Physics

HSC Course

2008

Year 12 Half Yearly Assessment Task

Exam / Practical and Processes

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 I.D. number on each answer sheet

Teachers: Mr Coombes, Mr Robson, Mr Pitt

Task Weighting: 30 %

1. Outline the consequences of a spacecraft re-entering the Earth's atmosphere at the wrong angle. 2M

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2. Calculate the g force on an astronaut as a rocket takes off from the Earth's surface if the acceleration of the rocket is 4.9 m s^{-2}. 2M

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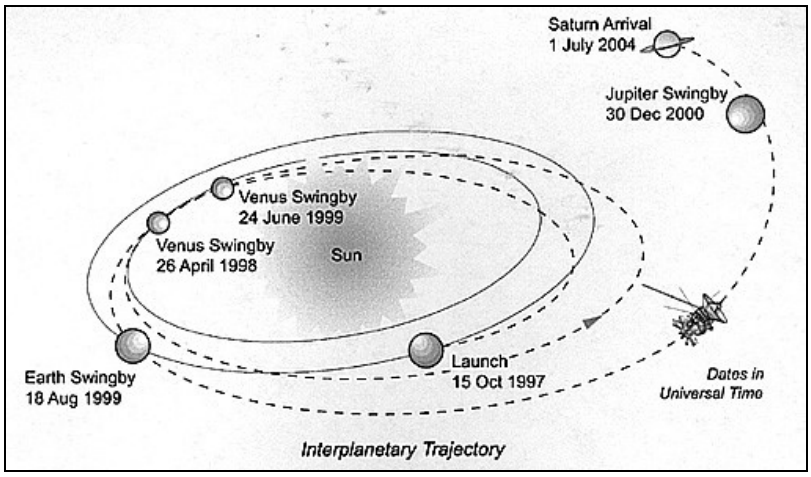
3. On October 15, 1997, the Cassini-Huygens spacecraft was launched from Cape Canaveral Air Force Base. Its mission was to travel to Saturn and perform a detailed study of the planet and its moons.

   (a) The diagram below shows the trajectory of the spacecraft. The two flybys of Venus, one past the Earth and one past Jupiter added 2 billion kilometres to the overall distance required to travel directly to Saturn.



   Justify the use of such a complex trajectory 2M

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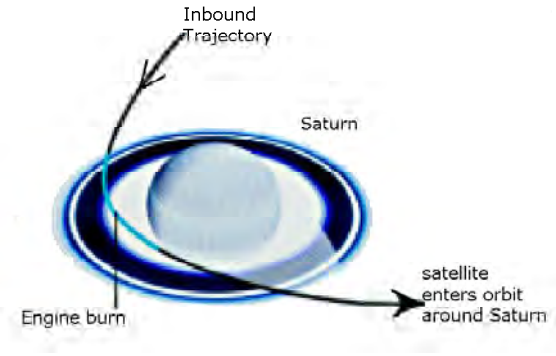
(b) The diagram below shows the trajectory of Cassini-Huygens as it approached Saturn. At the crucial point indicated (Engine burn), the spacecraft was programmed to fire its main engine to slow its speed and enter an orbit around Saturn.



Assess the importance of Newton's Universal Law of Gravitation in determining the length of the engine burn. 2M

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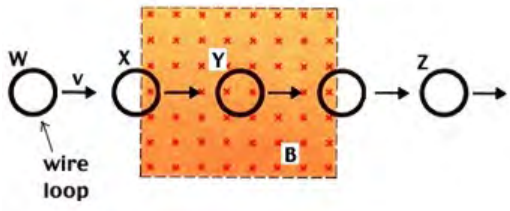
4. A wire loop is moved in a magnetic field, passing through the points W, X, Y Z, as shown below.



(a) Identify any point/s at which the movement of the loop would result in the generation of a potential difference.

..... 1M

(b) Use Faraday's law to explain why there was a potential difference in the loop at the point/s indicated in (a)

..... 2M

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5. The orbital velocity of a satellite around the central body is given by the expression

$$v = \sqrt{\frac{GM}{r}}$$

where M is the mass of the parent body and r is the straight-line distance between their centres. The table below contains data about Mercury, the planet in the solar system that is closest to the Sun.

Mass	0.05527 M_E
Equatorial Radius	0.3826 R_E
Rotational Inclination	0.1°
Surface Temperature	-170°C (side facing away from Sun) to 430°C (side facing Sun)
Atmosphere	Trace
Orbital Period	87.969257 days

Note: M_E = mass of the Earth

R_E = radius of the Earth

(a) Calculate orbital velocity of Mercury. 2M

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(b) Compare the weight of a 10 kg mass on the surface of Mercury with the weight of same mass on the surface of the Earth. 2M

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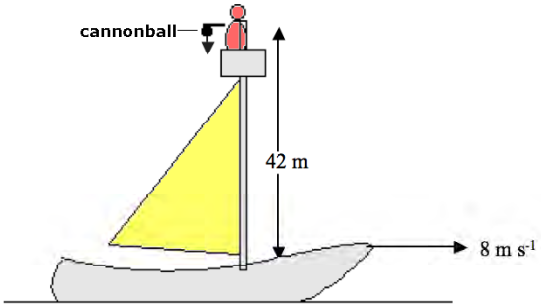
6. The diagram below shows a tall ship moving with a velocity of 8 m s^{-1} to the east. A cannonball is held 42 metres above the deck by a crew member. A person watching from the shore waves to the crew member who then drops the cannonball.




Person on shore

(a) On the diagram, clearly mark the position on the deck the cannonball will hit. 1M

(b) Calculate the velocity of the cannonball just before it hits the deck relative to the person on the shore. 3M

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(c) The ship is equipped with an engine powered by a new form of energy, the infinite improbability drive. The engine allows the ship to **instantaneously** reach any speed up to the speed of light. The ship's captain turns on the engine, causing the ship to travel at a velocity of 0.8c. The crew member then drops a second cannonball.

(i) Calculate the time taken for the cannonball to reach the deck as measured by the person on the shore. 2M

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(ii) Special relativity theory predicts that distances are contracted in the direction of motion. What is the horizontal distance moved by the cannonball as measured by the crew member on the ship?
Explain your answer. 2M

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7. A student wanted to determine what factors would influence the current generated when a permanent magnet was moved near a coil of wire as shown in the diagram below.

(a) Identify another piece of equipment that would be essential to carrying out this investigation and outline how it would be used. 1M

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(b) Outline a method that a student could use to investigate the effect that the distance of the magnet from the coil had on the generated current. 2M

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(c) Identify the independent variable for the procedure described in (b) 1M

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(d) Identify two other variables that would affect the generated current. 2M

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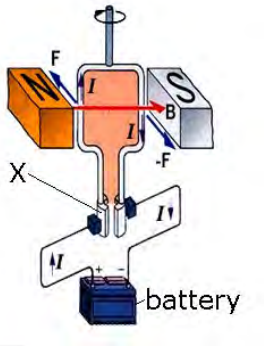
8. The following diagram represents a DC motor with a 200-turn coil 8 cm high by 5 cm wide. The magnets produce a field with a strength of 0.1 T.



(a) Identify the part labelled X. 1M

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(b) Explain the role of the part labelled X. 2M

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(c) Calculate the maximum torque of the motor if the current in the motor is 5A. 3M

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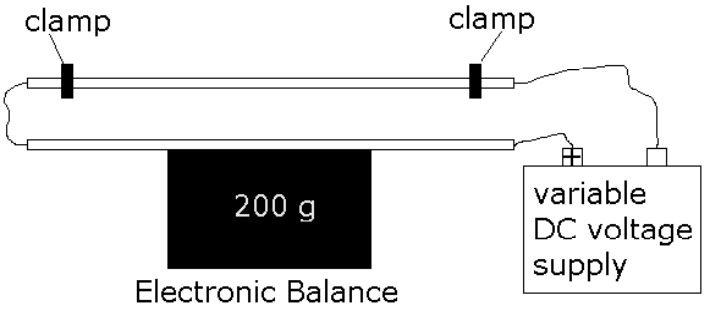
9. A student conducted an investigation to measure the force between two parallel current-carrying conductors as shown below. The mass of the wires is negligible compared with the mass of the two parallel rods.



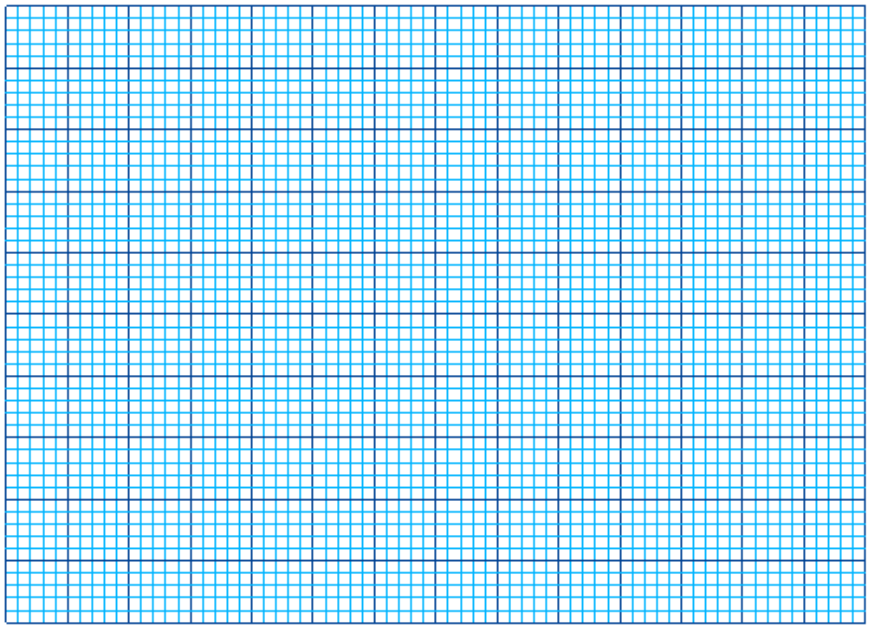
(a) Identify the direction of the force between the two wires.

..... 1M

(b) The student varied the current and recorded the corresponding mass reading shown by the electronic balance. The student converted the mass measured by the balance into a force in newtons and recorded this and other information in a table as shown below.

Force (x 10^{-5} N)	3.2	5.0	7.2	10.3	12.8	16.2
I^2 (A^2)	16	25	36	49	64	81

Construct a graph of force vs current squared on the graph paper below. 4M



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(c) Calculate the gradient of the graph and use this value to work out the distance between the wires in the experiment. 2M

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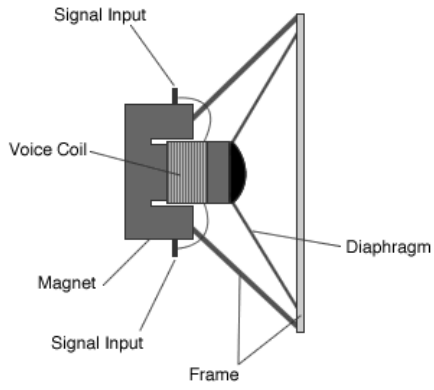
10. The diagram below illustrates the main parts of a loudspeaker



With reference to the diagram, explain the how the motor effect can be utilised by a loudspeaker to produce different sounds. 3M

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11. Assess the impact of advances in physics on the development of satellite technology. 5M

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END OF EXAM

Marking Criteria

Q1. Criteria	Mark/s
Presents two results of incorrect entry angle – too steep / excessive heat production; too shallow / bounce off atmosphere rather than re-enter	2
Presents one result	1

Q2. Criteria	Mark/s
Calculates the g (1.5 g) force taking into account both the force of gravity and the acceleration of the rocket	2
Demonstrates some understanding of the concept of g-force	1

Q3a. Criteria	Mark/s
Reasons that the slingshot effect being used at each planetary encounter increases the velocity (or momentum) of the satellite AND states the consequence – requires less fuel or takes less time overall.	2
States that the manoeuvres near the planets increase the velocity (or momentum) of the spacecraft.	1

Q3b. Criteria	Mark/s
Makes a judgement of the importance of the Universal Law of Gravitation (significant) supported by a reason (the law predicts the force of gravity, which provided the centripetal force, which depends on the velocity of the spacecraft, which was determined by the length of burn of the engines)	2
Makes a judgement supported by less comprehensive reasoning OR recognise the consequences of an incorrect length burn.	1

Q4a. Criteria	Mark/s
Identifies the point X	1

Q4b. Criteria	Mark/s
States Faraday's law (the induced voltage is proportional to the rate of flux change) and that at point X a potential difference is produced because the flux through the loop is changing.	2
States that at X, the flux through the loop is changing or correctly states Faradays Law.	1

Q5a. Criteria	Mark/s
Answer recognises the need to use Kepler's 3rd law in conjunction with the mass of the Sun to calculate the radius of orbit and substitutes the mass of the sun into the formula for orbital velocity	2
Answer recognises the need to use Kepler's 3rd law in conjunction with the mass of the sun to calculate the radius of orbit OR Substitutes the mass of the Sun into the formula for orbital velocity	1

Q5b. Criteria	Mark/s
Correct quantitative comparison Earth 98 N Mercury 37 N	2
Identifies that the weight on Mercury is less than that on the Earth	1

Q6a. Criteria	Mark/s
Marks the point clearly at the base of the mast directly below the point of release	1

Q6b. Criteria	Mark/s
Substitutes into the formula $v_y^2 = u_y^2 + 2a_y\Delta y$ to calculate the vertical velocity component (28.69 m s^{-1}) and adds this to the horizontal velocity to obtain the resultant velocity (29.8 m s^{-1} at an angle of 15.6° to the vertical)	3
Substitutes into the formula $v_y^2 = u_y^2 + 2a_y\Delta y$ to calculate the vertical velocity component (28.69 m s^{-1}) and adds this to the horizontal velocity to obtain the resultant speed of 29.8 m s^{-1}	2
Calculates the vertical velocity of the cannonball as it hits the deck.	1

Q6c(i). Criteria	Mark/s
Calculates the time taken for the cannonball to hit the deck in the F.O.R. of the ship (2.93 s) AND calculates the dilated time due to the relative movement (4.87 s)	2
Calculates the time taken to hit the deck in the F.O.R. of the ship OR uses the time dilation formula	1

Q6c(ii). Criteria	Mark/s
Explains that the horizontal distance moved in the ship's F.O.R. is zero because the initial horizontal motion of the cannonball is zero in the ship's F.O.R. and therefore the ball moves horizontally with the ship at 0.8c relative to the sea, but relative to the ship there is no horizontal motion OR Calculates the relativistic horizontal distance travelled by the ship across the water at 0.8c from the ship's F.O.R. in the non-relativistic time (from the ship's F.O.R.) of 2.93 s and provides reasoning for this interpretation.	2
	1

Q7a. Criteria	Mark/s
Identifies the required equipment (galvanometer) and states that it is used to identify the presence of an induced current OR that it has to be connected in series with the coil	1

Q7b. Criteria	Mark/s
Describes a method that reliably produces a constant movement of the magnet, which can be repeated at different distances from the coil.	2
Implies that the distance must be varied but confuses the movement of the magnet with the distance from the coil at which the movement is carried out.	1

Q8a. Criteria	Mark/s
Identifies X as the split-ring commutator	1

Q8b. Criteria	Mark/s
Reasons that after every 180° revolution, the force on the sides of the coil needs to be reversed to maintain a torque in the same direction and therefore the split-ring commutator is needed to accomplish this.	2
Provides a less clearly reasoned explanation of the role of the split-ring commutator.	1

Q8c. Criteria	Mark/s
Applies the formula Torque = NBIA to find the maximum torque (200 x 0.1 x 5 x 0.08 x 0.05 = 0.40 N m)	3
Substitutes at least one correct value into the formula for torque	2
Writes the correct formula for toque.	1

Q9a. Criteria	Mark/s
States that there is a force of repulsion between the rods.	1

Q9b. Criteria	Mark/s
Shows quantity and units on both axes AND Has an appropriate scale on both axes AND Plots the points accurately using 'x' AND Draws an appropriate line of best fit	4
Three of the above	3
Two of the above	2
One of the above	1

Q9c. Criteria	Mark/s
Calculates the correct gradient ($F/I^2=2x10^{-6}$) AND shows substitution and appropriate manipulation of $F=kI_1I_2/d$	2
Calculates the correct gradient OR shows substitution (of incorrect gradient) and appropriate manipulation of $F=kI_1I_2/d$	1

Q10. Criteria	Mark/s
Relates the current in the coil to the production of a force that moves the diaphragm and identifies this as the motor effect AND Explains that by increasing the current, a larger force is created, producing a louder sound AND Explains that changing the frequency of the AC current in the coil changes the frequency of the sound correspondingly.	3
Explains the application of the motor effect and describes one way in which different sounds can be produced	2
Identifies that the current in the coil causes the diaphragm to move.	1

Q11. Criteria	Mark/s
Identifies at least two advances in physics and clearly relates these to development of satellite technology AND makes an assessment. The answer must demonstrate an understanding of the difference between scientific advances, as opposed to technological advances. The answer must not contain irrelevant material and communication skills must be of a high standard. The answer must not contain any erroneous statements.	5
Identifies at least two advances in physics and less clearly relates at least one to development of satellite technology AND makes an assessment. The answer must not contain any erroneous statements.	4
Makes an assessment AND Identifies at least two advances in physics or technology that are implicitly (or not clearly) related to development of satellite technology OR Relates two advances in technology specifically to satellite technology	3
Identifies one advance in physics/ technology that is implicitly related to development of satellite technology AND makes an assessment OR Identifies at least two advances in physics/technology that are implicitly related to development of satellite technology	2
Identifies one advance in physics that is implicitly related to development of satellite technology	1

Sample Answers