Physics

HSC Course

2013

Year 12 Trial HSC Examination

Total marks 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours

- Attempt all questions
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your I.D. number on each answer sheet
- Liquid paper must NOT be used on this paper

- For your convenience, the multiple choice answer sheet at the back may be removed from the rest of the paper

Total marks – 100
Section I
75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
Attempt questions 1-20 (multiple choice)
Allow about 30 minutes for this part.

Part B – 55 marks
Allow about 1 hour and 45 minutes for this part

Section II – Medical Physics Module
25 marks
Allow about 45 minutes for this part

Teachers: Mr Coombes, Mr Trotter

Task Weighting: 40 %

Multiple-choice Answer Sheet

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

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

(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) ⬭

Section I – Part A – Answer all questions on the multiple choice answer sheet.

20 marks Allow about 30 minutes for this part.

1. An astronaut travels to the moon. Which statement correctly summarises the differences experienced by the astronaut?

   (A) His mass is lower and he can jump higher.

   (B) His weight is lower and he can jump higher.

   (C) His mass is the same and he cannot jump higher.

   (D) His weight is the same and he cannot jump higher.

2. Why do all objects at any particular point on the Earth's surface accelerate at the same rate in free fall?

   (A) The gravitational force acting on each object is the same.

   (B) The gravitational force on each object is proportional to its mass.

   (C) The acceleration is inversely proportional to the mass of each object.

   (D) The acceleration is directly proportional to the gravitational force on each mass.

3. Which of the following statements is correct for a geostationary satellite compared to a low earth orbit satellite?

   (A) a constant orbital radius and a lower orbital velocity.

   (B) a constant orbital radius and a higher orbital velocity.

   (C) a variable orbital radius and a lower orbital velocity.

   (D) a variable orbital radius and a higher orbital velocity.

4. A spaceship is travelling at 0.9c away from the Earth. Microwave pulses sent by the spaceship are received once per second on Earth.

   What is the time interval between each pulse, as measured on the spaceship?

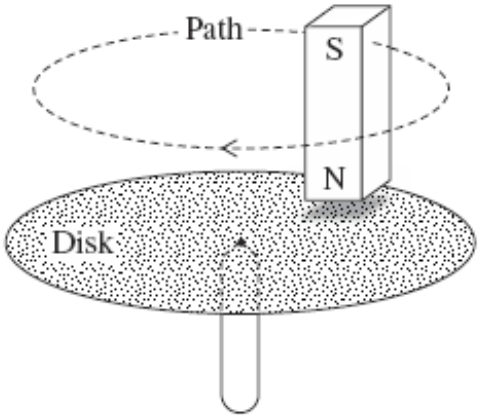
   (A) 0 s

   (B) 0.4 s

   (C) 1.0 s

   (D) 2.3 s

5. A student conducts an investigation by moving a magnet in a circular path slightly above a thin metal disk, which is free to move.



   Which of the following would correctly show the observation and conclusion of the student's investigation?

	Observation	**Conclusion**
(A)	The disk rotates in the opposite direction to the magnet	The motor effect forces the disc in the opposite direction to the magnet
(B)	The disk rotates in the same direction to the magnet	The motor effect forces the disc in the same direction as the magnet
(C)	The disk rotates in the opposite direction to the magnet	Eddy currents in the disc increase the relative motion between the disc and magnet
(D)	The disk rotates in the same direction to the magnet	Eddy currents in the disc reduce the relative motion between the disc and magnet

6. The minimum energy required to eject an electron from the surface of aluminium is 4.08 electron Volts (eV). What would be the wavelength, in metres, of the light needed to eject an electron from the surface of aluminium?

   (A) 6.54×10^{-19}

   (B) 3.04×10^{-7}

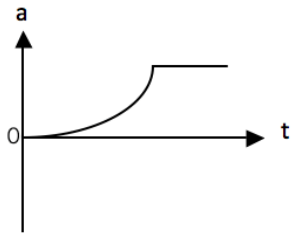
   (C) 9.86×10^{14}

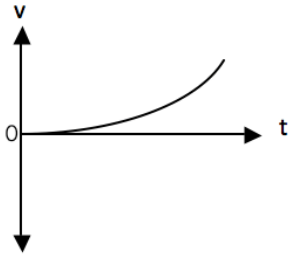
   (D) 2.96×10^{23}

7. A rocket was launched vertically upwards as shown in the photograph. The fuel in the rocket lasts for 30 seconds.

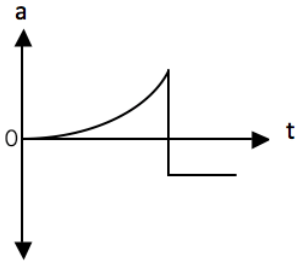
Which pair of graphs best describes the acceleration (a) and the velocity (v) of the rocket over a period (t) of 40 seconds.

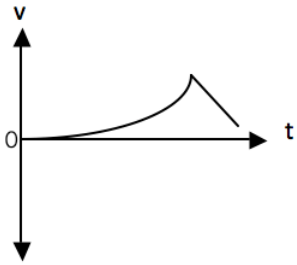
(A)



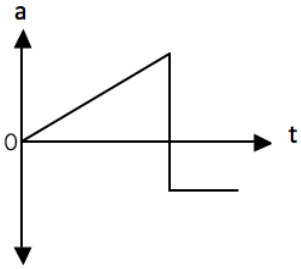


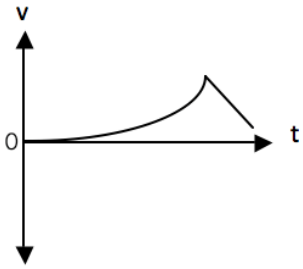
(B)



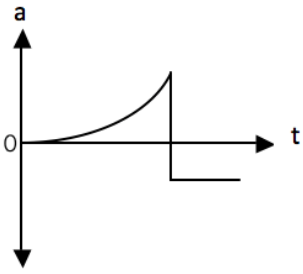


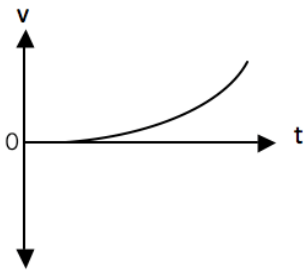
(C)





(D)





8. Which response correctly gives the reason why travel to distant galaxies may one day be possible?

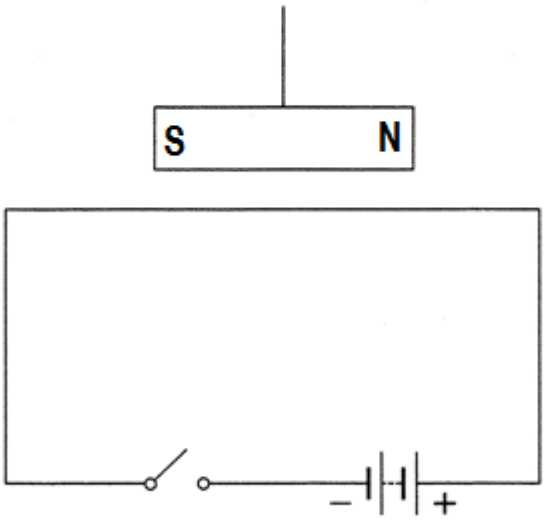
   (A) The speed of light will be able to be exceeded.

   (B) Mass dilation of a space craft makes it decrease mass.

   (C) Time dilation allows for a person to age more slowly at high velocities.

   (D) Length contraction allows for the distance to far away galaxies to contract.

9. A magnet is suspended over a conducting wire as shown.



   What will the north pole of the magnet do when the switch is closed?

   (A) Move to the left.

   (B) Move to the right.

   (C) Rotate into the page.

   (D) Rotate out of the page.

10. Which of the following methods can be used to reduce eddy currents in transformers?

   (A) Placing laminations in the core.

   (B) Cooling the core below its critical temperature.

   (C) Using a core that is conductive but not magnetic.

   (D) Winding both the primary and secondary coil around the same magnetic core.

11. A large industrial electric motor has a minimum rotational speed to prevent the motor from overheating. Which response correctly identifies the reason for this?

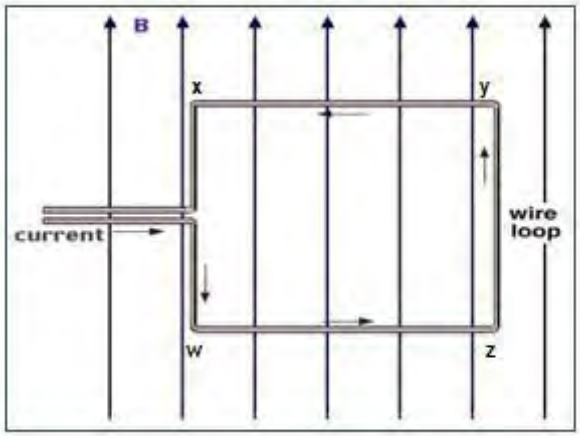
   (A) At lower speeds friction in the motor increases.

   (B) The resistance of the coils increase at lower speeds.

   (C) The back emf decreases causing more current in the coils.

   (D) The induced eddy currents increase and this produces heat.

12. The loop below is placed in a magnetic field as shown.

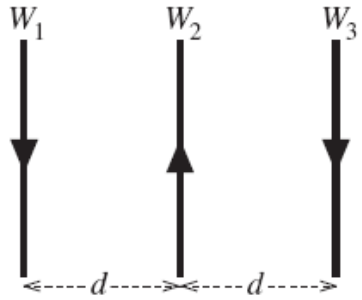


Which of the following best describes what will happen to the loop?

	Direction of force on WZ	Direction of force on XY	Rotation of loop before stopping
(A)	Into the page	Out of the page	90^0
(B)	Out of the page	Into the page	90^0
(C)	Into the page	Out of the page	180^0
(D)	Out of the page	Into the page	180^0

13. Three identical conductors shown below have been measured to have the following currents.

Conductor	Current (A)
W_1	1
W_2	4
W_3	16



Conductor W_2 is an equal distance from W_1 and W_3. What is the initial net force acting on W_1

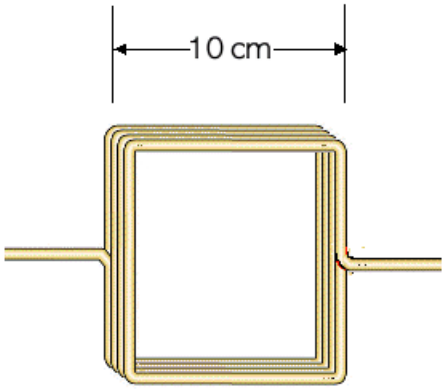
(A) Zero.

(B) Non-zero and to the right.

(C) Non-zero and to the left.

(D) Non-zero and out of the page.

14. A student constructs a small electric motor by winding 20 coils in a square shape as shown below.



The resistance of the motor is 60 Ω and a 12 V battery supplies energy. Two magnets in the motor produce a magnetic field of 0.5 T.

What is the maximum torque supplied to the motor?

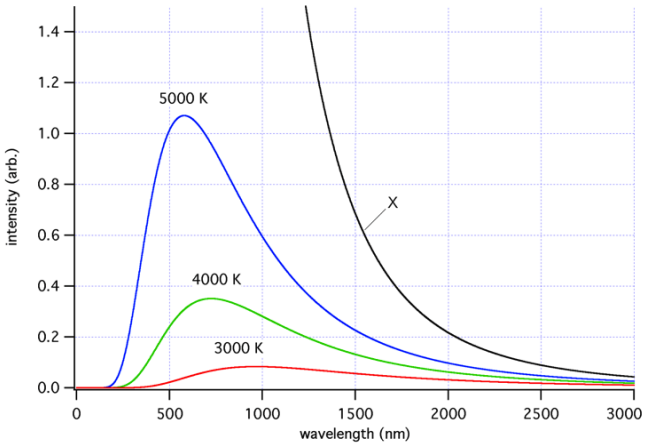
(A) 0.02 N.m

(B) 1 N.m

(C) 6 N.m

(D) 200 N.m

15. This graph shows the radiation curves for black bodies at three different temperatures.



What does the curve labelled "X" represent?

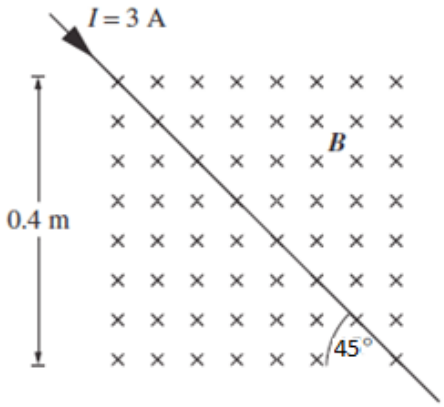
(A) A black body with a temperature greater than 5000 K.

(B) A black body with a temperature less than 3000 K.

(C) The results of a model for black body radiation first proposed by Planck.

(D) The radiation curve for black bodies predicted by the wave model for light.

16. A conducting wire is placed in a magnetic field of 0.5T as shown.



What is the magnitude of the force experienced by the wire closest to?

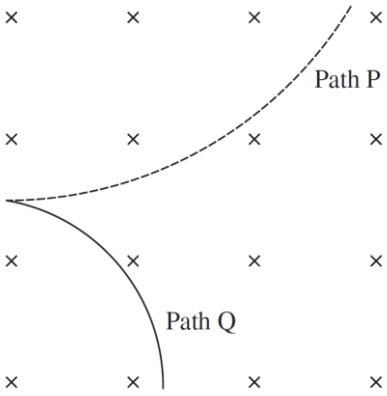
(A) 0.6N towards top right.

(B) 0.6N towards bottom left.

(C) 0.85N towards top right.

(D) 0.85N towards bottom left.

17. The diagram shows the paths taken by two moving charged particles when they enter a region of uniform magnetic field.



Which of the following statements best explains the paths of the two particles?

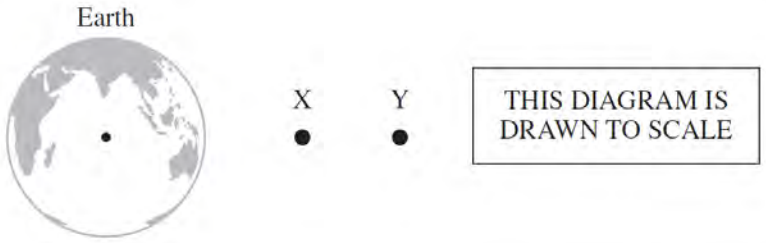
(A) Particle P has the same charge as particle Q.

(B) Particle P has a greater mass than particle Q.

(C) Particle P has a lower velocity than particle Q.

(D) Particle P has a higher magnitude charge than particle Q.

18. A satellite is moved from point X to point Y. The gravitational force on the satellite at point X is 50,000 N.



What is the gravitational force experienced by the satellite in its new orbit?

(A) 12,500 N

(B) 22,222 N

(C) 25,000 N

(D) 33,333 N

19. Which of the following elements could be added to a crystal of silicon to make an n-type semiconductor?

(A) boron

(B) gallium

(C) arsenic

(D) germanium

20. A student performs an investigation where they measure the acceleration due to gravity using a pendulum and a stopwatch. The student then performs the same experiment a second time and achieved results consistent with the first experiment. For what purpose would the student conduct the second experiment?

A) increase validity

B) increase accuracy

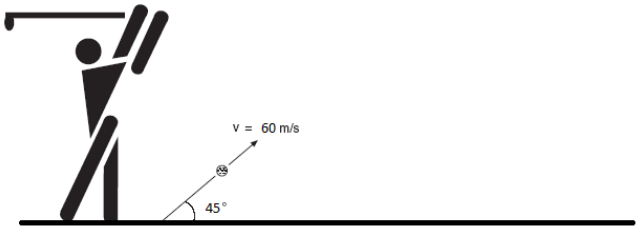
C) increase precision

D) increase reliability

Section I – Part B - Answer all questions in the space provided.

55 Marks Allow about 1 hour and 45 minutes for this part

21. A golfer strikes a ball at $60ms^{-1}$ at 45^0 across flat ground as shown in the diagram below.



Calculate the maximum height and range of the projectile. [4M]

.....

.....

.....

.....

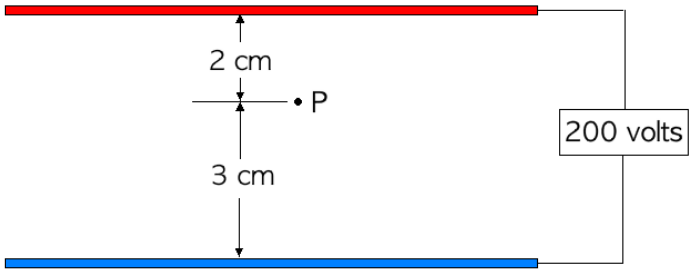
.....

.....

.....

.....

22. Two oppositely charged metal plates are separated by 5 cm and the voltage between them is 200 V. Calculate the force that would act on an electron placed at the position, P, between the plates. [3M]



.....

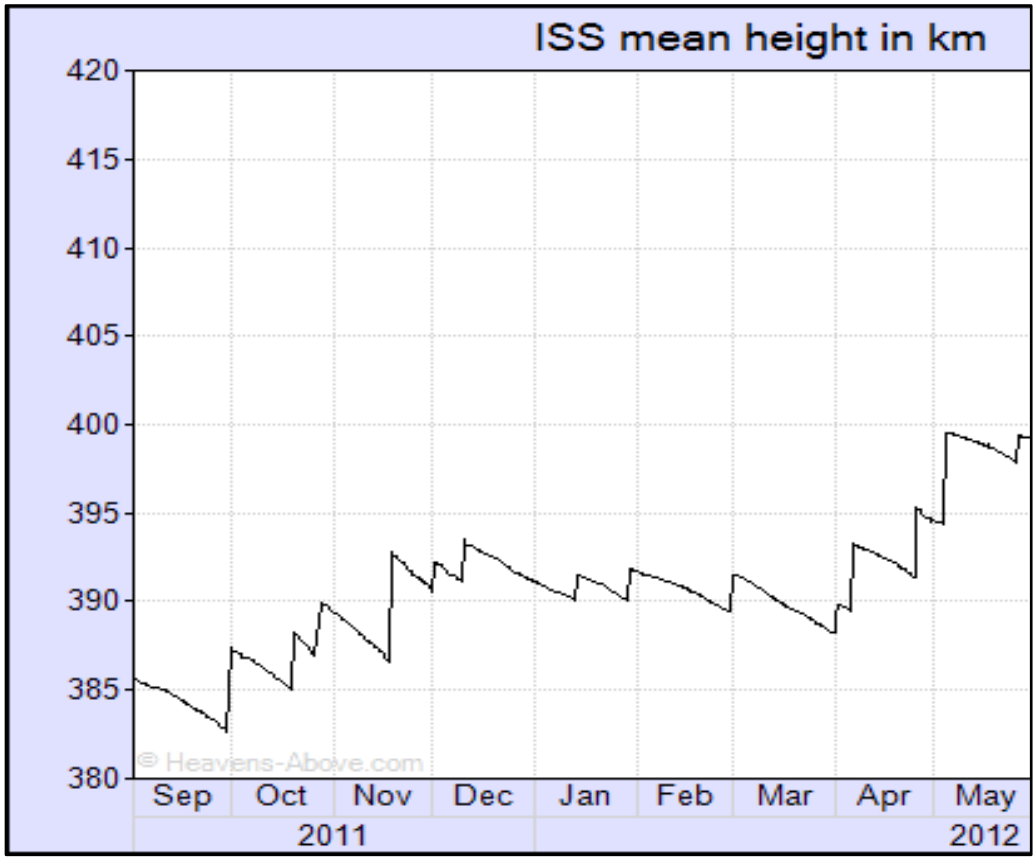
.....

.....

.....

.....

23. The following graph shows the height of the International Space Station satellite.



Explain the changes in altitude experienced by the satellite over the time period shown. [4M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

24. In class you carried out a first-hand investigation to demonstrate the effect on a generated electric current when the distance between the coil and the magnet was varied. Recount the method and results of this investigation. [5M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

25. Outline the method used by JJ Thomson to determine the charge to mass ratio of an electron. [5M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

26. The diagram below represents the apparatus used by Heinrich Hertz to investigate electromagnetic waves.

Outline the method used by Hertz to determine the speed of the radiation he was investigating. [4M]

.....

.....

.....

.....

.....

.....

.....

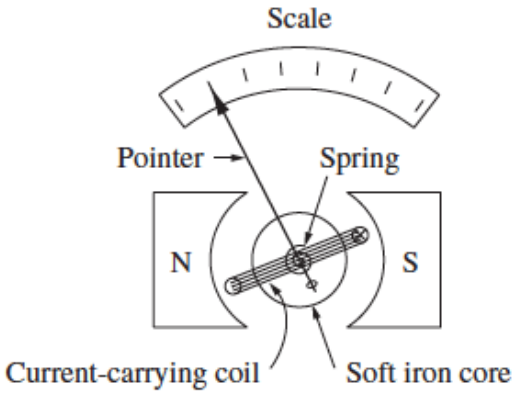
.....

.....

.....

.....

27. The following diagram shows a galvanometer.



(a) Compare the structure of this galvanometer with an electric motor. [2M]

.....

.....

.....

.....

.....

(b) Explain how the galvanometer is able to measure different magnitudes of current. [3M]

.....

.....

.....

.....

.....

28. Analyse the factors that rocket scientists must take into consideration when launching a satellite into a geostationary orbit. [7M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

29. In Australia, most power plants burn a fuel, such as coal, or use the energy of falling water to generate electricity on a large scale. Assess the impact on the environment of such large scale electricity generation. [5M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

30. The distance to the star Alpha Centuari is 4.367 light years as measured from Earth. Using a relevant calculation, explain how a rocket could complete the journey from Earth to Alpha Centauri in 3.28 years. [3M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

31. Escape velocity is achieved when an object is given kinetic energy to exactly equal the object's gravitational potential energy. Calculate the escape velocity of a 20 kg cannonball on the surface of the Earth. (Radius of the Earth = 6400 km)

[3M]

.....

.....

.....

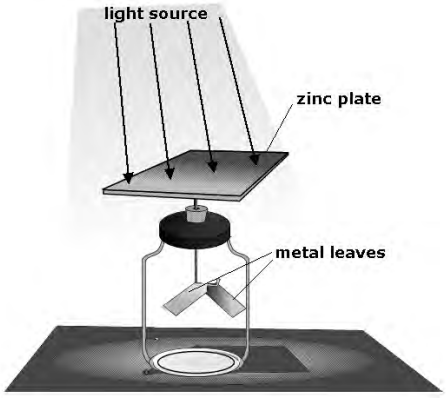
.....

.....

.....

.....

32. An electroscope was charged negatively causing the metal leaves on the electroscope to diverge as shown in the following diagram. A monochromatic green light source was directed onto a zinc metal plate sitting on top of the electroscope and it was observed that this caused the electroscope to discharge.



The electroscope was given the same charge again and the same green light was shone onto a caesium plate. In this case the electroscope discharged but at a much slower rate. Explain the observations made by the student. [3M]

.....

.....

.....

.....

.....

33. Using Einstein's theory of relativity, explain how a scientific theory is validated. [4M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

Section II – Medical Physics - Answer all questions in the space provided.

25 marks Allow about 45 minutes for this part

Question 38

(a) Compare the properties of ultrasound and sound in a normal human hearing range. [2M]

.....

.....

.....

.....

(b) Describe how the piezoelectric effect is used to detect ultrasound. [2M]

.....

.....

.....

.....

.....

.....

(c) Use data in the table to calculate the percentage of ultrasound reflected when it passes from muscle to fat. [3M]

Tissue	*Density* ($kg\ m^{-3}$)	*Velocity of sound* ($m\ s^{-1}$)
Muscle	1040	1630
Fat	945	1460
Bone	2560	3050

.....

.....

.....

.....

.....

(d) Explain two situations where Doppler ultrasound would be a superior diagnostic tool than a CT scan. [4M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(e) Outline the two different mechanisms that produce x-ray photons in an x-ray tube. [4M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(f) Assess the effects on individuals and society of the use of X-rays and CT scans in medical diagnosis. [5M]

.....

.....

.....

.....

.....

.....

.....

.....

.....

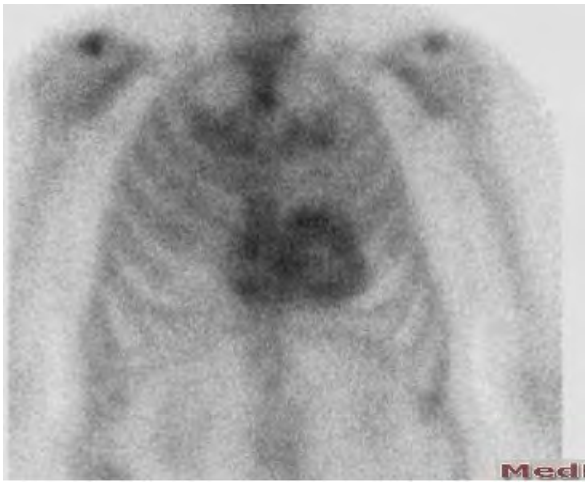
.....

.....

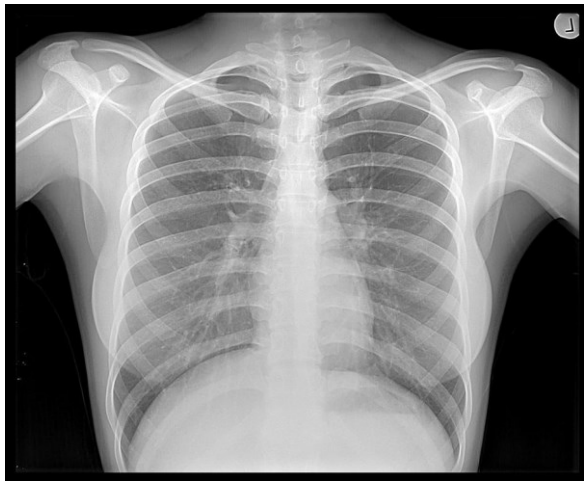
.....

.....

(g) The photographs below show scans of the chest.



Scan X



Scan Y

(i) Contrast how these two scans are produced. [3M]

.....

.....

.....

.....

.....

.....

(ii) Which of these scans would be most likely to detect a 2mm tumour in the lungs? Justify your answer. [2M]

.....

.....

.....

.....

.....

.....

END OF EXAM

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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

$$Z = \rho v$$

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

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

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

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

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

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

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

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

$$\frac{V_{\text{out}}}{V_{\text{in}}} = -\frac{R_{\text{f}}}{R_{\text{i}}}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number — 79 Au — Symbol of element

Atomic Weight — 197.0 — Name of element

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 65.41 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 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] 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 183.8 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 [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] 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 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.

This page is blank

Multiple-choice Answer Sheet

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

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

(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) ⬭

Part A

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) ⬭
16.	(A)	⬭	(B)	⬭	(C)	⬭	(D) ⬭
17.	(A)	⬭	(B)	⬭	(C)	⬭	(D) ⬭
18.	(A)	⬭	(B)	⬭	(C)	⬭	(D) ⬭
19.	(A)	⬭	(B)	⬭	(C)	⬭	(D) ⬭
20.	(A)	⬭	(B)	⬭	(C)	⬭	(D) ⬭

Marking Guidelines Trial Exam 2013 Year 12 Physics

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

Part B.

21. Marking criteria	Marks
Correct height of 92m and range of 367m calculated.	4
Correct equations used and calculations with one or two errors.	2-3
One correct relevant calculation (eg time of flight)	1

22. Marking criteria	Marks
Correct magnitude of 6.4×10^{-16}N calculated.	3
Correct equations and calculation with one error.	2
Recognises both equations required and attempts calculation.	1

23. Marking criteria	Marks
Identifies the reasons for falls in altitude(orbital decay) and rises (boosts in velocity) and relates each aspect to forces and changes in velocity.	4
Identifies the reasons for altitude changes and gives a detailed explanation of one aspect.	3
Identifies reasons without explanation OR gives a good explanation for one of the reasons.	1-2

24

Marking criteria	Marks
A detailed method including how velocity was controlled, galvanometer used, specific distances used, multiple repetition AND results summarised correctly.	5
All of the above with one or two aspects not covered in detail.	3-4
Recounts some aspects of the correct experiment. Eg move a magnet into a coil.	1-2

25

Marking criteria	Marks
Both parts of Thomson's experiment recounted correctly in detail including a mathematical analysis.	4-5
One part of the experiment recounted in detail or both parts recounted but lacks detail.(eg no mathematical analysis)	2-3
Limited understanding of his work demonstrated.	1

26

Marking criteria	Marks
A detailed description of his work including the known frequency of the oscillator, how the receiver was moved to produce an interference pattern which is analysed to work out the wavelength and the use of $v=f\lambda$.	4
A less detailed description OR answer does not correctly explain the method used to work out wavelength.	2-3
One aspect of the experiment related to speed calculation described. Eg Used the equation $v=f\lambda$.	1

27a

Marking criteria	Marks
Outlines one significant structural similarity AND difference	2
Outlines one significant structural similarity OR difference	1

27b

Marking criteria	Marks
Detailed answer that refers to the coil and spring and relates the motor effect to the torque experiences by both at different current magnitudes.	3
Answer demonstrates a significant understanding of how the galvanometer works but lacks some detail.	2
Identifies one aspect of how the galvanometer works.	1

28

Marking criteria	Marks
Three relevant features of a geostationary satellite related to considerations that must be taken during launch AND A clear and coherent answer with correct use of scientific terminology.	6-7
Two relevant features of a geostationary satellite related to considerations that must be taken during launch AND A sound use of scientific terms.	4-5
One relevant feature analysed OR two/three features of rocket launch in general	2-3
One aspect of launch identified.	1

NOTE : Relevant features include
Attaining the correct altitude in conjunction with correct orbital velocity.
Ensuring the satellite is positioned above the equator
Launching east to west in order to orbit in same direction

29

Marking criteria	Marks
Makes a judgement of the impacts AND Describes in detail the environmental issues of coal fired and hydroelectric generators and links each issue to an impact on the environment.	4-5
Makes a judgement AND describes issues of both generators OR Makes a judgement and describes issues of one type of generator linked to environmental impacts.	2-3
Identifies environmental issues of generators.	1

30

Marking criteria	Marks
Correct use of time dilation/length contraction equation to determine velocity required (>0.8c) and correct justification based on calculation.	2-3
Answer identifies specific aspect of special relativity relevant to question including incorrect use of equation.	1

31

Marking criteria	Marks
Correct answer given with E_K equated to E_P and correct substitution.	3
E_K equated to E_P and correct substitution.	2
Correct equation from E_K equated to E_P	1

32

Marking criteria	Marks
Answer comprehensively explains that Cs has higher threshold frequency than Zn and electroscope discharges naturally as the photoelectric effect is not occurring.	3
Answer explains that Cs has higher threshold frequency than Zn and electroscope discharges naturally as the photoelectric effect is not occurring with one minor error.	2
Incorrect answer but correct relationship between light frequency and E_K of electrons or intensity of light and number of emitted electrons.	1

33

Marking criteria	Marks
A detailed explanation which clearly links at least two significant pieces of evidence from scientific experiments, to the process of validating a scientific theory.	3-4
A more general answer which does not draw as direct links between pieces of evidence and validating a scientific theory.	1-2

38a

Marking criteria	Marks
Answer includes either two significant differences or one significant similarity and one significant difference	2
Answer includes either one significant difference or one significant similarity.	1

38b

Marking criteria	Marks
Answer clearly describes pressure variations in the crystal lattice of the piezoelectric crystal caused by ultrasound, being transformed into an alternating voltage signal.	2
Answer gives clear description as above but with small omission.	1

38c

Marking criteria	Marks
Correct reflected percentage calculated through correct determination of acoustic impedances and correct substitution in to equation.	3
Correct determination of acoustic impedances and correct substitution in to equation.	2
Correct determination of acoustic impedances.	1

38d

Marking criteria	Marks
Answer uses two specific situations where Doppler ultrasound is used and makes substantial links to where it is superior to CT scans	4
Answer uses two specific situations where Doppler ultrasound is used and makes reasonable links to where it is superior to CT scans	3
Answer uses two situations where Doppler ultrasound is used and makes links to where it is superior to CT scans.	2
Answer uses one situation where Doppler ultrasound is used and gives one reason why it is superior to CT scans.	1

38e

Marking criteria	Marks
Comprehensive outline of mechanisms for producing Bremsstrahlung (including rapid deceleration of electrons, conversion of E_K to X-ray) and characteristic radiation (including ejection of inner shell electron and drop in energy level of a higher energy electron, producing x-rays).	4
Outline of mechanisms as above, but missing one minor piece of information.	3
Basic outline of mechanisms, missing two or more pieces of information	1-2

38f

Marking criteria	Marks
Answer makes a valid assessment of effects. Must include two specific, significant effects on individuals and two specific, significant effects on society.	4-5
Answer makes a valid assessment of effects and includes two specific, significant effects on individuals or two specific, significant effects on society.	2-3
Answer makes a valid assessment of effects and attempts to address effects on individuals or society.	1

38g(i)

Marking criteria	Marks
Three statements **directly** contrasting the **production** of x-rays and bone scans.	3
Two statements **directly** contrasting the **production** of x-rays and bone scans OR Three relevant indirect contrasts.	2
One statement **directly** contrasting the **production** of x-rays and bone scans OR Two relevant indirect contrasts.	1

38g(ii)

Marking criteria	Marks
Answer identifies scan X and includes substantial justification, addressing either the capabilities of bone scans or limitations of x-rays.	2
Answer identifies scan X and includes minimal justification, addressing either the capabilities of bone scans or limitations of x-rays.	1