Government of **Western Australia**
Curriculum Council

WACE
Western Australian Certificate of Education

Western Australian Certificate of Education
Examination, 2010

Question/Answer Booklet

PHYSICS

Stage 2

Please place your student identification label in this box

Student Number: In figures | | | | | | | | |

In words _____

_____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Formulae and Constants Sheet

To be provided by the candidate

Standard items: pens, pencils, eraser, correction fluid/tape, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the Curriculum Council for this course

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

2011/4188
Web version of 2010/30269

Ref: 10-108

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Short answers	17	17	70	64	40
Section Two: Problem-solving	6	6	90	80	50
Section Three: Comprehension	1	1	20	16	10
				Total	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2010.* Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer Booklet.

3. Working or reasoning should be shown clearly when calculating or estimating answers.

4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

See next page

Section One: Short answers **40% (64 Marks)**

This section has **seventeen (17)** questions. Answer **all** questions. Write your answers in the space provided.

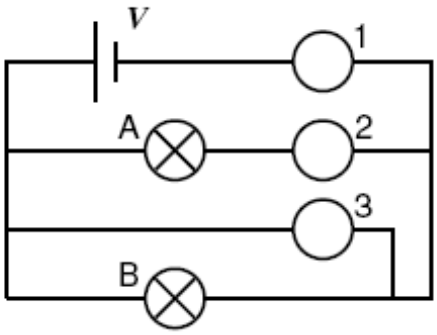
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 70 minutes

Question 1 **(3 marks)**

A lighting circuit diagram includes a cell and two globes A and B as shown below.



(a) Indicate in circle 1 the direction of the conventional current through this point. (1 mark)

(b) In circles 2 and 3, place a V or A to indicate if a voltmeter or ammeter would be most appropriate to complete the circuit diagram. (2 marks)

Question 2 **(3 marks)**

There are at least 37 isotopes of gold, but only one is stable. The stable isotope of gold is written as $^{197}_{79}\mathrm{Au}$.

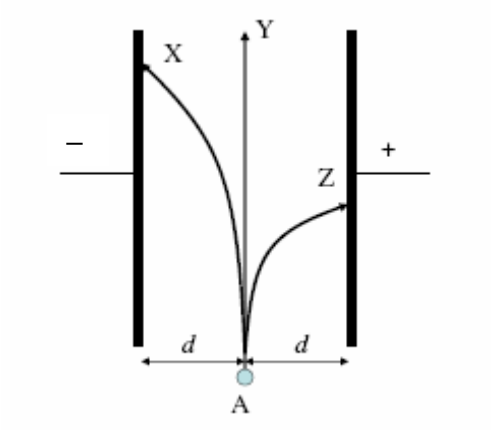
(a) Determine how many neutrons the stable isotope of gold contains. (1 mark)

(b) Compare what occurs to an isotope that is not 'stable' with an isotope that is 'stable'. (2 marks)

See next page

Question 3 **(1 mark)**

There is a uniform electric field between two charged parallel plates as shown below. Three particles (α, β and γ) are ejected from A into the field parallel with the plates with similar velocities. Their paths (X, Y and Z) are shown on the diagram below.



The particles and their paths are best named as

A	X = γ	Y = β and	Z = α
B	X = α	Y = β and	Z = γ
C	X = β	Y = α and	Z = γ
D	X = α	Y = γ and	Z = β
E	X = γ	Y = α and	Z = β
F	X = β	Y = γ and	Z = α

Answer: _____

Question 4 **(3 marks)**

Airships, blimps, scientific balloons and party balloons are usually inflated with helium. However, someone thinks that helium, $^{4}_{2}\mathrm{He}$, being a product of radioactive decay, is unsafe. Explain, with reference to the ionisation of atoms, the relative safety of helium.

_____

_____

_____

_____

_____

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See next page

Question 5 **(4 marks)**

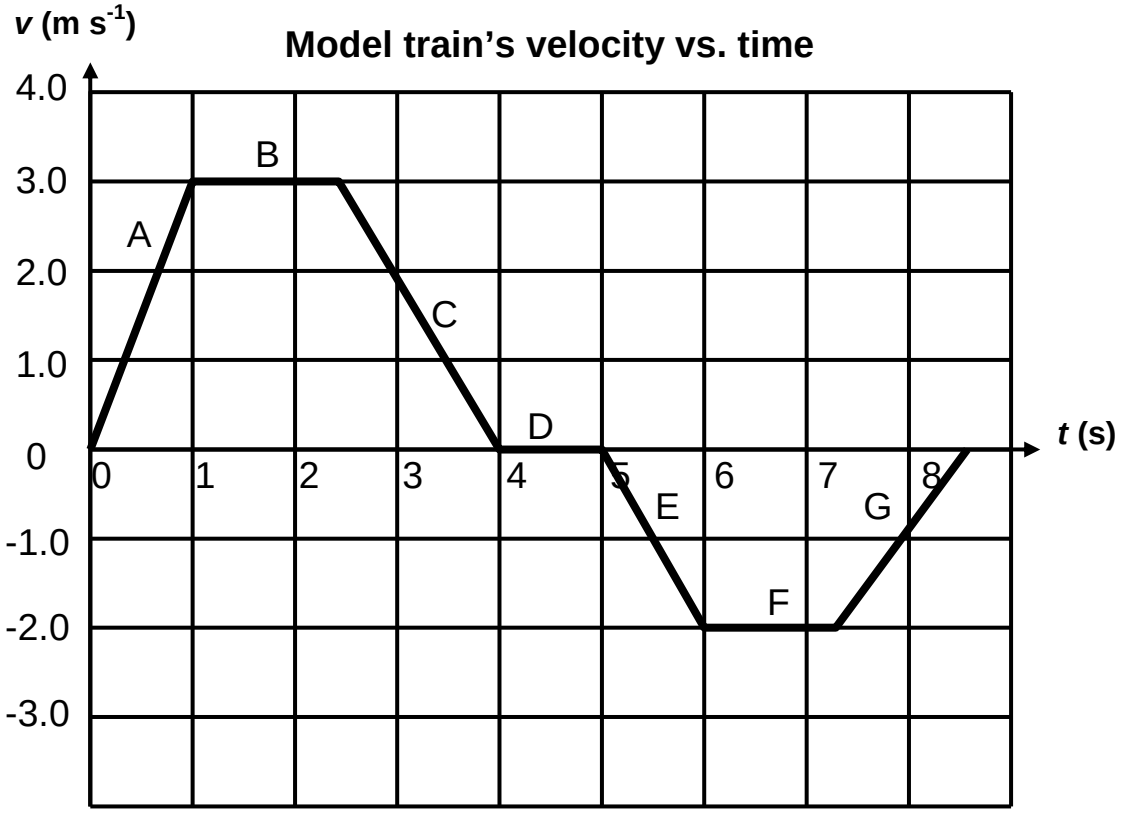
(a) Sketch a diagram of a circuit that has a total resistance of 15.0 Ω, consisting of only 10.0 Ω resistors. Include a power supply and a switch in your circuit. (2 marks)

(b) Calculate the potential difference required to provide a total current of 1.50 A through the circuit. (2 marks)

See next page

Question 6 **(3 marks)**

A model electric train's velocity is graphed as it moves along a section of straight track.



(a) During which section of the graph is the acceleration the greatest? (1 mark)

Circle the correct answer: A B C D E F G

(b) During which section is the train not moving? (1 mark)

Circle the correct answer: A B C D E F G

(c) At the end of the journey, the train's displacement relative to its starting position will be: (1 mark)

Circle the correct answer: Positive Zero Negative

See next page

Question 7 **(4 marks)**

A hair dryer was used for 10.0 minutes to dry a person's wet hair. When the hair dryer was connected to a 240 V supply, it drew a current of 4.80 A.

(a) How much charge passed through the coil of the hair dryer in this time? (2 marks)

(b) Calculate the power of the hair dryer. (2 marks)

Question 8 **(4 marks)**

A 25.0 gram cube of ice, initially at 0.00°C, fell on a bench and melted.

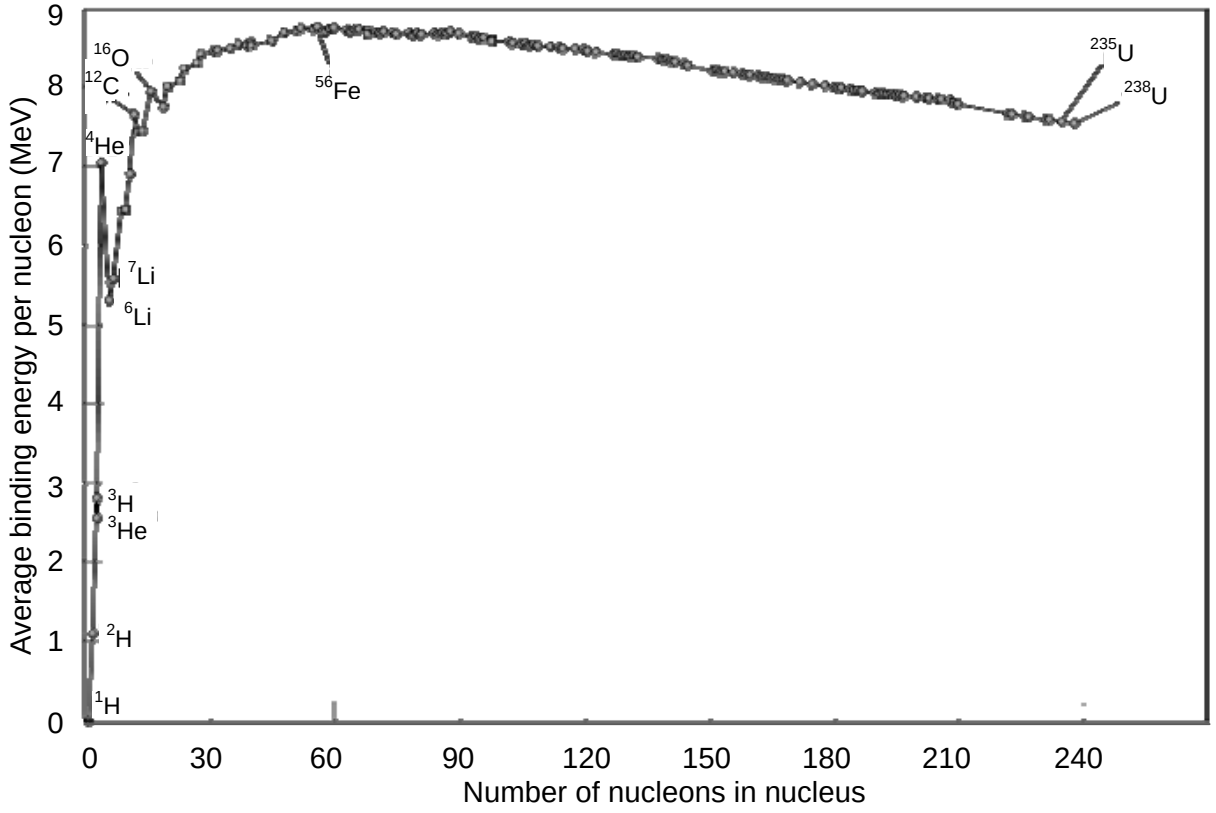
(a) Calculate the energy required to change the ice cube from a solid to a liquid. (2 marks)

(b) Describe briefly what happened to the particles of the bench that were in contact with the ice cube as it melted. (2 marks)

See next page

Question 9 **(3 marks)**

Below is a binding energy curve for common isotopes.



(a) Which element listed is considered to be the most stable? (1 mark)

Circle the correct answer: ^{3}He ^{4}He ^{56}Fe ^{235}U

(b) Explain your choice, using information from the graph. (2 marks)

See next page

Question 10 **(3 marks)**

Uranium-235, $^{235}_{92}\mathrm{U}$, has a half life of 7.35×10^5 years and uranium-238, $^{238}_{92}\mathrm{U}$, has a half life of 4.5×10^6 years. Compare the two isotopes of uranium, given that they both have the same number of atoms.

(a) Which sample would have the greater weight? (1 mark)

Circle the correct answer: uranium-235 equal uranium-238

(b) Which sample would have the greater number of decays per second? (1 mark)

Circle the correct answer: uranium-235 equal uranium-238

(c) The isotope uranium-238, $^{238}_{92}\mathrm{U}$, will decay into an isotope of thorium-234, $^{234}_{90}\mathrm{Th}$. Which other particle is produced by this decay? (1 mark)

Circle the correct answer: $^{4}_{2}\alpha$ $^{0}_{1}\beta$ $^{0}_{-1}\beta$

Question 11 **(4 marks)**

One of the original theories of heat involved the concept of heat being contained in an object and, when the object was cut, the heat contained in the object being released. Drilling holes in cannons challenged this theory. As the drill bit becomes duller, the cannon and drill bit get hotter and it takes longer to drill a hole to the right depth.

(a) Explain why the cannon gets hotter when the drill becomes less sharp. (2 marks)

(b) Water is used when drilling holes through rock during mining operations to keep the drill bit from overheating. If 0.150 litres of the cooling water (initially at 100°C) was evaporated, how much energy was removed from the drill? (2 marks)

See next page

Question 12 **(4 marks)**

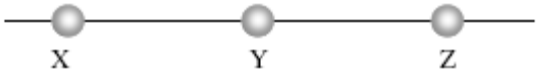
E, F, G and H are very small glass balls. F, G and H are charged, but it is not known what type of charge they possess. In order to test the types of charge on these balls, we charge glass ball E by rubbing it with silk. This removes electrons from the glass ball.

(a) Once E has been charged, we find E attracts F and F repels G, but G attracts H. Which are two negatively charged balls? (1 mark)

A E and F
B F and H
C E and G
D F and G

Correct answer: _____

Three balls are selected from these four balls and renamed 'X', 'Y' and 'Z'. These three balls are placed in a straight line with a reasonable distance between them. Balls X and Z are fixed in place and Y is kept in equilibrium through electrostatic forces as shown below.



(b) For Y to stay in a stable position, the charges on the spheres need to be (1 mark)

A X is positive, Y is positive and Z is negative.
B X is positive, Y is negative and Z is positive.
C X is negative, Y is positive and Z is positive.
D X is negative, Y is negative and Z is positive.

Correct answer: _____

(c) An atom has two electrons removed from it. Which statement is correct? (2 marks)

A The atom becomes a different isotope.
B The atom becomes more positive.
C The atom becomes more negative.
D The atom is unchanged.

Correct answer: _____

Explain your choice.

_____

_____

_____

Question 13 **(6 marks)**

Thorium, $^{228}_{90}\mathrm{Th}$, is a radioactive isotope that undergoes decay via a series of steps to eventually reach bismuth, $^{212}_{83}\mathrm{Bi}$, a stable isotope. Each of these steps involves the release of ionising radiation.

(a) Determine how many alpha $^{4}_{2}\alpha$ and beta $^{0}_{-1}\beta$ particles in total are released in the transitions between these two isotopes. Show your working. (3 marks)

Number of alpha particles: _____ Number of beta particles: _____

(b) In an experiment to study radioactive decay, a 100 gram sample of thorium is placed in a sealed container to decay. After a suitable length of time, the thorium atoms have become mostly bismuth atoms. The container is regularly analysed over this time. Describe how the number of decays per second and the weight of the container change during this time. (3 marks)

_____

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Question 14 **(4 marks)**

A major source of energy in the Universe is a product of fusion reactions. These include many steps and are very complex. One reaction involves the combination of four protons and two electrons to form a helium nucleus, two neutrinos and six photons. Neutrinos and photons have no mass. The overall equation for this reaction can be written as

$$4\,{}_{1}^{1}\mathrm{H} + 2\mathrm{e}^{-} \rightarrow {}_{2}^{4}\mathrm{He} + 2\nu + 6\gamma$$

(a) Use the information listed in the table below to calculate the energy (in MeV) released from this process due to the mass defect. (2 marks)

Particle	Proton	Helium	Electron	Neutron
Mass (u)	1.007276	4.002602	0.000549	1.008665

(b) The major component of the Sun is ${}_{1}^{1}\mathrm{H}$, which enables fusion reactions to take place. Explain why this is important to us on Earth. (2 marks)

See next page

Question 15 **(5 marks)**

The average power supplied by an adult's heart for circulating blood is about 1.5 watts.

(a) How much work does an adult human heart do in one hour? (2 marks)

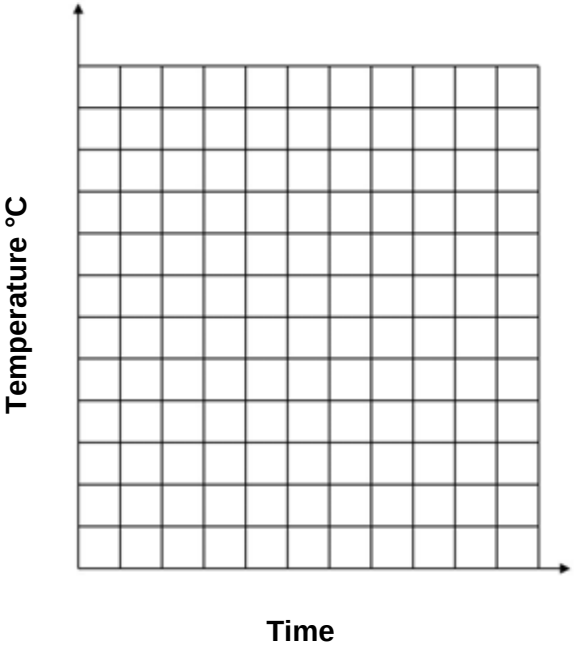
(b) If this amount of work is used to lift a 50.0 kg object with a constant velocity, what is the theoretical maximum height to which the object can be raised? Use an energy value of 5000 J if you were unable to determine an answer for (a). (3 marks)

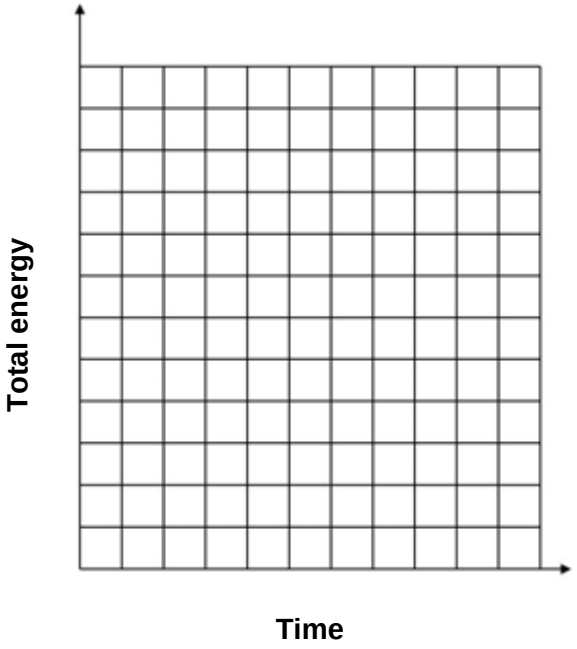
See next page

Question 16 **(5 marks)**

An experiment is conducted in which 500 mL of ice at 0.00°C is placed into a beaker. An electric heater with a constant power output is used to heat the beaker.

(a) Sketch graphs on the axes below showing the temperature change over time, and the energy input over time, as the ice is melted and then brought to a boil. Label melting point and boiling point on the temperature graph. (3 marks)



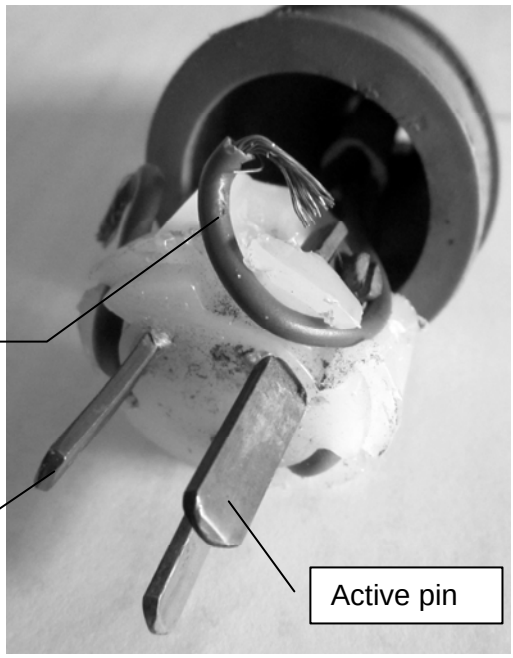


(b) The experiment was repeated with a small fan placed on the top of the beaker. Explain how this would affect the melting and boiling results. (2 marks)

See next page

Question 17 **(5 marks)**

A person complained to an electrician about getting a shock when changing a light globe in a lamp even though the lamp had been switched off. The electrician examined the plug and found the active and neutral wires had been swapped around in the plug and explained that appliance switches are only designed to operate on the active wire.



(a) Describe the conditions that led to the person receiving the shock. (3 marks)

(b) Name a safety feature in modern houses that limits the risk of receiving an electric shock, and describe how it works. (2 marks)

Name: _____

Description: _____

End of Section One

See next page

Section Two: Problem-solving **50% (80 Marks)**

This section has **six (6)** questions. Answer **all** questions. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

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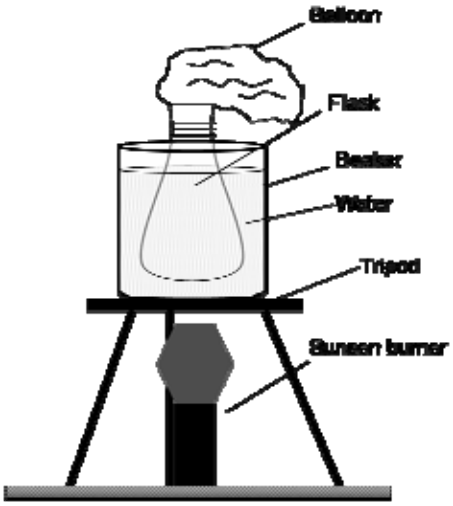
Suggested working time: 90 minutes

Question 18 **(12 marks)**

An empty, clean and clear flask was put into a refrigerator for one hour. The flask was then taken from the refrigerator and a balloon was placed on the open end of the flask. The flask was then placed into a beaker with hot water, as shown below.



(a) Explain what was seen to happen to the balloon as the gas in the flask absorbed the thermal energy from the hot water. (2 marks)

(b) Indicate the form of energy transfer (conduction, convection or radiation) that occurred in the following situations: (3 marks)

(i) between the Bunsen burner flames and the tripod: _____

(ii) between the tripod and the beaker: _____

(iii) between the water and the flask: _____

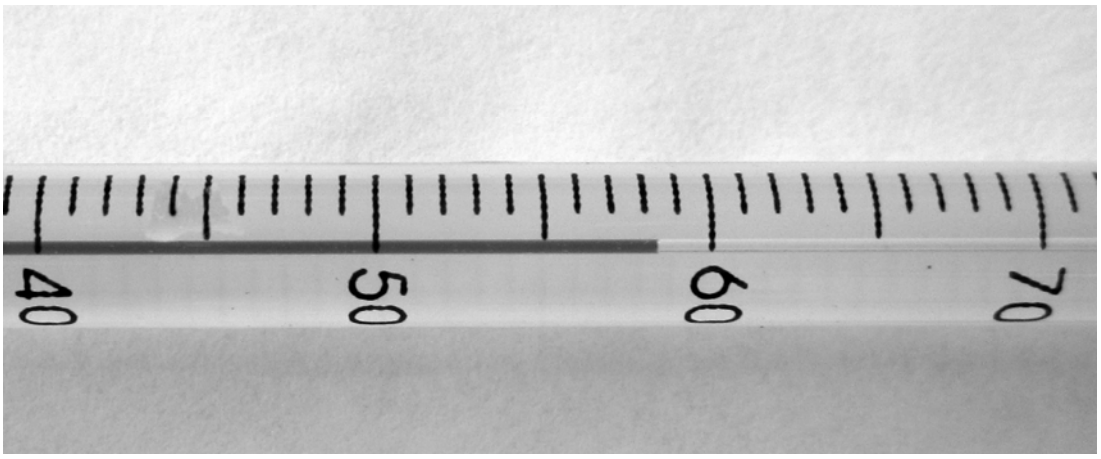
See next page

(c) Consider the following statements describing what happens when the water and the gas in the balloon are at the same temperature. (2 marks)

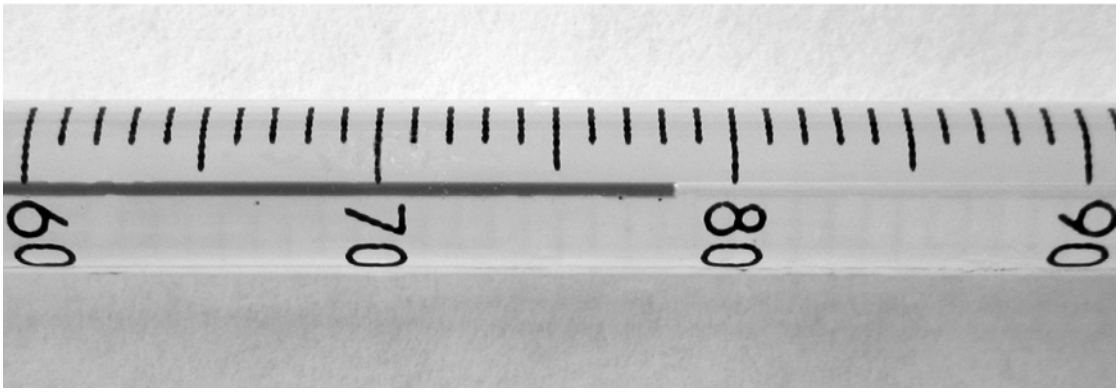
A The water has more internal energy overall than the gas.
B The average energy of the water's molecules is greater than the average energy of the gas molecules.
C The heat will flow from the water to the gas.

Which of the above statements is or are true? _____

(d) A thermometer was used to measure the temperature of the water in degrees Celsius at two different times, labelled 'before' and 'after'. Determine the readings, then calculate the temperature change and the absolute uncertainty of the temperature difference. Use significant figures appropriately. (5 marks)



Temperature before: _____



Temperature after: _____

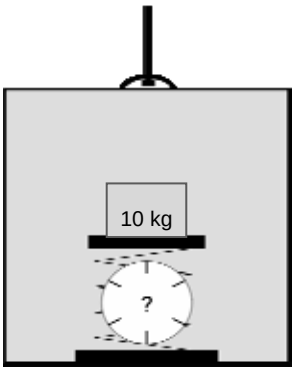
Temperature difference: _____

Absolute uncertainty: _____

Question 19 **(11 marks)**

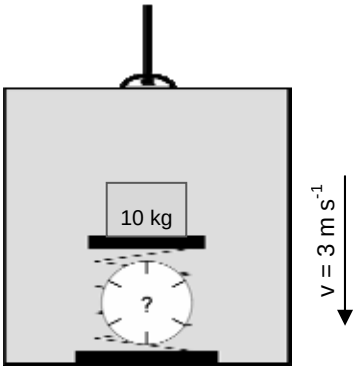
An experiment is conducted in which an object with a mass of 10 kg is placed on a scale sitting on the floor of an elevator, as shown in the diagrams below. Assuming the local gravity is 9.8 m s^{-2}, estimate the reading of the scale in newtons when

(a) (i) the elevator is stationary; (1 mark)



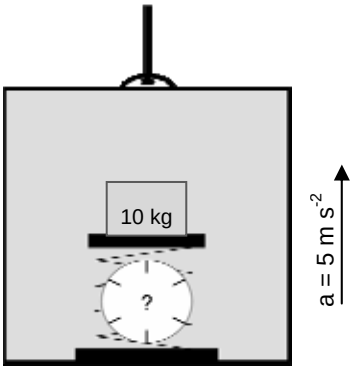
Answer: _____

(ii) the elevator moves down at a constant velocity; (2 marks)



Answer: _____

(iii) the elevator accelerates up at a constant acceleration. (2 marks)

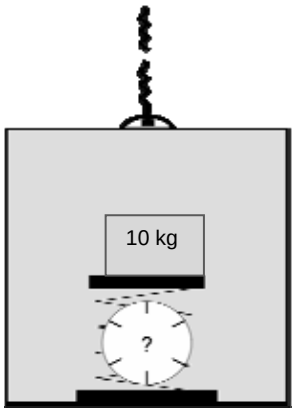


Answer: _____

See next page

(b) During the experiment, while the elevator was accelerating up at a constant acceleration, the cable suddenly broke and the elevator began to fall freely.

(i) Determine the new scale reading. (2 marks)



Answer: _____

(ii) The elevator was moving upward at 5.30 m s^{-1} when the cable broke. It took 1.50 s to reach the ground. How high above the ground was the elevator when the cable broke? (2 marks)

(c) Modern elevators are equipped with speed governors that apply a braking friction when a maximum speed is exceeded. These brakes bring the elevator slowly to a stop. Explain why it is desirable for the elevator to be brought to a stop slowly rather than quickly. (2 marks)

_____

_____

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_____

See next page

Question 20 **(15 marks)**

A set of 16 party lights is purchased to decorate the back patio of a house for a birthday party. When all lights are functional they draw a current of 3.20 A from the 24.0 V transformer supplied. When one globe is removed, half of the globes go out, leaving the other half working. When one of these working globes is removed, the remaining seven working globes go out.

(a) Explain why the other seven globes went out when the second globe was removed, but not when the first globe was removed. (2 marks)

(b) Draw a simple circuit diagram to show how to wire all 16 globes to the 24 V power supply. (2 marks)

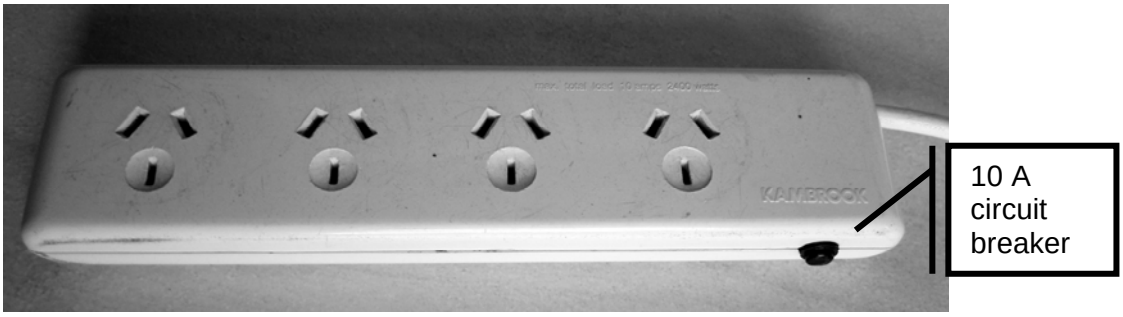
(c) Determine the voltage across each globe. (2 marks)

See next page

(d) Determine the current through each globe. (2 marks)

(e) Calculate the power consumed by each globe. (2 marks)

(f) If you wanted to have more than one set of lights, you might use a power board similar to the one below. This power board has a 10.0 A circuit breaker built into it, as shown in the picture.



(i) How many sets of these party lights can operate from the power board before the circuit breaker is overloaded? (2 marks)

(ii) Explain the purpose of the circuit breaker. (2 marks)

(iii) Is the circuit breaker connected to the power circuit in series or in parallel? (1 mark)

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See next page

Question 21 **(13 marks)**

When a uranium-235 nucleus absorbs a neutron, many fission products are possible. One such reaction in a nuclear power plant results in the formation of lanthanum-148 (La), bromine-85 (Br) and neutrons.

(a) Write an equation for this reaction and identify clearly the number of neutrons produced. (2 marks)

(b) How do the neutrons released in this reaction differ from those that took part in the initial fission reaction? (1 mark)

Many of the products of such fission reactions are themselves radioactive but are not able to be used as an energy source for the reactor. This waste is taken from the site and stored permanently in a safe and secure place where its activity can be monitored. The measured activity from some radioactive waste when it was first removed from the reactor was 128 Bq above the background count of 2.00 Bq.

(c) Explain what is meant by the term 'background count' and give an example of a source that contributes to it.

(2 marks)

Explanation _____

_____

Example _____

(d) If the average half-life of the waste in part (c) is taken as being 7.00×10^5 years, calculate how long it will take for its activity to reach the same level as the background count. (4 marks)

See next page

The safety device worn by an 85.0 kg nuclear power plant worker indicated that they absorbed 24.0 J of energy overall when exposed to this waste fuel during one work period.

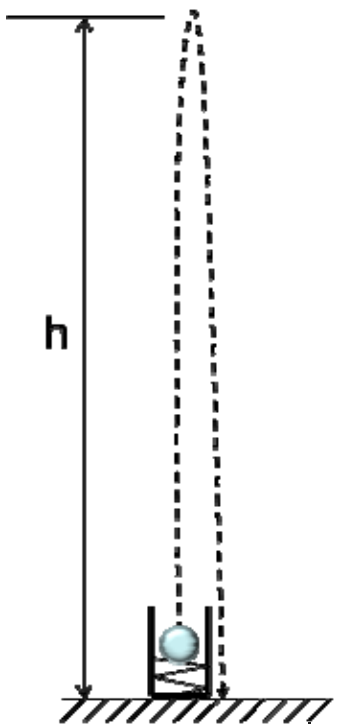
(e) Calculate the dose they absorbed. (2 marks)

(f) Determine the dose equivalent for the worker, assuming all of the absorbed radiation is from gamma rays. (2 marks)

See next page

Question 22 **(16 marks)**

A vertical cylinder contains a spring. A ball sits on the top of the spring, as shown in the diagram. The length of the cylinder is 0.500 m and the uncompressed length of the spring is 0.400 m. The spring is then squashed down to 0.100 m and released. The kinetic energy of the ball (m = 0.500 kg) when it leaves the spring is 100 J.



(a) Calculate the average force that the spring exerts on the ball to launch it. (3 marks)

(b) Calculate the velocity of the object when it leaves the top of the spring. (2 marks)

(c) Determine the height, h, the object reaches above the ground. (4 marks)

See next page

(d) Determine the acceleration of the object at the highest point. (1 mark)

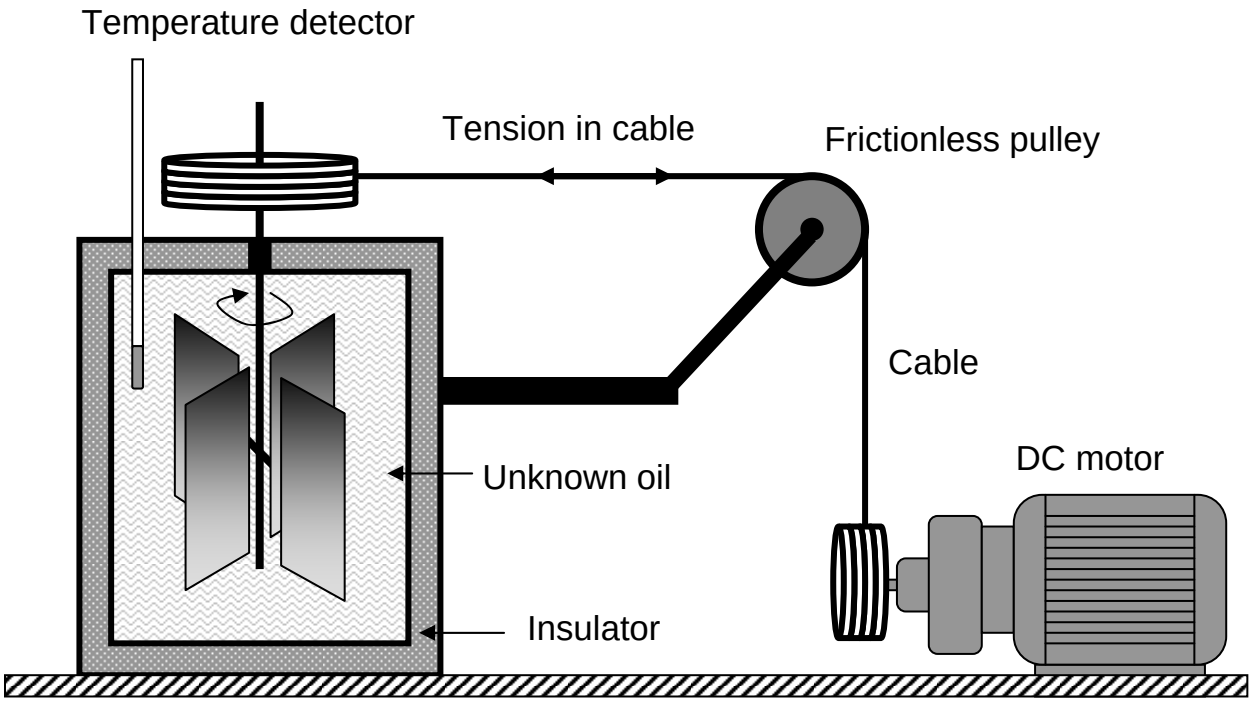
(e) Determine the final velocity of the object, the instant before it hits the ground. (3 marks)

(f) Calculate the time needed for the object to reach the ground from the highest point. (3 marks)

See next page

Question 23 **(13 marks)**

A modified Joule's heat apparatus, shown in the figure below, can be used to determine the specific heat capacity of an unknown liquid. A 40.0 watt 12.0 volt DC motor provides the necessary energy input to the oil through the motion of the cable and paddle. A student wants to use this apparatus to distinguish whether a liquid is olive oil or generic vegetable oil. 0.500 kg of oil is used in the experiment.



(a) Draw a free body diagram showing the forces acting on the frictionless pulley. (2 marks)

(b) During one trial, the DC motor winds up the cable at a constant velocity for 50 seconds. Calculate the work done by the motor. (2 marks)

See next page

(c) Using previous experimental results, the device was determined to have an 80% energy conversion efficiency from the electric motor to the oil.

(i) Explain what 'efficiency' means in this context. (2 marks)

(ii) Using information from parts (b) and (c), calculate the energy input into the oil. (1 mark)

(iii) What is one possible source of energy loss in the system? (1 mark)

(d) After several more trials, the results of this experiment are averaged and can be summarised as

'the temperature of this oil is raised 1.7°C from an energy input to the oil of 1.8×10^3 J'.

(i) Calculate the specific heat capacity of the liquid using these values. (3 marks)

(ii) A search on the internet finds the specific heat capacities for olive oil and generic vegetable oil listed as 1.97×10^3 and 1.67×10^3 J kg^{-1} K^{-1}, respectively. Explain which oil you think is in the apparatus. (2 marks)

End of Section Two

See next page

Section Three: Comprehension **10% (16 Marks)**

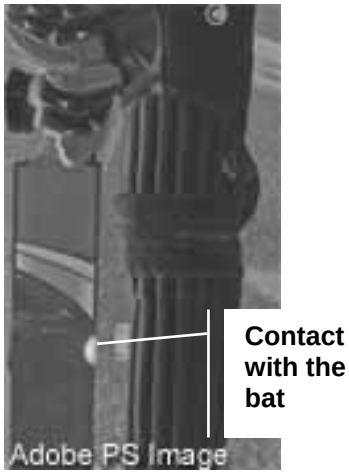
This section contains **one (1)** question. You must answer this question. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 20 minutes.

Question 24



Original image altered by Curriculum Council for copyright reasons.

In cricket, a batsman is judged 'out' if the ball is caught after hitting the bat. The batsman is 'not out' if the ball is caught after hitting the batsman's leg. A cricket umpire must sometimes decide whether the ball hit the bat, the batsman's leg, or if both have been hit, which happened first. This can be tricky because the bat and the leg may be very close together, and the contact occurs over a very short time.

A technology called Hot Spot can be used to resolve this issue. Hot Spot is an infra-red imaging system, and is used to determine where, or what, the ball actually hit. There are two Hot Spot infra-red cameras, one at each end of the cricket ground. These measure and record the temperature of the bat and the batsman, before and after the ball makes contact. The infra-red images are then processed by a computer to show temperature differences between the 'before' and 'after' images.

The point is to show accurately whether the ball has hit the bat, the batsman's glove, the batsman's leg, or none of these. The black-and-white images produced by Hot Spot can potentially allow an umpire to precisely localise the ball's point of impact, and so reduce the risk of making an incorrect decision.

(a) Using the image above as a reference, which would have the higher temperature? (1 mark)

Circle the correct answer: a light part a dark part not enough information

(b) Explain how the infra-red cameras are able to 'sense' where the contact or collision point has occurred. (2 marks)

See next page

(c) The increase in heat energy of the contact point only lasts for a short time. Explain one form of heat transfer that is likely to occur in this situation. (3 marks)

(d) A 161 gram cricket ball moving at 25.0 m s^{-1} hits the edge of a stationary bat transferring 18.1 J of energy to the bat.

(i) Calculate the speed of the ball after the collision. (4 marks)

(ii) At the moment the photograph is taken, about 4 grams of wood absorb the 18.1 J of energy and increase in temperature. Estimate the temperature increase of this portion of the bat, given that the specific heat of the bat is 2.25×10^3 J kg^{-1} K^{-1}. Give your answer to an appropriate number of significant figures. (4 marks)

See next page

(e) After the ball is struck, it rolls along the ground and comes to a stop. Use Newton's Second Law to explain this. (2 marks)

End of questions

Additional working space

Additional working space

Additional working space

ACKNOWLEDGEMENTS

Section One

Question 9 Binding energy curve graph from: Fastfission. (2009). Retrieved November 18, 2009 from http://commons.wikimedia.org/wiki/File:Binding_energy_curve_-_common_isotopes.svg.

Question 11 Image from: Encyclopedie Larousse Illustree. (1897). Canon_de_16_Gribeauval_pour_les_sieges. Retrieved April 29, 2010 from http://en.wikipedia.org/wiki/File:Canon_de_16_Gribeauval_pour_les_sieges_before_1923.jpg#file.

Section Three

Question 24 Adapted from: Hot Spot (cricket). (2010, February 5). *Wikipedia.* Retrieved February 22, 2010, from http://en.wikipedia.org/w/index.php?title=Hot_Spot_(cricket)&oldid=342080831.

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