SECTION A
Respond to all items in this section

Item 1

A team of doctors arrives at a regional hospital to attend to patients with cancer, where two elements are considered for treatment purposes. Cobalt – 60 and Cesium – 137, of half-lives 21 hours and 2 days. Students attending the session are asked to use this information to determine which element is more appropriate for treatment. They are also required to state whether such elements have industrial applications and give at least an example.

The doctors wanted to determine the level of ionizing radiation from samples to be used for the treatment of cancer in order to ensure that they are sate for use.

The students were asked to identify the devices that could be used in this investigation and explain how it is used.

During the same session, hospital engineers demonstrated on automatic light control system used around the hospital compound. The system contains a photosensitive surface. Different sources of varying frequencies such as red light and ultraviolet radiation were directed into the sensor. It was observed that ultraviolet light successfully activated the control circuit causing lights to switch on, while bright red light failed to activate the system even when its intensity was increased. The students were asked to explain these observations, given that the work function of the photosensitive surface is 2.28eV.

Support material:

Frequency of red light = 4.3×10^{14} Hz

Frequency of UV light = 8.0×10^{14} Hz

Task:

As a learner of Physics;

(a) Analyze the information and address the concerns raised in the hospital.

(b) Identify the device that could be used in the investigation and explain how it is used to achieve the desired purpose.

Item 2

During many sports competitions, officiating errors often cause arguments and sometimes fights. Recently, video technology has been introduced to help minimize such human errors.

In the final moments of a basketball game, a player of mass 80kg begins sprinting from one end of the court when 4.0 seconds remain on the game clock, starting for rest, the player accelerates uniformly in a straight line towards the centre line, which is 14m horizontally from the hoop, and immediately releases the ball on reaching that point. The ball enters the hoop after the buzzer. Unsure whether the basket should count, the referee consults the video assistant referee (VAR). The replay captures the instant the player starts sprinting and the instant the ball enters the hoop, but not the instant the ball leaves the player's hands. The video shows that the ball entered the hoop 5.25 after the sprint began. The ball was released from a height of 2.4m and passed through the hoop at a height of 305 cm.

During the final sprint, some players argued that the count surface was slippery due to sweat. The referee therefore wondered whether the friction between the player's shoes and the court surface was sufficient to allow the player to accelerate without slipping while running towards the centre line.

At the closing ceremony, Michael, a former professional basketball player advised the players to focus on proper jump shot technique where the player jumps vertically and releases the ball while monetary stable in the air. He also emphasized a smooth follow through, where a player releases the ball by fully extending the arms in the direction of the target (hoop).

Support Material:

- The basketball was released at an angle of 46^0 to the horizontal with a velocity of 12 ms^{-1}.
- The basket counts only if the ball is released before the buzzer.
- Air resistance is negligible.
- Coefficient of friction between the player's shoes and the court = 0.5

Task:

As a learner of Physics;

(a) Determine whether the score is valid, analyze and explain the motion of the player.

(b) Explain Michael's closing remarks.

SECTION B

PART I

Respond to one item from this part.

Item 3

At a certain secondary school, learners are developing a solar water heating system to provide hot water for laboratory use. The system uses a large concave mirror of surface diameter 2.4 m to concentrate sunlight onto a blackened metal container containing water. Assume that the sun radiator as a perfect black body at a temperature of 6000 k and is at a distance of 1.5×10^{11} m from the earth. Due to losses in the system only 65% of the power reflected by the mirror reaches the blackened metal container.

During the first trial, the water became only slightly warm. The learners suspected that the blackened metal container had not been placed at the position where the reflected sunlight is most concentrated.

However, they did not know how to determine this position. After correctly positioning the container, the learners placed 5kg of ice at -5^0C into the container for the solar system to be considered efficient, the ice should completely melt and the resulting water should attain a temperature of at least 80^0C within a time not exceeding one lesson period. The teacher then asked the learners to identify the device uses to measure the final temperature of the water and described how it is used.

One of the learners thereafter inquired from the teacher whether concave mirrors have other real-life applications. The teacher explained that concave mirrors are also used by dentists during the examinations of teeth. The learner was challenged to carryout research and explain how concave mirrors are used in dental examinations.

Support Material:

In church there was a piano with string of length 2.0m and density of 8000 kgm^{-3} when the transmission in the string produces strain of 1% the fundamental note obtained from the string in the transverse vibration is 170 HZ but no one knew how to determine the young's modulus of the string. For the string to be used in the piano the young's modulus should not exceed 3.7×10^{11} pa

Support Material:

- Refractive index of the core, $n_1 = 1.52$
- Refractive index of cladding $n_2 = 1.8$
- Refractive index of air, $n_3 = 1.0$

Task:

As a learner of Physics;

You have been selected, analyze the information given in the scenario and fully address the claims and concerns.

PART II

Respond to one item from this part

Item 5

At a regional hospital, Joy, a medical intern is updating patient records using a tablet a sensitive touch screen, while working, she notices that tiny dust particles are attracted towards the screen whenever her finger move close to it. She suspects that the screen has become electrically charged during use. To investigate her observation a laboratory technician provides her with a device consisting of two thin metal foils enclosed in a glass far. Joy is required to explain how the device can be used to test whether the tablet screen is charged and how the dust particles were attracted towards the screen.

While the tablet is charging, Joy notices that the copper charging cable is becoming warm which confused her and what to understand this confusing effect. This prompts her to look up for the standard values of the temperature coefficient and the resistivity of a good conducting wire.

She finds that a good wire should have temperature coefficient of $0.004k^{-1}$ and resistivity 1.7×10^{-8} Ωm, to verify whether the charging cable is suitable, she

measures its properties and finds that the cable is 1.5 m long with a cross section area of 2.0 X $10^{-7}m^2$

The cable has a resistance of 0.1275Ω at 20 °c, which rises to 0.1530 Ω at 70 ^{0}C after an hour of charging.

Suddenly, a "Code blue" emergency is announced. A doctor brings a defibrillator explains that it contains a 150 uF device that slowly charges up to 2,000V before releasing its stored energy in a short pulse to restart the patient's heart. Joy interested in finding out how much energy the device can store such that she can include it in her internship report.

Task:

As a learner of Physics;

(a) Analyze the information in the scenario and help Joy find out about this kind of a wire she has and the value of energy to include in the report.

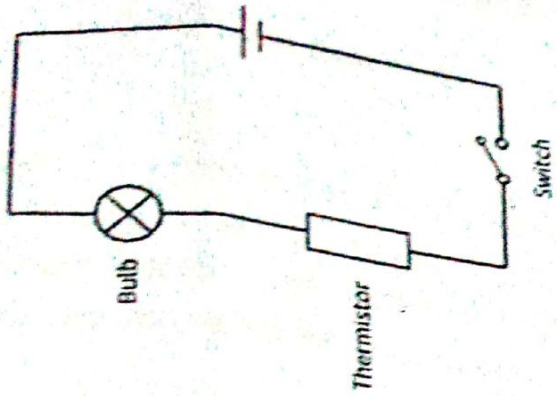
(b) Help Joy identify the device, give the required explanation and to also understand the confusing effect.

Item 6

After finishing Master's degree in U.K in medicine and surgery, Peter returned back to Uganda and constructed a very big private hospital dealing in treating all kinds of diseases. For accuracy reasons he installed cameras everywhere in and outside the building. Each camera has a 4uF capacitor within for powering camera flash gun of average power output 4KW every two minutes.

According to the technicians, a camera functions accurately if the average current provided by the capacitor is at least 5 X 10^{-2}A. However, Peter could not verify this for each camera installed his building. The capacitor inside each camera charges automatically to maintain the current supplied to the device constant according to the technician. The can be explained more by the variation graph of current and time for charging a capacitor but still Peter does not understand anything about this.

Every bulb connected in each of the hospital wards is arranged in series with a thermistor as shown in the circuit below.



Whenever the switch is put on, the bulb first dims and as time goes on the brightness of the bulb increases. This left Peter wondering and happy but has no explanation on what brings all this.

Immediately after all these connections the team from the Ministry of Health visited Peter's hospital to check out whether it qualifies for a license. On entering one of the labs, all electrical connections are served by one strong device having charge all over its spherical surface on top.

The team leader from the Ministry wanted to confirm whether the charges on the spherical surface of the device is working normally.

Peter did not know how to confirm this to the team of health inspectors. However, he responded to them that the spherical surface has a diameter of 4 m and terminal p.d of the machine is operating at 5×10^{9}v. This again gave the team leader more inquiries which included the energy stored and electric potential gradient at the surface of the sphere. Peter had nothing to say about this.

Task:

(a) Analyze the given data to address the concerns raised.

(b) With illustration, describe how charge supplied by the electric device i generated.

End