IB · DP · Physics

2 hours 8 questions

Practice Paper 2

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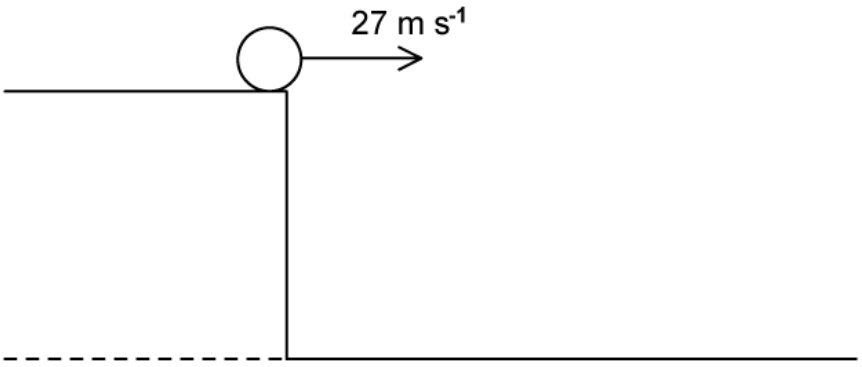
Total Marks **/90**

1 (a) A ball is projected horizontally at 27 m s^{-1} from a vertical cliff. It travels a horizontal distance of 40 m before hitting the ground.

Assume that air resistance is negligible.



(a) Calculate the vertical velocity of the ball just before it hits the ground.

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(4 marks)

(b) (b) Calculate the height of the cliff.

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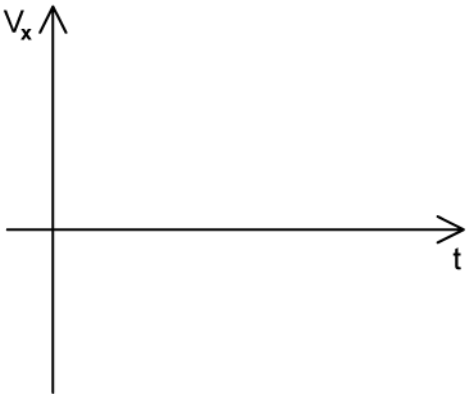
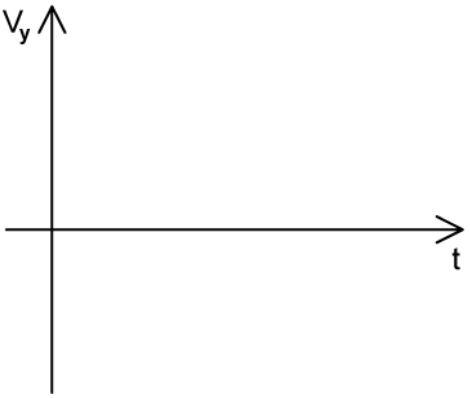
(2 marks)

(c) (c) Sketch the graphs to show how the horizontal and vertical components of the velocity of the ball, v_x and v_y change with time *t* just before the ball hits the ground.

Label any appropriate values on the axes.





(3 marks)

(d) (d) Calculate the resultant velocity of the ball just before it hits the ground.

(2 marks)

2 (a) This question is about the specific heat capacity of an ideal gas.

(a) Outline two assumptions made in the kinetic model of an ideal

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(2 marks)

(b) Xenon–131 behaves as an ideal gas over a large range of temperatures and pressures.

(b) One mole of Xenon–131 is stored at 20 °C in a cylinder of fixed volume. The Xenon gas is heated at a constant rate and the internal energy increased by 450 J. The new temperature of the Xenon gas is 41.7 °C.

(i) Define one mole of Xenon.

[1]

(ii) Calculate the specific heat capacity of gaseous Xenon–131.

[2]

(iii) Calculate the average kinetic energy of the molecules of Xenon at this new temperature.

[2]

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(5 marks)

(c) The volume of the sealed container is 0.054 m^3.

(c) Calculate the change in pressure of the gas due to the energy supplied in part (b).

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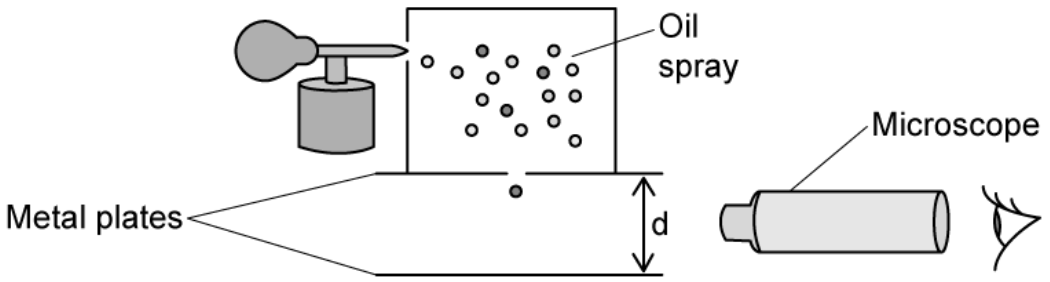
(4 marks)

(d) One end of the container is replaced with a moveable piston. The piston is compressed until the pressure of the container is 67000 Pa.

(d) Determine the new volume of the container.

(2 marks)

3 (a) An experiment to determine the charge on an electron is shown.

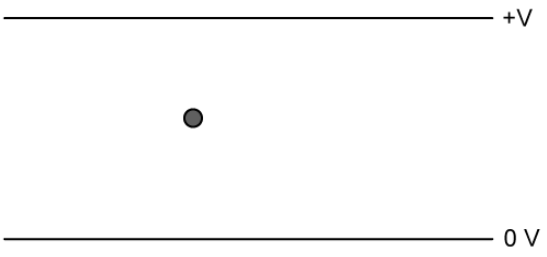


Negatively charged oil drops are sprayed into a region above two parallel metal plates which are separated by a distance, *d*. The oil drops enter the region between the plates.

(a) A potential difference *V* is applied which causes an electric field to be set up between the plates.

(i) Using the sketch below, which shows one oil drop falling between the plates, show the electric field between the plates.

[1]



(ii) Hence or otherwise explain why the oil drop stops falling when *V* is increased.

[2]

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(3 marks)

(b) The oil drop has mass = m and charge = q. The distance between the plates = 2.5 cm.

The oil drop stops falling when potential difference, V = 5000 V

(b) Determine the charge to mass ratio of the oil drop.

[2]

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(2 marks)

(c) Two oil drops are suspended between the plates at the same time. The oil drops can be considered as identical point charges with mass 1×10^{-13} kg which are spaced 2.2 mm apart.

(c) Calculate the electrostatic force between the drops.

[2]

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(2 marks)

(d) For the oil drops in part (c)

(d) Describe and explain the expected observations as the potential difference increases above 5000 V, using a mathematical expression to justify your answer.

[2]

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(2 marks)

4 (a) Transitions between three energy levels in a particular atom give rise to three spectral lines. In decreasing magnitudes, these are f_1, f_2 and f_3.

The equation which relates f_1, f_2 and f_3 is:

$$f_1 = f_2 + f_3$$

(a) Explain, including through the use of a sketch, how this equation relates f_1, f_2 and f_3.

[3]

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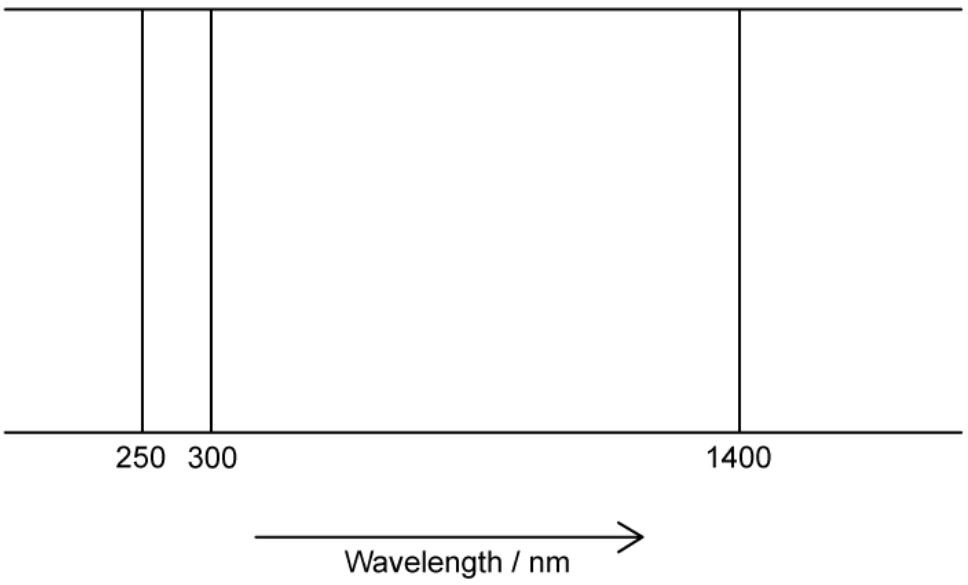
(3 marks)

(b) A different atom has a complete line emission spectra with a ground state energy of –10.0 eV. is:



(b)

Sketch and label a diagram of the possible energy levels for the atomic line spectra shown.

[5 marks]

(5 marks)

(c) (c) Explain the significance of an electron at an energy level of 0 eV.

[3]

(3 marks)

(d) (d)

(i) Explain the statement 'the first excitation energy of the hydrogen atom is 10.2 eV'

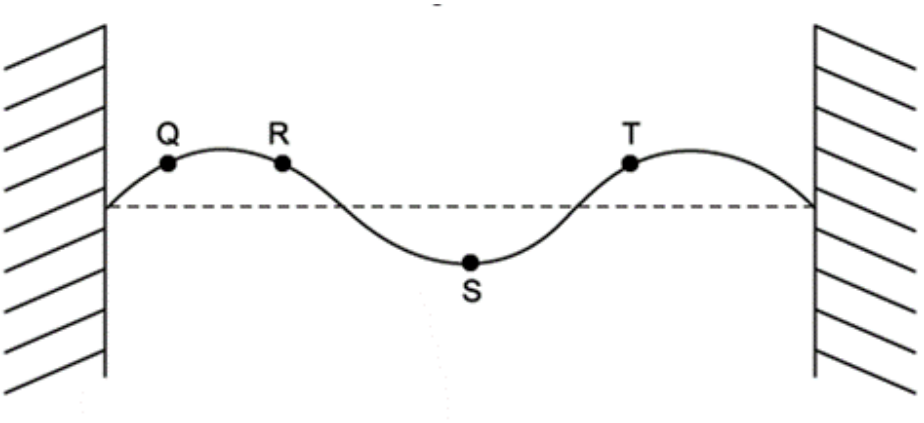
[1]

(ii) The ground state of hydrogen is –13.6 eV. Calculate the speed of the slowest electron that could cause this excitation of a hydrogen atom.

[2]

(3 marks)

5 (a) The diagram shows the appearance of a stationary wave on a stretched string at one instant in time. In the position shown each part of the string is at a maximum displacement.



(a) Mark clearly on the diagram the direction in which points **Q**, **R**, **S** and **T** are about to move.

(2 marks)

(b) In the diagram from part (a), the frequency of vibration is 240 Hz.

(b) Calculate the frequency of the second harmonic for this string.

(2 marks)

(c) The speed of the transverse waves along the string is 55 m s^{-1}.

(c) Calculate the length of the string.

(3 marks)

(d) (d) Compare the amplitude and phase of points **R** and **S** on the string in the diagram used in part (a).

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(2 marks)

6 (a) A manufacturing company is looking to revolutionise the way water can be heated in the home. Fuels can be compared using energy density and specific energy.

(a) Match, by drawing a line, energy density and specific energy to the quantity they compare and their units.

Specific Energy	Mass	$J\ m^{-3}$
Energy Density	Volume	$J\ kg^{-1}$

[4]

(4 marks)

(b) Kerosene is a clean and cost−effective energy source for heating water. The specific energy of Kerosene is 48×10^6 J kg^{-1} and the energy density is 3.3×10^{10} J m^{-3}.

$$Density = \frac{Energy\ density}{Specific\ energy}$$

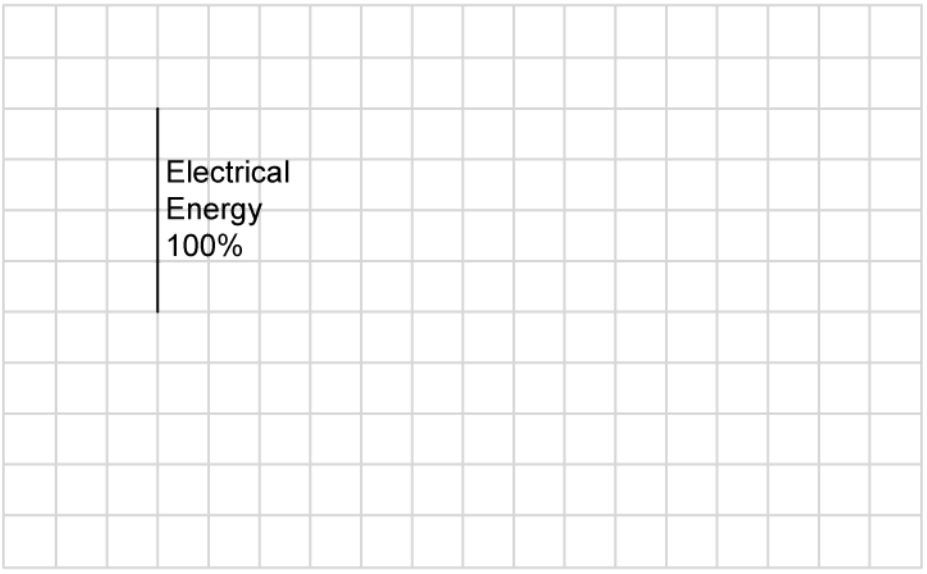
(b) Calculate the density of Kerosene.

[3]

(3 marks)

(c) A new kettle is being developed that claims to be 75% efficient.

(c) Sketch a Sankey diagram on the squares below to represent this situation.



[3]

(3 marks)

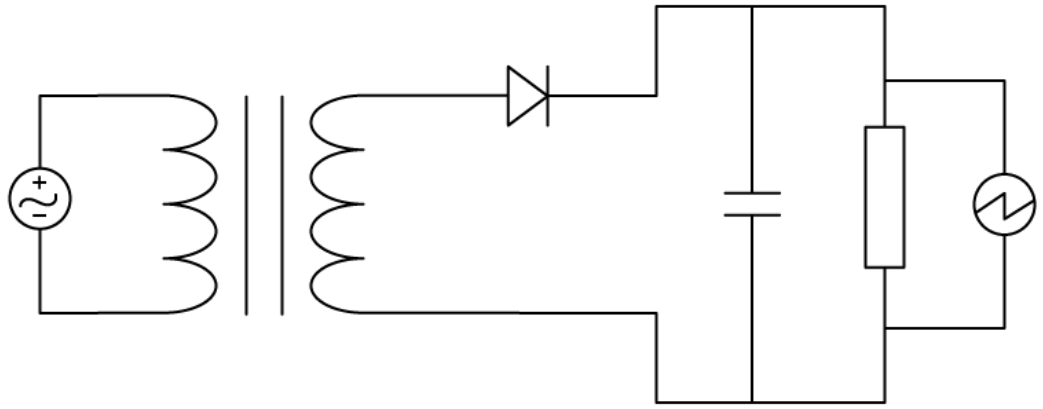
(d) In a new prototype kettle, claimed to be 95% efficient, 300 000 J of energy is required to raise the temperature of the full kettle of water from room temperature to boiling point.

(d) Calculate the amount of energy wasted by the kettle.

[2]

(2 marks)

7 (a) An investigation into rectification used the circuit shown.

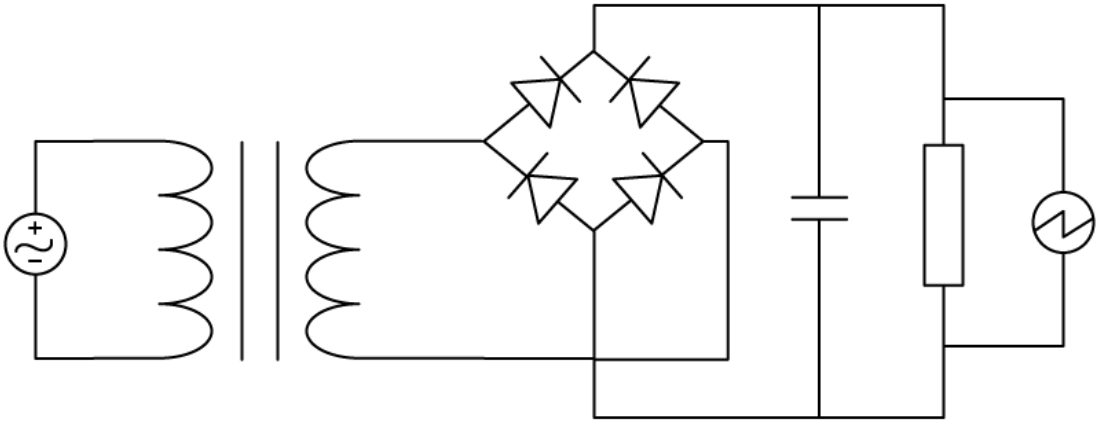


(a) For this investigation, sketch the resulting graph.

[2]

(2 marks)

(b) The investigation continues, using a second circuit.

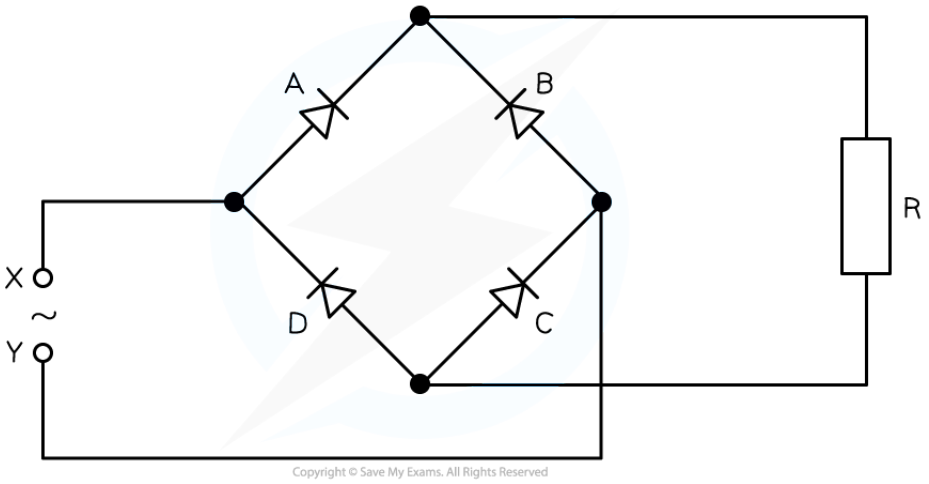


(b) Sketch the expected graph of the output voltage for this circuit.

[3]

(3 marks)

(c) A bridge rectifier consisting of four ideal diodes is connected to an ac generator with terminals X and Y.

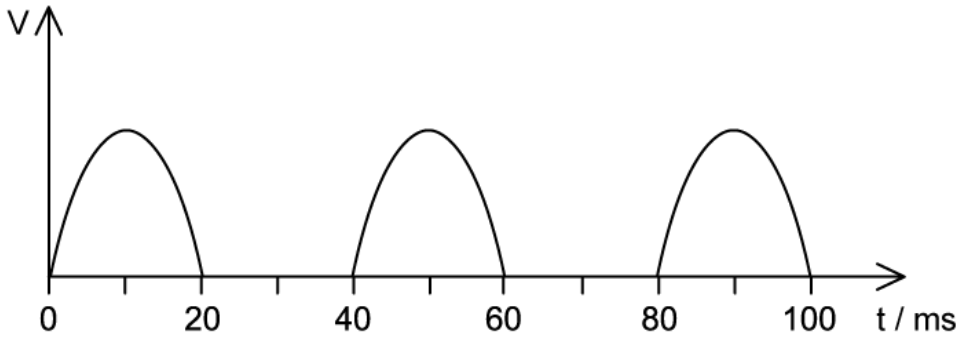


(c) Identify which diodes are conducting when terminal X of the ac generator is negative.

[2]

(2 marks)

(d) The graph shows the output from an ac generator after undergoing half-wave rectification.



The load resistor has a resistance of 3.6 kΩ. Capacitors of 360 nF and 60 μF are available.

(d) Select the appropriate capacitor to smooth this output.

[3]

(3 marks)

8 (a) (a) Show that all nuclei have the same density.

[3]

(3 marks)

(b) A beam of neutrons is fired normally at a thin foil sheet made from tin. The beam has energy 75 MeV and the first diffraction minimum is observed at an angle of 15° relative to the central bright fringe.

(b) Calculate an estimate for the radius of the tin nucleus.

[4]

(4 marks)

(c) The tin ($^{50}\mathrm{Sn}$) foil was replaced by thin aluminium ($^{13}\mathrm{Al}$) foil.

(c) Deduce and explain the expected difference in the observations between the two experiments.

[2]

(3 marks)

(d) An isotope of tin has a half-life of 129 days. It undergoes beta-minus decay to a meta-stable isotope of antimony.

(d) Calculate the percentage of the sample which will consist of antimony after 2 years.
[2]

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(2 marks)