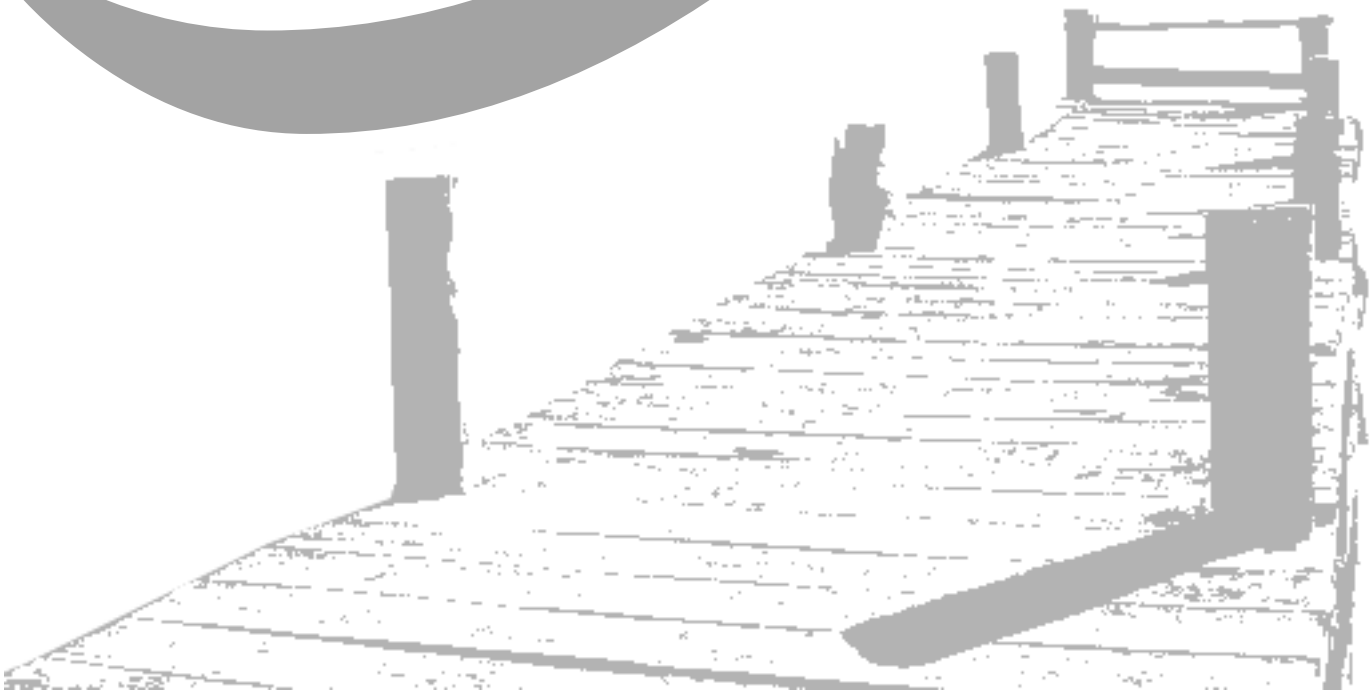
GCE
AS and A Level

Physics A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 4A: Approved specimen question paper

Version 1.3



General Certificate of Education
2010
Advanced Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

version 1.3

PHYSICS A PHYA4/1
Unit 4: Fields and Further Mechanics

Section A

SPECIMEN PAPER

For this paper you must have:
- an objective test answer sheet
- black ball-point pen
- a calculator
- a question paper/answer book for Section B (enclosed)

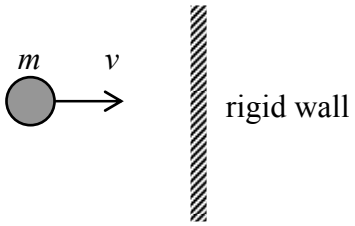
Instructions
- Use a black ball-point pen. Do **not** use pencil.
- Answer **all** questions in this section.
- For each question there are four responses. When you have selected the response which you think is the most appropriate answer to a question, mark this response on your answer sheet.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book **not** on the answer sheet.

Information
- The maximum mark for this paper is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

1 For the two physical quantities, impulse and force, which one of the following is correct?

A Impulse is a scalar and force is a scalar.
B Impulse is a scalar and force is a vector.
C Impulse is a vector and force is a scalar.
D impulse is a vector and force is a vector.

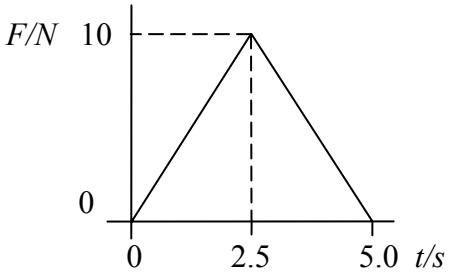
2 A particle of mass *m* strikes a rigid wall perpendicularly from the left with velocity *v*.



If the collision is perfectly elastic, the change in momentum of the particle which occurs as a result of the collision is

A 2*mv* to the right.
B 2*mv* to the left.
C *mv* to the left.
D zero.

3



A force, *F*, varies with time, *t*, as shown by the graph and is applied to a body initially at rest on a smooth surface. What is the momentum of the body after 5.0 s?

A zero.
B 12.5 N s.
C 25 N s.
D 50 N s.

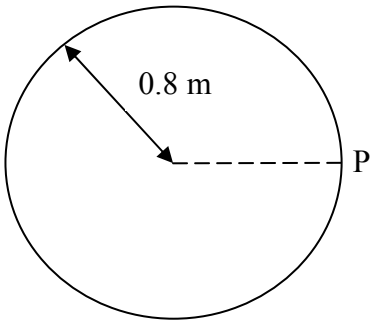
4 The rate of change of momentum of a body falling freely under gravity is equal to its

A weight.
B power.
C kinetic energy.
D potential energy.

5 What is the value of the angular velocity of a point on the surface of the Earth?

A 1.2×10^{-5} rad s^{-1}
B 7.3×10^{-5} rad s^{-1}
C 2.6 × 10-1 rad s^{-1}
D 4.6×10^{2} rad s^{-1}

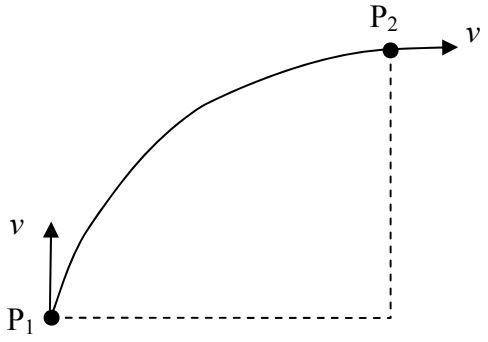
6



A model car moves in a circular path of radius 0.8 m at an angular speed of $\frac{\pi}{2}$ rad s^{-1}. What is its displacement from point P, 6 s after passing P?

A zero
B 1.6 m
C 0.4 πm
D 1.6 πm

7 A particle of mass m moves horizontally at constant speed v along the arc of a circle from P_1 to P_2 under the action of a force. What is the work done on the particle by the force during this displacement?



A zero

B $\frac{\pi m v^2}{2}$

C $mv^2\sqrt{2}$

D $2\,mv^2$

8 A body moves with simple harmonic motion of amplitude 0.50 m and period 4π seconds. What is the speed of the body when the displacement of the body from the equilibrium position is 0.30 m?

A $0.10\ \text{m s}^{-1}$
B $0.15\ \text{m s}^{-1}$
C $0.20\ \text{m s}^{-1}$
D $0.40\ \text{m s}^{-1}$

9 The time period of a simple pendulum is doubled when the length of the pendulum is increased by 3.0 m. What is the original length of the pendulum?

A 1.0 m
B 1.5 m
C 3.0 m
D 6.0 m

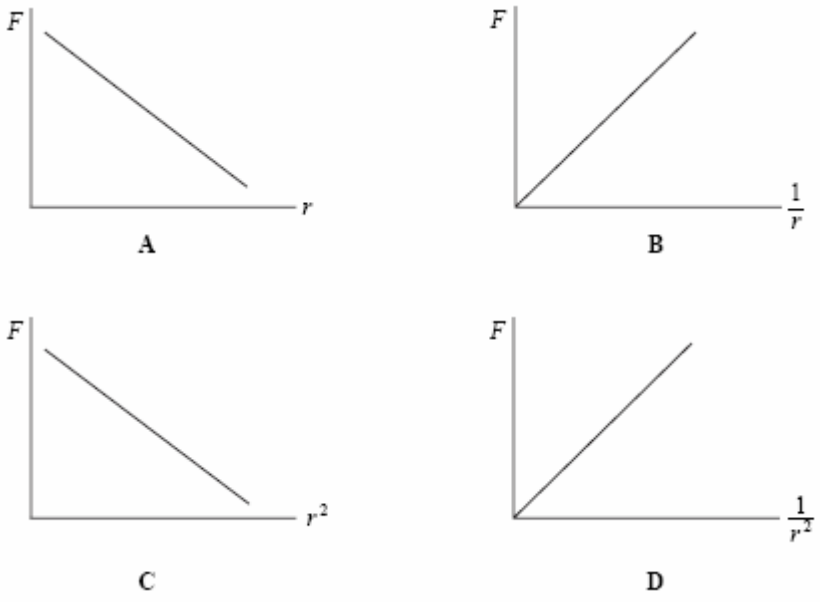
10 Which one of the following statements is **not** true for a body vibrating in simple harmonic motion when damping is present?

A The damping force is always in the opposite direction to the velocity.
B The damping force is always in the opposite direction to the displacement.
C The presence of damping gradually reduces the maximum potential energy of the system.
D The presence of damping gradually reduces the maximum kinetic energy of the system.

11 The Earth has density ρ and radius R. The gravitational field strength at the surface is g. What is the gravitational field strength at the surface of a planet of density 2ρ and radius $2R$?

A g
B $2g$
C $4g$
D $16g$

12 Which one of the following graphs correctly shows the relationship between the gravitational force, F, between two masses and their separation, r?



13 Near the surface of a planet the gravitational field strength is uniform and for two points, 10 m apart vertically, the gravitational potential difference is 3 J kg^{-1}. How much work must be done in raising a mass of 4 kg vertically through 5 m?

A 3 J
B 6 J
C 12 J
D 15 J

14 Two isolated point charges are separated by 0.04 m and attract each other with a force of 20 μN. If the distance between them is increased by 0.04 m, what is the new force of attraction?

A 5 μN
B 10 μN
C 20 μN
D 40 μN

15 Two protons, each of mass *m* and charge *e*, are a distance *d* apart. Which one of the following expressions correctly gives the ratio $\left(\frac{\text{electrostatic force}}{\text{gravitational force}}\right)$ for the forces acting between them?

A $\frac{4\pi\varepsilon_0 e^2}{Gm^2}$

B $\frac{Ge^2}{4\pi\varepsilon_0 m^2}$

C $\frac{e^2 m^2}{4\pi\varepsilon_0 G}$

D $\frac{e^2}{4\pi\varepsilon_0 Gm^2}$

16 An electron travelling at constant speed enters a uniform electric field at right angles to the field. While the electron is in the filed it accelerates in a direction which is

A in the same direction as the electric field
B in the opposite direction to the electric field
C in the same direction as the motion of the electron
D in the opposite direction to the motion of the electron

17 Which one of the following statements about electric potential and electric field strength is correct?

A electric potential is zero whenever the electric field strength is zero
B electric field strength is a scalar quantity
C electric potential is a vector quantity
D electric potential due to a point charge varies as (1/*r*) where *r* is the distance from the point charge

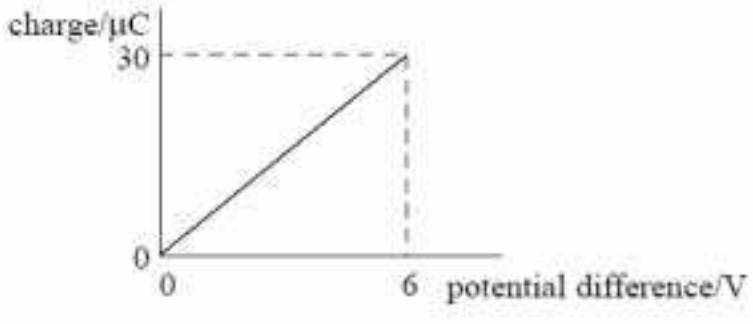
18 A 1000 μF capacitor and a 10 μF capacitor are charged so that the potential difference across each of them is the same. The charge stored in the 1000 μF capacitor is Q_1 and the charge stored in the 10 μF capacitor is Q_2. What is the ratio $\frac{Q_1}{Q_2}$?

A 100
B 10
C 1
D $\frac{1}{100}$

19 In experiments to pass a very high current through a gas, a bank of capacitors of total capacitance 50 μF is charged to 30kV. If the bank of capacitors could be discharged completely in 5.0 ms, what would be the mean power delivered?

A 22 kW
B 110 kW
C 4.5 MW
D 9.0 MW

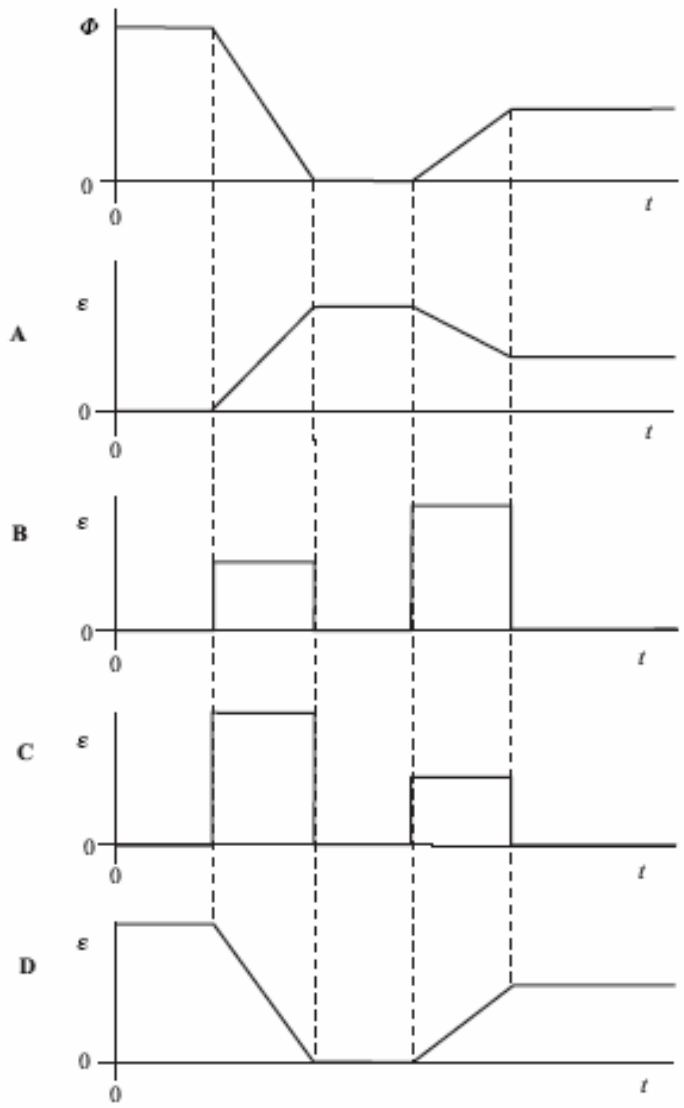
20 The graph shows how the charge stored by a capacitor varies with the potential difference across it as it is charged from a 6 V battery.



Which one of the following statements is **not** correct?

A The capacitance of the capacitor is 5.0 μF.
B When the potential difference is 2 V the charge stored is 10 μC.
C When the potential difference is 2 V the energy stored is 10 μJ.
D When the potential difference is 6 V the energy stored is 180 μJ.

21 The magnetic flux, Φ, through a coil varies with time, t, as shown by the first graph. Which one of the following graphs, A to D, best represents how the magnitude, ϵ, of the induced emf varies in this same period of time?



22 Protons, each of mass m and charge e, follow a circular path when travelling perpendicular to a magnetic field of uniform flux density B. What is the time taken for one complete orbit?

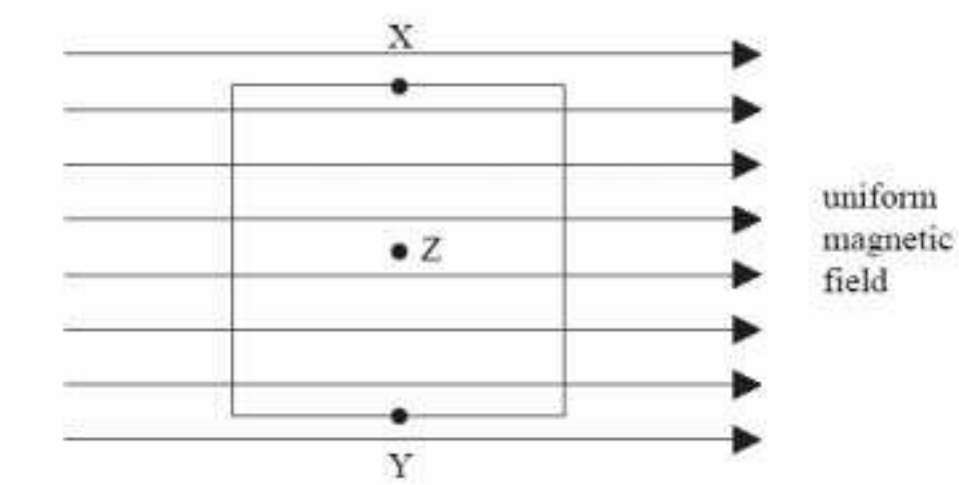
A $\dfrac{2\pi eB}{m}$

B $\dfrac{m}{2\pi eB}$

C $\dfrac{eB}{2\pi m}$

D $\dfrac{2\pi m}{eB}$

23



The diagram shows a square coil with its plane parallel to a uniform magnetic field. Which one of the following would induce an emf in the coil?

A movement of the coil slightly to the left
B movement of the coil slightly downwards
C rotation of the coil about an axis through XY
D rotation of the coil about an axis perpendicular to the plane of the coil through Z

24 The primary winding of a perfectly efficient transformer has 200 turns and the secondary has 1000 turns. When a sinusoidal pd of rms value 10 V is applied to the input, there is a primary current of rms value 0.10 A rms. Which line in the following table, **A** to **D**, gives correct rms output values obtainable from the secondary when the primary is supplied in this way?

	rms output emf/V	**rms output current/A**
A	50	0.10
B	50	0.02
C	10	0.10
D	10	0.02

25 Why, when transporting electricity on the National Grid, are high voltages and low currents used?

A The energy lost by radiation from electromagnetic waves is reduced.
B The electrons move more rapidly.
C The heat losses are reduced.
D The resistance of the power lines is reduced.

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Physics A

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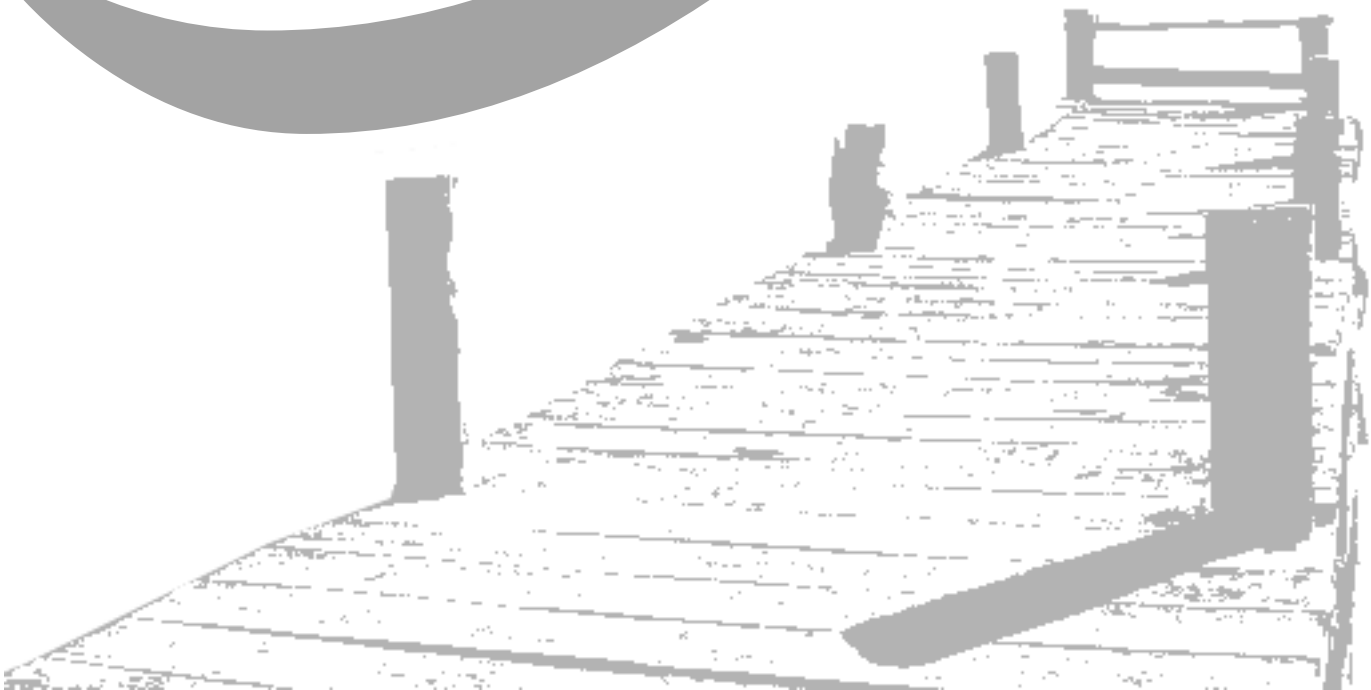
Unit 4B: Approved specimen question paper

Version 1.1



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Centre Number						Candidate Number				
Candidate Signature										

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version 1.1

PHYSICS A PHYA4/2
Unit 4 Fields and Further Mechanics

Section B

SPECIMEN PAPER

Time allowed: 1 hour

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- A *Data and Formula Booklet* is provided as a loose insert.

Information
- The maximum mark for this paper is 50.
- The marks for the questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers. You will be assessed on your quality of written communication where indicated in the question.

For Examiner's Use			
Number	Mark	Number	Mark
1		**5**	
2		**6**	
3			
4			
Total (Column 1)			
Total (Column 2)			
TOTAL			
Examiner's Initials			

1 A golf club undergoes an *inelastic* collision with a stationary golf ball and gives it an initial velocity of 60 m s^{-1}. The ball is in contact with the club for 15 ms and the mass of the ball is 4.5×10^{-2} kg.

(a) Explain what is meant by an inelastic collision.

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(1 mark)

(b) Calculate

(i) the change in momentum of the ball,

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(ii) the average force the club exerts on the ball.

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(4 marks)

Total 5 marks

2 (a) A spring, which hangs from a fixed support, extends by 40 mm when a mass of 0.25 kg is suspended from it.

(i) Calculate the spring constant of the spring.

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(ii) An additional mass of 0.44 kg is then placed on the spring and the system is set into vertical oscillation. Show that the oscillation frequency is 1.5 Hz.

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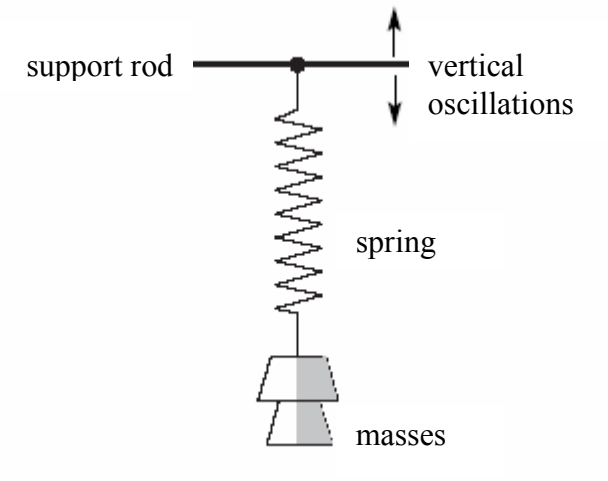
(4 marks)

(b) With both masses still in place, the spring is now suspended from a horizontal support rod that can be made to oscillate vertically, as shown in **Figure 1**, with amplitude 30 mm at several different frequencies.

Figure 1



The response of the masses suspended from the spring to the vertical oscillations of the support rod varies with frequency. Describe and explain, as fully as you can, the motion of the masses when the support rod oscillates at a frequency of (i) 0.2 Hz, (ii) 1.5 Hz and (iii) 10 Hz.
The quality of your written answer will be assessed in this question.

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(6 marks)

Total 10 marks

3 Communications satellites are usually placed in a *geo-synchronous* orbit.

(a) State **two** features of a geo-synchronous orbit.

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(2 marks)

(b) The mass of the Earth 6.00×10^{24} kg and its mean radius is 6.40×10^{6} m.

(i) Show that the radius of a geo-synchronous orbit must be 4.23×10^{7} m,

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(ii) Calculate the increase in potential energy of a satellite of 750 kg when it is raised from the Earth's surface into a geo-synchronous orbit.

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(6 marks)

(c) Satellites in orbits nearer the Earth than geo-synchronous satellites may be used in the future to track road vehicles.

(i) State and explain **one** reason why geo-synchronous satellites would not be suitable for such a purpose.

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(ii) Give **two** points you would make in arguing for or against tracking road vehicles. Explain your answers.

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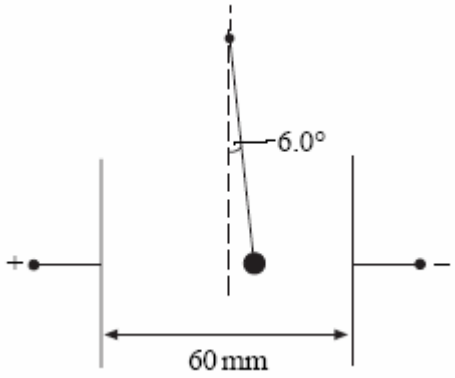
(4 marks)

Total 12 marks

4 A small charged sphere of mass 2.1×10^{-4} kg, suspended from a thread of insulating material, was placed between two vertical parallel plates 60 mm apart. When a potential difference of 4200 V was applied to the plates, the sphere moved until the thread made an angle of 6.0º to the vertical, as shown in **Figure 2**.

Figure 2



(a) Show that the electrostatic force F on the sphere is given by $F = mg \tan 6.0º$, where m is the mass of the sphere.

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(3 marks)

(b) Calculate the charge on the sphere.

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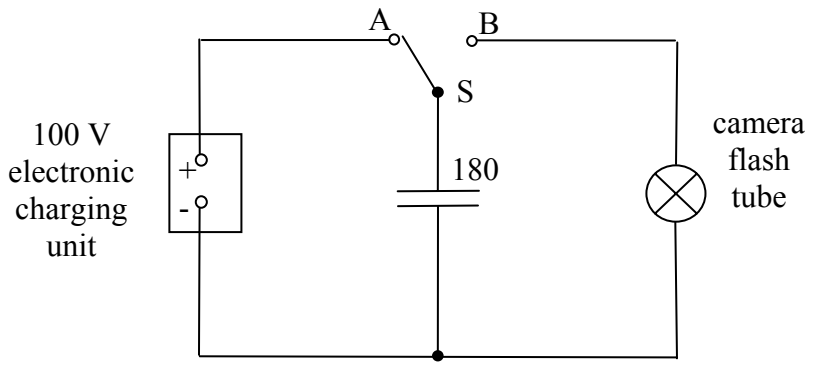
(3 marks)

Total 6 marks

5 The flash tube in a camera produces a flash of light when a 180 μF capacitor is discharged across the tube.

Figure 3



(a) The capacitor is charged to a pd of 100 V from an electronic charging unit in the camera, as shown in **Figure 3**.
Calculate,

(i) the energy stored in the capacitor,

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(ii) the work done by the battery.

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(2 marks)

(b) When a photograph is taken, switch S in **Figure 3** is automatically moved from A to B and the capacitor is discharged across the flash tube. The discharge circuit has a resistance of 1.5 Ω. Emission of light from the flash tube ceases when the pd falls below 30 V.

(i) Calculate the duration of the light flash.

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(ii) The capacitor in the circuit in **Figure 3** is replaced by a capacitor of greater capacitance. Discuss the effect of this change on the photograph image of a moving object.

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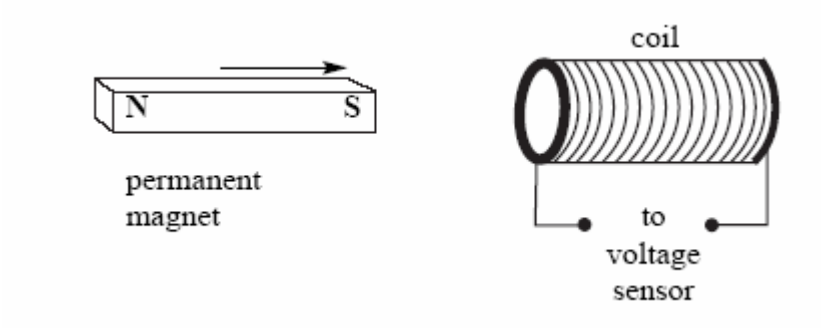
(4 marks)

Total 6 marks

6 (a) In an experiment to illustrate electromagnetic induction, a permanent magnet is moved towards a coil, as shown in **Figure 4**, causing an emf to be induced across the coil.

Figure 4



Using Faraday's law, explain why a larger emf would be induced in this experiment if a stronger magnet were moved at the same speed.

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(3 marks)

(b) A conductor of length l is moved at constant speed v so that is passes perpendicularly through a uniform magnetic field of flux density B, as shown in **Figure 5**.

Figure 5

Show that the induced emf, ϵ, across the ends of the conductor is given by

$$\epsilon = Blv.$$

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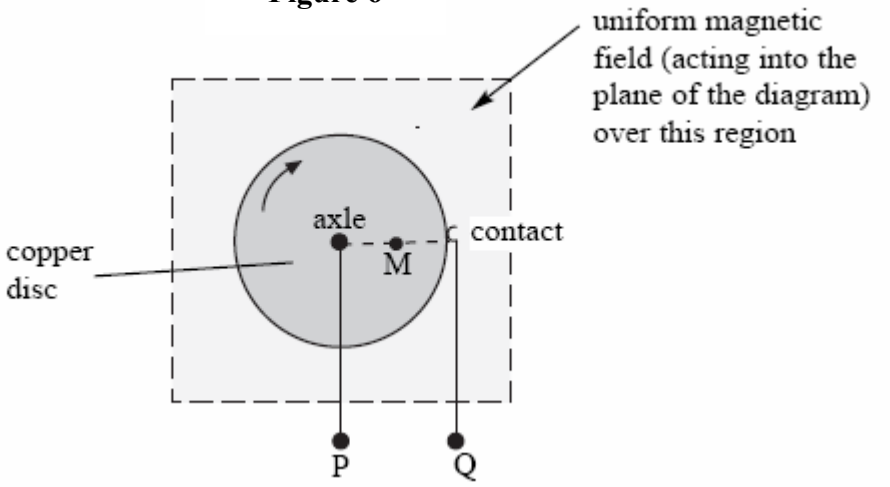
(3 marks)

(c) A simple electrical generator can be made from a copper disc, which is rotated at right angles to a magnetic field, directed into the plane of the diagram (**Figure 6**). An emf is developed across the terminals P (connected to the axle) and Q (connected to a contact on the edge of the disc).

Figure 6



The radius of the disc is 64 mm and it is rotated at 16 revolutions per second in a uniform magnetic field of flux density 28 mT.

(i) Calculate the angular speed of the disc.

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(ii) Calculate the linear speed of mid-point M of a radius of the disc.

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(iii) Hence, or otherwise, calculate the emf induced across the terminals P and Q.

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(5 marks)

Total 11 marks