# Physics
# Higher level
# Paper 1

Tuesday 8 November 2016 (morning)

1 hour

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**Instructions to candidates**

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[40 marks]**.



8816 – 6501

**1.** A boy jumps from a wall 3 m high. What is an estimate of the change in momentum of the boy when he lands without rebounding?

A. $5\times10^{0}\,\text{kg m s}^{-1}$

B. $5\times10^{1}\,\text{kg m s}^{-1}$

C. $5\times10^{2}\,\text{kg m s}^{-1}$

D. $5\times10^{3}\,\text{kg m s}^{-1}$

**2.** A car moves north at a constant speed of $3\,\text{m s}^{-1}$ for 20 s and then east at a constant speed of $4\,\text{m s}^{-1}$ for 20 s. What is the average speed of the car during this motion?

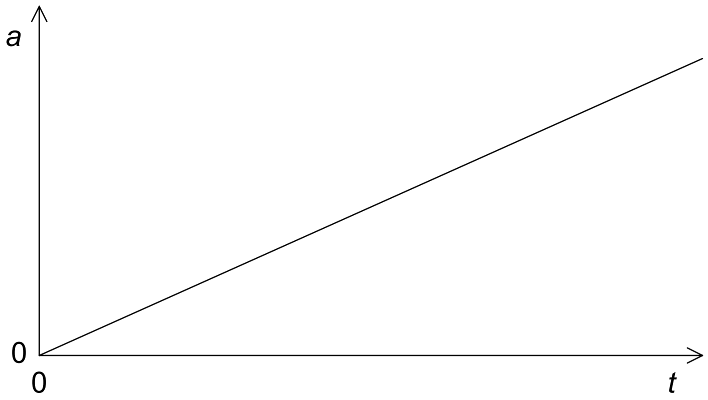
A. $7.0\,\text{m s}^{-1}$

B. $5.0\,\text{m s}^{-1}$

C. $3.5\,\text{m s}^{-1}$

D. $2.5\,\text{m s}^{-1}$

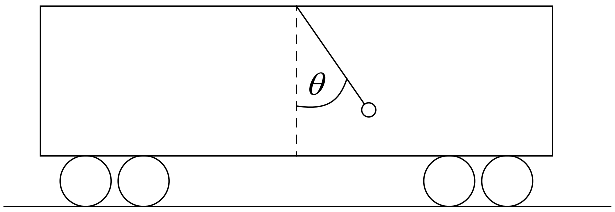
**3.** A student draws a graph to show the variation with time $t$ of the acceleration $a$ of an object.




What can the student deduce from this graph only, and what quantity from the graph is used to make this deduction?

| | Deduction | Quantity used |
|---|---|---|
| A. | change in velocity | gradient of graph |
| B. | change in velocity | area under line |
| C. | change in displacement | gradient of graph |
| D. | change in displacement | area under line |

**4.** A mass is suspended from the ceiling of a train carriage by a string. The string makes an angle $\theta$ with the vertical when the train is accelerating along a straight horizontal track.




What is the acceleration of the train?

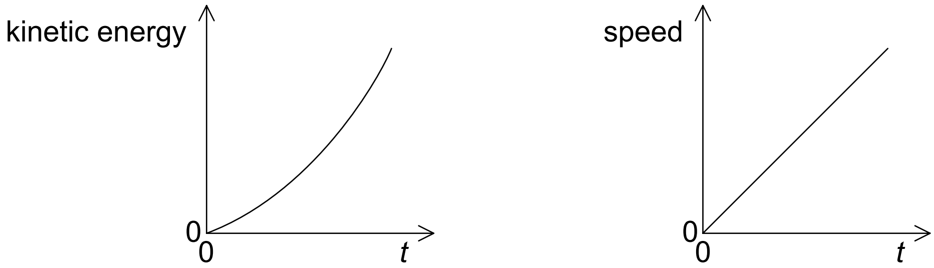
A. $g\sin\theta$

B. $g\cos\theta$

C. $g\tan\theta$

D. $\dfrac{g}{\tan\theta}$

**5.** An object, initially at rest, is accelerated by a constant force. Which graphs show the variation with time $t$ of the kinetic energy and the variation with time $t$ of the speed of the object?

A.
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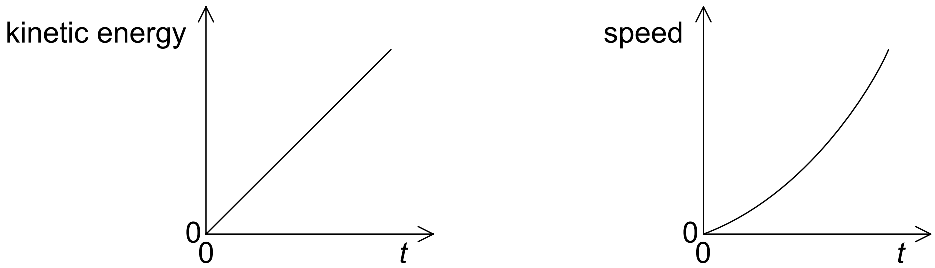


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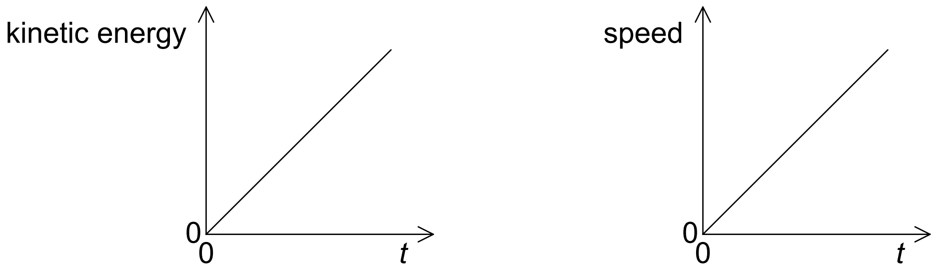


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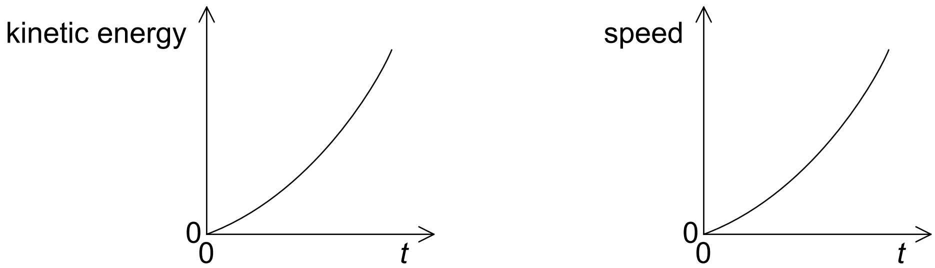
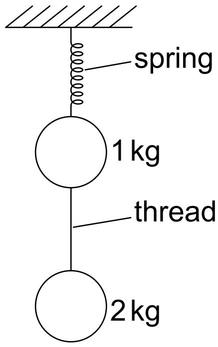


**6.** Two stationary objects of mass 1 kg and 2 kg are connected by a thread and suspended from a spring.




The thread is cut. Immediately after the cut, what are the magnitudes of the accelerations of the objects in terms of the acceleration due to gravity $g$?

| | **Acceleration of 1 kg object** | **Acceleration of 2 kg object** |
|---|---|---|
| A. | $3g$ | $2g$ |
| B. | $2g$ | $2g$ |
| C. | $3g$ | $1g$ |
| D. | $2g$ | $1g$ |

**7.** An object of mass 2 kg is thrown vertically downwards with an initial kinetic energy of 100 J. What is the distance fallen by the object at the instant when its kinetic energy has doubled?

A. 2.5 m

B. 5.0 m

C. 10 m

D. 14 m

**8.** A student of weight 600 N climbs a vertical ladder 6.0 m tall in a time of 8.0 s. What is the power developed by the student against gravity?

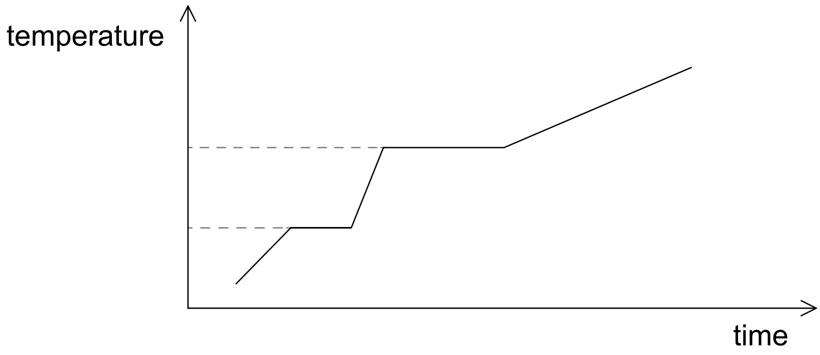
A. 22 W

B. 45 W

C. 220 W

D. 450 W

**9.** Energy is supplied at a constant rate to a fixed mass of a material. The material begins as a solid. The graph shows the variation of the temperature of the material with time.




The specific heat capacities of the solid, liquid and gaseous forms of the material are $c_s$ $c_l$ and $c_g$ respectively. What can be deduced about the values of $c_s$ $c_l$ and $c_g$?

A. $c_s > c_g > c_l$

B. $c_l > c_s > c_g$

C. $c_l > c_g > c_s$

D. $c_g > c_s > c_l$

**10.** The pressure of a fixed mass of an ideal gas in a container is decreased at constant temperature. For the molecules of the gas there will be a decrease in

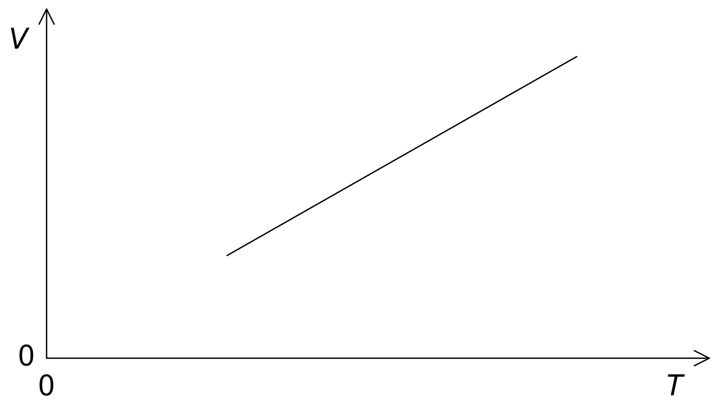
A. the mean square speed.

B. the number striking the container walls every second.

C. the force between them.

D. their diameter.

**11.** An ideal gas of $N$ molecules is maintained at a constant pressure $p$. The graph shows how the volume $V$ of the gas varies with absolute temperature $T$.




What is the gradient of the graph?

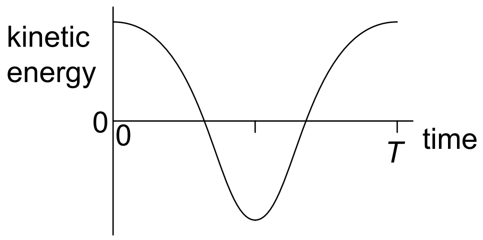
A. $\frac{N}{p}$

B. $\frac{NR}{p}$

C. $\frac{Nk_B}{p}$

D. $\frac{N}{Rp}$

**12.** A particle oscillates with simple harmonic motion (shm) of period $T$. Which graph shows the variation with time of the kinetic energy of the particle?

A.
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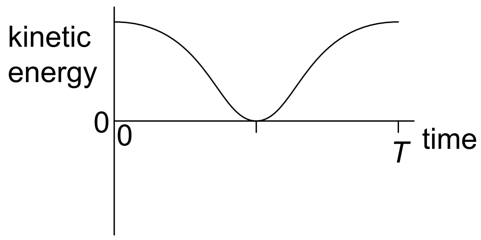


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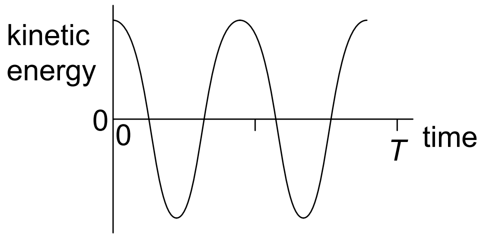


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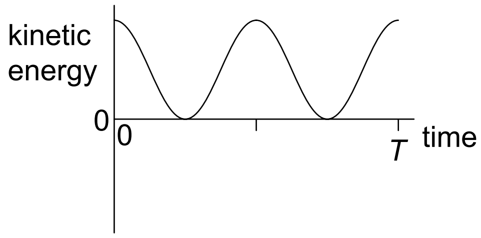
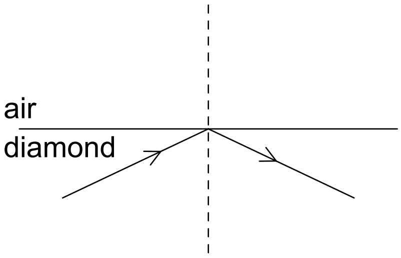
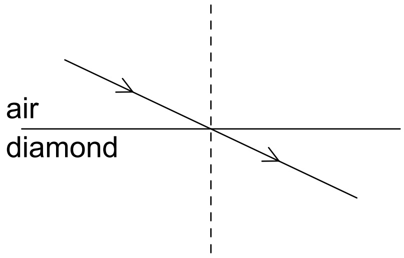


**13.** A light ray is incident on an air–diamond boundary. The refractive index of diamond is greater than 1. Which diagram shows the correct path of the light ray?

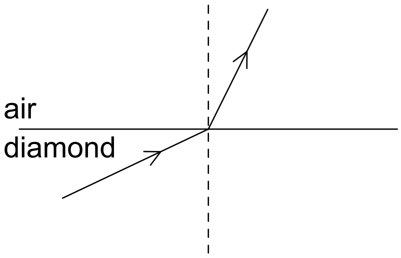
A.




B.




C.

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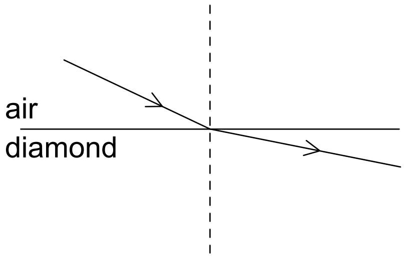



**14.** A point source of light of amplitude $A_0$ gives rise to a particular light intensity when viewed at a distance from the source. When the amplitude is increased and the viewing distance is doubled, the light intensity is doubled. What is the new amplitude of the source?

A. $2A_0$

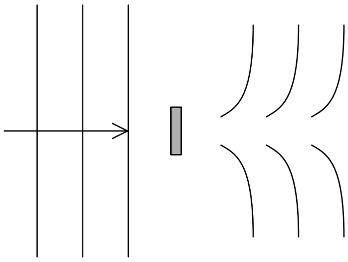
B. $2\sqrt{2}\,A_0$

C. $4A_0$

D. $8A_0$

**15.** Which diagram shows the shape of the wavefront as a result of the diffraction of plane waves by an object?

A.



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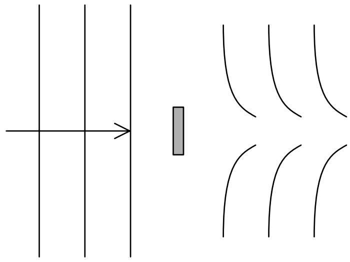
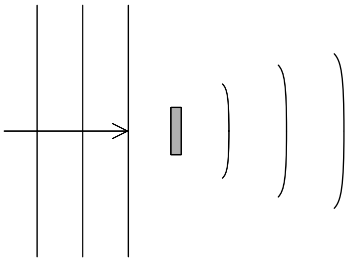
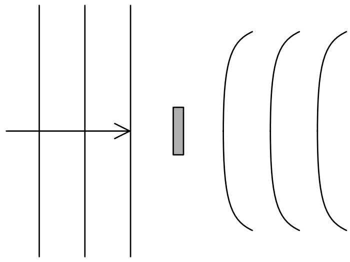


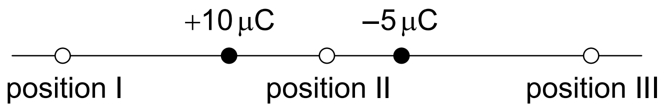
C.



D.



**16.** A –5 μC charge and a +10 μC charge are a fixed distance apart.




not to scale

Where can the electric field be zero?

A. position I only

B. position II only

C. position III only

D. positions I, II and III

**17.** A 12 V battery has an internal resistance of 2.0 Ω. A load of variable resistance is connected across the battery and adjusted to have resistance equal to that of the internal resistance of the battery. Which statement is correct for this circuit?

A. The current in the battery is 6 A.

B. The potential difference across the load is 12 V.

C. The power dissipated in the battery is 18 W.

D. The resistance in the circuit is 1.0 Ω.

**18.** A wire carrying a current $I$ is at right angles to a uniform magnetic field of strength $B$. A magnetic force $F$ is exerted on the wire. Which force acts when the same wire is placed at right angles to a uniform magnetic field of strength $2B$ when the current is $\frac{I}{4}$?

A. $\frac{F}{4}$

B. $\frac{F}{2}$

C. $F$

D. $2F$

**19.** An object at the end of a wooden rod rotates in a vertical circle at a constant angular velocity. What is correct about the tension in the rod?

A. It is greatest when the object is at the bottom of the circle.

B. It is greatest when the object is halfway up the circle.

C. It is greatest when the object is at the top of the circle.

D. It is unchanged throughout the motion.

**20.** Which of the following lists the particles emitted during radioactive decay in order of increasing ionizing power?

A. $\gamma, \beta, \alpha$

B. $\beta, \alpha, \gamma$

C. $\alpha, \gamma, \beta$

D. $\alpha, \beta, \gamma$

**21.** When an alpha particle collides with a nucleus of nitrogen-14 ($^{14}_{7}N$), a nucleus X can be produced together with a proton. What is X?

A. $^{18}_{8}X$

B. $^{17}_{8}X$

C. $^{18}_{9}X$

D. $^{17}_{9}X$

**22.** The mass defect for deuterium is $4\times10^{-30}$ kg. What is the binding energy of deuterium?

A. $4\times10^{-7}$ eV

B. $8\times10^{-2}$ eV

C. $2\times10^{6}$ eV

D. $2\times10^{12}$ eV

**23.** What are the principal energy changes in a photovoltaic cell and in a solar heating panel?

| | **Photovoltaic cell** | **Solar heating panel** |
|---|---|---|
| A. | solar to electrical | solar to thermal |
| B. | solar to thermal | solar to thermal |
| C. | solar to electrical | electrical to thermal |
| D. | solar to thermal | electrical to thermal |

**24.** The solar constant is the intensity of the Sun's radiation at

A. the surface of the Earth.

B. the mean distance from the Sun of the Earth's orbit around the Sun.

C. the surface of the Sun.

D. 10 km above the surface of the Earth.

**25.** X and Y are two spherical black-body radiators that emit the same total power. The absolute temperature of X is half that of Y.

What is $\dfrac{\text{radius of X}}{\text{radius of Y}}$?

A. 4

B. 8

C. 16

D. 32

**26.** A particle is oscillating with simple harmonic motion (shm) of amplitude $x_0$ and maximum kinetic energy $E_k$. What is the potential energy of the system when the particle is a distance $0.20x_0$ from its maximum displacement?

A. $0.20\,E_k$

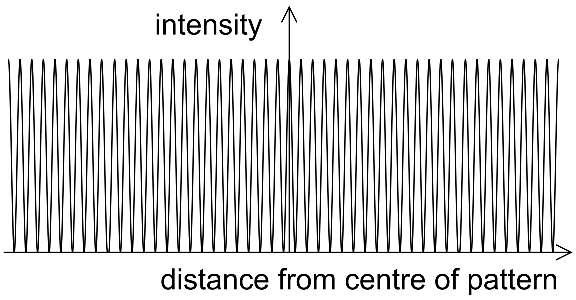
B. $0.36\,E_k$

C. $0.64\,E_k$

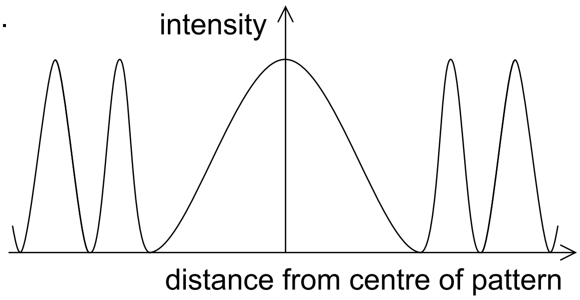
D. $0.80\,E_k$

**27.** Monochromatic light is incident on a double slit. Both slits have a finite width. The light then forms an interference pattern on a screen some distance away. Which graph shows the variation of intensity with distance from the centre of the pattern?

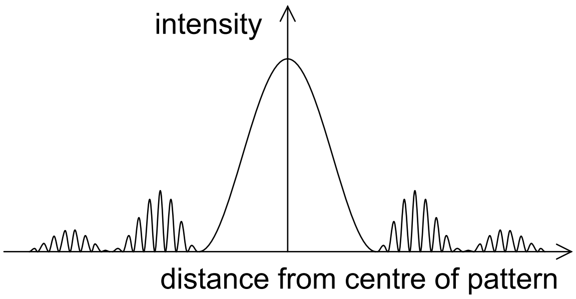
A.



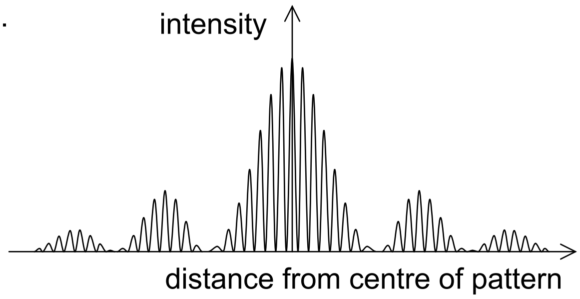

B.




C.




D.




**28.** Light of wavelength $\lambda$ is incident normally on a diffraction grating that has a slit separation of $\frac{7\lambda}{2}$. What is the greatest number of maxima that can be observed using this arrangement?

A. 4

B. 6

C. 7

D. 9

**29.** A diffraction grating is used to observe light of wavelength 400 nm. The light illuminates 100 slits of the grating. What is the minimum wavelength difference that can be resolved when the second order of diffraction is viewed?

A. 1 nm

B. 2 nm

C. 4 nm

D. 8 nm

**30.** What is the unit of $G\varepsilon_0$, where $G$ is the gravitational constant and $\varepsilon_0$ is the permittivity of free space?

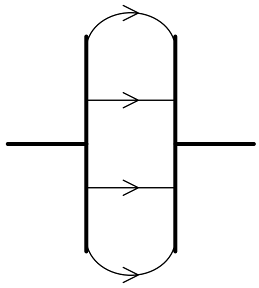
A. $\text{C kg}^{-1}$

B. $\text{C}^2\text{ kg}^{-2}$

C. C kg

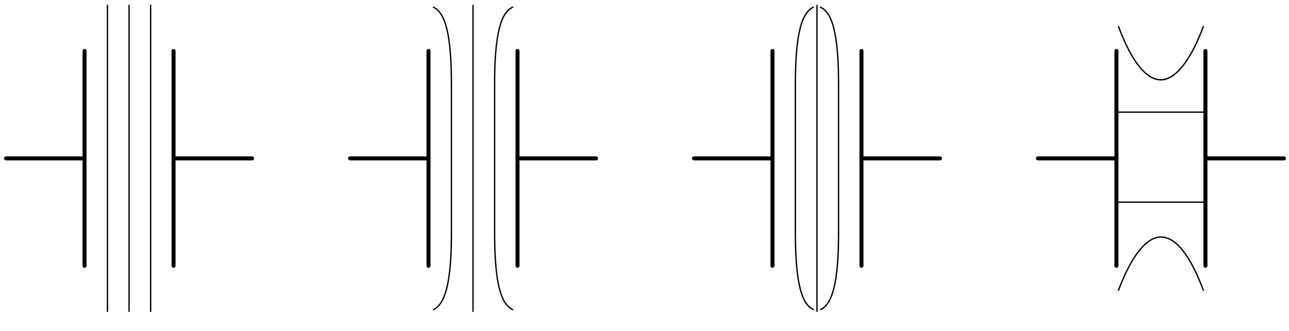
D. $\text{C}^2\text{ kg}^2$

**31.** Two parallel metal plates are connected to a dc power supply. An electric field forms in the space between the plates as shown.



What is the shape of the equipotentials surfaces that result from this arrangement?

A. B. C. D.



**32.** A satellite of mass 1500 kg is in the Earth's gravitational field. It moves from a point where the gravitational potential is $-30\,\text{MJ}\,\text{kg}^{-1}$ to a point where the gravitational potential is $-20\,\text{MJ}\,\text{kg}^{-1}$. What is the direction of movement of the satellite and the change in its gravitational potential energy?

| | **Direction of movement of satellite** | **Change in gravitational potential energy / GJ** |
|---|---|---|
| A. | away from Earth | 15 |
| B. | away from Earth | 75 |
| C. | towards Earth | 15 |
| D. | towards Earth | 75 |

**33.** Which of the following reduces the energy losses in a transformer?

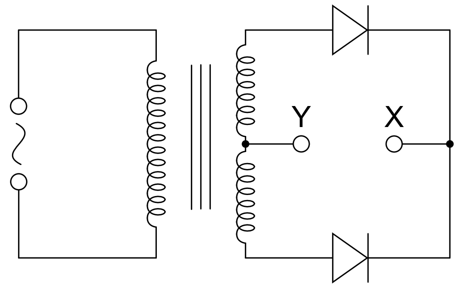
A. Using thinner wires for the windings.

B. Using a solid core instead of a laminated core.

C. Using a core made of steel instead of iron.

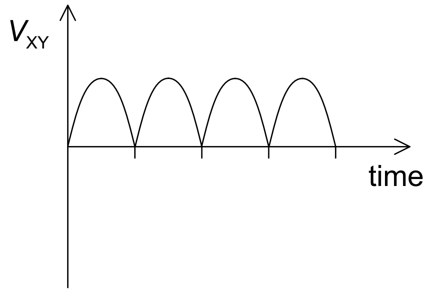
D. Linking more flux from the primary to the secondary core.

**34.** The secondary coil of an alternating current (ac) transformer is connected to two diodes as shown.

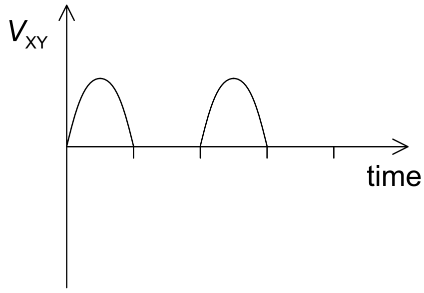



Which graph shows the variation with time of the potential difference $V_{XY}$ between X and Y?

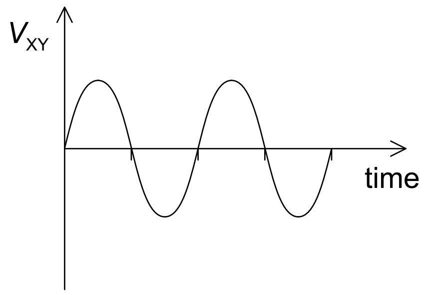
A.



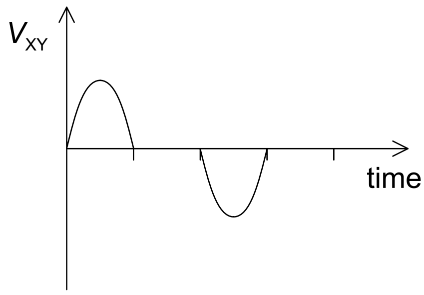

B.




C.




D.




**35.** A parallel-plate capacitor is connected to a battery. What happens when a sheet of dielectric material is inserted between the plates without disconnecting the battery?

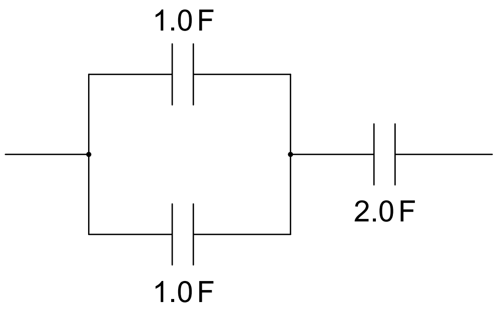
A. The capacitance is unchanged.

B. The charge stored decreases.

C. The energy stored increases.

D. The potential difference between the plates decreases.

**36.** Three capacitors are arranged as shown.




What is the total capacitance of the arrangement?

A. 1.0 F

B. 2.5 F

C. 3.0 F

D. 4.0 F

**37.** Pair production by a photon occurs in the presence of a nucleus. For this process, which of momentum and energy are conserved?

| | **Momentum** | **Energy** |
|---|---|---|
| A. | not conserved | not conserved |
| B. | not conserved | conserved |
| C. | conserved | not conserved |
| D. | conserved | conserved |

**38.** An electron of mass $m$ has an uncertainty in its position $r$. What is the uncertainty in the speed of this electron?

A. $\frac{h}{4\pi r}$

B. $\frac{hr}{4\pi m}$

C. $\frac{hm}{4\pi r}$

D. $\frac{h}{4\pi mr}$

**39.** Which of the following, observed during a radioactive-decay experiment, provide evidence for the existence of nuclear energy levels?

I. The spectrum of alpha particle energies
II. The spectrum of beta particle energies
III. The spectrum of gamma ray energies

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

**40.** What is the charge on an electron antineutrino and during what process is an electron antineutrino produced?

| | **Charge on electron antineutrino** | **Production of electron antineutrino** |
|---|---|---|
| A. | negative | during $\beta^+$ emission |
| B. | negative | during $\beta^-$ emission |
| C. | zero | during $\beta^+$ emission |
| D. | zero | during $\beta^-$ emission |