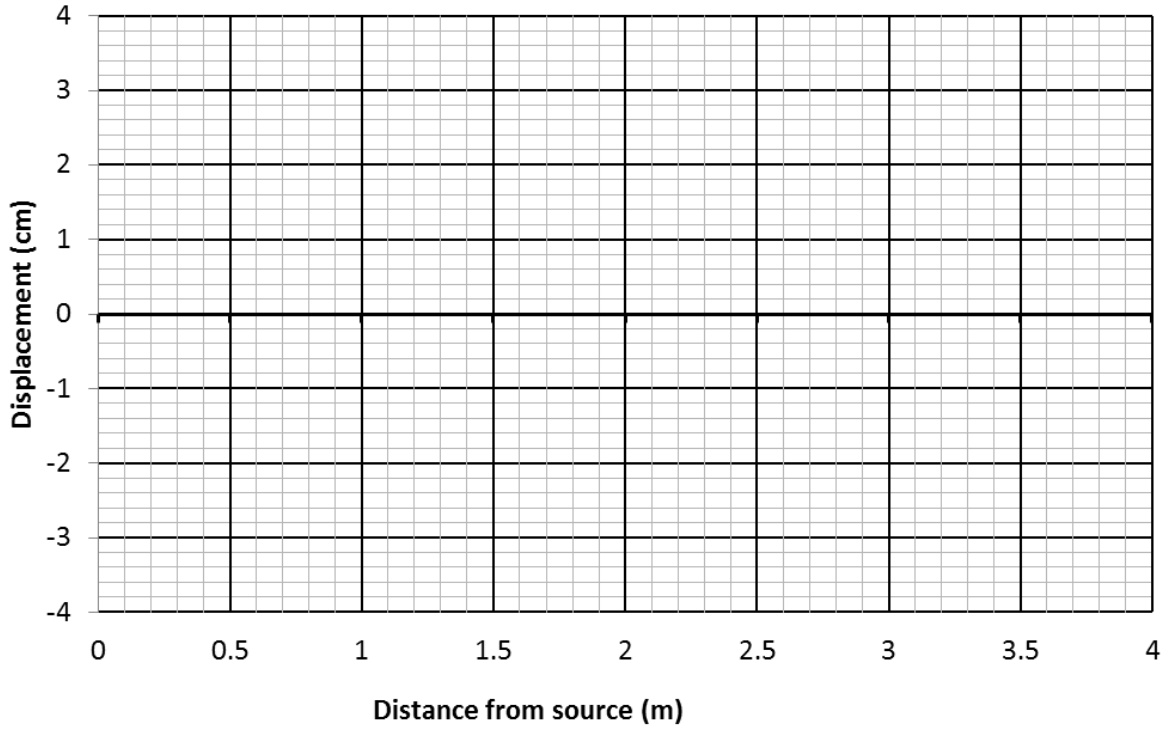
Name

Question 19 (2 marks) **Marks**

The following graph shows a medium with 2 waves moving through it simultaneously.



Draw the combined displacement of the medium as a result of these 2 waves. 2



Class

Name

Question 20 (2 marks) **Marks**

Ganymede and Callisto both orbit the planet Jupiter.

Moon	**Period (days)**	**Mean Distance from Jupiter (million km)**
Callisto	16.69	1.88
Ganymede	?	1.07

Use the data in the above table to determine the period of Ganymede's orbit around Jupiter.

2

Class

Name

Question 21 (7 marks) **Marks**

(a) An element of mass number 241 and atomic number 95 undergoes an alpha decay.

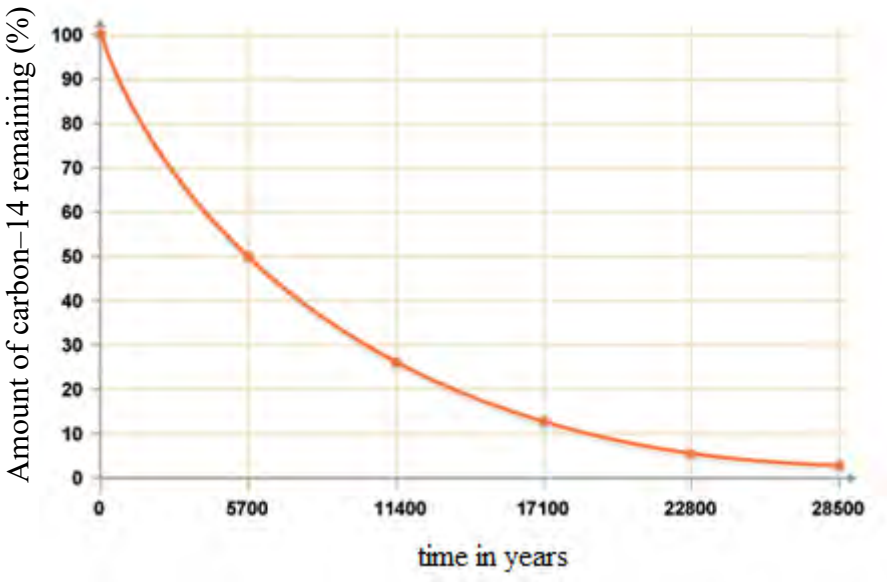
Write a nuclear decay equation using correct chemical symbols for this reaction.

2

(b) Carbon-14 undergoes beta minus decay.

Write a nuclear decay equation for this reaction. 2

(c) (i) The decay graph for carbon-14 is depicted below.



Using this graph, determine the half-life for carbon-14. 1

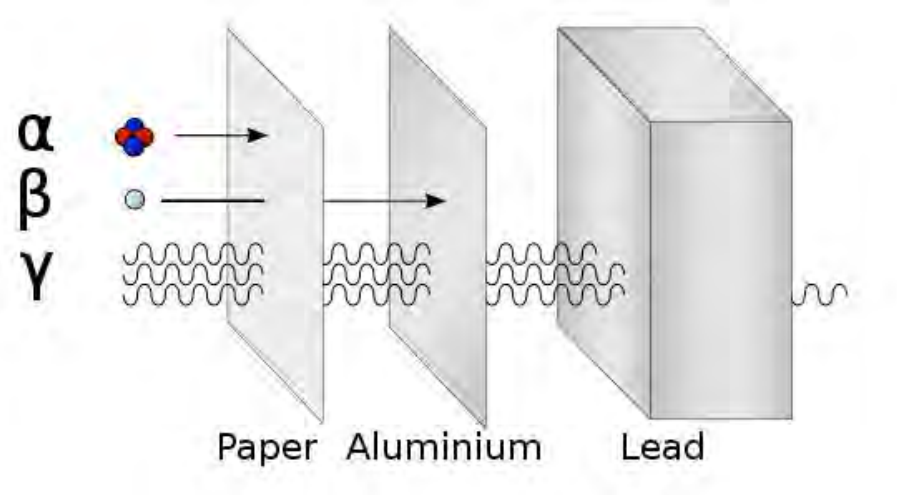
(ii) If a piece of wood is measured to have only 1/16 of its original carbon-14 remaining, how old is the piece of wood? 2

Class

Name

Question 22 (2 marks) **Marks**

Consider the following diagram.



Explain why gamma rays are significantly more penetrating than alpha particles.

2

Class

Name

Question 23 (4 marks) **Marks**

With the aid of labelled diagrams, show how the geocentric and heliocentric models of the Universe explain the retrograde motion of Mars.

4

Class

Name

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Class

Name

Question 24 (5 marks) **Marks**

A racing car is attempting to break the 'standing kilometre' time record. From rest, when the starting light turns green, the car accelerates at its maximum rate and crosses the finish line 40 s later on the race track travelling at 180 kmh^{-1}.

(a) Calculate the final speed of the racing car in ms^{-1}. 1

(b) Calculate the acceleration of the racing car for the 40 s. 1

(c) Calculate the average speed of the racing car in for the 40 s. 1

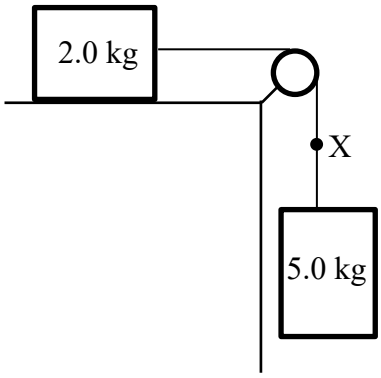
(d) Immediately after crossing the finish line, the racing car applied the brakes. It took 90 s for the car to come to rest. Assuming uniform deceleration, calculate the distance travelled from the finishing line until the racing car came to rest. 2

Class

Name

Question 25 (2 marks) **Marks**

Consider the two blocks shown in the following diagram.



The blocks are connected by a light, inextensible string over a frictionless pulley. The 2.0 kg block is resting on a smooth horizontal surface.

Calculate the magnitude of the tension force in the string at X.

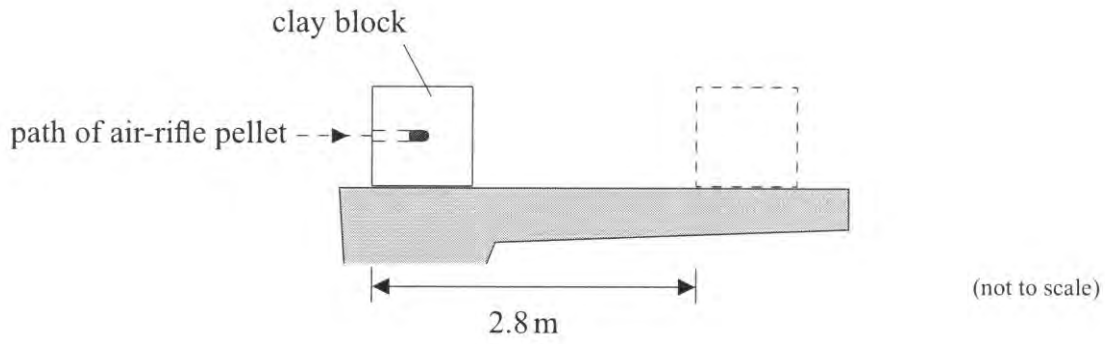
2

Class

Name

Question 26 (5 marks) **Marks**

In an experiment, an air-rifle pellet is fired into a clay block that rests on a horizontal table.



The air-rifle pellet remains inside the clay block after impact. As a result of the collision, the clay block slides along the table in a straight line and comes to rest. Further data related to the experiment are given below.

Mass of air-rifle pellet	= 2.0 g
Mass of clay block	= 56 g
Velocity of pellet just before impact	= 140 ms^{-1}
Stopping distance of clay block	= 2.8 m

(a) Calculate the speed of the clay block immediately after the air-rifle pellet strikes it. 2

Question 26 continued on next page.

Class

Name

Question 26 continued. **Marks**

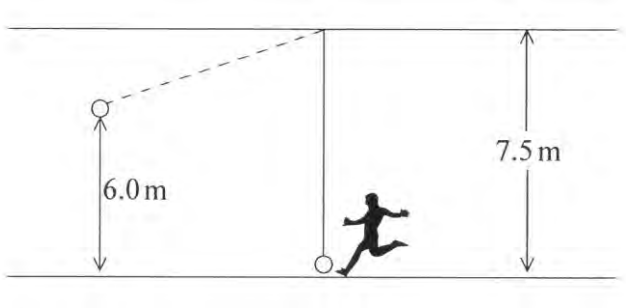
(b) Calculate the magnitude of the average force of friction that the table exerts on the clay block while it is coming to rest. 3

Class

Name

Question 27 (4 marks) **Marks**

A ball is suspended from a ceiling by a string 7.5 m long. The ball is kicked horizontally and rises to a maximum height of 6.0 m as shown in the following diagram.



(a) Ignoring air resistance, calculate the initial speed of the ball immediately after it is kicked. 2

(b) The mass of the ball is 0.550 kg and the impact time of the kicker's foot with the ball is 0.15 s.

Calculate the magnitude of the average force exerted on the ball by the kick. 2

Class

Name

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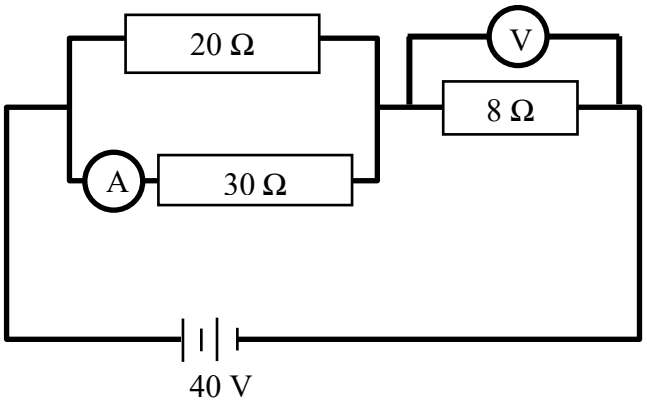
Class

Name

Question 28 (6 marks) **Marks**

Consider the circuit shown in the diagram below.



(a) Determine the total resistance of the circuit. 2

(b) Determine the total current in the circuit. 1

(c) Determine the reading on the voltmeter in the circuit. 1

(d) Determine the reading on the ammeter in the circuit. 2

Class

Name

Question 29 (5 marks) **Marks**

A house light is used to convert electrical energy into light energy. The house light draws 6 A of current when connected to a 240 V power supply.

(a) Calculate the resistance of the house light. 1

(b) Calculate the number of electrons flowing per second through the house light. 2

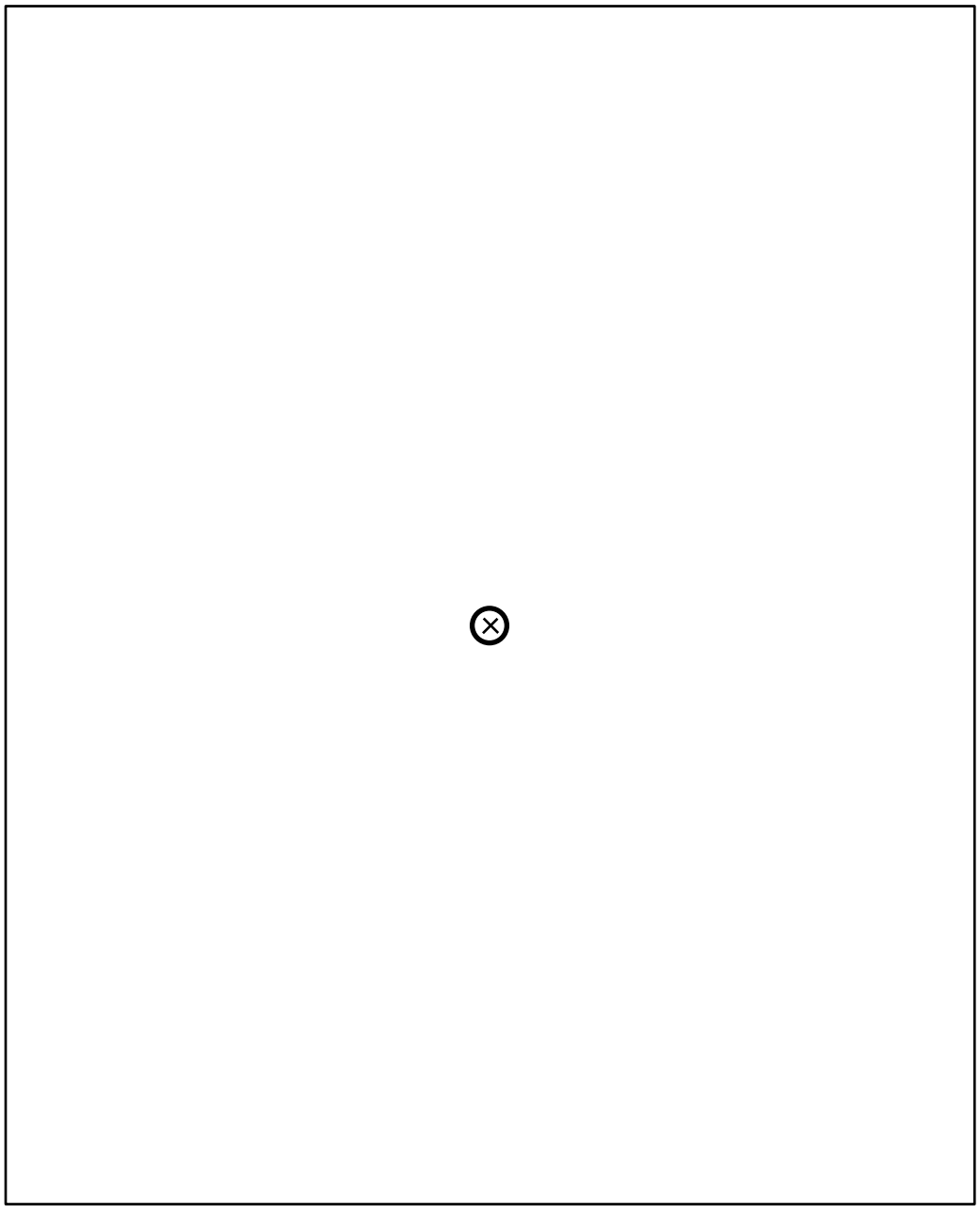
(c) Briefly explain what will happen to the power output if a higher resistance house light is used with the 240 V power supply. 2

Class

Name

Question 30 (2 marks) **Marks**

Draw the magnetic field surrounding a wire carrying conventional current into the page. 2



Class

Name

Question 31 (2 marks) **Marks**

Double insulation, fuses and circuit breakers are three safety features commonly used in electrical circuits within the home.

Choose one of these features and briefly describe the general principle of the named feature.

Name of feature :_____

Description :_____ 2

_____

_____

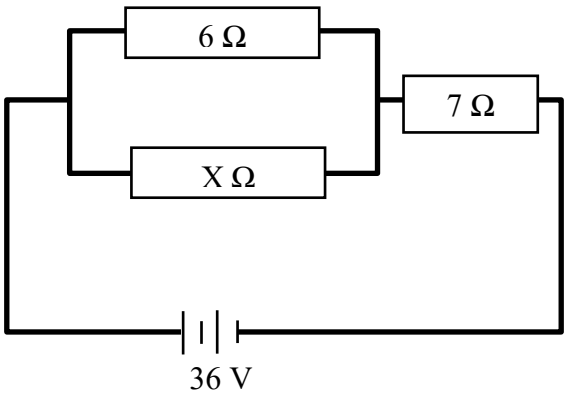
_____

Class

Name

Question 32 (3 marks) **Marks**

Consider the following circuit.



A current of 0.5 A flows through resistor X.

(a) Calculate the current through the 6 Ω resistor. 2

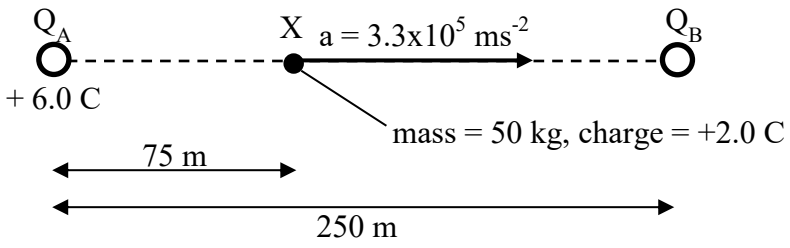
(b) Calculate the value of the resistor labelled X. 1

Class

Name

Question 33 (4 marks) **Marks**

The diagram below shows two charges, Q_A and Q_B fixed in place and separated by a distance of 250 m. Q_A has a charge of +6.0 C, but the charge on Q_B is unknown. A third charge, of mass 50 kg and charge +2.0 C, is placed at X, 75 m from Q_A.



When it is released, the charge at X has an acceleration of $3.3x10^5\ ms^{-2}$ to the right.

Calculate the charge Q_B.

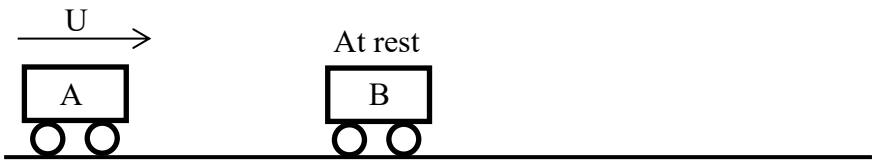
4

Class

Name

Question 34 (4 marks) **Marks**

The diagram below shows two trolleys, A and B. Initially, trolley A of mass 2.0 kg has a velocity of U to the right and trolley B of mass m_B is at rest.



Trolleys A and B collide elastically. After the collision, trolley A has a velocity of 7U/9 to the right.

Calculate the mass of trolley B.

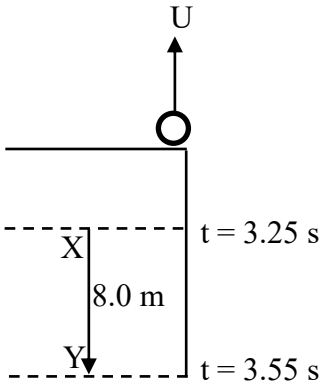
4

Class

Name

Question 35 (4 marks) **Marks**

A ball is thrown upwards at a speed U from the top of a high building as shown in the diagram below.



The ball passes a point X 3.25 s after it was thrown, and a point Y, which is 8.0 m below X, 0.30 s later.

Calculate the initial speed, U, of the ball.

4

Physics

Data Sheet

Charge on the 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}
Radius of Earth, R_E	6.4×10^6 m
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi}\right)$	2×10^{-7} N A^{-2}
Universal gravitational constant, G	6.7×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's 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}
Coulomb's constant, k	9.0×10^9 Nm^2C^{-2}

FORMULAE SHEET FORM V ONLY

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

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

$$v = u + at$$

$$v^2 = u^2 + 2ar$$

$$r = ut + \frac{1}{2}at^2$$

$$\sum F = ma$$

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

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

$$E_p = mgh$$

$$W = Fr$$

$$p = mv$$

$$\Delta p = F_n t$$

$$F = mg$$

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

$$E = \frac{V}{d}$$

$$F = \frac{kQ_1Q_2}{d^2}$$

$$I = \frac{Q}{t}$$

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

$$P = VI$$

$$Energy = VIt$$

$$v = f\lambda$$

$$f = \frac{1}{T}$$

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

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

$$n\lambda = d\sin\theta$$

$$n\lambda = \frac{dx}{L}$$

$$E_p = -\frac{Gm_1m_2}{r}$$

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

$$F = \frac{Gm_1m_2}{d^2}$$

$$E = mc^2$$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

$$d = \frac{1}{P}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100\left(m_B - m_A\right)/5$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

$$\lambda = \frac{h}{mv}$$

$$A_0 = \frac{V_{out}}{V_{in}}$$

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$

Surface area of a sphere of radius, R = $4\pi R^2$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number
Symbol
Standard Atomic Weight
Name

79 Au 197.0 Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium						

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Elements with atomic numbers 112 and above have been reported but not fully authenticated.

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of data. Some data may have been modified.

SYDNEY GRAMMAR SCHOOL

CRIB

Class

Name

2014
FORM V
ANNUAL EXAMINATION

Physics
Part A
ANSWER SHEET

General Instructions

- Write your class and candidate number in the space provided.
- Attempt all questions 1 – 14
- Use a blue or black pen
- Select the alternative A, B, C, or D that best answers the question.
- Fill in the response circle completely.

1.	A	B	C	●
2.	A	●	C	D
3.	A	B	●	D
4.	A	●	C	D
5.	●	B	C	D
6.	A	B	C	●
7.	●	B	C	D
8.	●	B	C	D
9.	A	B	●	D
10.	A	B	C	●
11.	A	B	C	●
12.	●	B	C	D
13.	●	B	C	D
14.	A	●	C	D

Class

PCK CBID

Name

Part B

Total marks (83)
Attempt ALL Questions
Allow about 1 hour and 40 minutes for this Part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 15 (2 marks) **Marks**

The intensity of a point source of light is 10 Wm^{-2} at a distance of 2 m.

Calculate the intensity at a distance of 5 m away from the point source. 2

$I_A d_A^2 = I_B d_B^2$ (If $I \propto \frac{1}{d^2}$ then $I = \frac{k}{d^2}$; Id^2 = constant).

($I_A = 10\ Wm^{-2}$, $d_A = 2m$) ($I_B = ?$, $d_B = 5m$)

$I_B = I_A \left(\frac{d_A}{d_B}\right)^2 = 10\left(\frac{2}{5}\right)^2 = 10\left(\frac{4}{25}\right)$

$= 1.6\ Wm^{-2}$

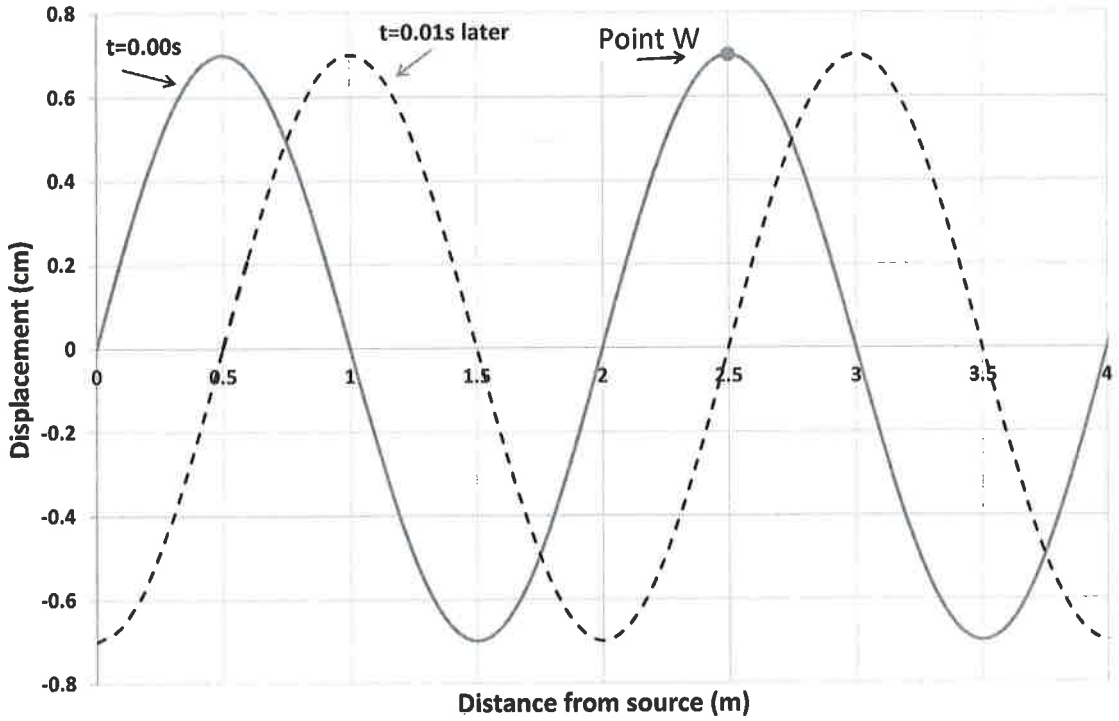
(1) right equation using all 4 variables.
(1) right answer.

Class

Name

Question 16 (6 marks) **Marks**

The following diagram shows the displacement versus distance graph for a transverse wave moving to the right at two instants of time: t = 0.0 s and 0.01 s later.



(a) Use the graphs above to determine:-

(i) the amplitude of the wave. 1

0·7cm (must have units)

(ii) the wavelength of the wave. 1

2m

Question 16 continued on next page.

Class

Name

Question 16 continued. **Marks**

(iii) the speed of the wave. 1

Wave moves 0·5m in 0·01s

$v = \frac{d}{t} = \frac{0.5}{0.01} = 50 m/s$

(can use period, frequency from (iv) or (v) $v = f\lambda$)

(iv) the frequency of the wave. 1

$v = f\lambda$ $f = \frac{v}{\lambda} = \frac{50}{2} =$

$= 25 Hz.$

(v) the period of the wave. 1

Period = 4 × 0·01s (from graph)

or $\frac{1}{f}$ from (iv) = 0·04s.

(vi) the direction of motion of the particle at point W between t = 0.0 s and t = 0.01 s. 1

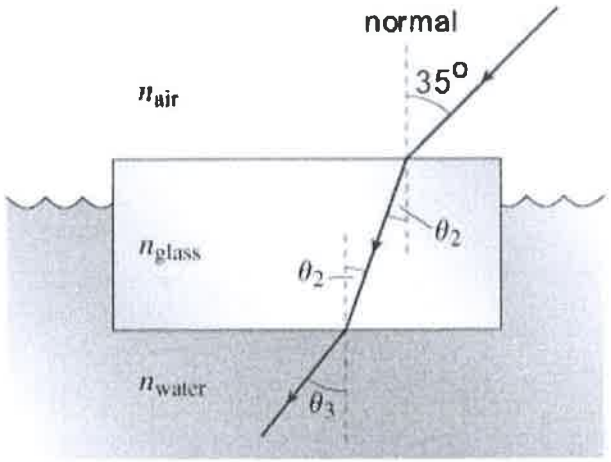
Downwards. from 0·7cm to 0cm.

Class

Name

Question 17 (5 marks) **Marks**

A light ray is shone from air (n_{air}=1.0) through glass (n_{glass}= 1.49) to water (n_{water}=1.33). The angle of incidence is 35°



(a) Calculate the angle of refraction, θ_2, as the light passes from air to glass. 2

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1 \sin 35^\circ = 1.49 \sin\theta_2$ (1) correct substitution into correct equation

$\sin\theta_2 = \frac{\sin 35^\circ}{1.49}$ (1) correct answer solved

$\theta_2 = 22.64^\circ$

(b) Calculate the angle of refraction into the water θ_3, as the light passes from glass to water. 2

$1.49 \sin 22.64^\circ = 1.33 \sin\theta_3$ (1) correctly using both refractive indexes.

$\sin\theta_3 = \frac{1.49}{1.33} \sin 22.64.$

$\theta_3 = 25.55^\circ$ (1) solve equation for answer.

(carry forward angle from (a), but must use (a) not 35°)

Question 17 continued on next page.

Class

Name

Question 17 continued. **Marks**

(c) Calculate the speed of light in the water. 1

$n_3 = \frac{c}{v}$, $v_3 = \frac{c}{n_3} = \frac{3\times10^8}{1.33}$

$= 2.26\times10^8$ m/s

Many answered using Snells Law.

or From formula sheet $\frac{\sin i}{\sin r} = \frac{\lambda_1}{\lambda_2} = \frac{\left(\frac{v_1}{f}\right)}{\left(\frac{v_2}{f}\right)} = \frac{v_1}{v_2}$

It can be shown

$$\frac{\sin\theta_1}{v_1} = \frac{\sin\theta_2}{v_2} = \frac{\sin\theta_3}{v_3}$$

$$v_3 = v_1 \frac{\sin\theta_3}{\sin\theta_1}$$

$$= 3\times10^8 \times \frac{\sin 25.5^0}{\sin 35^0}$$

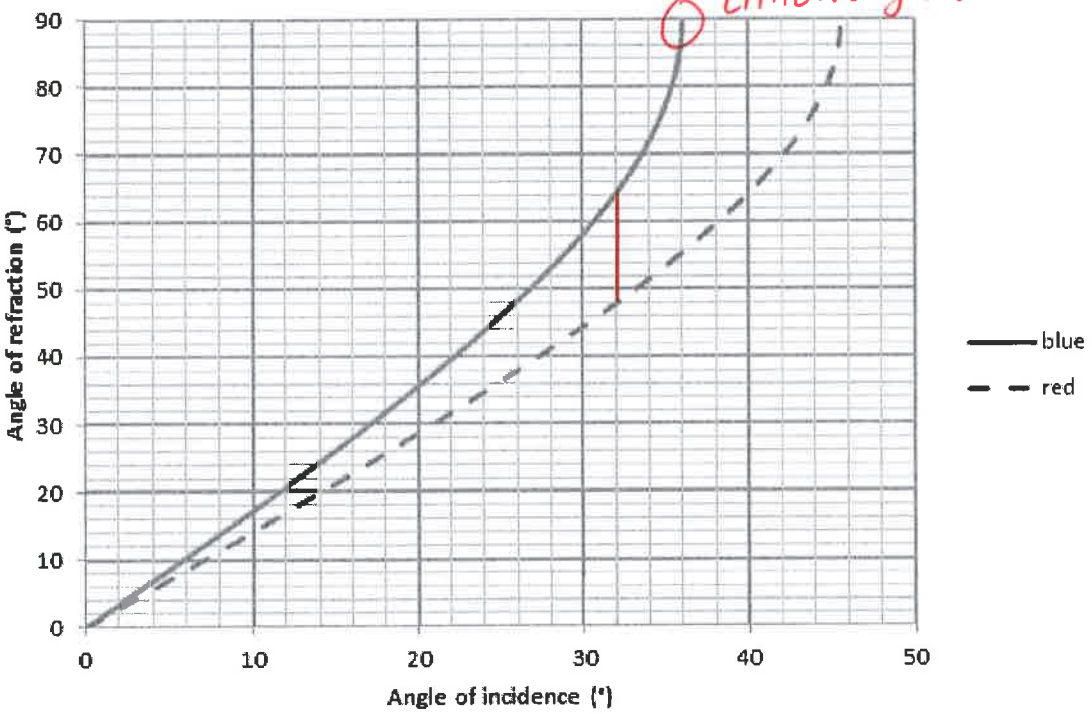
$$= 2.26\times10^8 \text{ m/s}$$

Class

Name

Question 18 (7 marks) **Marks**

The refractive index of Medium X varies depending on the wavelength of the light entering it. The graph below shows how the angle of refraction varies depending on the angle of incidence when blue and red light travel **from Medium X to air.**



critical angle when r = 90°

(a) Use the graph to determine the critical angle for blue light in Medium X. 2

36° (when refracted angle = 90°).

① right colour used (red ~ 45-46°)

① correct critical angle.

Question 18 continued on next page.

Class

Name

Question 18 continued. **Marks**

(b) Determine the refractive index for blue light in Medium X. 2

$\frac{\sin 36^0}{\sin 90^0} = \frac{n_{air}}{n_x} = \frac{1}{n_x}$, $n_x = \frac{1}{\sin 36^0}$

$= 1.7$

(1) correct formula or method

(1) correct answer.

(c) What would the angle of incidence have to be for there to be a 16 degree difference in the angle of refraction between blue and red light when the light travels from Medium X to air? 1

32^0 (31.5 - 32.5 accepted)

(d) Identify which colour of light slows down the most in Medium X. 2
Explain your answer.

Blue light (1) mark.

Explain (1)

(A) Refraction comparison For the same incident angle blue light is refracted more away from the normal. This would indicate a greater change in speed entering air where both go at the same speed.

(B) Refractive Index comparison
The refractive index of red light is 1.4 (must be calculated for comparison). means it slows down less than blue light at 1.7.

(C) Calculation of velocities $V_{blue} = 1.8 \times 10^8 m/s$, $V_{red} = 2.1 \times 10^8 m/s$

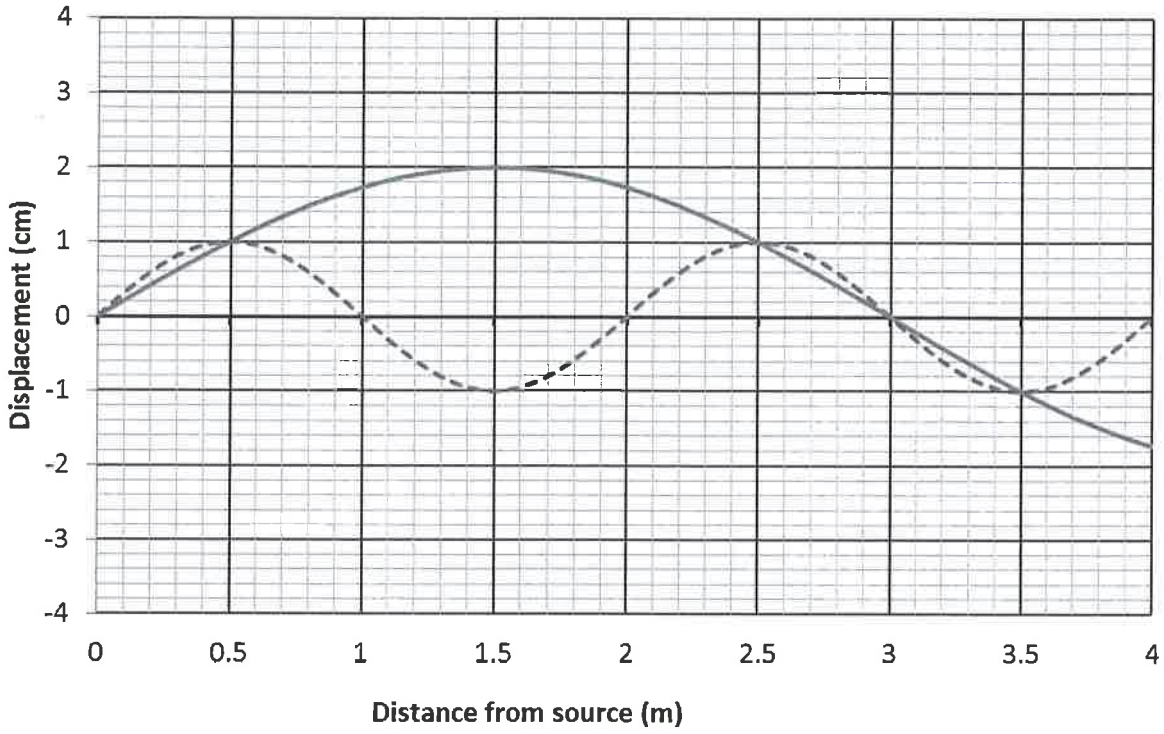
Note: Answers must make an implicit link between observation and outcome. | Refraction is from Medium X to air answers that infer otherwise are misinterpreting

Class SRW

Name

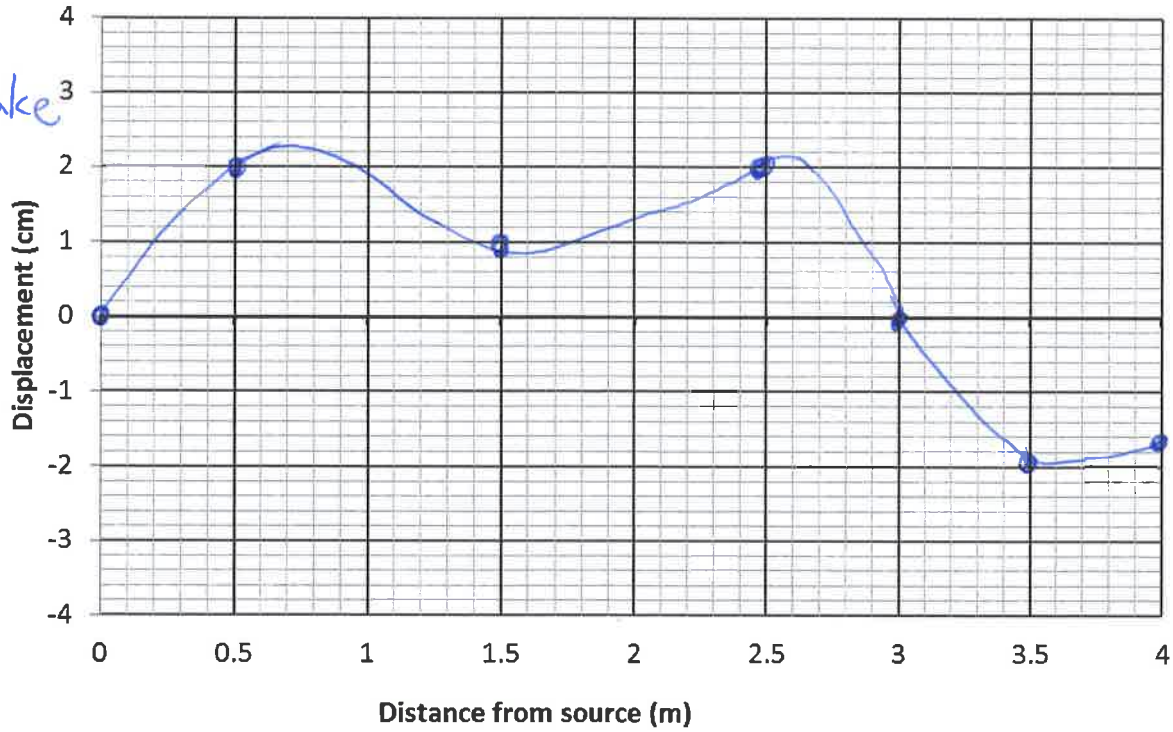
Question 19 (2 marks) **Marks**

The following graph shows a medium with 2 waves moving through it simultaneously.



Draw the combined displacement of the medium as a result of these 2 waves. 2

Any mistake on ● = 1 mark off



Class

Name

Question 20 (2 marks) **Marks**

Ganymede and Callisto both orbit the planet Jupiter.

Moon	Period (days)	Mean Distance from Jupiter (million km)
Callisto	16.69	1.88
Ganymede	?	1.07

Use the data in the above table to determine the period of Ganymede's orbit around Jupiter.

$\frac{T_1^2}{r_1^3} = \frac{T_2^2}{r_2^3}$ (1)

$\therefore T_1 = \sqrt{\frac{(16.69)^2 \times (1.07)^3}{1.88^3}} = 7.16 \text{ days}$

2

Class

Name

Question 21 (7 marks) **Marks**

(a) An element of mass number 241 and atomic number 95 undergoes an alpha decay.

Write a nuclear decay equation using correct chemical symbols for this reaction. 2

① $^{241}_{95}Am \rightarrow {}^{4}_{2}\alpha + {}^{237}_{93}Np$ ①

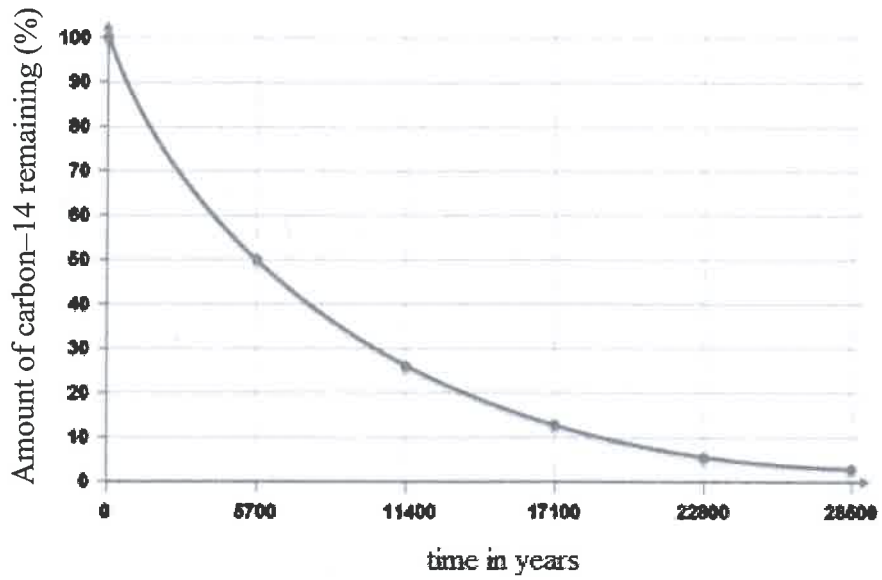
(b) Carbon-14 undergoes beta minus decay.

Write a nuclear decay equation for this reaction. 2

① $^{14}_{6}C \rightarrow {}^{0}_{-1}e + {}^{14}_{7}N$ ①

Ignored $^{0}_{0}\bar{\nu}$

(c) (i) The decay graph for carbon-14 is depicted below.



Using this graph, determine the half-life for carbon-14. 1

5700 years

(ii) If a piece of wood is measured to have only 1/16 of its original carbon-14 remaining, how old is the piece of wood? 2

4 half lives ①

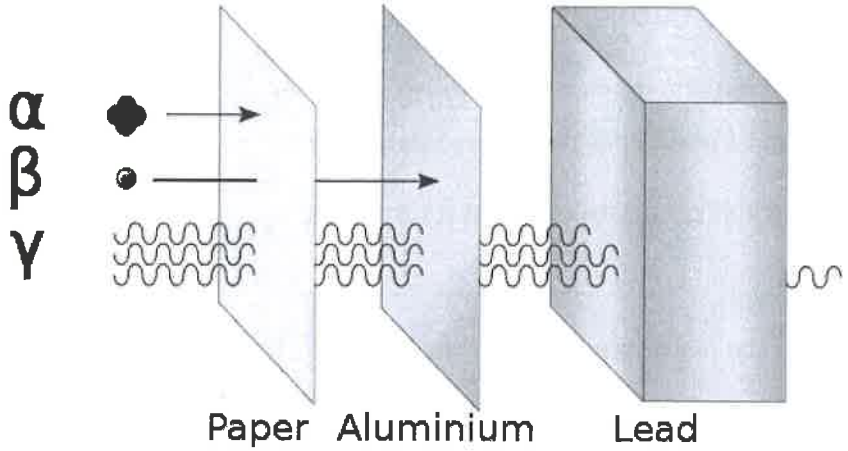
4 × 5700 = 22800 years ①

Class

Name

Question 22 (2 marks) **Marks**

Consider the following diagram.



Explain why gamma rays are significantly more penetrating than alpha particles.

(1) γ rays uncharged α particles +2 charge 2

(1) Any sensible comparison
eg α highly ionizing γ not
α interact strongly with charges γ does not
γ high speed α lower speed
α large mass γ no mass

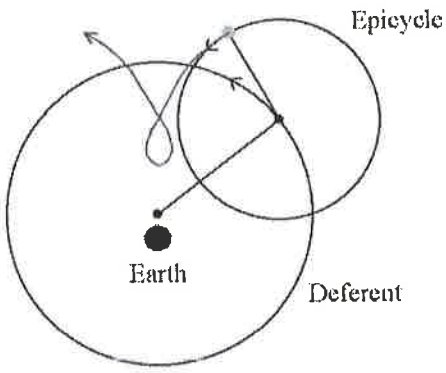
Class

Name

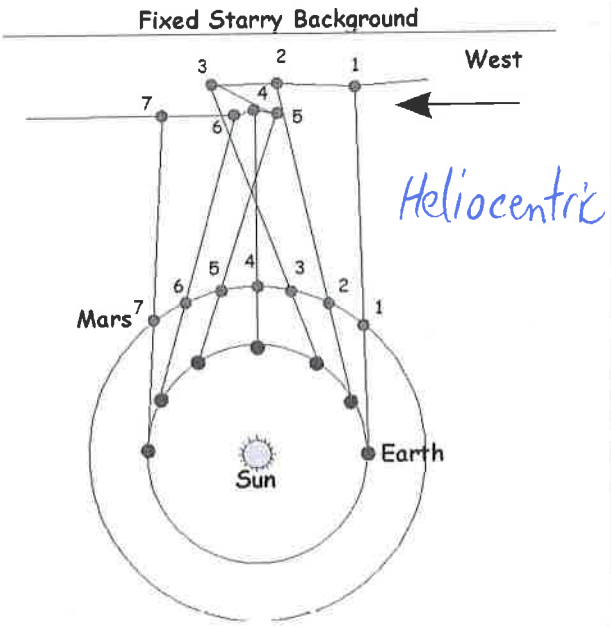
Question 23 (4 marks) **Marks**

With the aid of labelled diagrams, show how the geocentric and heliocentric models of the Universe explain the retrograde motion of Mars.

Geocentric



Heliocentric



4

Marked very generously

Geocentric Model (2) (Diagram + description)

Retrograde motion explain by the planet moving backwards on its epicycle.

Heliocentric Model (2) (Diagram + description)

Retrograde motion explained by planet being overtaken by the Earth and so its position relative to the background stars moves backwards.

CRIB
Class

MTK
Name

Question 24 (5 marks) **Marks**

A racing car is attempting to break the 'standing kilometre' time record. From rest, when the starting light turns green, the car accelerates at its maximum rate and crosses the finish line 40 s later on the race track travelling at 180 kmh^{-1}.

(a) Calculate the final speed of the racing car in ms^{-1}. 1

$\frac{180}{3.6} = 50\ ms^{-1}$

(b) Calculate the acceleration of the racing car for the 40 s. 1

$a = 50-0/40 = 1.25\ ms^{-2}$

(c) Calculate the average speed of the racing car in for the 40 s. 1

$V_{av} = \frac{50+0}{2} = 25\ ms^{-1}$

(d) Immediately after crossing the finish line, the racing car applied the brakes. It took 90 s for the car to come to rest. Assuming uniform deceleration, calculate the distance travelled from the finishing line until the racing car came to rest. 2

(1) $a = 0-50/90 = -0.56\ ms^{-2}$

$r = ut + \frac{1}{2}at^2$

$= 50 \times 90 + \frac{1}{2} \times -0.56 \times 90^2$

(1) $= 2250\ m$.

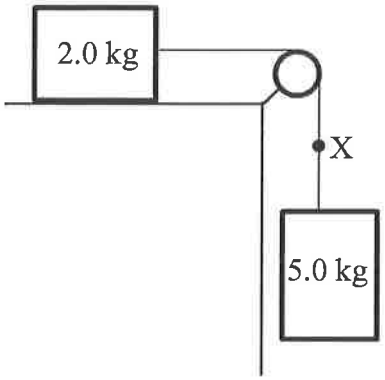
NB: Marked 2232.50m OK if rounded too soon.

Class

Name

Question 25 (2 marks) **Marks**

Consider the two blocks shown in the following diagram.



The blocks are connected by a light, inextensible string over a frictionless pulley. The 2.0 kg block is resting on a smooth horizontal surface.

Calculate the magnitude of the tension force in the string at X.

(1) $a = \frac{5g}{5+2} = 7\ ms^{-2}$ 2

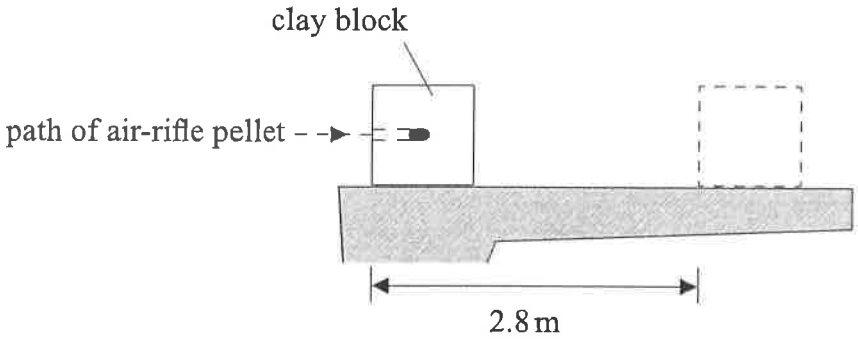
(1) $T = 2a = 14\ N$.

Class

Name

Question 26 (5 marks) **Marks**

In an experiment, an air-rifle pellet is fired into a clay block that rests on a horizontal table.



(not to scale)

The air-rifle pellet remains inside the clay block after impact. As a result of the collision, the clay block slides along the table in a straight line and comes to rest. Further data related to the experiment are given below.

Mass of air-rifle pellet	= 2.0 g
Mass of clay block	= 56 g
Velocity of pellet just before impact	= 140 ms^{-1}
Stopping distance of clay block	= 2.8 m

(a) Calculate the speed of the clay block immediately after the air-rifle pellet strikes it. 2

$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$

(1) $2 \times 140 + 0 = (56 + 2) v$

(1) $v = 4.8\ ms^{-1}$

Question 26 continued on next page.

Class

Name

Question 26 continued. **Marks**

(b) Calculate the magnitude of the average force of friction that the table exerts on the clay block while it is coming to rest. 3

(1) $E_K = \frac{1}{2} mv^2 = \frac{1}{2} \times 0.058 \times 4.83^2 = 0.675\,J$

(1) $F = W/r = \frac{0.675}{2.8}$

(1) $= 0.24\,N$.

OR via $v^2 = u^2 + 2ar$

$0 = 4.83^2 + 2a \times 2.8$

(1) $a = -4.16\ ms^{-2}$

$F = ma$

(1) $= 0.058 \times 4.16$

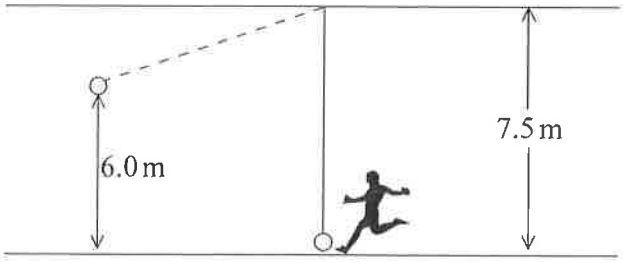
(1) $= 0.24\,N$

Class

Name

Question 27 (4 marks) **Marks**

A ball is suspended from a ceiling by a string 7.5 m long. The ball is kicked horizontally and rises to a maximum height of 6.0 m as shown in the following diagram.



(a) Ignoring air resistance, calculate the initial speed of the ball immediately after it is kicked. 2

$\Delta GPE = \Delta KE \quad \frac{1}{2}mv^2 = mgh$

(1) $v^2 = 2gh$

$= 2 \times 9.8 \times 6$

(1) $v = 10.8\ ms^{-1}$

(b) The mass of the ball is 0.550 kg and the impact time of the kicker's foot with the ball is 0.15 s.

Calculate the magnitude of the average force exerted on the ball by the kick. 2

$Ft = \Delta mv$

(1) $F = \frac{0.55 \times 10.8}{0.15}$

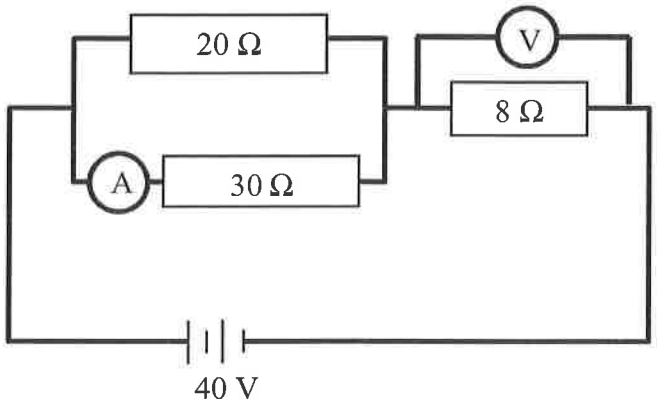
(1) $= 39.8\ N$

Class

Name

Question 28 (6 marks) **Marks**

Consider the circuit shown in the diagram below.



(a) Determine the total resistance of the circuit. 2

$R_{||}$: $\frac{1}{R_{||}} = \frac{1}{20} + \frac{1}{30}$ ∴ $R_{||} = 12\Omega$ ✓① mk.

$R_{total} = 8 + 12 = 20\Omega$ ✓① mk.

(b) Determine the total current in the circuit. 1

$I_T = \frac{40}{20} = 2A$ ✓① mk

[$I_T = \frac{40}{\text{Ans (a)}}$

(c) Determine the reading on the voltmeter in the circuit. 1

$V_{8\Omega} = 2 \times 8 = 16V$ ✓① mk.

[$V_{8\Omega} = 8 \times \text{Ans(b)}$

(d) Determine the reading on the ammeter in the circuit. 2

$V_{30\Omega} = 40 - 16 = 24V$ ✓① mk.

[$V_{30\Omega} = 40 - \text{Ans(c)}$]

$I = 24/30 = 0.8A$ ✓① mk.

[$I = \frac{(40 - \text{Ans(c)})}{30}$ if $\frac{3}{5} \times 2 = 1.2A$ ✓x

Class

Name

Question 29 (5 marks) **Marks**

A house light is used to convert electrical energy into light energy. The house light draws 6 A of current when connected to a 240 V power supply.

(a) Calculate the resistance of the house light. 1

$R = V/I = 240/6 = 40\Omega$ ✓1mk

(b) Calculate the number of electrons flowing per second through the house light. 2

$Q = It$

$= 6 \times 1 = 6C.$ ✓1mk.

no. of $e^- = |6/-1.602\times10^{-19}|$

$= 3.75 \times 10^{19}$ electrons ✓1mk.

(c) Briefly explain what will happen to the power output if a higher resistance house light is used with the 240 V power supply. 2

From $P = V^2/R$. ✓1mk

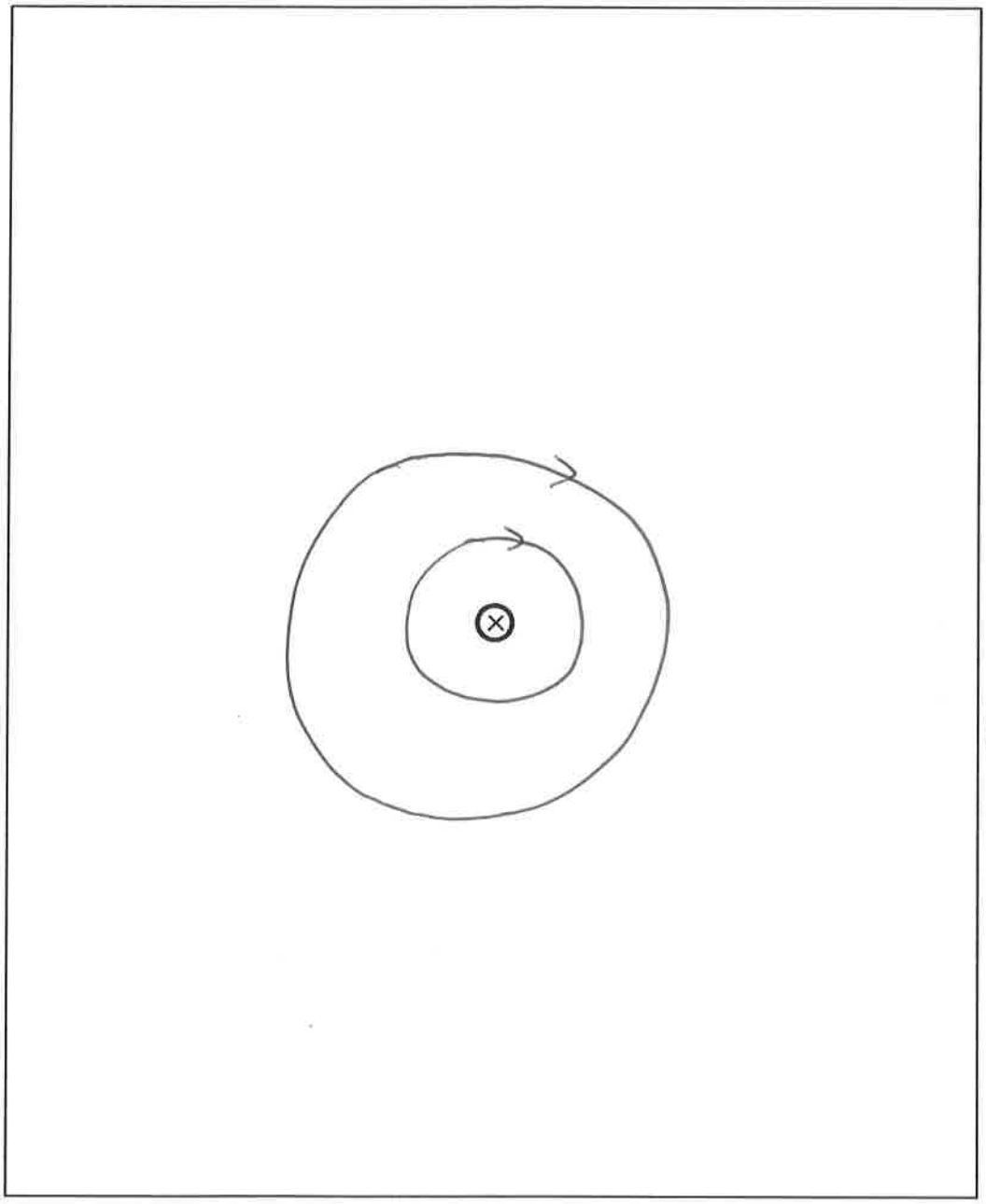
if R increases, P decreases ✓1mk.

Class

Name

Question 30 (2 marks) **Marks**

Draw the magnetic field surrounding a wire carrying conventional current into the page. 2



√1mk for circles correctly spaced.
√1mk arrows

Note: a minimum of two circles needs to be shown

Class

Name

Question 31 (2 marks) **Marks**

Double insulation, fuses and circuit breakers are three safety features commonly used in electrical circuits within the home.

Choose one of these features and briefly describe the general principle of the named feature.

Name of feature : fuse

Description : large current melts low melting point alloy ✓1mk. 2

stops the current/breaks the circuit or description of purpose - to prevent a fire or to prevent electrocution. ✓1mk.

OR/

Name of device : circuit breaker

Description : breaks (opens) circuit (switches off the power) when ✓1mk. 2
current too high/exceeds a certain safe limit

To prevent a fire, or to protect ✓1mk.
humans from electrocution (or shock).

OR/

Name of device : double insulation

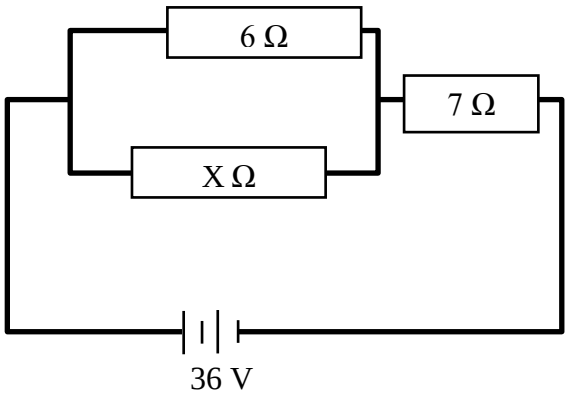
Description : electrical appliances have a 2
casing of rigid plastic to act as ✓1mk
insulation i.e. an inner and outer casing.

To prevent humans from electrocution
(or shock). ✓1 mk

AAH - CRIB

Question 32 (3 marks) **Marks**

Consider the following circuit.



A current of 0.5 A flows through resistor X.

(a) Calculate the current through the 6 Ω resistor. 2

$7(I + 0.5) + 6I = 36$ (or equivalent expression in I) **1 Mark**

I=2.5 A **2 Marks**

(b) Calculate the value of the resistor labelled X. 1

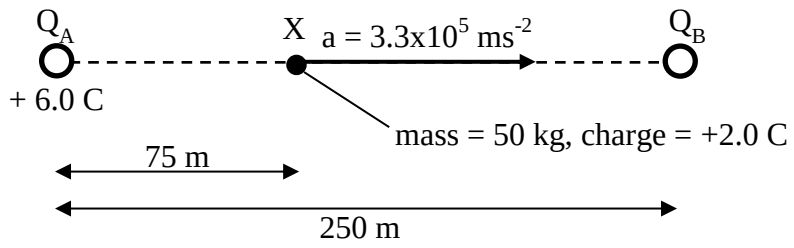
$0.5X = 6I$

X=30 Ω **1 Mark**

Carry through possible from (a) ***if*** workings are clear.

Question 33 (4 marks) **Marks**

The diagram below shows two charges, Q_A and Q_B fixed in place and separated by a distance of 250 m. Q_A has a charge of +6.0 C, but the charge on Q_B is unknown. A third charge, of mass 50 kg and charge +2.0 C, is placed at X, 75 m from Q_A.



When it is released, the charge at X has an acceleration of 3.3x10^5 ms^{-2} to the right.

Calculate the charge Q_B.

$F_X = 3.3x10^5 \times 50 = 1.65x10^7$ N **1 Mark**

Valid substitution into Coulomb's Law for force due to Q_A or Q_B **1 Mark**

Correct Answer but wrong sign **1 Mark**

Correct Answer plus right sign **2 Marks**

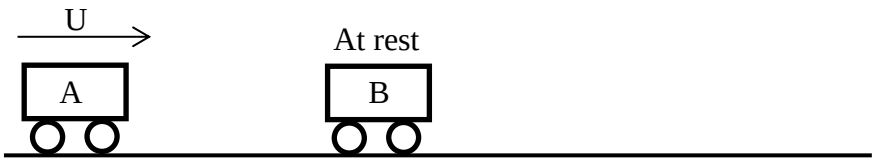
Answer:

$1.65x10^7 = [k.6.2/75^2] - [k.Q_B.2/(250-75)^2]$ (assuming Q_B is positive)

Q_B = +4.59 C

Question 34 (4 marks) **Marks**

The diagram below shows two trolleys, A and B. Initially, trolley A of mass 2.0 kg has a velocity of U to the right and trolley B of mass m_B is at rest.



Trolleys A and B collide elastically. After the collision, trolley A has a velocity of 7U/9 to the right.

Calculate the mass of trolley B.

Valid conservation of momentum expression **1 Mark**

e.g. $2U = 14U/9 + M_BV_B$

Valid conservation of energy expression **1 Mark**

e.g. $U^2 = 49U^2/81 + M_BV_B^2/2$ OR $V_B - 7U/9 = U$

Substitution to form valid expression in terms of M_B **1 Mark**

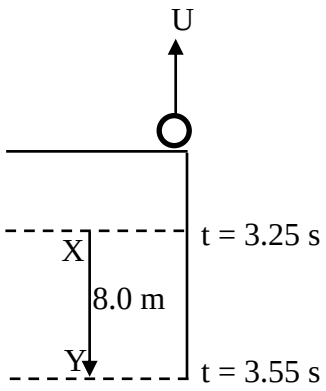
e.g. $4U/9 = 16M_BU/9$

Final Answer: **$\underline{M_B = 0.25\ kg}$** **1 Mark**

NB – if answer assumes trolleys coalesce – MAX 1 Mark

Question 35 (4 marks) **Marks**

A ball is thrown upwards at a speed U from the top of a high building as shown in the diagram below.



The ball passes a point X 3.25 s after it was thrown, and a point Y, which is 8.0 m below X, 0.30 s later.

Calculate the initial speed, U, of the ball.

Valid Equation for ball at X **1 Mark**

e.g. $r_X = -3.25U + 4.9x3.25^2$

Valid Equation for ball at Y **1 Mark**

e.g. $r_X + 8 = -3.55U + 4.9x3.55^2$

Valid combination of equations above: **1 Mark**

e.g. $-3.25U + 4.9x3.25^2 = -3.55U + 4.9x3.55^2 - 8$

Correct Answer: **$\underline{U=6.65\ ms^{-1}}$** **1 Mark**

NB – Other valid approaches credited as appropriate.