ID Number: _____

Physics

HSC Course

2010

Year 12 Half-Yearly Examination

Total marks 50

General Instructions

- Reading time – 5 minutes
- Working time – 1.5 hours

- Attempt all questions
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your ID 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

This paper has two parts, Part A and Part B

Part A – 10 marks
Attempt questions 1-10 (multiple choice)
Allow about 15 minutes for this part.

Part B – 40 marks
Attempt questions 11 to 17
Allow about 75 minutes for this part

Task Weighting: 30%

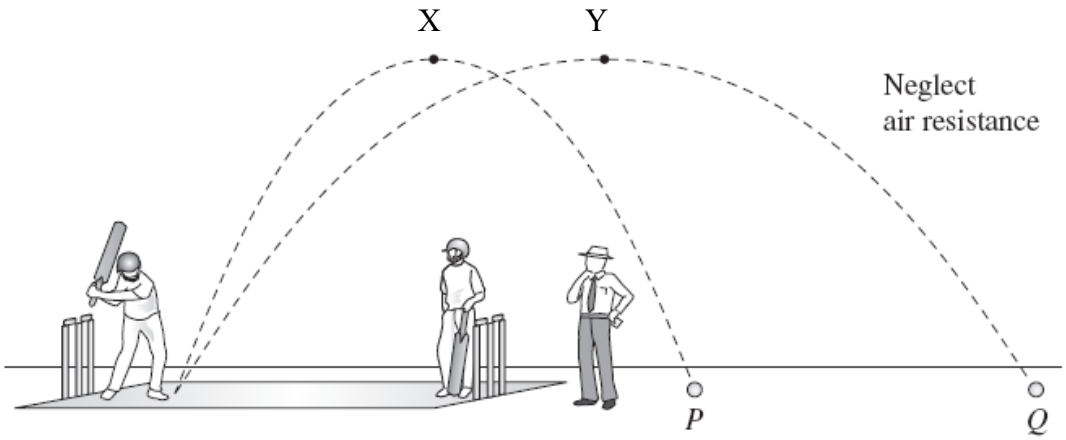
ID Number: _____

Part A: Multiple Choice Questions (1 mark each)

1. The gravitational acceleration on the surface of Mars is 3.72 m s^{-2}. An astronaut wearing his space suit on the Moon, where the gravitational acceleration is 1.6 m s^{-2}, has a weight of 224 N. If the astronaut was standing stationary on the surface of Mars, which of the following would correctly represent his mass?

   A) 520.8 N
   B) 224 N
   C) 140 kg
   D) 60.2 kg

2. The following shows a game of cricket.



The picture shows two shots hit by the batsman to points Q and P.

Which of the following correctly compares the shots hit to points P and Q?

   A) The velocity of the ball at point X is the same as the velocity at point Y.
   B) Ball Q has the same time of flight as ball P.
   C) The acceleration acting on ball P is greater than on ball Q.
   D) The initial vertical velocity of ball Q is greater than that of ball P.

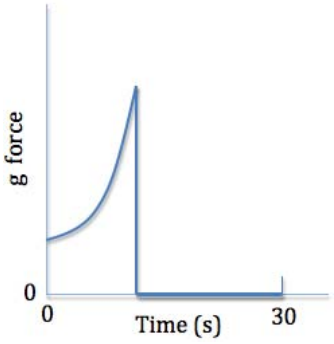
3. A toy rocket of mass 5 kg has a thrusting force of 200 N. If the rocket is fired directly upwards, how far does it travel in the first 3 seconds of its flight? (assume no mass loss)

   A) 90.6 m
   B) 120 m
   C) 136 m
   D) 180 m

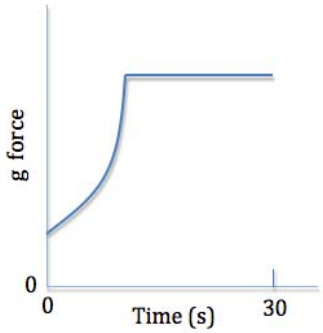
4. During the launch of a test rocket, the rocket engine burned and produced a constant thrust for a period of 12 seconds before it was switched off. A parachute was opened 30 seconds after launch to control the rocket's decent back to Earth.

Identify which graph best illustrates the g forces acting on the rocket over the first 30 seconds.

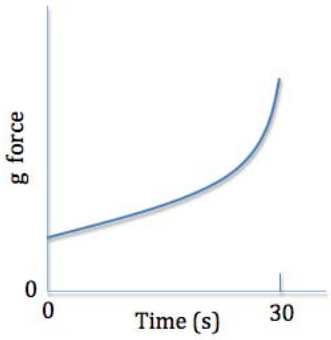
(A)



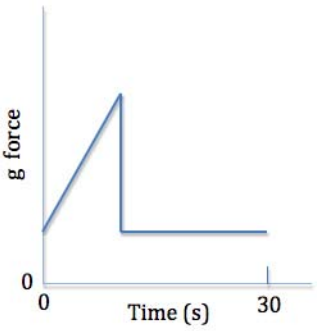
(B)



(C)



(D)



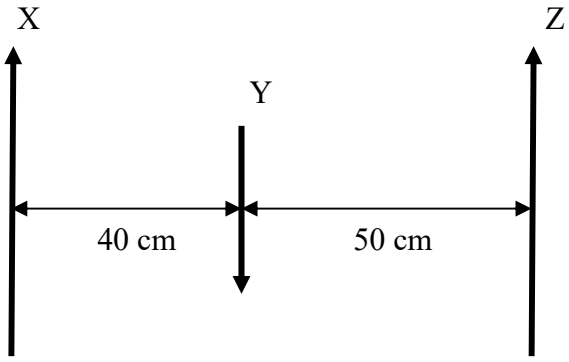
5. Which of the following best defines gravitational potential energy?

A) the work done to move an object from a very large distance away to a point in a gravitational field
B) the energy required to increase the altitude from the surface of a planet to a height of 1 km
C) the energy gained by an object as it falls under the influence of gravity
D) the energy required at the surface of a planet to propel an object an infinite distance

6. The Michelson-Morley attempt to measure the velocity of the Earth through the aether is considered to be a significant experiment. This is because the results

A) demonstrated conclusively that the aether did not exist
B) showed that the speed of light is a relative quantity
C) provided the first experimental support for Special Relativity
D) showed that light is a wave that forms interference patterns

7. Three wires, X, Y and Z, each carrying acurrent of 2 A in the direction indicated by the arrow, are positioned as shown in a vacuum.



NOT TO SCALE

X and Z share a common length of 1.2 m. Y is 70 cm long. The magnitude and direction of the force acting on Z is

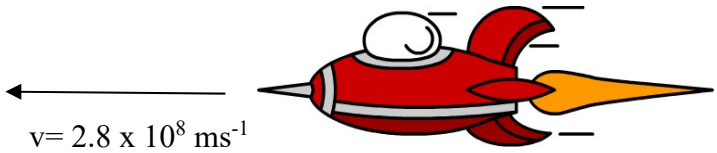
A) 0

B) 5.3×10^{-8} N to the right

C) 5.0×10^{-7} N to the right

D) 2.2×10^{-6} N to the right

8. A spaceship travelling at 2.8×10^{8} m s^{-1} passes an observer on Earth as shown in the diagram



observer

The observer measures the length of the spacecraft as 124.0 m. An astronaut on board the spacecraft will measure its length to be closest to

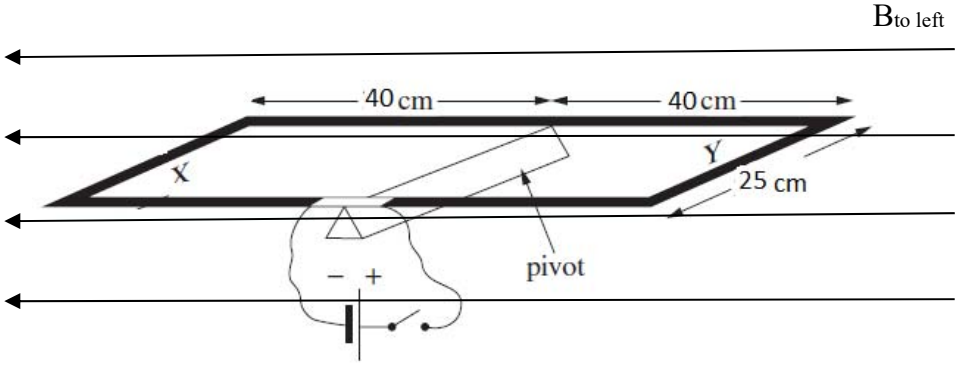
A) 44.5 m

B) 124.0 m

C) 254.6 m

D) 345.4 m

9. The diagram shows a single rectangular coil of dimensions 80 cm x 25 cm on a pivot. The coil is placed in a uniform magnetic field of 0.5 tesla directed from Y to X so that the plane of the coil is parallel to the magnetic field.



When the switch is closed, a current of 30 amperes flows through the coil.
Which of the following would prevent the coil from starting to rotate when the switch is closed?

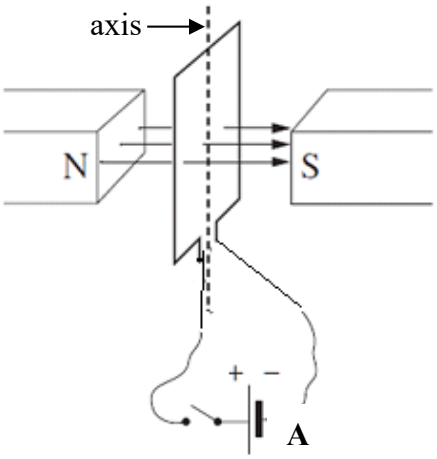
A) Hang a mass of 382 grams from side X

B) Hang a mass of 382 grams from side Y

C) Hang a mass of 765 grams from side X

D) Hang a mass of 765 grams from side Y

10. The diagram shows a simple DC motor with a single coil which is connected to a battery.The coil is free to rotate about the axis.



What happens to the coil when the switch is closed?

A) It does not move.

B) It rotates clockwise as seen from A.

C) It rotates anticlockwise as seen from A.

D) It oscillates about the axis

Section B

Attempt questions 11-17

11. A sensitive spring balance was attached to the ceiling of an elevator in a tall building and a 1 kg mass hung from it. A video camera was set up to record any change in the readings as the lift moved between different floors. An 8 second section of the tape was analysed and the measurements recorded in the table below.

Time (s)	Balance reading (kg)
0	1.0
1	0.85
2	0.85
3	0.86
4	0.86
5	0.84
6	1.0
7	1.0
8	1.0

a) Qualitatively describe the motion of the lift between t = 1 s and t = 5 s (1M)

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b) A student stated that the elevator was stationary during the last 3 seconds. Assess this statement. (2M)

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c) Explain how the results distinguish between inertial and non-inertial frames of reference. (2M)

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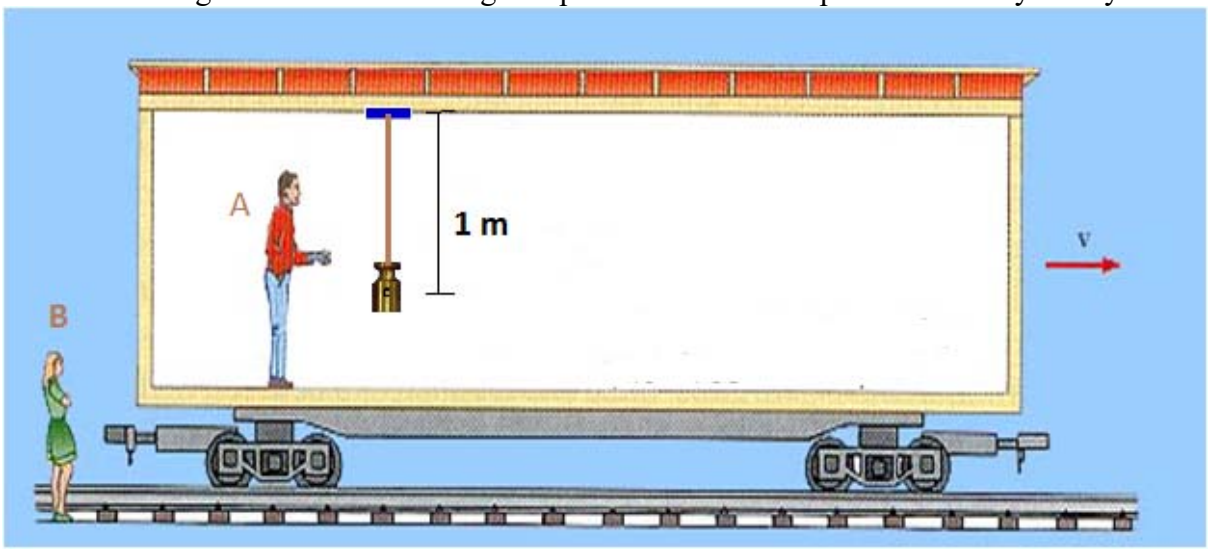
12. The diagram illustrates a thought experiment based on Special Relativity theory.



A one metre pendulum was attached to the ceiling of a high speed train tavelling with a constant velocity of 0.9c. The pendulum was set swinging and observer A on board the train accurately determined the period of the pendulum as 2.01 seconds.

a) Contrast the motion of the pendulum observed by A with the observations made by B, an observer standing beside the tracks. (2M)

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b) Determine the period of the pendulum as measured by B. (2M)

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c) Explain how this experiment relates to the principle of relativity. (3M)

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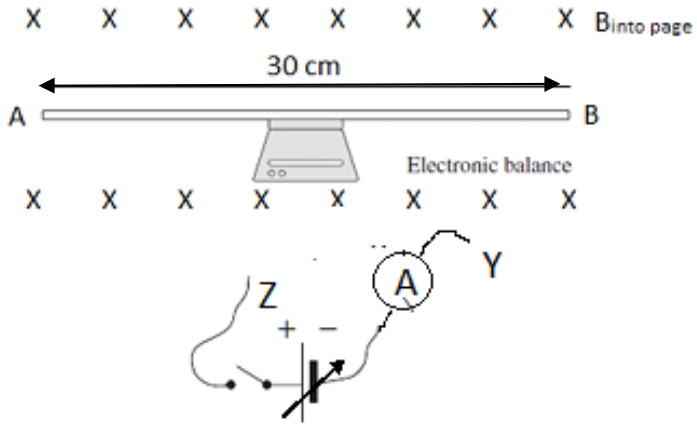
13. A straight 30 cm length of copper wire, AB, was placed on a sensitive electronic balance which displays readings in newtons. A uniform magnetic field was applied perpendicular to the wire. The wire was then connected to a variable DC power source and an ammeter. The switch was closed and readings taken of the current and apparent mass of the wire as the voltage was increased.

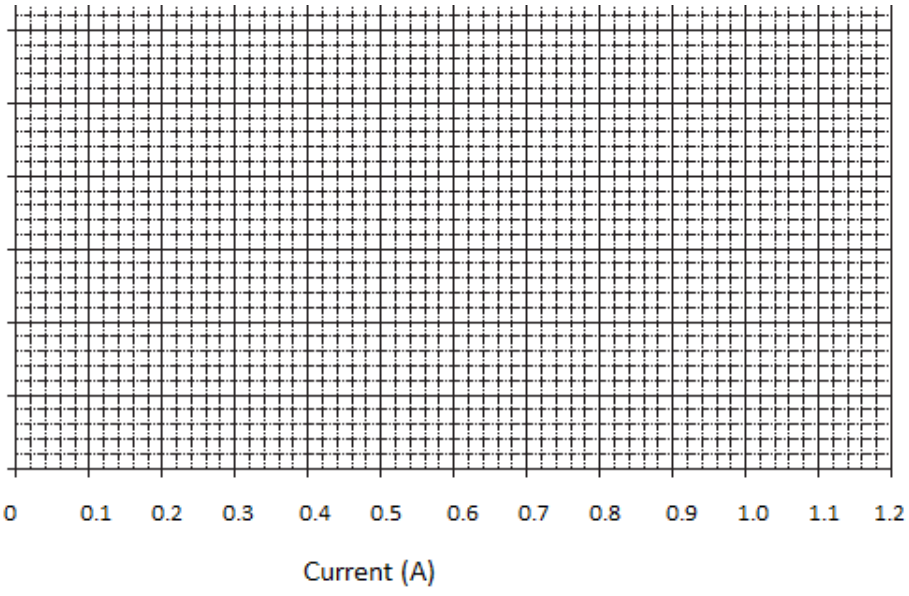


The results are shown in the table below.

Current (A)	Balance Reading (N)
0.25	0.18
0.36	0.21
0.58	0.26
0.92	0.35
1.20	0.43

a) On the diagram above, connect the ends of the copper wire to the connections Y and Z so the current is moving in the correct direction for these results (1M)

b) Plot the data in the table and draw a line of best fit (2M)



c) Using the graph

(i) Determine the mass of the copper wire. (2M)

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(ii) Calculate the strength of the applied magnetic field. (3M)

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14. A team of astronomers has discovered 2 planets in orbit around the star 55 Cancri. The table below lists some data about each of the planets.

Planet	Orbital Period (Earth days)	Mass (kg)	Orbital Radius (km)
A	14.6	1.898×10^{27}	15×10^{6}
B	6616.5	8.54×10^{27}	

Calculate the orbital radius of planet B. (3M)

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15. Einstein's Special Relativity theory is based on two postulates

1. The laws of physics are the same in all inertial frames of reference and
2. The speed of light always has the same value which is independent of the motion of the light source and observer.

Assess the importance of the second postulate in changing the direction of scientific thinking (4M)

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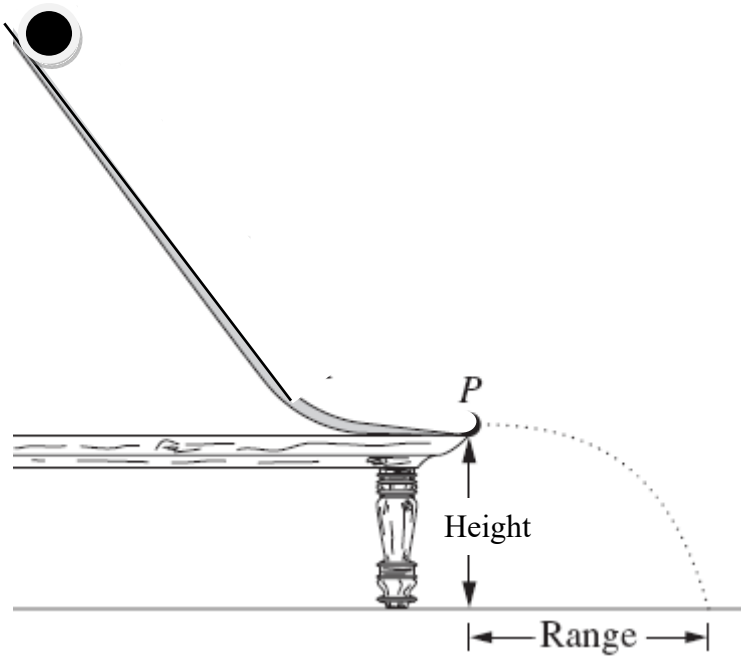
16. A student conducts an investigation as shown below.

He let a ball roll down a ramp and then off the end of a table at point P.

He repeated this procedure several times for different table heights.

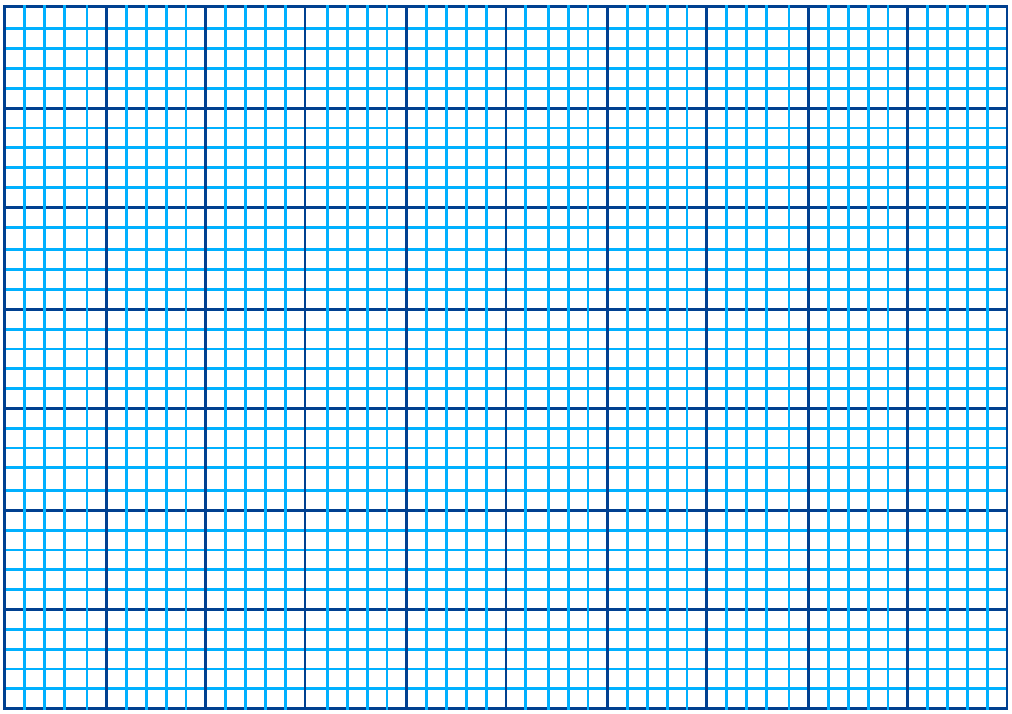
Each time he measured the range of the ball.



The results were tabulated as follows.

Height of table (cm)	Range (cm)
30	20
60	28
90	34
120	39
150	43

(a) Construct a line of best fit graph of the data in the table. (3M)



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

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(c) Identify the dependant, independent and one controlled (fixed) variable for this investigation. (2M)

Independent.....

Dependent .....

Controlled .....

17. During a space shuttle mission astronauts are propelled from the Earth into a low-earth orbit and eventually return to the Earth. Analyse the changes in the g-forces experienced by astronauts throughout the mission. (6M)

HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

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

$$v = f\lambda$$

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

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

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

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

$$P = VI$$

$$\text{Energy} = VIt$$

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

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

$$\Sigma F = ma$$

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

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

$$W = Fs$$

$$p = mv$$

$$\text{Impulse} = Ft$$

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

$$F = mg$$

$$v_x^2 = u_x^2$$

$$v = u + at$$

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

$$\Delta x = u_x t$$

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

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

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

$$E = mc^2$$

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

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

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

FORMULAE SHEET

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

$$F = BIl\sin\theta$$

$$\tau = Fd$$

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

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

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

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

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

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

$$F = qvB\sin\theta$$

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

$$E = hf$$

$$c = f\lambda$$

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

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

$$Z = \rho v$$

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

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

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

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79	Symbol of element
	Au	
Atomic Weight	197.0	
	Gold	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.

ID Number: _____

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) ⬭

Marking Criteria

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

Q11a Criteria	Marks
Response states the lift is ACCELERATING downwards (at an almost constant rate)	1

Q11b Criteria	Marks
Response contains a clear assessment that the statement is incorrect AND Explains that the lift could also be moving with a constant velocity since it is an inertial reference frame (readings of 1.0 kg are the expected values for a system moving with a constant velocity or stationary)	2
Response contains a clear assessment that the statement is incorrect OR Explains that the lift could also be moving with a constant velocity since it is an inertial reference frame.	1

Q11c Criteria	Marks
Response clearly states the difference between inertial and non-inertial reference frames AND provides a thorough link between specific readings and the type of frame.	2
Response states the difference between the two types of reference frame.	1

Q12a. Criteria	Mark/s
Well structured contrast which outlines two significance differences, one of which must be that observer B sees the pendulum swing more slowly than A.	2
Outlines one significant difference	1

Q12b. Criteria	Mark/s
Correct calculation showing formula, substitution and final answer, including units (4.61 s)	2
Correct formula and substation but incorrect final answer	1

Q12c Criteria	Marks
Response shows an understanding of the principle of relativity AND Clearly relates this to a specific detail in the thought experiment (for example, the motion of the pendulum does not allow A to tell whether they are moving but does allow B to distinguish since the period is different to the expected value determined from Newtonian mechanics)	3
Response shows an understanding of the principle of relativity AND Establishes a general link between the thought experiment and the principle.	2
Response defines the principle of relativity OR Provides a thorough explanation of how the experiment demonstrates time dilation.	1

Q13a Criteria	Marks
Correctly joins Y to A and Z to B using lines	1

Q13b. Criteria	Mark/s
Y-axis labelled with quantity and units, points plotted correctly and a good straight line of best fit (y-intercept close to 0.12)	
Points plotted correctly and EITHER the y-axis is labelled with quantity and units OR there is a good straight line of best fit	1.5
Points plotted correctly OR The Y-axis is labelled with quantity and units AND there is a good straight line of best fit for the marked points.	1

Q13c(i). Criteria	Mark/s
Calculation uses the y-intercept (~ 0.12 N) on the graph and F = mg to calculate the mass (~ 0.012 kg)	2
Calculation uses the y-intercept but does not correctly calculate the mass.	1

Q13c(ii) Criteria	Marks
Correctly calculates the gradient of the line AND Clearly links the gradient to F = BIl formula AND then calculates the field strength (~ 0.86 T) OR Choose a point on the line of best fit (net force) AND subtract weight of wire (y-intercept) to determine force due to magnetic field AND then calculate B using F = BIl formula (Answer must clearly show link to the graph)	3
Calculation uses the gradient and establishes a link to the formula but final answer is incorrect.	2
Gradient correctly calculated	1

Q14. Criteria	Mark/s
Correct answer of 8.85×10^8km	3
Correct working with one error.	2
Correct substitution into the equation to find mass of star.	1

Q15. Criteria	Mark/s
Answer makes a clear judgement of the importance and describes changes in scientific thinking using a logical progression and correct scientific terminology.	4
Describes changes well but without judgement or Makes a judgement but does not clearly describe the changes in thinking.	3
A judgement and an outline of one change in thinking.	2
One change outlined.	1

Q16a. Criteria	Mark/s
Points correctly plotted, axes labelled and a curved line of best fit.	3
Two of the above	2
One of the above	1

Q16b. Criteria	Mark/s
Relationship clearly described. E.g. As the height of the table increases the range increases at a	2

decreasing rate.	
Relationship partially described.	1

Q16c. Criteria	Mark/s
All variables correct	2
Two of the three variables correct.	1

Q17. Criteria	Mark/s
One change in g-forces identified during launch, in orbit and during re-entry AND Each change related to the motion and forces experienced by the craft using correct scientific terminology	5-6
Changes analysed correctly for only two parts of the mission OR Changes correctly identified but not analysed.	3-4
Answer demonstrates some understanding of why g-forces change during a mission.	1-2