TEACHER: ……. CANDIDATE NUMBER: ……..

2009

Trial HSC Examination

HSC Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your student number and Teacher's name at the top of each page where relevant
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper

Total marks – 100

This examination has TWO SECTIONS, Section 1 and section 2

SECTION I – Total marks 75
This section has two parts **Part A and Part B**

Part A – 15 marks
Attempt Questions 1–15

- Allow about 30 minutes for this part

Part B – 60 marks
Longer Answer Question

- Attempt Questions 16–27
- Allow about 1 hour 45 minutes for this part

SECTION II – Total marks 25
Option Question

- Allow about 45 minutes for this part
- USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS

Section I
Part A – 15 marks

Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1–15.

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1. Jupiter has a gravitational acceleration equal to 2.53 times that of Earth's gravitational attraction. An object on Jupiter weighs 253 N.

   What would be its weight on Earth?

   A 24.8 N
   B 98 N
   C 100 N
   D 980 N

2. The gravitational potential at a point P above the surface of a planet is defined as the work done per unit mass in moving a small test mass between P and another point.

   Which of the following defines this displacement?

   A From infinity to point P
   B From point P to infinity
   C From point P to the surface of the planet
   D From the surface of the planet to point P

3. A satellite is placed in orbit in a circular orbit around the Earth.

   If the orbital radius of the satellite increases, what effect will this have on its kinetic and gravitational potential energy?

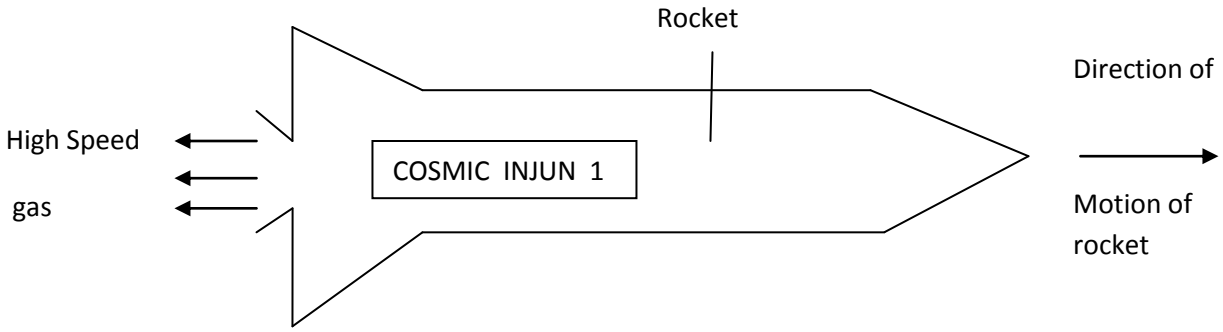
	KINETIC ENERGY	GRAVITATIONAL POTENTIAL ENERGY
A	Increase	Decrease
B	Increase	Increase
C	Decrease	Decrease
D	Decrease	Increase

4. Planets A and B orbit the same star. The orbital radius of planet B is four times that of planet A.

Which of the following is the magnitude of the orbital period for planet B, compared to the orbital period for planet A?

A 4
B 8
C 16
D 64

5. The engine of a rocket ejects gas at a high speed, as shown below.



Which statement explains why the rocket accelerates forward?

A The momentum of the gas is equal to the momentum of the rocket.
B The gas pushes on the air at the back of the rocket.
C The change in momentum of the gas gives rise to a force on the rocket.
D The ejected gas creates a region of high pressure behind the rocket.

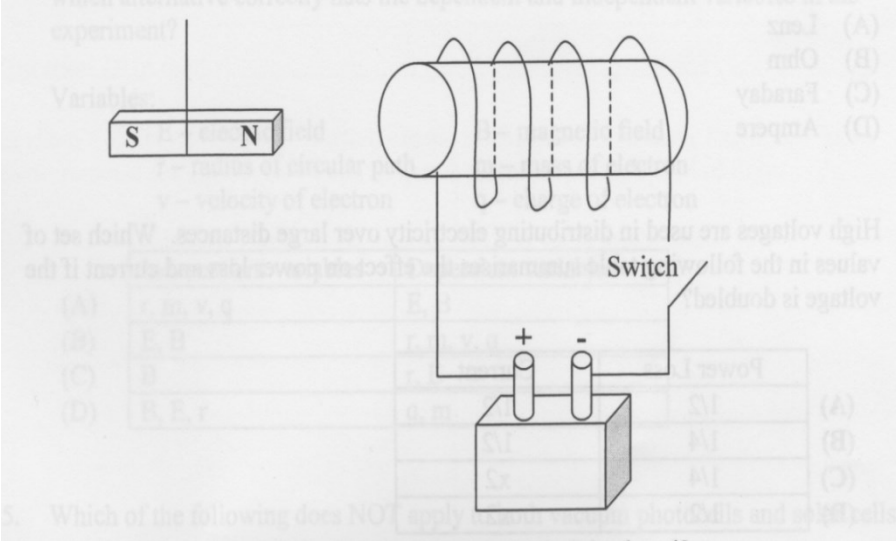
6. Which of the following describes two advantages of generating AC current, compared to DC current?

A AC is readily stored in batteries and runs AC motors, which are simpler, cheaper and more reliable than DC motors.
B When transmitted, AC can use transformers to lower the voltage and uses the entire cross-section of its conducting cable; decreasing energy loses.
C The frequency of AC can be very precisely controlled for motors which need accurate speeds (e.g. Clocks, tape recorders) and transformers can be used to change voltage.
D AC runs motors which are cheaper, simpler more reliable and uses the entire cross-section of its conducting cable; decreasing energy loses.

7. What is the reason for laminating the iron core in transformers?

A To increase the magnetic field passing through the core.
B To increase eddy currents.
C To prevent heat production.
D To reduce heating effects.

8. A bar magnet is held suspended at rest, near a fixed coil as shown below.



What will happen to the bar magnet when the switch is closed?

A It will move to the right.
B It will move to the left.
C It will remain stationary.
D It will rotate clockwise.

9. A flat metal pendulum disc is set swinging between the poles of a horseshoe magnet, so that the plane of the disc is perpendicular to the magnetic field.

Which statement explains why the disc slows down?

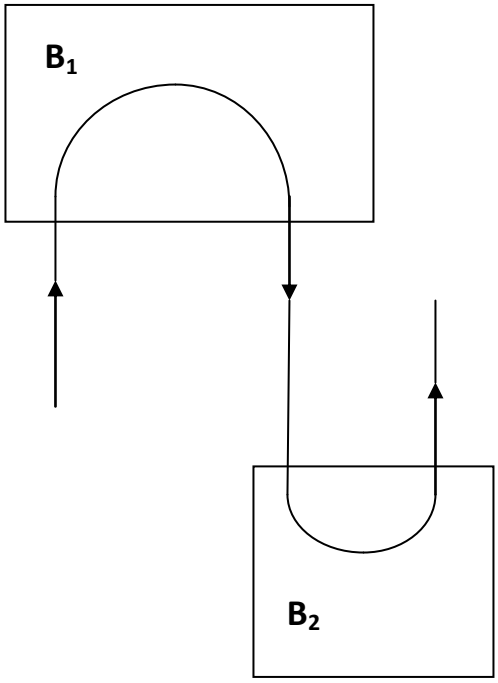
A A back emf is set up in the disc.
B The magnetic field experiences a force in the opposite direction.
C Electromagnetic braking is occurring.
D Relative motion of the conductor in the magnetic field accelerates the disc.

10. Which of the following explains why the resistance in metals increases as they are heated?

A Expansion of the metal
B Increased lattice vibration
C Pairing of electrons
D The effect of impurities

Use the following information to answer questions **11 AND 12**.

An electron moving at speed v encounters two magnetic fields, $\mathbf{B_1}$ and $\mathbf{B_2}$.
The magnetic fields are restricted to the rectangular areas shown and the electron moves in a semi-circular path through each field as shown in the following diagram.



11. What are the directions of the magnetic fields $\mathbf{B_1}$ and $\mathbf{B_2}$?

	Magnetic field B_1	**Magnetic field B_2**
A	Out of the page	Into the page
B	Out of the page	Out of the page
C	Into the page	Out of the page
D	Into the page	Into the page

12. How does the strength of the magnetic fields $\mathbf{B_1}$ and $\mathbf{B_2}$ compare?

A $\mathbf{B_2}$ is stronger than $\mathbf{B_1}$.

B $\mathbf{B_1}$ is stronger than $\mathbf{B_2}$.

C $\mathbf{B_1}$ and $\mathbf{B_2}$ are equal in strength.

D $\mathbf{B_1}$ and $\mathbf{B_2}$ cannot be compared.

13. What does a cathode ray tube containing a Maltese cross tell us about cathode rays?

A They travel in straight lines.

B They have mass.

C They have momentum.

D They have electric charge

14. What is the wavelength of a quantum of radiation carrying 3×10^{-31} kJ of energy?

A 6.6×10^{-1} m
B 6.6×10^{2} m
C 4.5×10^{5} m
D 4.5×10^{8} m

15. Which substance, which could be easily purified, was used to make the first transistors?

A Germanium

B Silicon

C p-type aluminum

D n-type carbon

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	OUTCOME	**MARK**
	Knowledge and understanding	/70
Q 22, 23	Planning and conducting investigations	/14
Q 14, 16,17,21	Scientific thinking/problem solving/communication	/16
Total		/ 100

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST answer.

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**

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PART B

TOTAL MARKS 60

Attempt ALL questions

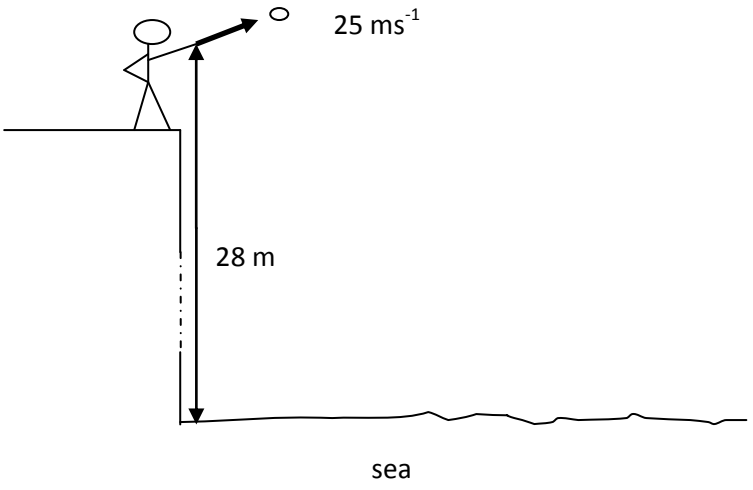
Answer each question in the space provided

Question 16

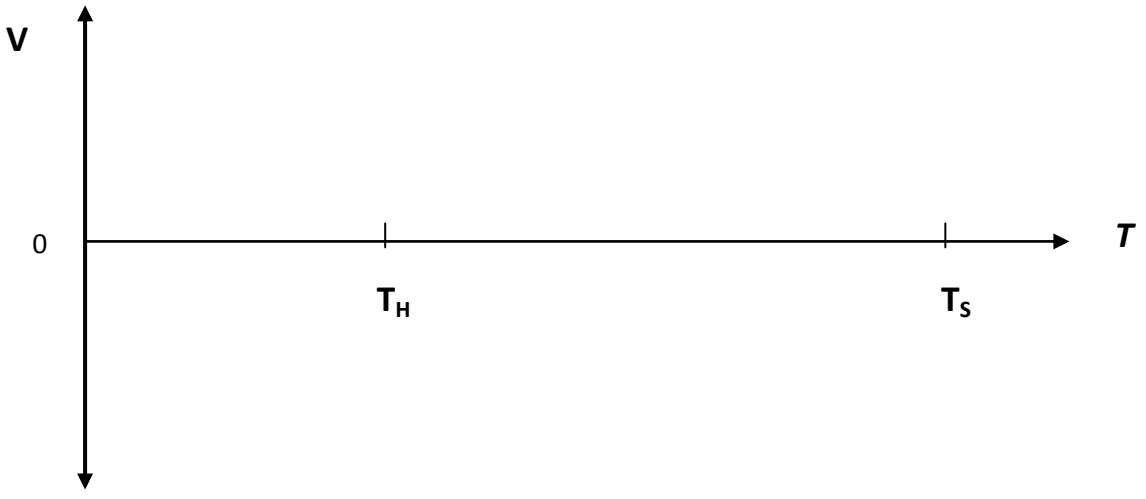
A stone is thrown from the top of a cliff at a height of 28 m above the sea. The stone is thrown at a speed of 25 ms^{-1} at an angle of 30^o above the horizontal. (Air resistance is negligible).

The maximum height reached by the stone from the point at which it is thrown is 8.0 m.

The stone leaves the cliff at time $T = 0$. It reaches its maximum height at $T = T_H$ and strikes the sea at $T = T_S$.



(a) On the axis below, sketch a graph to show the variation in the magnitude of the vertical component of the velocity of the stone, from $T = 0$ to $T = T_S$. **2**



(b) Calculate the time (*T – total, time of flight*) it will take for the stone to hit the water. **2**

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(c) Explain why the section of graph in (a) above, $\mathbf{T_H}$ to $\mathbf{T_S}$, is longer than the section of graph, vertical axis to $\mathbf{T_H}$. **1**

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Question 17

An unmanned multi-stage rocket, carrying a weather satellite, is launched towards the planet Venus. At various altitudes above Earth, first the fuel tanks and then the booster rockets fall back to Earth and the satellite continues to Venus.

(a) Describe the changing acceleration of the rocket after its launch. **2**

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Venus is sometimes called "Earth's sister' because of its similar size and gravity. It has a mass of 4.87×10^{24} kg and an average radius of 6060 km. As the 150 kg satellite slowly approaches the surface of Venus it is influenced by Venus's gravitational field.

(b) Calculate the *gravitational field strength* on the surface of Venus. **2**

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Question 18

(a) Explain the concept of *g-force.* **2**

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(b) Identify ONE strategy used during rocket take off to minimise the effect of the g-force acting on astronauts. **1**

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Question 19

(a) An underground transformer near a house can decrease voltages from a dangerous 12kV to a domestic 240V level.

Calculate the primary-to-secondary turns ratio for this transformer. **2**

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(b) Discuss the impact of the development of transformers on society. **3**

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Question 20

Outline how the electrical transmission lines within the power grid are: **6**

- Provided with very high voltages
- Insulated from supporting pylons
- Protected from lightning strikes

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Question 21

a. In relation to superconductors, define the term *critical temperature*, T_C. **1**

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b. Identify 3 properties of superconductors below their critical temperature. **3**

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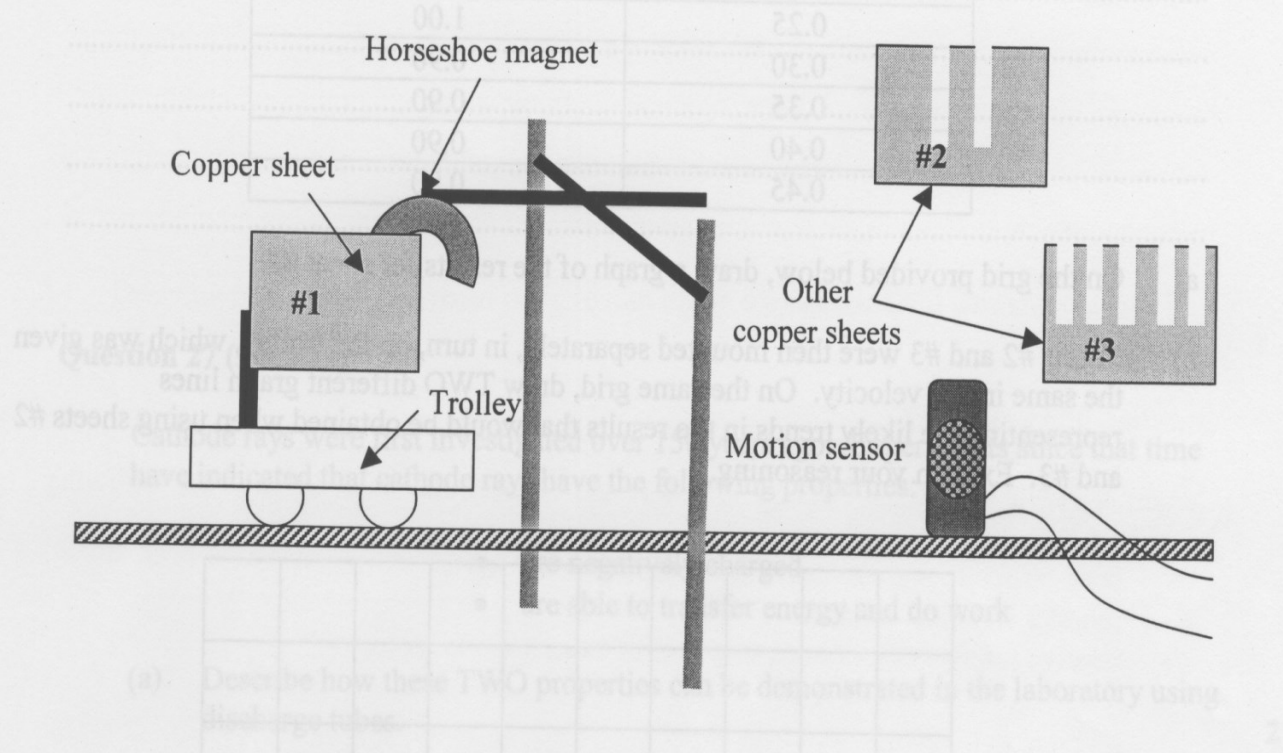
Question 22

In an experiment on eddy currents, some physics students used the following apparatus



They used the sensor to record the velocity of the trolley before, during and after it passed through the horseshoe magnet. All copper sheets were of equal mass.

A table of results obtained for sheet #1 is shown below.

Results for Sheet # 1

Time (s)	Velocity of Trolley (m s^{-1})
0.00	1.30
0.05	1.30
0.10	1.30
0.15	1.20
0.20	1.10
0.25	1.00
0.30	0.90
0.35	0.90
0.40	0.90
0.45	0.90

(a) On the grid provided below, draw a graph of the results for sheet #1. **4**

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(b) Sheets #2 and #3 were then mounted separately, in turn, on the trolley, which was given the same initial velocity. On the same grid, draw TWO different graph lines representing the likely trends in the results that would be obtained when using sheets #2 and #3. **Clearly indicate the graph lines for sheets #2 and #3**. Explain your reasoning. **4**

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Question 23

During the course you carried out a first hand investigation to demonstrate the production of an alternating current.

(a) Describe how you carried out this investigation. Include a diagram as part of your description. **4**

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(b) Explain how you showed that you had produced an **<u>alternating</u>** current. **2**

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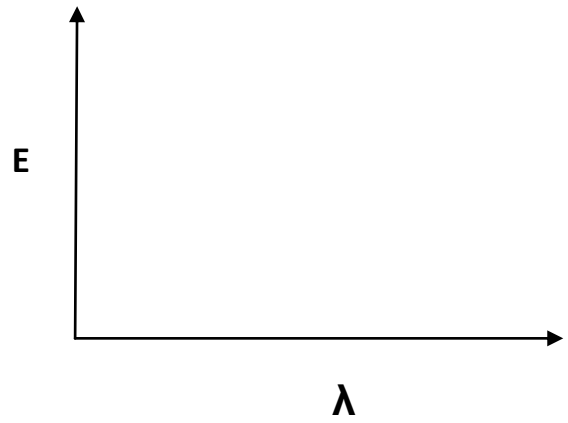
Question 24

During a student investigation of the photoelectric effect it was observed that when a medium-intensity green light of wavelength 515 nm was shone onto a photocell a small current was produced.

However, no current was detected when using yellow light of the same intensity.

(a) On the axis below, sketch the relationship between energy, **E** and wavelength, **λ** of a photon. **1**



(b) Calculate the energy (in electron-volts) of this green light. **2**

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Question 24 (continued)

(c) Consider the following statements by two students during the investigation:

- **Student 1**
  "If high-intensity red light was used instead of the yellow light then a current would be produced."

- **Student 2**

  'If low-intensity violet light was used instead of the green light then no current would be produced."

Comment on each of these statements made by the students. **4**

Student 1

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Student 2

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Question 25

An ultraviolet photon of wavelength 140 nm strikes the surface of a metal with work function of 1.26 eV. What is the maximum energy of the emitted electron? **3**

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Question 26

Describe why doping of pure semiconductor materials is necessary, and how it changes the electrical properties of the material, in terms of the negative charge carriers and positive holes. Include examples of materials used for semiconductors and materials used in the doping process. **5**

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Question 27

Discuss reasons why solid state devices replaced thermionic devices. **4**

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Section II

Option – Quanta to Quarks

USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS

Question 31

(a) (i) Discuss, using a diagram, the structure of the Rutherford model of the atom, explaining how this model differed from the model preceding it. **4**

(ii) State ONE change to the Rutherford model of the atom made by Bohr. **1**

(iii) Bohr supported his model of the atom with 4 postulates.

Explain how one of these postulates supported his model of the atom. **3**

(b) Determine the wavelength of the light emitted when a hydrogen atom has an electron transition from the n= 6 to the n = 2 energy level according to the Bohr model. **3**

(c) The Bohr-Rutherford model of the atom was unable to explain a number of experimental observations and consequently physicists sought to improve on this model.

Assess the contributions made by Heisenberg and Pauli to the development of atomic theory. **4**

(d) Describe one application of radioisotopes. **2**

(e) (i) When you visit ANSTO for information about their new nuclear reactor, the guide persons explain that the reactor uses enriched uranium.

Explain the meaning of the term ‘enriched uranium’. **1**

(ii) Why does the uranium, (U-238), need to be enriched? **1**

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(f) For the theoretical reaction below, calculate the amount of energy released or absorbed when a neutron reacts with a uranium-235 atom to produce the isotopes of barium and krypton plus 2 neutrons, as shown below. **4**

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{144}_{56}Ba + {}^{90}_{36}Kr + 2\,{}^{1}_{0}n$$

Given:

Particle	Mass (u)
$^{235}_{92}U$	235.043 923
$^{144}_{56}Ba$	143.922 941
$^{90}_{36}Kr$	89.919 528

(g) In the new nuclear reactor at ANSTO at Lucas Heights, the tour guides state that the reactor contains heavy water.

Explain two of the purposes for the use of heavy water in the ANSTO nuclear reactor. **2**