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| Centre Number       |  |  |  |  |  | Candidate Number |  |  |  |  |
| Surname             |  |  |  |  |  |                  |  |  |  |  |
| Other Names         |  |  |  |  |  |                  |  |  |  |  |
| Candidate Signature |  |  |  |  |  |                  |  |  |  |  |



General Certificate of Education  
Advanced Level Examination  
January 2012

## Physics A

## PHYA4/1

### Unit 4 Fields and Further Mechanics Section A

Tuesday 24 January 2012 1.30 pm to 3.15 pm

**In addition to this paper you will require:**

- an objective test answer sheet
- a black ink or black ball-point pen
- a calculator
- a question paper/answer book for Section B (enclosed)
- a Data and Formulae booklet.

#### Time allowed

- The total time for both sections of this paper is 1 hour 45 minutes. You are advised to spend approximately 45 minutes on this section.

#### Instructions

- Use black ink or 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

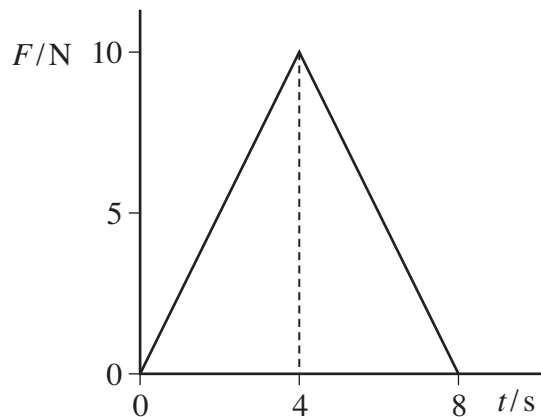
- The maximum mark for this section is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

**Multiple choice questions**

Each of Questions 1 to 25 is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response and mark its letter on the answer sheet.

You are advised to spend approximately **45 minutes** on this section.

- 1** A ball of mass 2.0 kg, initially at rest, is acted on by a force  $F$  which varies with time  $t$  as shown by the graph.



What is the velocity of the ball after 8.0 s?

- A**  $20 \text{ m s}^{-1}$   
**B**  $40 \text{ m s}^{-1}$   
**C**  $80 \text{ m s}^{-1}$   
**D**  $160 \text{ m s}^{-1}$
- 2** A body X moving with a velocity  $v$  makes an elastic collision with a stationary body Y of equal mass on a smooth horizontal surface.

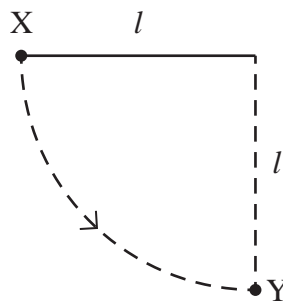


Which line, **A** to **D**, in the table gives the velocities of the two bodies after the collision?

|          | velocity of X  | velocity of Y  |
|----------|----------------|----------------|
| <b>A</b> | $\frac{v}{2}$  | $-\frac{v}{2}$ |
| <b>B</b> | $-\frac{v}{2}$ | $\frac{v}{2}$  |
| <b>C</b> | $v$            | 0              |
| <b>D</b> | 0              | $v$            |

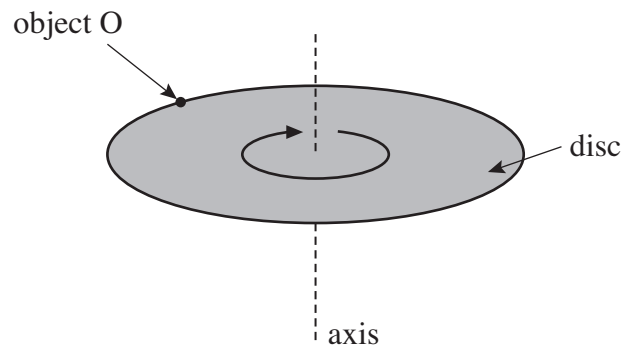


- 3 A ball of mass  $m$ , which is fixed to the end of a light string of length  $l$ , is released from rest at X.  
It swings in a circular path, passing through the lowest point Y at speed  $v$ .



If the tension in the string at Y is  $T$ , which one of the following equations represents a correct application of Newton's laws of motion to the ball at Y?

- A  $T = \frac{mv^2}{l} - mg$   
 B  $mg - T = \frac{mv^2}{l}$   
 C  $T - mg = \frac{mv^2}{l}$   
 D  $T + \frac{mv^2}{l} = mg$
- 4 A disc of diameter  $D$  is turning at a steady angular speed at frequency  $f$  about an axis through its centre.



What is the centripetal force on a small object O of mass  $m$  on the perimeter of the disc?

- A  $2\pi mfD$   
 B  $2\pi mf^2D$   
 C  $2\pi^2 mf^2D$   
 D  $2\pi mf^2D^2$

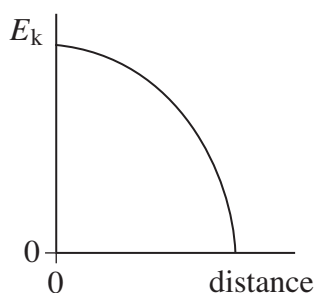
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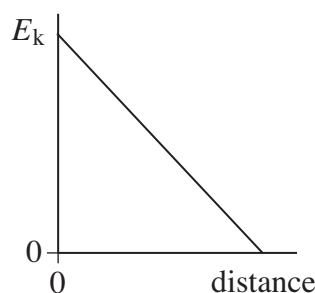
- 5 What is the angular speed of a car wheel of diameter 0.400 m when the speed of the car is  $108 \text{ km h}^{-1}$ ?
- A  $75 \text{ rad s}^{-1}$   
 B  $150 \text{ rad s}^{-1}$   
 C  $270 \text{ rad s}^{-1}$   
 D  $540 \text{ rad s}^{-1}$

- 6 Which one of the following statements is true when an object performs simple harmonic motion about a central point O?
- A The acceleration is always directed away from O.  
 B The acceleration and velocity are always in opposite directions.  
 C The acceleration and the displacement from O are always in the same direction.  
 D The graph of acceleration against displacement is a straight line.

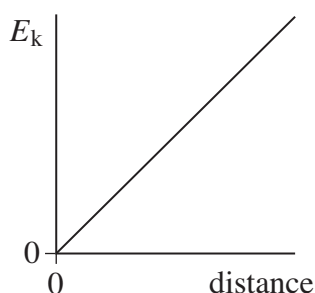
- 7 A body executes simple harmonic motion. Which one of the graphs, A to D, best shows the relationship between the kinetic energy,  $E_k$ , of the body and its distance from the centre of oscillation?



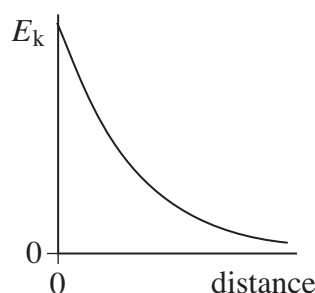
A



B



C



D

- 8 A mechanical system is oscillating at resonance with a constant amplitude. Which one of the following statements is **not** correct?
- A The applied force prevents the amplitude from becoming too large.  
 B The frequency of the applied force is the same as the natural frequency of oscillation of the system.  
 C The total energy of the system is constant.  
 D The amplitude of oscillations depends on the amount of damping.



9 Which one of the following statements about Newton's law of gravitation is correct?

Newton's law of gravitation explains

- A the origin of gravitational forces.
- B why a falling satellite burns up when it enters the Earth's atmosphere.
- C why projectiles maintain a uniform horizontal speed.
- D how various factors affect the gravitational force between two particles.

10 If an electron and proton are separated by a distance of  $5 \times 10^{-11}$  m, what is the approximate gravitational force of attraction between them?

- A  $2 \times 10^{-57}$  N
- B  $3 \times 10^{-47}$  N
- C  $4 \times 10^{-47}$  N
- D  $5 \times 10^{-37}$  N

11 A spherical planet of uniform density  $\rho$  has radius  $R$ .

Which line, **A** to **D**, in the table gives correct expressions for the mass of the planet and the gravitational field strength at its surface?

|          | mass of planet           | gravitational field strength at surface |
|----------|--------------------------|---|
| <b>A</b> | $\frac{4\pi R^2\rho}{3}$ | $\frac{4\pi GR\rho}{3}$                 |
| <b>B</b> | $\frac{4\pi R^3\rho}{3}$ | $\frac{4\pi GR\rho}{3}$                 |
| <b>C</b> | $\frac{4\pi R^2\rho}{3}$ | $\frac{4\pi G\rho}{3}$                  |
| <b>D</b> | $\frac{4\pi R^3\rho}{3}$ | $\frac{4\pi G\rho}{3}$                  |

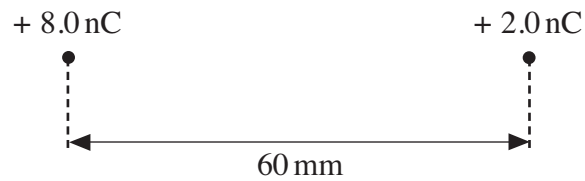
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- 12** The gravitational potential at the surface of the Earth, of radius  $R$ , is  $V$ . What is the gravitational potential at a point at a height  $R$  above the Earth's surface?
- A**  $\frac{V}{4}$
- B**  $\frac{V}{2}$
- C**  $V$
- D**  $2V$
- 13** A satellite is in orbit at a height  $h$  above the surface of a planet of mass  $M$  and radius  $R$ . What is the velocity of the satellite?
- A**  $\sqrt{\frac{GM}{(R+h)}}$
- B**  $\frac{\sqrt{GM(R+h)}}{R}$
- C**  $\sqrt{\frac{GM(R+h)}{R}}$
- D**  $\frac{\sqrt{GM}}{(R+h)}$
- 14** A repulsive force  $F$  acts between two positive point charges separated by a distance  $r$ . What will be the force between them if each charge is doubled and the distance between them is halved?
- A**  $F$
- B**  $2F$
- C**  $4F$
- D**  $16F$



- 15 The distance between two point charges of  $+ 8.0 \text{ nC}$  and  $+ 2.0 \text{ nC}$  is  $60 \text{ mm}$ .



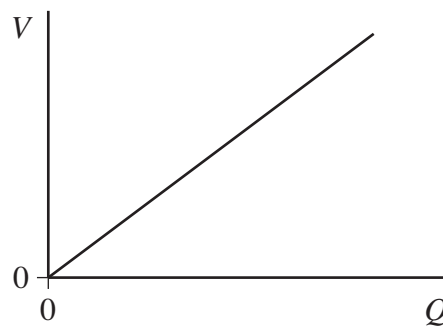
At a point between the charges, on the line joining them, the resultant electric field strength is zero. How far is this point from the  $+ 8.0 \text{ nC}$  charge?

- A 20 mm  
B 25 mm  
C 40 mm  
D 45 mm
- 16 Which one of the following **cannot** be used as a unit for electric field strength?
- A  $\text{J m}^{-1} \text{C}^{-1}$   
B  $\text{J A}^{-1} \text{s}^{-1} \text{m}^{-1}$   
C  $\text{N A}^{-1} \text{s}^{-1}$   
D  $\text{J C m}^{-1}$
- 17 A capacitor stores a charge of  $600 \mu\text{C}$  when charged to a potential difference (pd) of  $6.0 \text{ V}$ . What will be the pd across the plates if the charge stored increases by  $50\%$ ?
- A 3.0 V  
B 4.5 V  
C 9.0 V  
D 12.0 V

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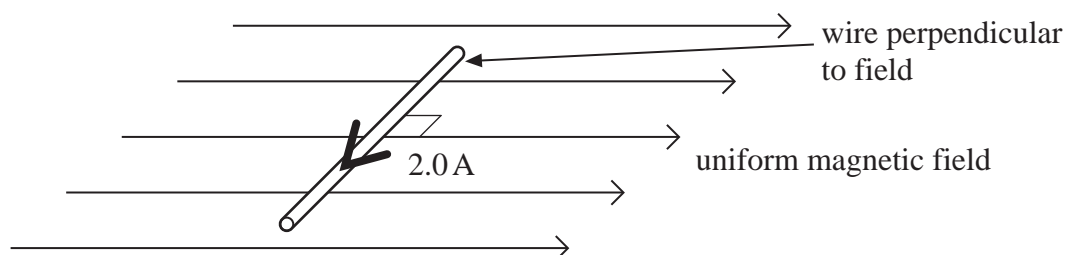


- 18 The graph shows the results of an experiment which was carried out to investigate the relationship between the charge  $Q$  stored by a capacitor and the pd  $V$  across it.



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

- A The energy stored can be calculated by finding the area under the line.
- B If a capacitor of smaller capacitance had been used the gradient of the graph would be steeper.
- C If  $Q$  were doubled, the energy stored would be quadrupled.
- D The gradient of the graph is equal to the capacitance of the capacitor.
- 19 A  $10\ \mu\text{F}$  capacitor is fully charged to a pd of  $3.0\ \text{kV}$ . The energy stored in the capacitor can be used to lift a load of  $5.0\ \text{kg}$  through a vertical height  $h$ . What is the approximate value of  $h$ ?
- A  $0.03\ \text{mm}$
- B  $0.9\ \text{mm}$
- C  $0.3\ \text{m}$
- D  $0.9\ \text{m}$
- 20 A horizontal straight wire of length  $0.30\ \text{m}$  carries a current of  $2.0\ \text{A}$  perpendicular to a horizontal uniform magnetic field of flux density  $5.0 \times 10^{-2}\ \text{T}$ . The wire 'floats' in equilibrium in the field.



What is the mass of the wire?

- A  $8.0 \times 10^{-4}\ \text{kg}$
- B  $3.1 \times 10^{-3}\ \text{kg}$
- C  $3.0 \times 10^{-2}\ \text{kg}$
- D  $8.2 \times 10^{-1}\ \text{kg}$





- 21 When a  $\beta$  particle moves at right angles through a uniform magnetic field it experiences a force  $F$ . An  $\alpha$  particle moves at right angles through a magnetic field of twice the magnetic flux density with velocity one tenth the velocity of the  $\beta$  particle. What is the magnitude of the force on the  $\alpha$  particle?
- A  $0.2F$   
B  $0.4F$   
C  $0.8F$   
D  $4.0F$
- 22 Charged particles, each of mass  $m$  and charge  $Q$ , travel at a constant speed in a circle of radius  $r$  in a uniform magnetic field of flux density  $B$ . Which expression gives the frequency of rotation of a particle in the beam?
- A  $\frac{BQ}{2\pi m}$   
B  $\frac{BQ}{m}$   
C  $\frac{BQ}{\pi m}$   
D  $\frac{2\pi BQ}{m}$
- 23 A 500 turn coil of cross-sectional area  $4.0 \times 10^{-3} \text{ m}^2$  is placed with its plane perpendicular to a magnetic field of flux density  $7.5 \times 10^{-4} \text{ T}$ . What is the value of the flux linkage for this coil?
- A  $3.0 \times 10^{-6} \text{ Wb turns}$   
B  $1.5 \times 10^{-3} \text{ Wb turns}$   
C  $0.19 \text{ Wb turns}$   
D  $94 \text{ Wb turns}$

Turn over ►



**24** The output electromotive force (emf) of a simple ac generator can be increased by any of the four factors listed.

Which one of these factors should **not** be changed if the frequency of the output is to remain unaffected when the emf is increased?

- A the area of the coil
- B the number of turns on the coil
- C the speed of rotation
- D the strength of the magnetic field

**25** Which one of the following would **not** reduce the energy losses in a transformer?

- A using thinner wire for the windings
- B using a laminated core instead of a solid core
- C using a core made from iron instead of steel
- D using a core that allows all the flux due to the primary coil to be linked to the secondary coil

**END OF QUESTIONS**



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