YEAR 11 PHYSICS REVISION

SEMESTER 1

Name: ______________________________ Teacher: __________________

Time allowed: reading time 10 minutes

working time 2½ hours

This examination consists of three parts (total, 148 marks).

PART A has FIFTEEN short answer questions and is worth 44 marks. It should take you about 50 minutes to complete.

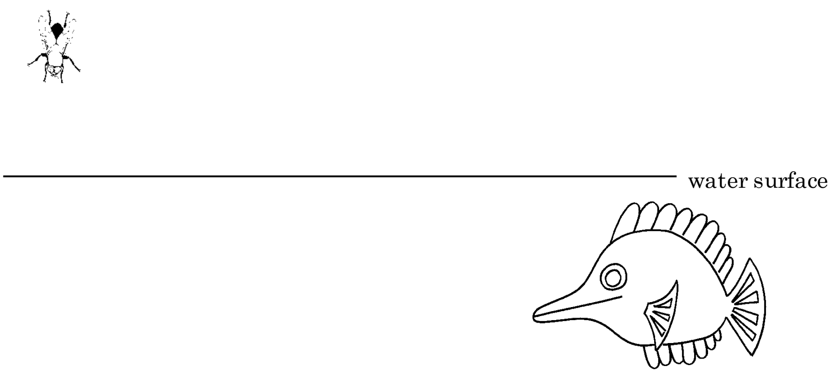
PART B consists of SIX extended answer questions and is worth 74 marks. It should take you about 70 minutes to complete.

PART C consists of TWO comprehension questions. It is worth 30 marks and should take you about 30 minutes to complete.

PART A: SHORT ANSWER

Please answer the items in Part A in the spaces provided. Where a numerical answer is required, give the final result to three significant digits unless instructed otherwise. This part of the examination consists of eleven questions and carries 44 marks.

A1. The diagram shows a fish looking out of a still pond. Show on the diagram approximately where the fish will see the fly to be. Show your reasoning clearly.



A2. If you take apart an expensive camera, you will find that the lens consists of several thin, curved glass strips glued together. What is the point of this?

A3. Peggy Sue has myopia. Describe, with the aid of diagrams, **<u>TWO</u>** possible abnormalities in her eyeball that could cause this defect of vision.

A4. Glass is "opaque" to almost all ultra violet wavelengths but "transparent" to visible wavelengths. Explain what these statements mean.

A5. Tin-121 ($^{121}_{50}Sn$) decays to an isotope of antimony (Sb) by beta emission.

(i) What is the atomic number of antimony? Explain your answer.

(ii) Write an equation showing this decay process.

A6. Suppose 4.00 kJ of elastic potential energy is stored in the leg muscles of an athlete as she is poised to jump vertically from a stationary crouch. She jumps, and at the highest point her centre of mass was raised a vertical distance of 1.20m.

(a) Her body mass is 60.0 kg. How much gravitational potential energy does she have at the highest point of the jump?

(b) With what speed did she leave the ground on take off?

A7. When a rocket is functioning, it applies a force to the hot exhaust molecules that are blasted out the back of the rocket. The exhaust molecules exert a force of equal magnitude on the rocket itself. If the two forces are of equal magnitude, why don't they simply cancel each other out?

A8. It is said that a golfer should always use the same amount of back-swing when making the first shot of a hole from the tee. It is then true that the ball goes a much greater distance because the golfer chooses a heavy wooden driver instead of an iron club to make the shot.

(a) Explain any differences in the speed of the two different clubs at the instant of impact with the golf ball.

(b) Give one reason why the driver can hit the ball further than the iron.

A9. The mass of a rocket on the launch pad is 3.00×10^3 kg. At the time it lifts off the launch pad the acceleration of the rocket is 40.0 m s^{-2}. Calculate the value of the thrust force provided by the rocket engines.

A10. When a car is moving at its top speed it is not accelerating, but it will eventually run out of fuel. Explain where all the energy stored in the fuel has gone.

A11. Every motor car has a top speed marked on its speedometer. This speedometer is an important part of the dashboard display in the car. *State* two important features of the automobile that can determine the value of its top speed. *Explain* how *each* feature helps to determine the value of the top speed.

Feature 1.

Feature 2

END OF PART A

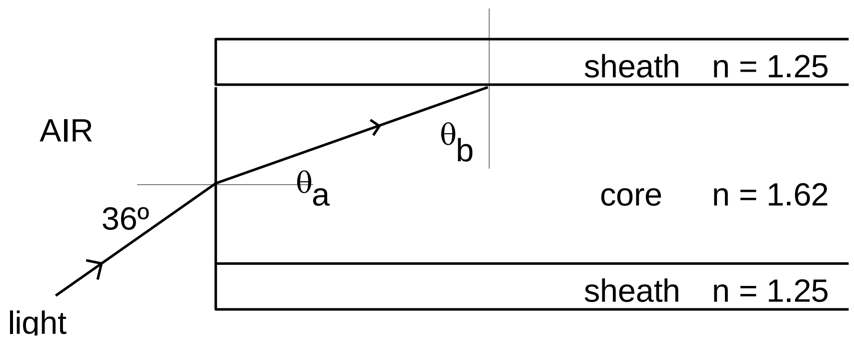
PART B: EXTENDED ANSWER

Please answer the items in Part B in the spaces provided. Where a numerical answer is required, give the final result to three significant digits unless instructed otherwise. This part of the examination carries 74 marks (six questions).

B1 (14 marks)

An optical fibre consists of a core (refractive index 1.62) surrounded by a thin sheath of material of refractive index 1.25.

A laser beam enters the fibre at an angle of incidence of 36.0°, as shown:



(a) Calculate the size of the angle θ_a. (4 marks)

(b) Calculate the size of the angle θ_b. (2 marks)

(c) What is the minimum value of θ_b, such that the light ray will be totally internally reflected at the interface between the core and the sheath? (4 marks)

(d) For the situation shown, determine through how many degrees you could bend the fibre before the light is lost from the core. (4 marks)

B2 (12 marks)

If you gaze into a soup spoon from one direction, you see an upright, magnified image of your face.

(a) Draw a ray diagram to show clearly how and where this image forms. (4 marks)

If you turn the spoon around, your face seems to be upside-down and diminished.

(b) Draw a ray diagram to show clearly how and where this image forms. (4 marks)

(c) In which case, (a) or (b), could you project a focussed image onto a sheet of paper? Justify your answer. (4 marks)

B3 (12 marks) In a student experiment, Zelda's group used a Geiger counter to measure the activity of a radioactive sample under different conditions.

(a) Zelda noticed that the Geiger counter registered a reading of 10 counts per minute even when there were no radioactive materials nearby. Where did this radioactivity come from? (2 marks)

(b) When a radioactive source was placed next to the Geiger tube, the counter registered 520 counts per minute, 510 counts per minute, and 514 counts per minute in three consecutive trials. Explain why the three readings were different from one another. (1 mark)

(c) Zelda's partner Maybelline held a sheet of paper between the radioactive source and the Geiger tube, and Zelda recorded another three consecutive readings. These were 504, 510 and 512 counts per minute. Then Maybelline took away the paper and held a sheet of aluminium foil between the source and the Geiger tube. The next three counts were 7, 9 and 8 per minute. What type or types of radiation did the source emit? Explain your reasoning. (2 marks)

(d) Do you think that the radioactive source that Zelda's group used had a long or a short half-life? Explain your reasoning. (2 marks)

Zelda's pet rabbit Skippy ate some grass that was contaminated by an alpha emitting radioisotope. Skippy's mass was 3.00 kg, and the total energy she received from the ingested radioisotope was 20.0 J.

(e) What was Skippy's radiation dose, in grays? (2 marks)

(f) Alpha radiation has a "quality factor" of 20.0. What was Skippy's dose equivalent (in sieverts)? (2 marks)

(g) What biological effect did this dose equivalent produce in Skippy? (1 mark)

B4. (12 marks) Cobalt-60 is a radioisotope often used to give doses of gamma radiation to cancer patients in hospitals.

(a) Two other kinds of radiation can be given off from radioisotopes, apart from gamma radiation. Name these two other radiations, and describe what each consists of. (4 marks)

(b) How does gamma treatment of cancer work? (2 marks)

(c) What would be the effect on the patient of using

(i) too low a dose of gamma radiation? (1 mark)

(ii) too high a dose? (2 marks)

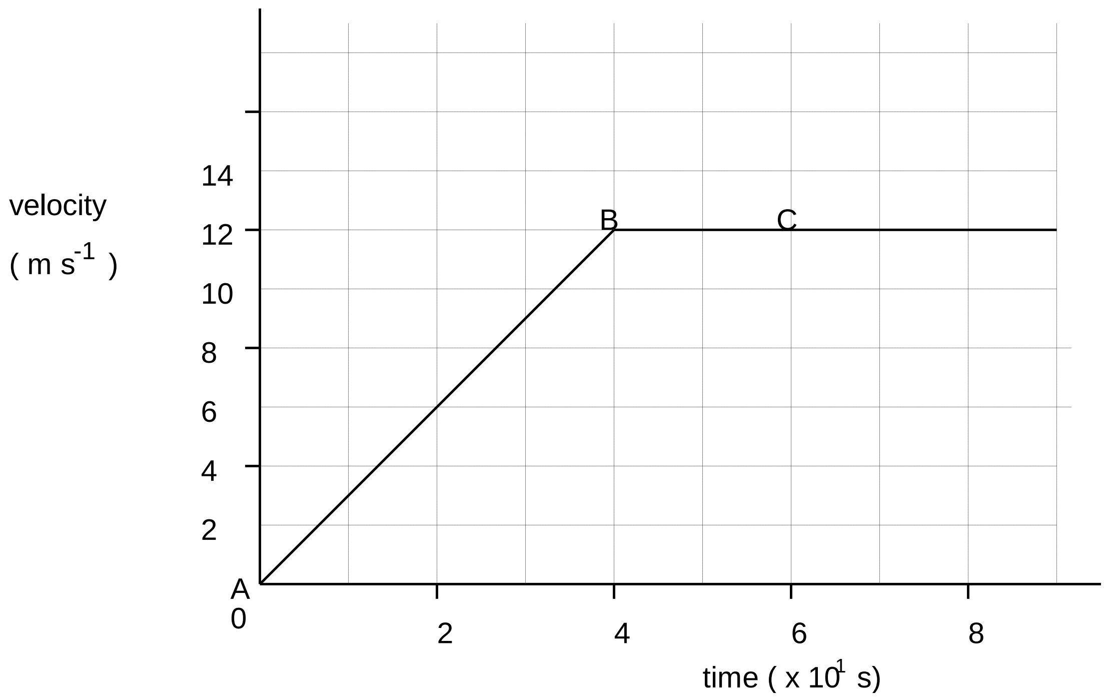
(f) The cobalt-60 gives off gamma radiation all the time, in all directions. This radiation must be stopped when it is not needed.

(i) Name a material suitable for blocking the gamma emissions. (1 mark)

(ii) Sketch a possible design for a container to hold the cobalt-60. Your design must block all the radiation when it is not needed, but must be able to let out a beam of gamma rays in a particular direction (towards the patient) when required. (2 marks)

B5. (12 marks) The graph below describes the motion of a cyclist as she moves through a journey from A to C.

By using the graph, answer the following questions.



(a) What distance is covered during the journey segment AB? (2 marks)

(b) What acceleration does the cyclist experience in the journey segment AB? (2 marks)

(c) What is the cyclist's acceleration in the journey segment BC? (2 marks)

(d) Why is it ***incorrect*** to say the average velocity for the journey AC was 6.00 metres per second? (2 marks)

(e) The combined mass of the cyclist and her cycle was 70.0 kg. Use this fact to draw a graph of force (*y* axis) versus time (*x* axis) for the journey AC. (4 marks)

B6. (12 marks) A car of mass 1.20 x 10^3 kg was moving at 25.0 m s^{-1} when it hit a tree. The car rebounded off the tree with a velocity of 2.00 m s^{-1}.

(a) What was the momentum of the car before the collision? (2 marks)

(b) What impulse did the car receive during the collision? (3 marks)

(c) What impulse did the tree receive during the collision? (2 marks)

(d) To answer question (c) you must apply one of Newton's laws of motion. Which law did you use, and how did you arrive at your answer to question (c)? (3 marks)

(e) If the collision took a total time of 4.00 s, what average force acted on the car during the collision? (2 marks)

END OF PART B

PART C: COMPREHENSION

Please answer the items in Part C in the spaces provided. This part of the examination consists of two questions and carries 30 marks.

C1. (15 marks) The passage below, by Gerard Kleczewski, is from The Road Patrol (June/July 1993). Read the passage, then answer the questions at the end of it.

"Speed kills"' they say. Wrong! It's the sudden stop at the end that does the damage!

Vehicles are not intrinsically dangerous: let's face it, you are most unlikely to have an accident if your car never leaves your driveway. Which tends to prove that it is the movement that causes all the problems. You see, as soon as your vehicle moves it comes under the influence of a variety of physical forces, some good for you, some bad. Things like momentum, kinetic energy, centripetal force, gravity, drag, directional force, etc.

The worst of that lot is kinetic energy, a function of the speed and loaded mass of the vehicle. This kinetic energy increases proportionally with the square of your speed. In other words, when you triple your speed (for example when you go from 30 km/h to 90 km/h) your kinetic energy increases 9 times (3x3).

This is not good because your braking distance will increase 9 times when you increase your speed 3 times. (Please note that I am not talking about the total stopping distance, as this would include the driver's thinking distance).

You probably realise what this means in practical terms: if you hit at 90 km/h the crash is going to be 9 times worse than it would be at 30 km/h. However if you take this a bit further, you will see that something good comes out of it. If faced with any crisis, wipe as much speed off the car as you can.

So, you see that firstly (before taking evasive action with the steering wheel), you have to decrease your speed as much as you can - without locking the wheels - and then you must try to avoid a hard landing. Given a choice, a clump of bushes is preferable to a parked car, and hitting the back of a parked car at 60 km/h will be pretty much the same as hitting a brick wall at half that speed.

Above all, never hit a tree!! Trees are the most unforgiving things that you may come up against in anger. There is no "give" in them and you concentrate the whole force on a narrow profile.

And of course, make sure that your loads are secure, the baby is in the baby capsule on the back seat, and you and your passengers are all correctly buckled in.

(a) Explain why the sudden stop in the collision is a killer. (3 marks)

(b) Verify the claim that the "stopping distance increases 9 times when the speed increases 3 times". (Assume that the braking force is constant.) (4 marks)

(c) What does "driver thinking time" have to do with the total stopping distance in a collision? (2 marks)

(d) Why is hitting the back of a parked car at 60 km/h pretty much the same as hitting a brick wall at half the speed? (3 marks)

(d) Why should loads be secured in a moving vehicle? (3 marks)

C2. (15 marks) The passage below is from *"HIFAR, the High Flux Australian Reactor"* (Lucas Heights Research Laboratories). Read the passage, then answer the questions at the end of it.

HOW HIFAR WORKS

A nuclear reactor, such as HIFAR, is a structure in which a fission chain reaction in the uranium fuel can be maintained and controlled. The key event is fission, in which a neutron hits the nucleus of a uranium atom and splits it. A great deal of energy is released, some of which is carried away by the two or three neutrons released in the process. They may fission further uranium atoms. The neutrons liberated in this chain reaction represent the "life blood" of all reactors; they permeate the whole volume of the reactor's core.

In HIFAR the objective is to maximise the number of free neutrons (whereas in a power station the objective is to maximise the energy output to make electricity).

ENERGY

The energy released in each fission event is mainly kinetic energy of the fission fragments, but they rapidly lose it by collisions with other atoms, thus heating up their surroundings. Neutrons, gamma-rays, beta particles and other forms of radiation deliver the remainder of the heat energy to the materials of the reactor. In HIFAR, this heat is dissipated through a cooling system and is not used to make electricity.

ENRICHMENT

Of the two isotopic forms in naturally occurring uranium, U235 (0.7%) and U238 (99.3%), only the U235 is fissionable. For optimum performance and flexibility most reactors use fuel that has a higher U235 content, ie it is "enriched".

Enrichment processes separate natural uranium into enriched uranium and "depleted" uranium (from which most of the U235 has been removed). HIFAR fuel is enriched to about 60% U235.

MODERATION

The two or three neutrons produced when a U235 atom splits are released at high speed. In order to split further U235 atoms, the neutrons must be slowed down, or "moderated". Moderation is a process similar to the way a cue ball on a pool table shares its energy with other balls by collisions. Light elements are good neutron moderators, but the best, hydrogen, also tends to absorb neutrons. Hydrogen's heavier isotope, deuterium, does not, and so water made from deuterium and oxygen, ie heavy water, is a good moderator. In HIFAR the uranium fuel elements are immersed in heavy water.

Heavy water is generally indistinguishable from ordinary water, except for its density, which is about 10% greater. It is not radioactive and occurs naturally in all water to the extent of about one part in 6 500. Its relative rarity means that heavy water is very expensive, about twenty times more than whisky.

COOLING

At full power HIFAR generates 10 megawatts of heat within the core. The heavy water also acts as the "primary coolant", as it is pumped around a closed circuit. For a variety of technical reasons, the maximum heavy water temperature is 51 °C. Since the water does not boil, there is no steam, therefore no opportunity to make electricity with a turbine generator. The heat is therefore a waste product.

The heavy water passes through heat exchangers, where the heat is transferred to tap water in a secondary circuit. This warm tap water is pumped through cooling towers outside the reactor building, where the heat is dissipated in the atmosphere. Cool tap water returns to the heat exchangers. Cool heavy water returns to the fuel elements.

Although the cooling system is designed to ensure that the fuel always remains covered, provisions has been made for dealing with an accident when the fuel becomes uncovered and leads to the possibility of melting. The Emergency Core Cooling System (ECCS) protects the reactor from meltdown.

(a) The article refers to the full power output of HIFAR as "10 megawatts of heat". Explain why ***this cannot be true***. (2 marks)

(b) The formula of an alpha particle is $^{4}_{2}He$. Uranium has atomic number 92.

(i) Write the formula for U238. (1 mark)

(ii) How many neutrons are there in an atom of U-235? (1 mark)

(c) Why is heavy water about 10% denser than ordinary water? (3 marks)

(d) Why does the HIFAR cooling system use two streams of coolant? That is, why not just circulate the warm heavy water to the cooling towers and then back into the reactor? (4 marks)

(e) Apart from installing electrical turbines (generators), some changes would be necessary in the design of HIFAR in order to use its heat to generate electricity. Describe and explain one such change. (4 marks)

END OF PAPER

CHECK YOUR WORK