IB · DP · Physics

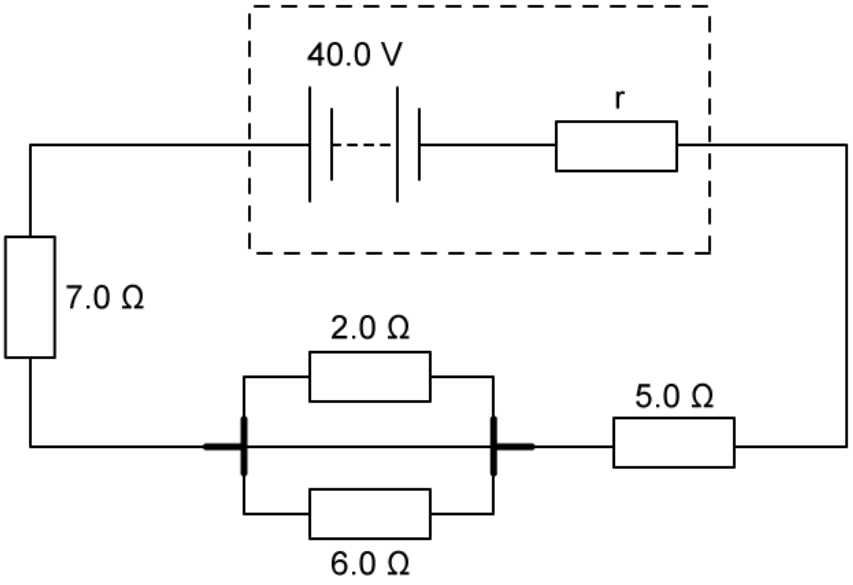
2 hours 9 questions

Practice Paper 2

Scan here to return to the course
or visit savemyexams.com

Total Marks **/90**

1 (a) The diagram shows a battery of e.m.f. 40.0 V and internal resistance, *r*.



The current in the battery is 2.5 A.

(a) Calculate the internal resistance *r*.

(4 marks)

(b) (b) Calculate the energy dissipated in the battery in 3.5 minutes.

(2 marks)

(c) The circuit is amended to include a primary and a secondary cell.

(c) Explain the function of primary and secondary cells and the role they have in an electric circuit.

(3 marks)

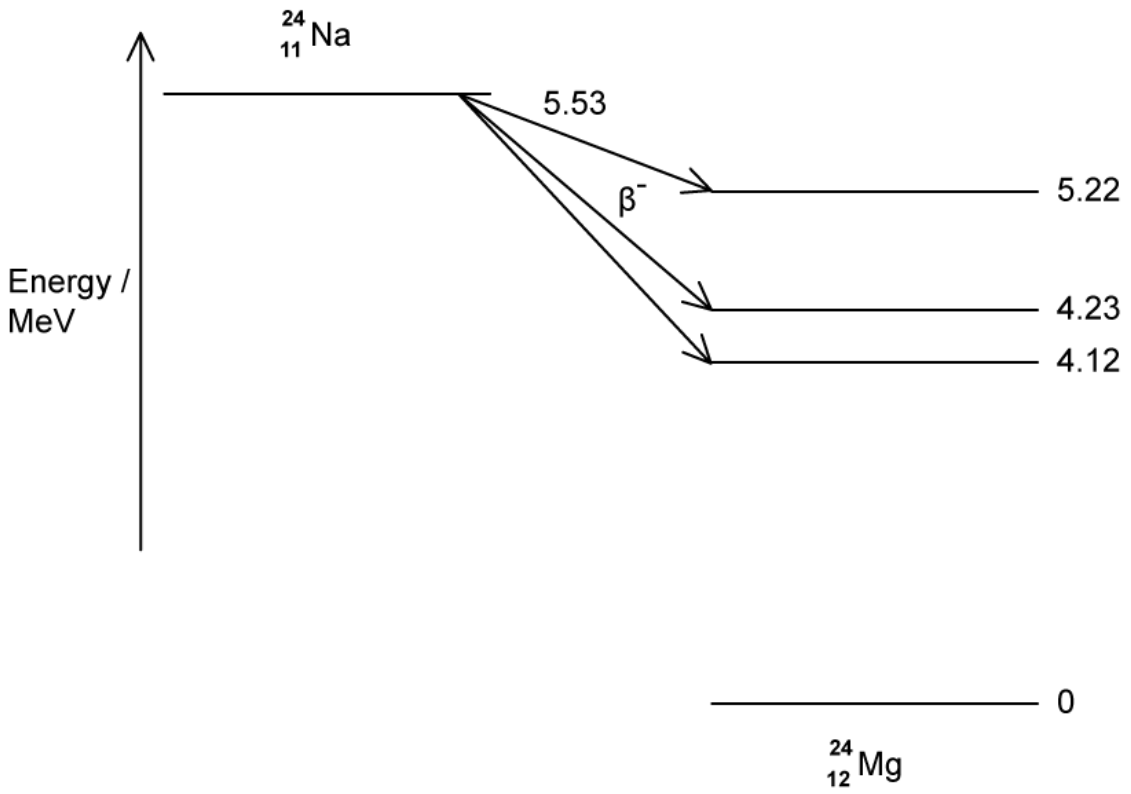
(d) The internal resistance of the battery affects the efficiency of the transfer of energy from the battery to the circuit.

(d) Explain what causes internal resistance and why this affects the efficiency of the battery.

(3 marks)

2 (a) A nucleus of sodium−24 decays into a stable nucleus of magnesium−24. It decays by β^- emission followed by the emission of γ-radiation as the magnesium−24 nucleus de-excites into its ground state.

The sodium−24 nucleus can decay to one of three excited states of the magnesium−24 nucleus. This is shown in the diagram below:



The energies of the excited states are shown relative to the ground state.

(a) Calculate the maximum possible speed of the emitted beta particle in MeV.

[2]

.....

.....

(2 marks)

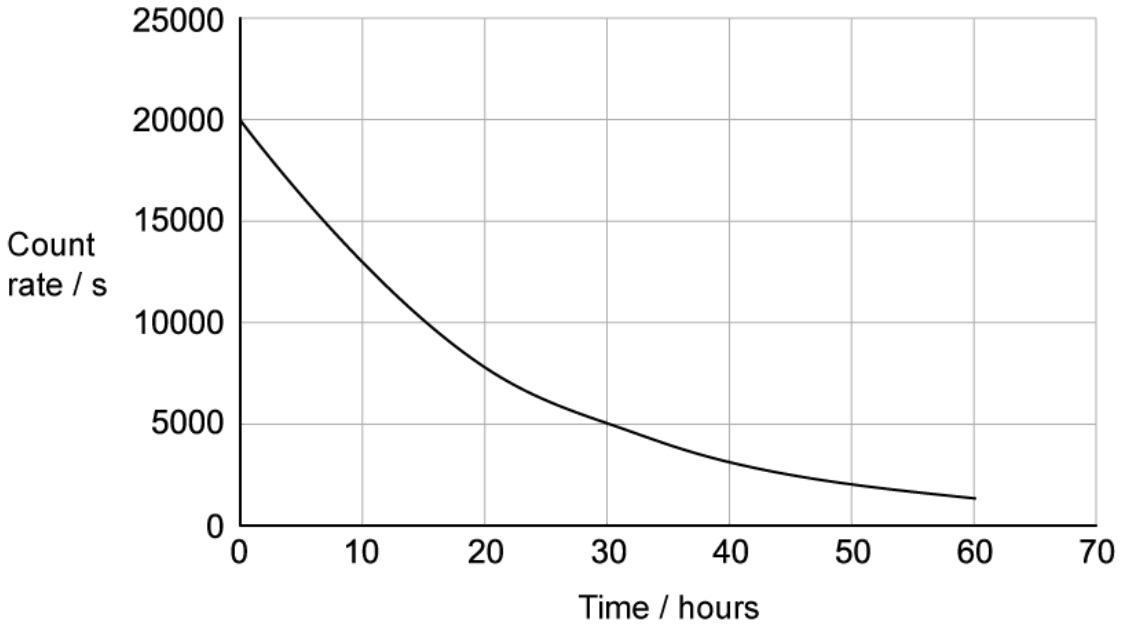
(b) The excited magnesium nucleus de-excites through production of gamma radiation of discrete wavelengths.

(b) Calculate the shortest wavelength of emitted radiation.

[3]

(3 marks)

(c) The graph shows the activity of a sample of sodium−24 with time.



(c) Use the graph to calculate the decay constant of sodium−24.

[2]

(2 marks)

(d) The detector in this experiment measures 4% of the activity from the sample.

(d) Determine the activity of sample after 27 hours from the start of the recording,

[3]

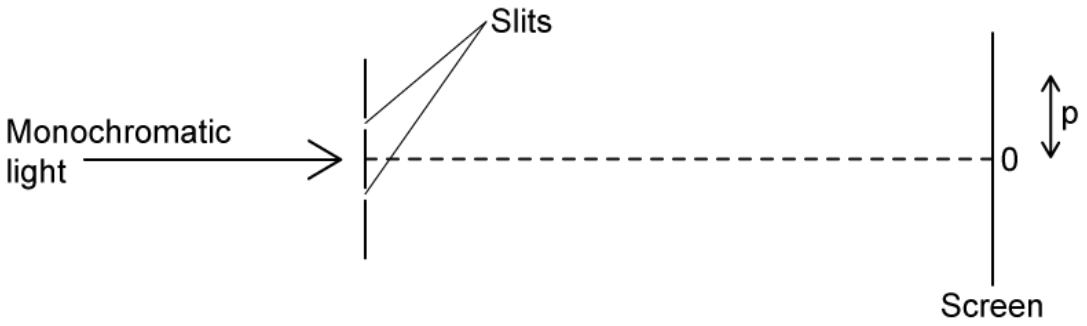
.....

.....

.....

(3 marks)

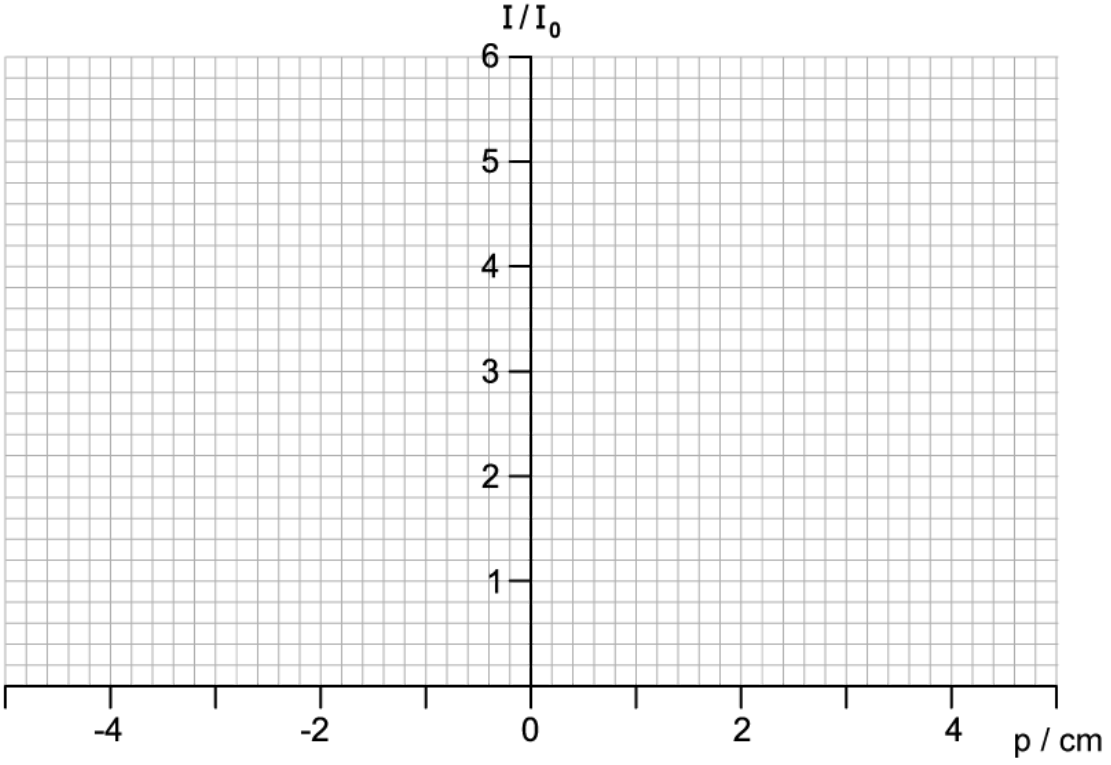
3 (a) Monochromatic light from a single source is incident on two thin parallel slits.



The following data are available:

- Distance from slits to screen = 4.5 m
- Wavelength = 690 nm
- Slit separation = 0.14 mm

The intensity, I of the light on the screen from each slit separately is I_0.



(a) Sketch, on the axis, a graph to show variation with distance p on the screen against the intensity of light detected on the screen for this arrangement.

[3]

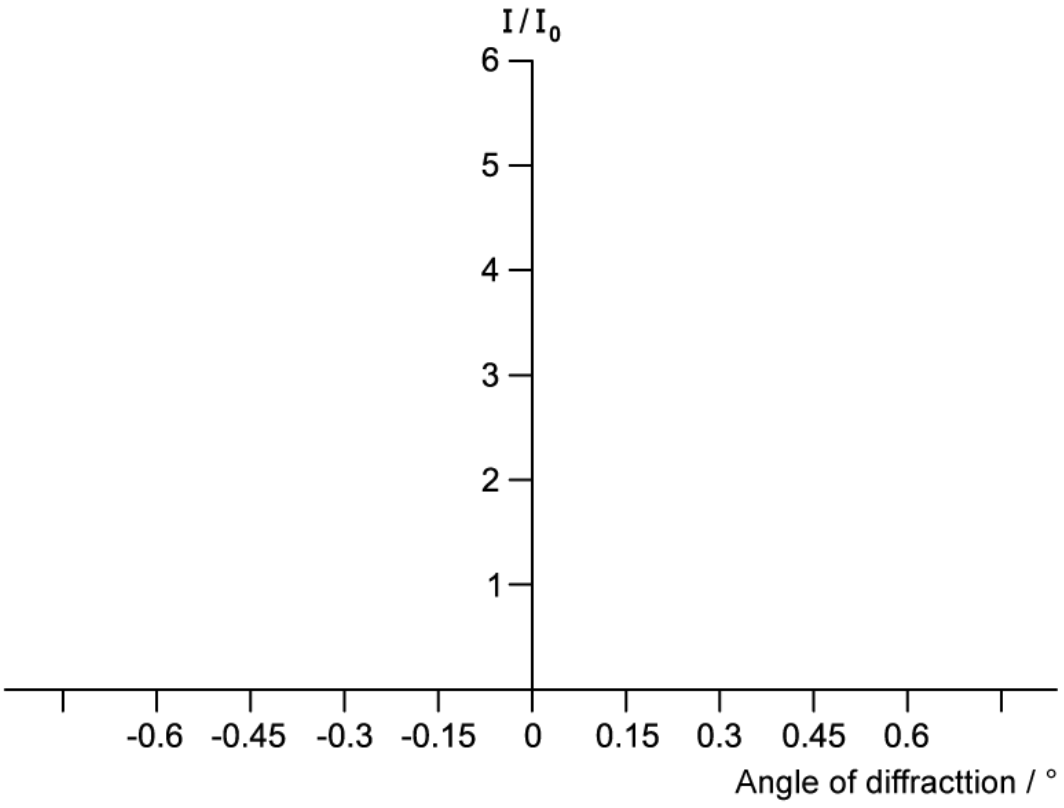
(3 marks)

(b) (b) Calculate the angle of diffraction of the central and subsequent two bright fringes that would appear on the screen.
Give your answer in degrees to one significant figure.

[3]

(3 marks)

(c) The relative intensity I_1 for the first bright fringe is $0.75I_0$ and for the second bright fringe I_2 is $0.25I_0$.



(c) Plot, on the axis, a graph to show this diffraction pattern.

[4]

(4 marks)

(d) (d) State and explain the changes that will occur to the diffraction pattern when the number of slits is increased from two to three.

[4]

(4 marks)

4 (a) This question is about a monatomic ideal gas.

(a) Outline what is meant by an ideal monatomic gas.

(2 marks)

(b) (b) Neon gas is kept in a container of volume 7.1×10^{-2} m^3, temperature 325 K and pressure 3.7×10^5 Pa.

(i) Calculate the number of moles of neon in the container.

[2]

(ii) Calculate the number of atoms in the gas.

[2]

(4 marks)

(c) (c) The volume of the gas is decreased to 4.2×10^{-2} m^3 at a constant temperature.

(i) Calculate the new pressure of the gas in Pa

[2]

(ii) Explain this change in pressure, in terms of molecular motion.

[2]

(4 marks)

(d) Energy is supplied to the gas at a rate of 10 J s^{-1} for 10 minutes. The specific heat capacity of neon is 904 J kg^{-1} K^{-1} and its atomic mass number is 21. The volume of the gas does not change.

(d) Determine the new pressure of the gas.

(3 marks)

5 (a) The orbits of the Earth and Jupiter are very nearly circular, with radii of 150×10^9 m and 778×10^9 m respectively. It takes Jupiter 11.8 years to complete a full orbit of the Sun.

(a) Show that the values in this question are consistent with Kepler's third law.

[2]

.....

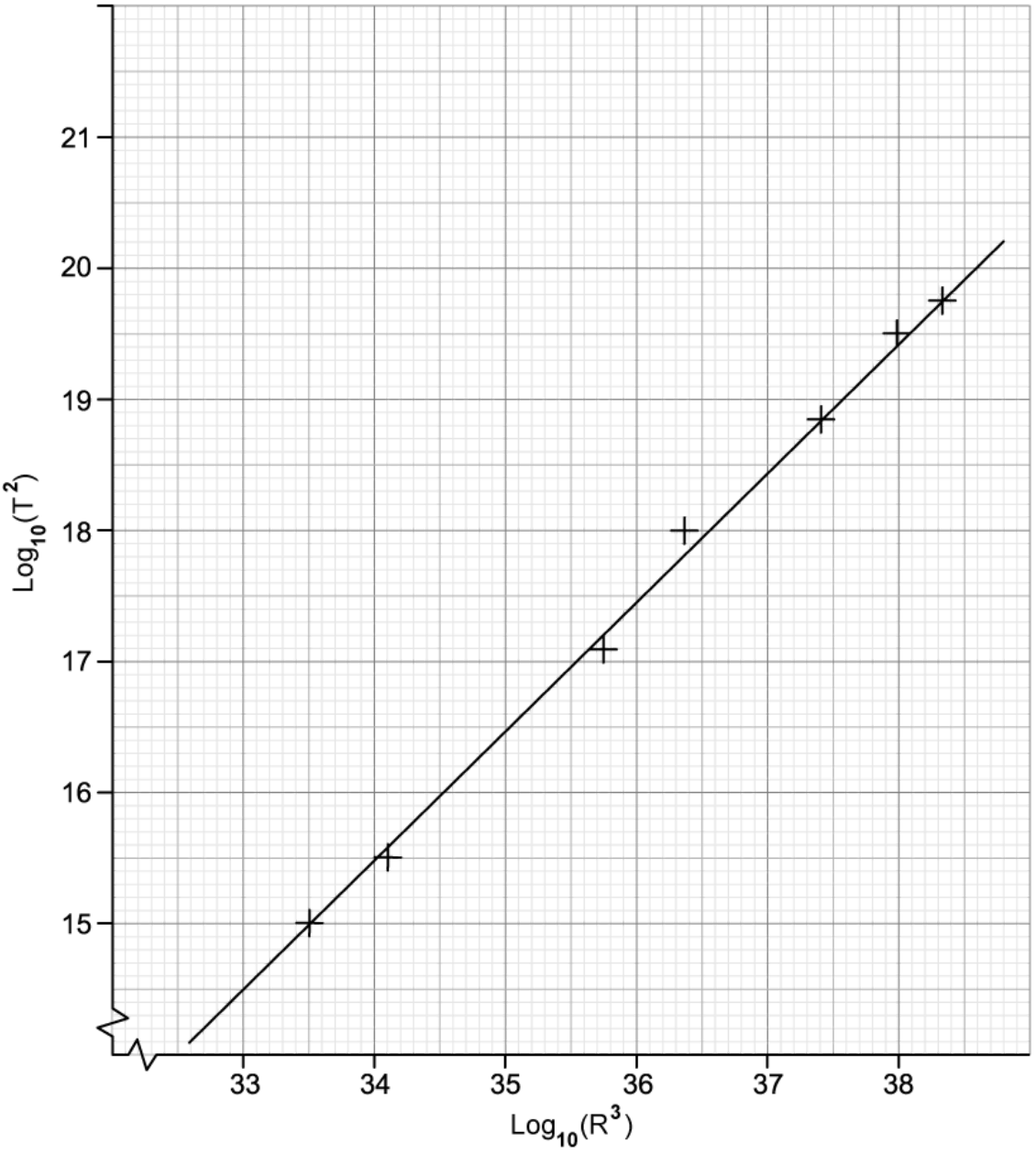
.....

(2 marks)

(b) Data from the orbits of different planets around our Sun is plotted in a graph of $\log(T^2)$ against $\log(R^3)$ as shown in the graph below, where *T* is the orbital period and *R* is the radius of the planet's orbit.

The values of *T* and *R* have been squared and cubed respectively due to Kepler's Third Law stating that:

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

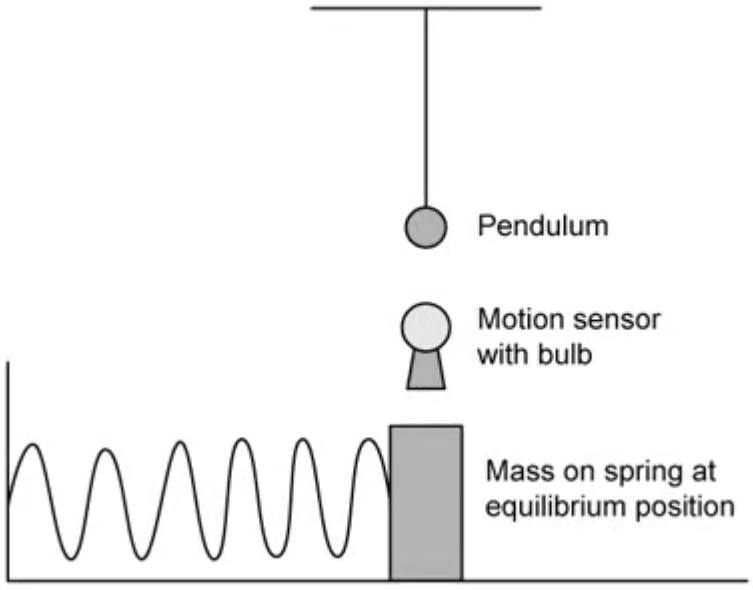


(b) Calculate the percentage error for the mass of the Sun obtained from the graph.

[4]

(4 marks)

6 (a) An experiment is carried out on Planet Z using a simple pendulum and a mass-spring system. The block moves horizontally on a frictionless surface. A motion sensor is placed above the equilibrium position of the block which lights up every time the block passes it.



The pendulum and the block are displaced from their equilibrium positions and oscillate with simple harmonic motion. The pendulum bob completes 150 full oscillations in seven minutes and the bulb lights up once every 0.70 seconds. The block has a mass of 349 g.

(a) Show that the value of the spring constant k is approximately 7 N m^{-1}.

[2]

.....

.....

(2 marks)

(b) The volume of Planet Z is the same as the volume of Earth, but Planet Z is twice as dense.

(b) For the experiment on Planet Z

(i) Show that the length of the pendulum, $l = \frac{4mg}{k}$

[2]

(ii) Calculate the value of l.

[2]

(4 marks)

(c) The angle that the pendulum string makes with the horizontal is 81.4 ° when the acceleration of the pendulum bob is at a maximum.

(c) Determine the maximum speed reached my the pendulum bob.

[3]

(3 marks)

(d) (d) Compare and contrast how performing the experiment on Planet Z, rather than on Earth, affects the period of the oscillations of the pendulum and the mass-spring system.

[2]

(2 marks)

7 (a) (a) The intensity of radiation from a source radiating energy at a rate of P follows an inverse square law with the distance, r, from the source.

(i) Derive an expression for intensity of this radiation at distance, r, from the source.

(ii) Outline an assumption made in part (i).

(3 marks)

(b) A planned Mars Rover will be powered using several solar panels each with dimensions of 2800 × 5900 mm. The equipment is tested on Earth at a point where the albedo of Earth's atmosphere is 0.310.

The radiant power of the Sun is 3.90×10^{26} W and the average radius of Earth's orbit around the Sun is 1.50×10^{11} m.

(b) Determine the power, in kW, incident on a single solar heating panel being tested on Earth.

Assume that the Sun is at its highest point and the light from the Sun is normally incident on the panel.

(4 marks)

(c) An astronomer uses the following data for a simple climatic model of Mars without an atmosphere:

Orbital radius between Mars and the Sun = 2.3×10^{11} m

Absorbed solar radiation = 493 W m^{-2}

(c) Determine the average albedo for Mars that is to be used in the modelling.

.....

.....

(2 marks)

(d)

(d) Determine the ratio $\frac{P_M}{P_E}$

Where P_M is the power of solar radiation incident on the solar panel on Mars and P_E is the power of solar radiation incident on the solar panel on Earth.

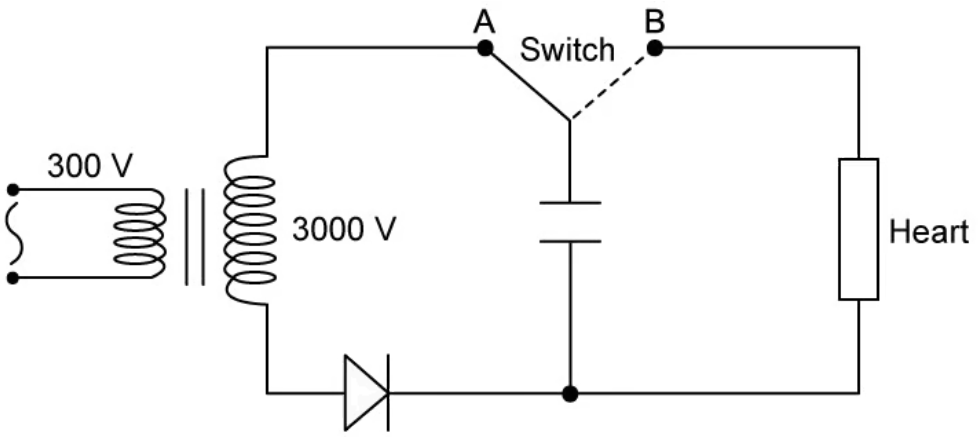
[2]

.....

.....

(2 marks)

8 (a) A defibrillator device sends an impulse of electrical energy to maintain a regular heartbeat in a person. The device is powered by an alternating current (ac) supply connected to a step-up transformer that charges a capacitor of capacitance 20 μF. The voltage in the circuit is 3000 V.



(a) Calculate the maximum energy stored in the capacitor.

[3]

.....

.....

.....

(3 marks)

(b) (b) Calculate the maximum charge, *q* stored in the capacitor.

[2]

.....

.....

(2 marks)

(c) The current in the circuit passes through the diode from left to right following the direction of the triangle symbol.

(c) Identify, by drawing a +, the positive plate of the capacitor.

[1]

.....

(1 mark)

(d) The switch is moved to position B.

(d) State what happens to the energy stored in the capacitor when the switch is moved to position B.

[1]

.....

(1 mark)

9 (a) A boulder falls into a lake and ripples propagate radially outwards. Two boats on the surface of the water are in line with the source and perform the simple harmonic motion, bobbing up and down as the ripples pass by. The boats are separated by a distance of 45 m.

Two observations were recorded; the first ripple took 3.8 s to travel between the boats; the boats are completely out of phase.

(a) Calculate the speed of the water wave.

[2]

(2 marks)

(b) (b) Explain why the amplitude of the wave will decrease with increasing distance from the source.

[4]

(4 marks)