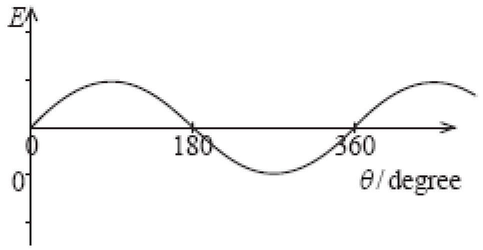
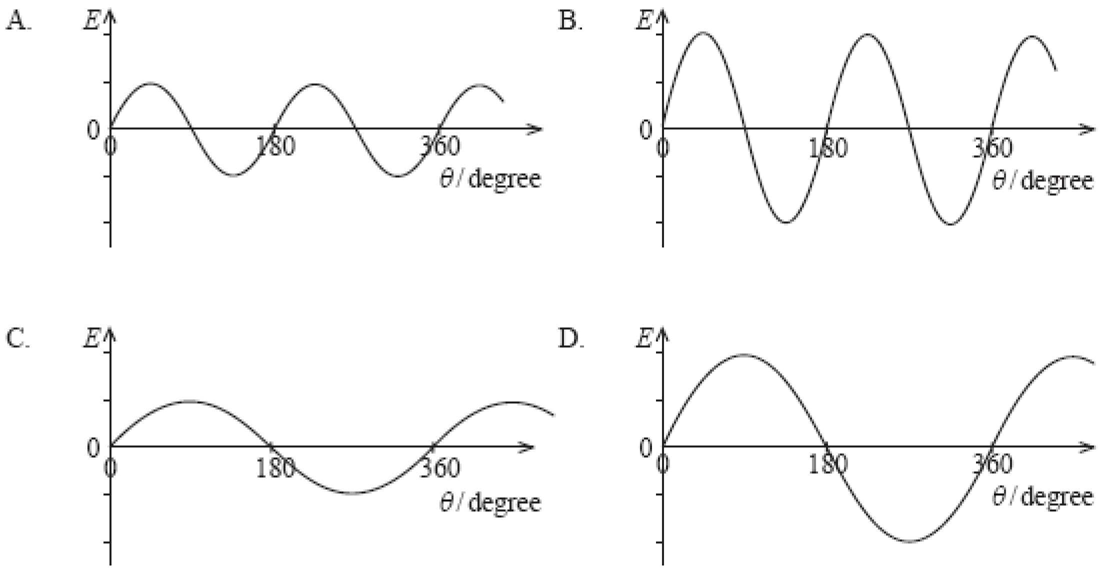
1. M05 H1 TZ1: 33

A coil rotates at a constant rate in a uniform magnetic field. The angle of rotation of the coil from its starting position is θ.

The variation with angle θ of the e.m.f. E generated in the coil is shown below.



Which **one** of the following graphs best shows the variation with θ from the starting position of the e.m.f. E when the rate of rotation of the coil is doubled?



2. M05 H1 TZ2: 27

A magnetic force acts on an electric charge in a magnetic field when

A. the charge is not moving.

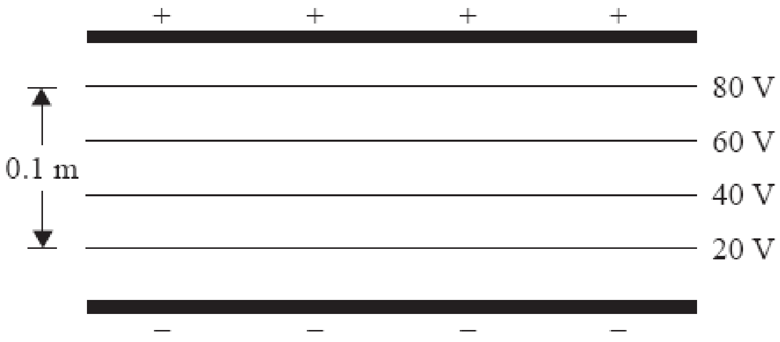
B. the charge moves in the direction of the magnetic field.

C. the charge moves in the opposite direction to the magnetic field.

D. the charge moves at right angles to the lines of the magnetic field.

3. M05 H1 TZ2: 29

The diagram below illustrates some equipotential lines between two charged parallel metal plates.



The electric field strength between the plates is

A. $6\,\text{N}\,\text{C}^{-1}$.

B. $8\,\text{N}\,\text{C}^{-1}$.

C. $600\,\text{N}\,\text{C}^{-1}$.

D. $800\,\text{N}\,\text{C}^{-1}$.

4. M05 H1 TZ2: 31

An ideal transformer has N_p turns on the primary coil and N_s turns on the secondary coil. The input power of the primary coil is P. The output power at the secondary coil is

A. P.

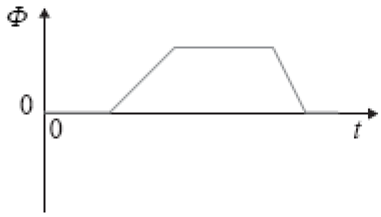
B. $\left(\frac{N_p}{N_s}\right)P$.

C. $\left(\frac{N_s}{N_p}\right)P$.

D. $\left(1-\frac{N_s}{N_p}\right)P$.

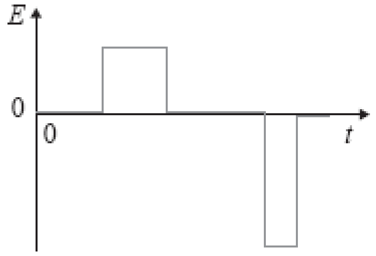
5. M05 H1 TZ2: 30

The variation with time t of the magnetic flux Φ through a coil is shown below.

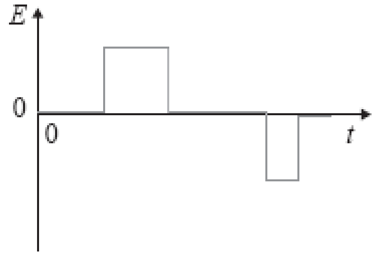


Which of the following diagrams best shows the variation with time t of the e.m.f. E induced in the coil?

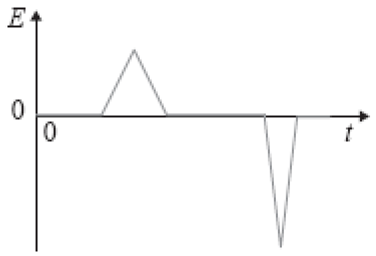
A.



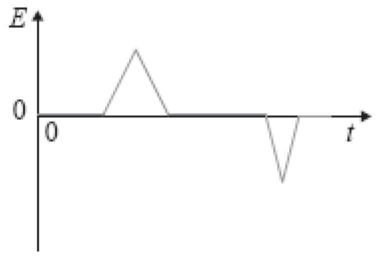
B.



C.



D.



6. M05 H2 TZ1: B2p2

Part 2 The satellite and electrical power generation

(a) Define *gravitational field strength.*

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(b) Use the definition of gravitational field strength to deduce that

$$GM = g_0 R^2$$

where M is the mass of the Earth, R it's radius and g_0 is the gravitational field strength at the surface of the Earth. (You may assume that the Earth is a uniform sphere with its mass concentrated at its centre.)

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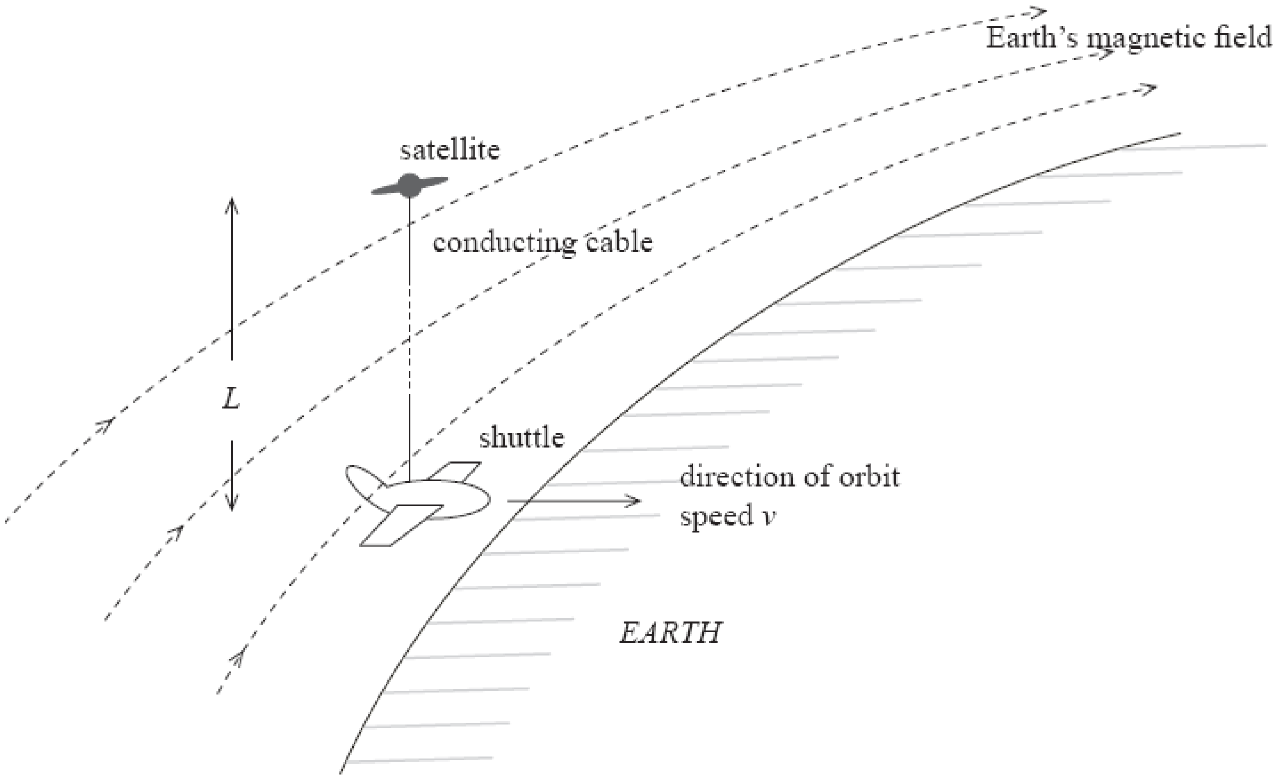
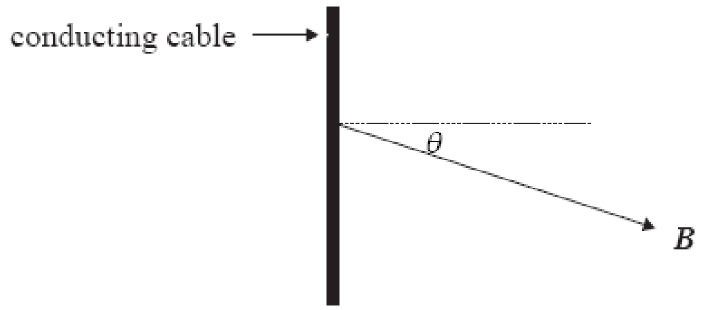
A space shuttle orbits the Earth and a small satellite is launched from the shuttle. The satellite carries a conducting cable connecting the satellite to the shuttle. When the satellite is a distance L from the shuttle, the cable is held straight by motors on the satellite.

Diagram 1



As the shuttle orbits the Earth with speed v, the conducting cable is moving at right angles to the Earth's magnetic field. The magnetic field vector $\boldsymbol{B}$ makes an angle θ to a line perpendicular to the conducting cable as shown in diagram 2. The velocity vector of the shuttle is directed out of the plane of the paper.

Diagram 2



(c) On diagram 2, draw an arrow to show the direction of the magnetic force on an electron in the conducting cable. Label the arrow F.

(d) State an expression for the force F on the electron in terms of B, v, e and θ, where B is the magnitude of the magnetic field strength and e is the electron charge.

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(e) Hence deduce an expression for the e.m.f. E induced in the conducting wire.

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(f) The shuttle is in an orbit that is 300 km above the surface of the Earth. Using the expression

$$GM = g_0 R^2$$

and given that $R = 6.4\times10^6$ m and $g_0 = 10\,\mathrm{N\,kg^{-1}}$, deduce that the orbital speed v of the satellite is $7.8\times10^3\ \mathrm{m\,s^{-1}}$.

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(g) The magnitude of the magnetic field strength is 6.3×10^{-6} T and the angle $\theta = 20°$. Estimate the length L of the cable required in order to generate an e.m.f. of 1 kV.

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