IB · DP · Physics

1 hour  8 questions

# Practice Paper 2

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**Total Marks** **/87**

**1 (a)** A truck driver's initial speed is 4.0 m $s^{-1}$ when they begin to accelerate at 6.0 m $s^{-2}$. After 3.0 seconds, they decelerate at 5.0 m $s^{-2}$ to stop at a set of traffic lights.

(a) Calculate the distance between the traffic lights and the point where the truck began to accelerate.

[4]

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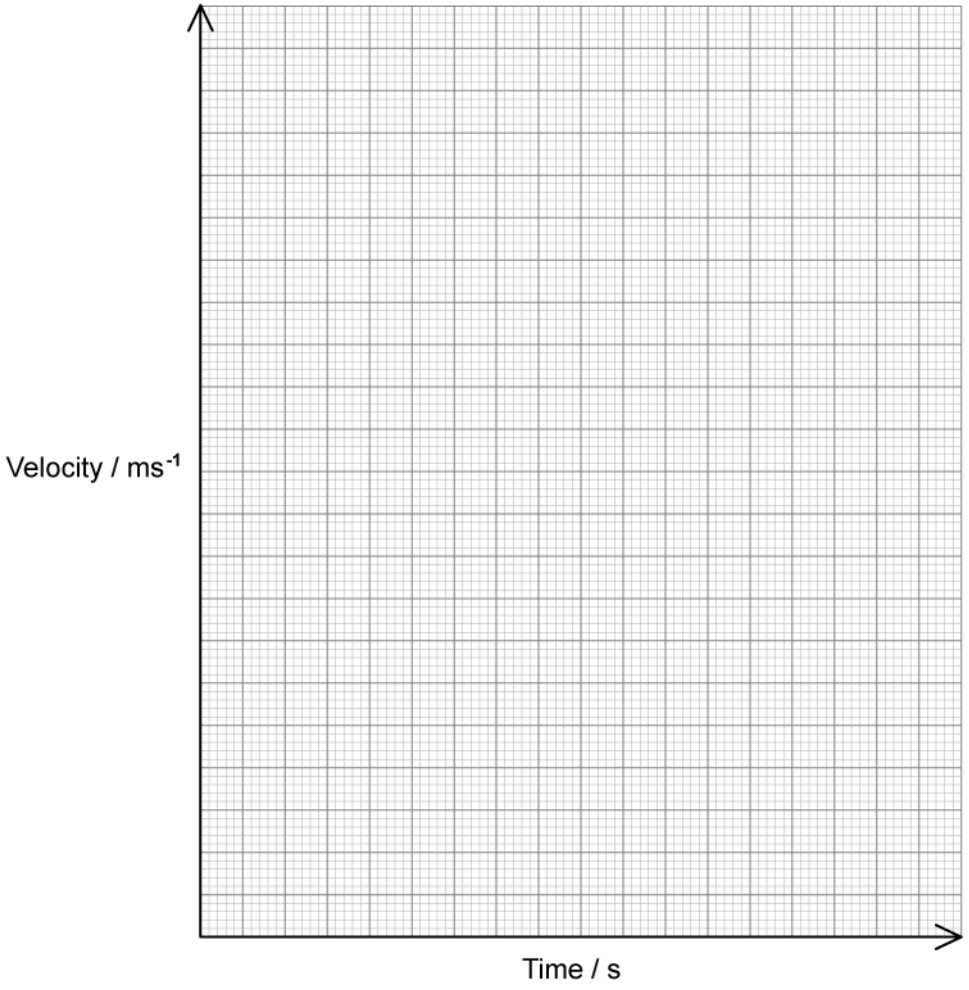
**(4 marks)**

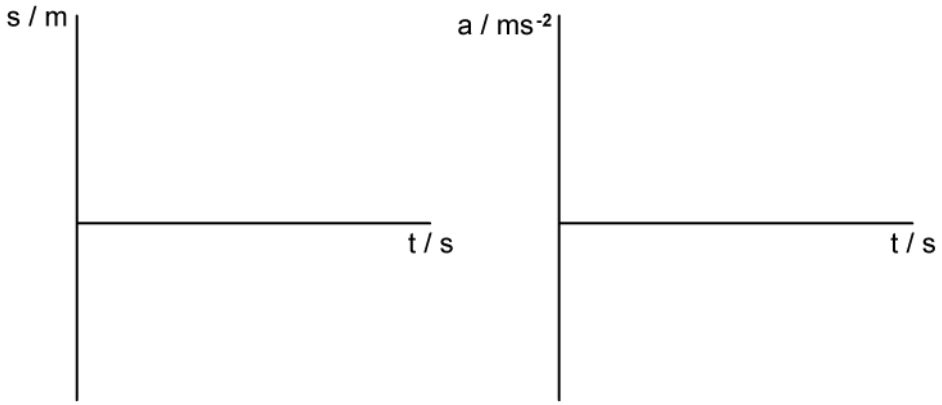
**(b)** (b) Draw the velocity-time graph on the axes provided for the motion of the truck in part (a).



[4]

**(4 marks)**

**(c)** (c) Sketch the displacement-time and acceleration-time graphs for the truck on the pair of axes provided. Label each axes appropriately.




[4]

**(4 marks)**

**2 (a)** A transformer inside the charger of a household appliance has a primary coil at 230 V and a secondary coil at 80 V. The number of turns in the primary coil is 1650.

(a) Calculate the number of turns in the secondary coil.

[3]

**(3 marks)**

**(b)** (b) Hence, state whether this is a step-up or step-down transformer. Explain your answer.

[2]

**(2 marks)**

**(c)** The appliance has an output power of 30 W.

(c) Calculate the output current for the appliance.

[3]

**(3 marks)**

**(d)** (d) Outline how eddy currents are reduced in the core of a transformer.

[2]

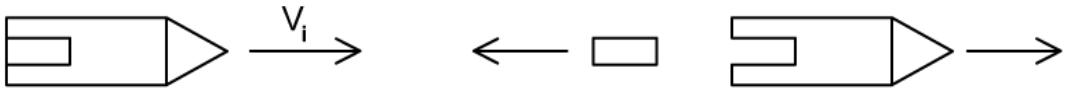
**(2 marks)**

**3 (a)** A space rocket is moving with constant velocity. The engines of the space rocket are turned on and it accelerates by burning fuel and ejecting gases.

(a) Discuss how the law of conservation of momentum allows the space rocket to accelerate forward, although it ejects gases in the opposite direction.

**(3 marks)**

**(b)** A rocket is travelling at constant velocity in space after exiting the Earth's atmosphere. The engines are turned off, and a module separates from the rocket.




The module has a mass of 6 000 kg and is ejected at 10 km $s^{-1}$. The combined mass of the rocket and the module is 81 000 kg and the remaining part of the rocket after the explosion travels at 4500 m $s^{-1}$ after the module has been ejected.

(b) Calculate the initial speed of the rocket.

**(4 marks)**

**(c)** Inside the rocket, some walls are padded to reduce damage to its interior when it is accelerated into space.

(c) Explain, with reference to change in momentum, why padded walls are less likely to cause damage to the interior of the rocket compared to a rigid wall.

**(2 marks)**

**4 (a)** Superposition occurs when two or more waves interfere with each other.

(a) (I) Explain the conditions required for a consistent stationary interference pattern to form during superposition.

[2]

(ii) Sketch a diagram to support your answer to part (i).

[2]

**(4 marks)**

**(b)** Superposition is often demonstrated using water waves which are transverse and clearly show increases and decreases in amplitude.

(b) Describe how sound waves can also undergo superposition.

**(3 marks)**

**(c)** Two microwave transmitters are placed 15 cm apart and connected to the same source. A receiver is placed 70 cm away and moved along a line parallel to the transmitters. The receiver detects and alternating pattern of maxima and minima.

(c) Explain how the maxima and minima are formed.

**(3 marks)**

**(d)** One transmitter is removed and a metal grille is placed between the transmitter and the receiver. The grille is rotated through $180^{o}$ and back round again. The signal at the receiver is heard to rise and fall as the grill rotates.

(d) (i) Explain what causes the rising and falling signal.

[2]

(ii) Sketch a graph to show the pattern of rising and falling signal.

[2]

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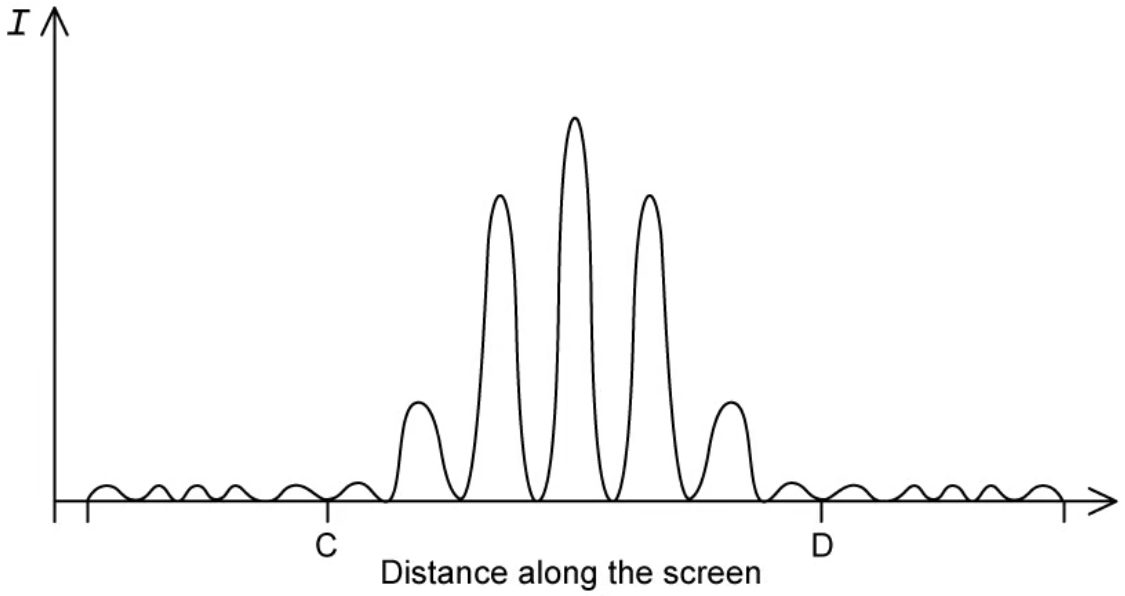
**(4 marks)**

**5 (a)** Monochromatic light is incident on a double-slit diffraction grating. After passing through the slits the light is brought to a focus on a screen. The intensity distribution of the light on the screen is shown in the diagram below.




The double-slit diffraction grating is now changed to a grating with many narrower slits, the same widths as the slits above.

(a) Sketch the new intensity pattern for the light between points C and D on the screen.

[3]

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**(3 marks)**

**(b)** The wavelength of the monochromatic light incident on the diffraction grating is 550 nm. The slit spacing of the diffraction grating is $1.34 \times 10^{-6}$ m.

(b) Calculate the angle between the two second-order maxima.

[2]

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**(2 marks)**

**(c)** (c) Calculate the total number of orders of diffracted light that can be observed on the screen.

[2]

**(2 marks)**

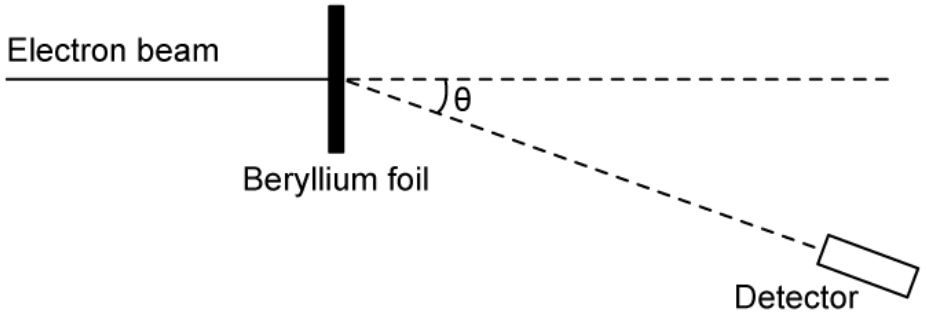
**(d)** Two sources of light now replace the light incident on the diffraction grating. One is the same as the wavelength of the previous source and the other has a slightly longer wavelength.

(d) Compare and contrast the new intensity pattern with the original. Comment on the intensity of the central maxima and the width of all maxima.

[3]

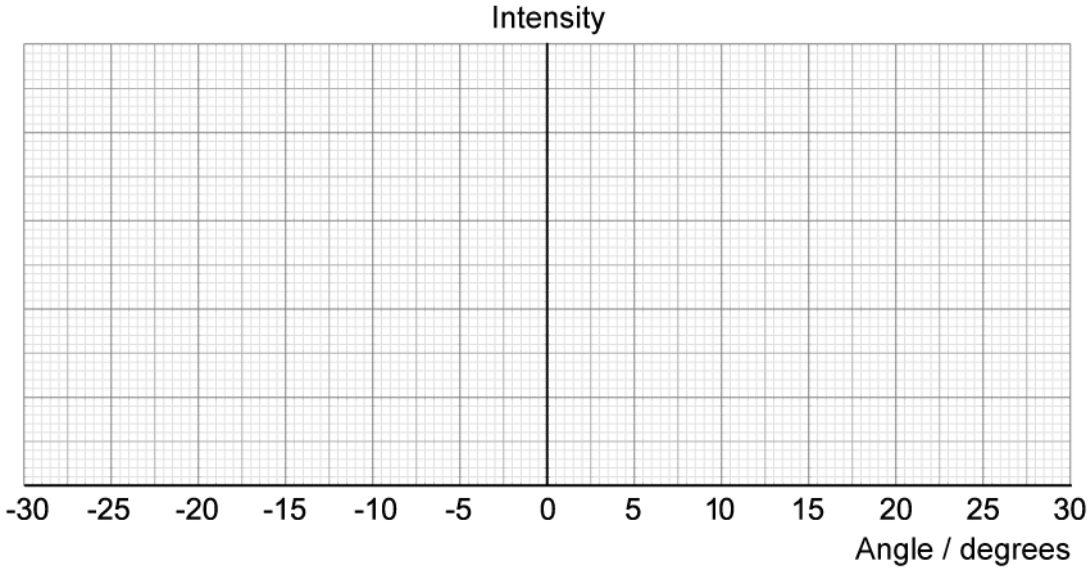
**(3 marks)**

**6 (a)** An electron beam of energy $1.3 \times 10^{-10}$ J is used to study the nuclear radius of beryllium-9. The beam is directed from the left at a thin sample of beryllium-9. A detector is placed at an angle $\theta$ relative to the direction of the incident beam.




The radius of a beryllium-9 nucleus is $2.9 \times 10^{-15}$ m. The beryllium-9 nuclei behave like a diffraction grating.

(a) Sketch the expected variation of electron intensity against the angle from the horizontal.




[3]

**(3 marks)**

**(b)** The isotope beryllium-10 is formed when a nucleus of deuterium $\left({}_{1}^{2}\mathrm{H}\right)$ collides with a nucleus of beryllium-9 $\left({}_{4}^{9}\mathrm{Be}\right)$. The radius of a deuterium nucleus is 1.5 fm.

(b)

(i) Determine the minimum initial kinetic energy, in J, that the deuterium nucleus must have in order to produce the isotope beryllium-10.

[2]

(ii) Outline an assumption made in this calculation.

[1]

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**(3 marks)**

**(c)** The nucleus of beryllium-9 is replaced by a nucleus of gold-197.

(c) Suggest the change, if any, to the following:

(i) Distance of closest approach of a deuterium nucleus.

[2]

(ii) Angle of minimum intensity from electron scattering. Assume the electrons have the same energy as in part (a).

[2]

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**(4 marks)**

**7 (a)** A capacitor consists of two parallel square pieces of aluminium separated by a vacuum 1.5 mm apart. The capacitance of the capacitor is 2.9 nF

(a) Calculate the length of one side of the plates.

[3]

**(3 marks)**

**(b)** A sheet of plastic film is placed between the foil which has $\varepsilon = 5\varepsilon_0$.

It begins to conduct when the electric field strength in it exceeds 4.3 MN $C^{-1}$.

(b)

(i) Calculate the maximum charge that can be stored on the capacitor.

[3]

(ii) Explain why the plastic film does not conduct below an electric field strength of 4.3 MN $C^{-1}$.

[1]

**(4 marks)**

**(c)** (c) Show that the change in maximum potential difference between the capacitor before and after the plastic film was introduced Is 26 kV.

[3]

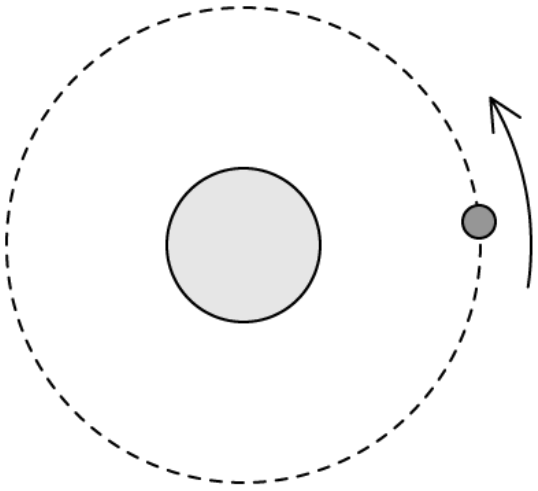
**(3 marks)**

**(d)** (d) Explain how the energy stored in the capacitor changes when the plastic film has been added.

[3]

**(3 marks)**

**8 (a)** A satellite is in a circular orbit around a planet of mass *M*.



(a) Sketch arrows to represent the velocity and acceleration of the satellite.

**(2 marks)**

**(b)** (b) Show that the angular speed, $\omega$ is related to the orbital radius $r$ by

$$r = \sqrt[3]{\frac{GM}{\omega^2}}$$

**(2 marks)**

**(c)** Because of friction with the upper atmosphere, the satellite slowly moves into another circular orbit with a smaller radius before.

(c) Suggest the effect of this on the satellites angular speed.

**(2 marks)**

**(d)** Titus and Enceladus are two of Saturn's moons. Data about these moons are given in the table.

| Moon | Orbit radius / m | Angular speed / rad $s^{-1}$ |
|---|---|---|
| Titan | $1.22 \times 10^{9}$ | |
| Enceladus | $2.38 \times 10^{8}$ | $5.31 \times 10^{-5}$ |

(d) Determine the mass of Saturn.

**(3 marks)**