Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Higher level
Paper 1

Monday 15 May 2017 (afternoon)

1 hour

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]**.

2217 – 6507

19 pages

1. What is the unit of electrical energy in fundamental SI units?

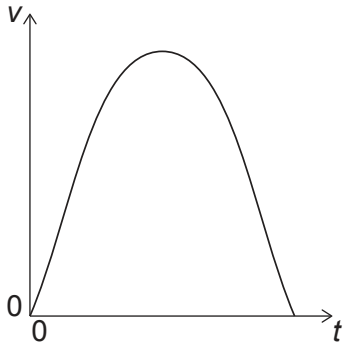
A. $\mathrm{kg\,m^2\,C^{-1}\,s}$

B. $\mathrm{kg\,m\,s^{-2}}$

C. $\mathrm{kg\,m^2\,s^{-2}}$

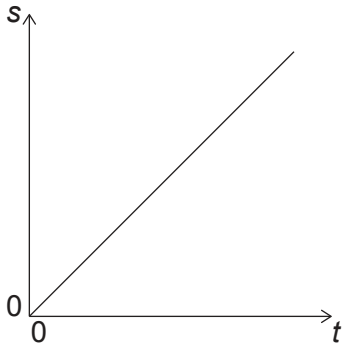
D. $\mathrm{kg\,m^2\,s^{-1}\,A}$

2. The graph shows the variation of speed v of an object with time t.



Which graph shows how the distance s travelled by the object varies with t?

A.



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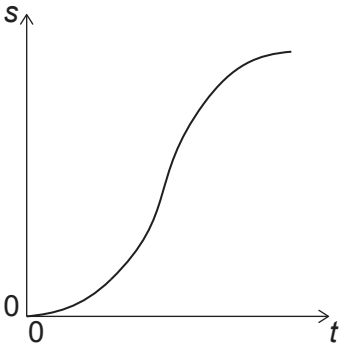

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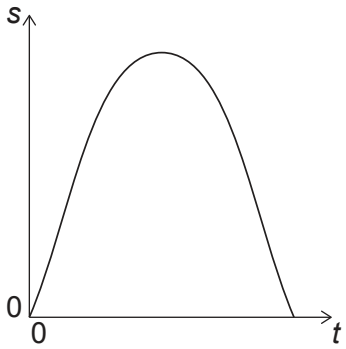

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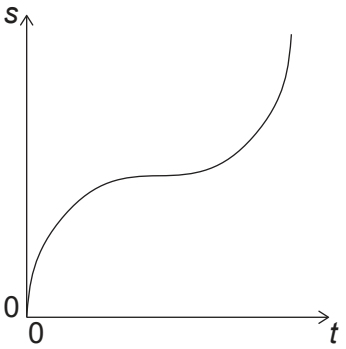
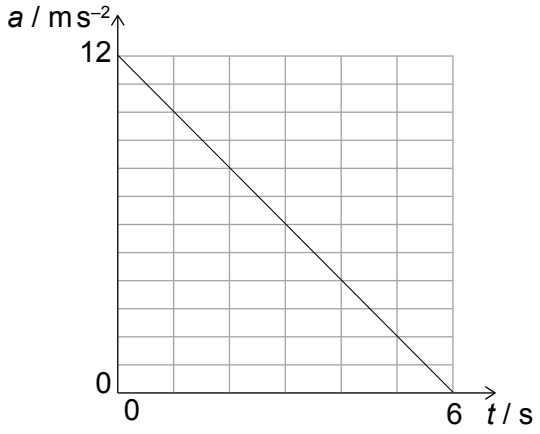


3. The graph shows the variation of the acceleration a of an object with time t.



What is the change in speed of the object shown by the graph?

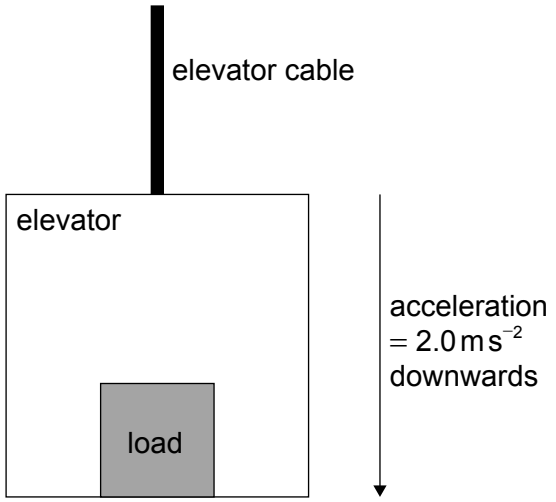
A. $0.5\,m\,s^{-1}$

B. $2.0\,m\,s^{-1}$

C. $36\,m\,s^{-1}$

D. $72\,m\,s^{-1}$

4. An elevator (lift) and its load have a total mass of 750 kg and accelerate vertically downwards at $2.0\,m\,s^{-2}$.



What is the tension in the elevator cable?

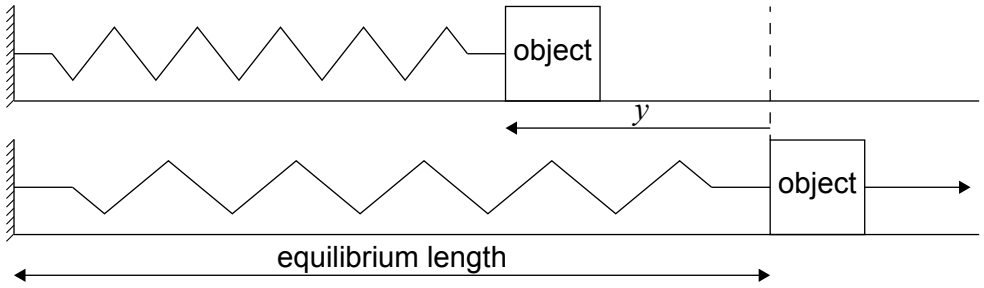
A. 1.5 kN

B. 6.0 kN

C. 7.5 kN

D. 9.0 kN

5. A horizontal spring of spring constant *k* and negligible mass is compressed through a distance y from its equilibrium length. An object of mass *m* that moves on a frictionless surface is placed at the end of the spring. The spring is released and returns to its equilibrium length.



What is the speed of the object just after it leaves the spring?

A. $y\sqrt{\frac{k}{m}}$

B. $y\sqrt{\frac{m}{k}}$

C. $y\frac{k}{m}$

D. $y\frac{m}{k}$

6. A car travelling at a constant velocity covers a distance of 100 m in 5.0 s. The thrust of the engine is 1.5 kN.

What is the power of the car?

A. 0.75 kW

B. 3.0 kW

C. 7.5 kW

D. 30 kW

7. A cyclist accelerates in a straight line. At one instant, when the cyclist is exerting a forward force of 40 N, the air resistance acting on the cyclist is 10 N.

What is the rate of change of momentum of the cyclist at this instant?

A. $10\,\text{kg m s}^{-2}$

B. $30\,\text{kg m s}^{-2}$

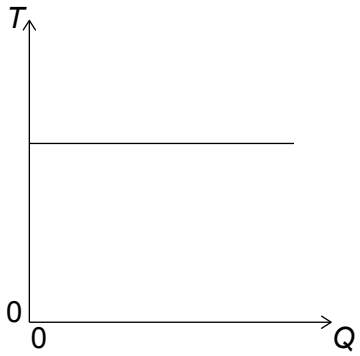
C. $40\,\text{kg m s}^{-2}$

D. $50\,\text{kg m s}^{-2}$

8. A liquid is initially at its freezing point. Energy is removed at a uniform rate from the liquid until it freezes completely.

Which graph shows how the temperature *T* of the liquid varies with the energy *Q* removed from the liquid?

A.



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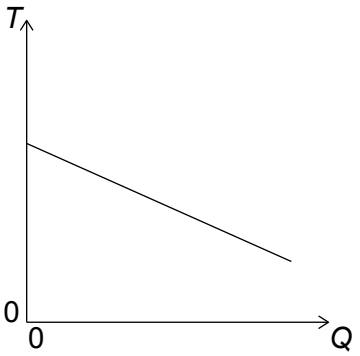
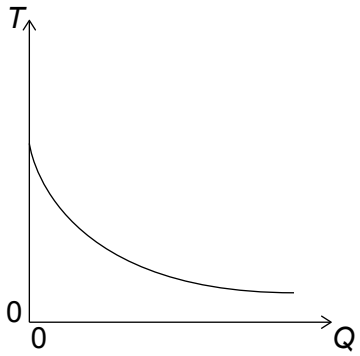


C.



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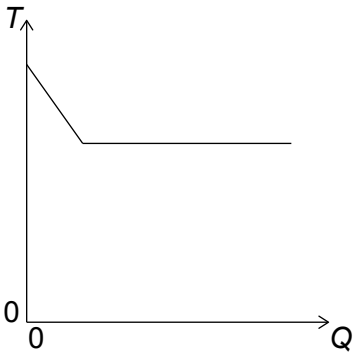
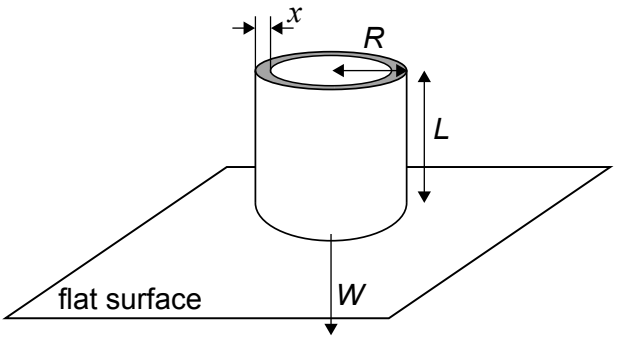


9. A thin-walled cylinder of weight *W*, open at both ends, rests on a flat surface. The cylinder has a height *L*, an average radius *R* and a thickness x where *R* is much greater than x.



What is the pressure exerted by the cylinder walls on the flat surface?

A. $\frac{W}{2\pi Rx}$

B. $\frac{W}{\pi R^2 x}$

C. $\frac{W}{\pi R^2}$

D. $\frac{W}{\pi R^2 L}$

10. A fixed mass of an ideal gas in a closed container with a movable piston initially occupies a volume *V*. The position of the piston is changed, so that the mean kinetic energy of the particles in the gas is doubled and the pressure remains constant.

What is the new volume of the gas?

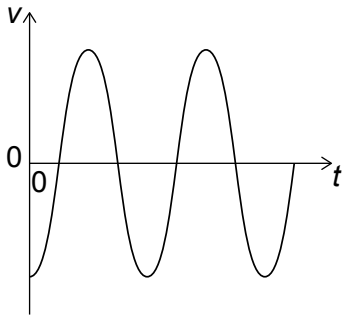
A. $\frac{V}{4}$

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

C. $2V$

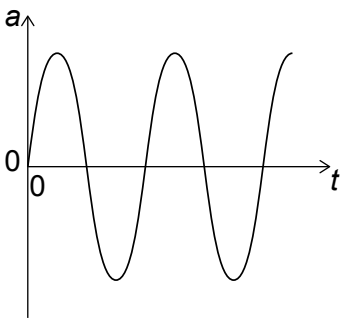
D. $4V$

11. A particle undergoes simple harmonic motion (SHM). The graph shows the variation of velocity v of the particle with time t.



What is the variation with time of the acceleration a of the particle?

A.



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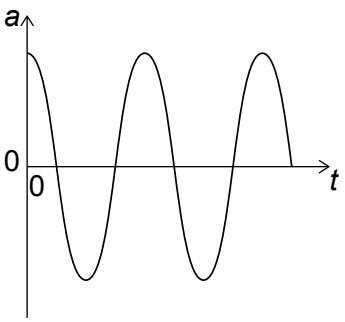

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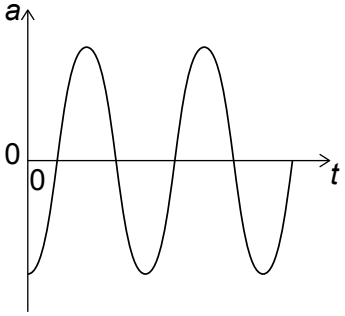

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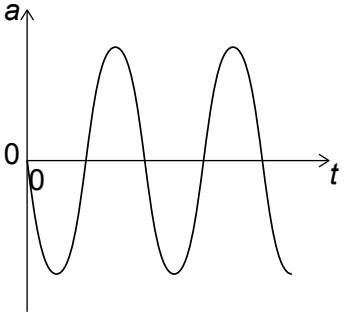


12. A travelling wave of period 5.0 ms travels along a stretched string at a speed of $40\,\text{m s}^{-1}$. Two points on the string are 0.050 m apart.

What is the phase difference between the two points?

A. 0

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

C. π

D. 2π

13. Properties of waves are

I. polarization
II. diffraction
III. refraction

Which of these properties apply to sound waves?

A. I and II

B. I and III

C. II and III

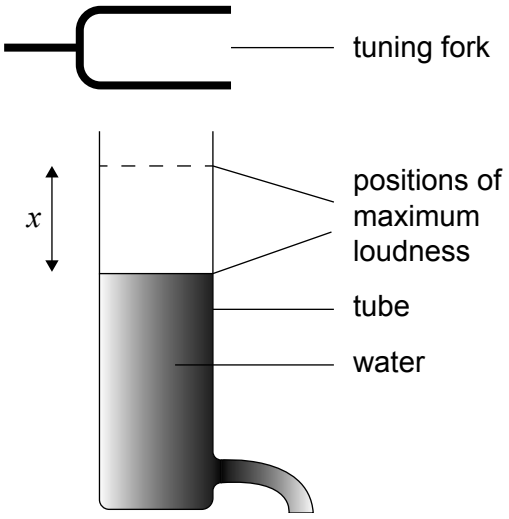
D. I, II and III

14. Unpolarized light of intensity I_0 is incident on the first of two polarizing sheets. Initially the planes of polarization of the sheets are perpendicular.

Which sheet must be rotated and by what angle so that light of intensity $\frac{I_0}{4}$ can emerge from the second sheet?

	Rotated sheet	Angle of rotation
A.	1 only	$\cos^{-1}\frac{\sqrt{2}}{2}$
B.	2 only	$\cos^{-1}\frac{1}{2}$
C.	1 or 2	$\cos^{-1}\frac{\sqrt{2}}{2}$
D.	1 or 2	$\cos^{-1}\frac{1}{2}$

15. Water is draining from a vertical tube that was initially full. A vibrating tuning fork is held near the top of the tube. For two positions of the water surface only, the sound is at its maximum loudness.



The distance between the two positions of maximum loudness is x.

What is the wavelength of the sound emitted by the tuning fork?

A. $\frac{x}{2}$

B. x

C. $\frac{3x}{2}$

D. $2x$

16. An electron is accelerated through a potential difference of 2.5 MV. What is the change in kinetic energy of the electron?

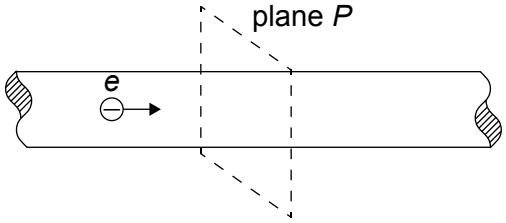
A. 0.4 μJ

B. 0.4 nJ

C. 0.4 pJ

D. 0.4 fJ

17. Electrons, each with a charge *e*, move with speed *v* along a metal wire. The electric current in the wire is I.



Plane *P* is perpendicular to the wire. How many electrons pass through plane *P* in each second?

A. $\frac{e}{I}$

B. $\frac{ve}{I}$

C. $\frac{I}{ve}$

D. $\frac{I}{e}$

18. An electron travelling at speed *v* perpendicular to a magnetic field of strength *B* experiences a force *F*.

What is the force acting on an alpha particle travelling at 2*v* parallel to a magnetic field of strength 2*B*?

A. 0

B. 2*F*

C. 4*F*

D. 8*F*

19. An object of constant mass is tied to the end of a rope of length l and made to move in a horizontal circle. The speed of the object is increased until the rope breaks at speed v. The length of the rope is then changed. At what other combination of rope length and speed will the rope break?

	Rope length	Speed
A.	$4l$	$2v$
B.	$2l$	v
C.	$2l$	$\frac{v}{2}$
D.	$4l$	$\frac{v}{2}$

20. A pure sample of nuclide A and a pure sample of nuclide B have the same activity at time $t = 0$. Nuclide A has a half-life of T, nuclide B has a half-life of $2T$.

What is $\frac{\text{activity of A}}{\text{activity of B}}$ when $t = 4T$?

A. 4

B 2

C. $\frac{1}{2}$

D. $\frac{1}{4}$

21. What is the definition of the unified atomic mass unit?

A. $\frac{1}{12}$ the mass of a neutral atom of carbon-12

B. The mass of a neutral atom of hydrogen-1

C. $\frac{1}{12}$ the mass of a nucleus of carbon-12

D. The mass of a nucleus of hydrogen-1

22. In nuclear fission, a nucleus of element X absorbs a neutron (n) to give a nucleus of element Y and a nucleus of element Z.

$$X + n \rightarrow Y + Z + 2n$$

What is $\frac{\text{magnitude of the binding energy per nucleon of Y}}{\text{magnitude of the binding energy per nucleon of X}}$ and $\frac{\text{total binding energy of Y and Z}}{\text{total binding energy of X}}$?

	$\frac{\textbf{Magnitude of the binding energy per nucleon of Y}}{\textbf{Magnitude of the binding energy per nucleon of X}}$	$\frac{\textbf{Total binding energy of Y and Z}}{\textbf{Total binding energy of X}}$
A.	greater than 1	greater than 1
B.	less than 1	greater than 1
C.	greater than 1	less than 1
D.	less than1	less than 1

23. An object can lose energy through

I. conduction

II. convection

III. radiation

What are the principal means for losing energy for a hot rock resting on the surface of the Moon?

A. I and II only

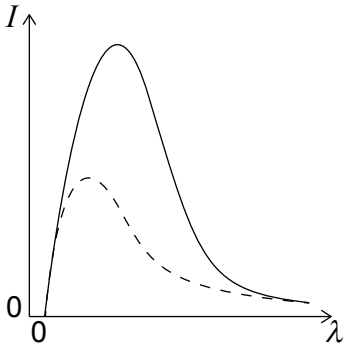
B. I and III only

C. II and III only

D. I, II and III

24. Planet X and planet Y both emit radiation as black bodies. Planet X has a surface temperature that is less than the surface temperature of planet Y.

What is the graph of the variation of intensity I with wavelength λ for the radiation emitted by planet Y? The graph for planet X is shown dotted.

A.


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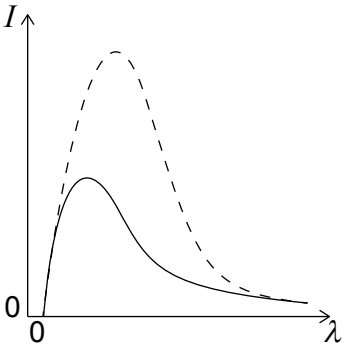
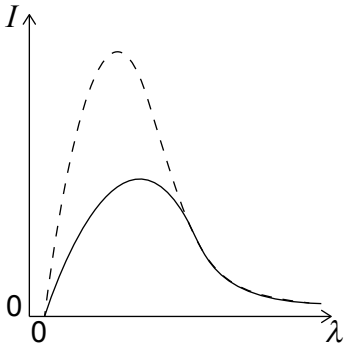


C.


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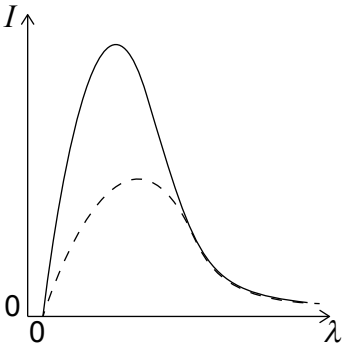


25. The average albedo of glacier ice is 0.25.

What is $\frac{\text{power absorbed by glacier ice}}{\text{power reflected by glacier ice}}$?

A. 0.25

B. 0.33

C. 2.5

D. 3.0

26. A pendulum oscillating near the surface of the Earth swings with a time period T. What is the time period of the same pendulum near the surface of the planet Mercury where the gravitational field strength is $0.4g$?

A. $0.4T$

B. $0.6T$

C. $1.6T$

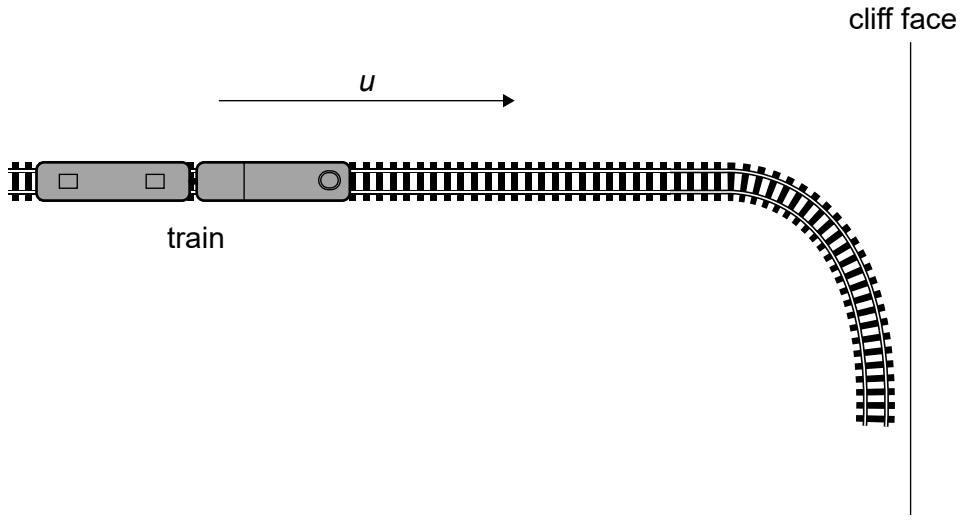
D. $2.5T$

27. For fringes to be observed in a double-slit interference experiment, the slits must emit waves that are coherent.

What conditions are required for the frequency of the waves and for the phase difference between the waves so that the waves are coherent?

	Frequency of waves	**Phase difference between waves**
A.	same	variable
B.	same	constant
C.	constant difference	variable
D.	constant difference	constant

28. A train moving at speed *u* relative to the ground, sounds a whistle of constant frequency f as it moves towards a vertical cliff face.



The sound from the whistle reaches the cliff face and is reflected back to the train. The speed of sound in stationary air is *c*.

What whistle frequency is observed on the train after the reflection?

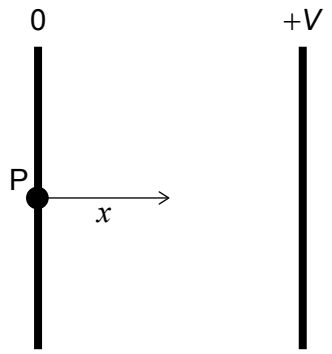
A. $\frac{(c+u)}{(c-u)}f$

B. $(c+u)f$

C. $(c-u)f$

D. $\frac{(c-u)}{(c+u)}f$

29. An electric field acts in the space between two charged parallel plates. One plate is at zero potential and the other is at potential $+V$.



The distance x is measured from point P in the direction perpendicular to the plate.

What is the dependence of the electric field strength E on x and what is the dependence of the electric potential V on x?

	E	***V***
A.	proportional to $\frac{1}{x^2}$	constant
B.	constant	proportional to x
C.	proportional to x	proportional to x
D.	proportional to x^2	constant

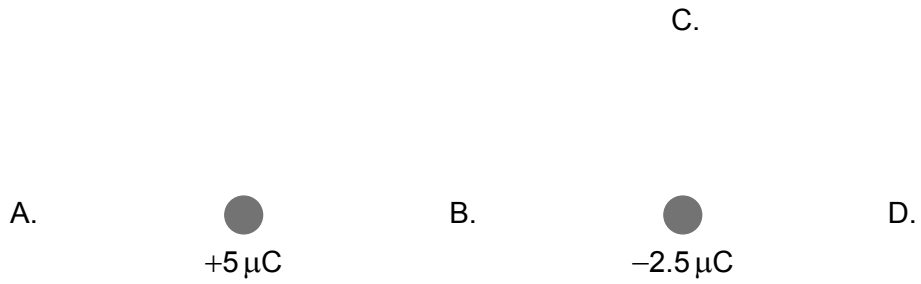
30. A satellite at the surface of the Earth has a weight W and gravitational potential energy E_p. The satellite is then placed in a circular orbit with a radius twice that of the Earth.

What is the weight of the satellite and the gravitational potential energy of the satellite when placed in orbit?

	Weight	**Gravitational potential energy**
A.	$0.25\,W$	$0.25\,E_p$
B.	$0.5\,W$	$0.25\,E_p$
C.	$0.25\,W$	$0.5\,E_p$
D.	$0.5\,W$	$0.5\,E_p$

31. Two point charges are at rest as shown.

At which position is the electric field strength greatest?



32. A direct current (dc) of 5A dissipates a power P in a resistor. Which peak value of the alternating current (ac) will dissipate an average power P in the same resistor?

A. 5A

B. $\frac{5}{2}$A

C. $\frac{5}{\sqrt{2}}$A

D. $5\sqrt{2}$A

33. What are the units of magnetic flux and magnetic field strength?

	Magnetic flux	Magnetic field strength
A.	Wb m^{-2}	Wb
B.	Wb	T
C.	Wb	T m^{-2}
D.	T m^{-2}	Wb m^{-2}

34. A battery is used to charge a capacitor fully through a resistor of resistance R. The energy supplied by the battery is E_b. The energy stored by the capacitor is E_c.

What is the relationship between E_b and E_c?

A. $E_b < E_c$

B. $E_b = E_c$

C. $E_b > E_c$

D. The relationship depends on R.

35. A capacitor is charged by a constant current of 2.5 μA for 100 s. As a result the potential difference across the capacitor increases by 5.0 V.

What is the capacitance of the capacitor?

A. 20 μF

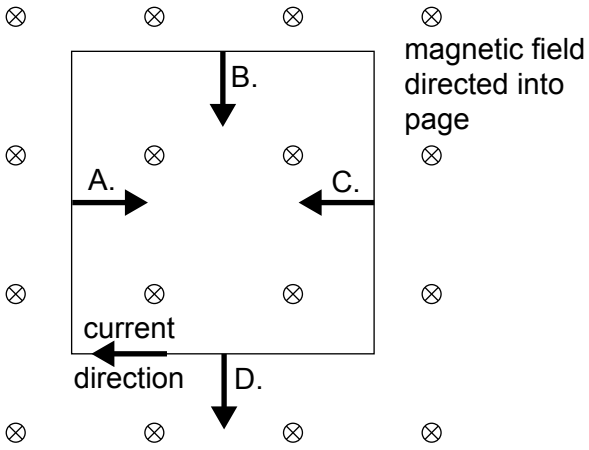
B. 50 μF

C. 20 mF

D. 50 mF

36. A conducting square coil is placed in a region where there is a uniform magnetic field. The magnetic field is directed into the page. There is a clockwise current in the coil.

What is a correct force that acts on a side of the coil?



37. The diameter of a silver-108 $\left({}^{108}_{47}\text{Ag}\right)$ nucleus is approximately three times that of the diameter of a nucleus of

A. ${}^{4}_{2}\text{He}$.

B. ${}^{7}_{3}\text{Li}$.

C. ${}^{11}_{5}\text{B}$.

D. ${}^{20}_{10}\text{Ne}$.

38. What can be used to calculate the probability of finding an electron in a particular region of space?

A. $\frac{\text{Planck's constant}}{4\pi \times \text{uncertainty in energy}}$

B. $\frac{\text{Planck's constant}}{4\pi \times \text{uncertainty in speed}}$

C. The magnitude of the wave function

D. The magnitude of the (wave function)^2

39. A photon of energy E and wavelength λ is scattered from an electron initially at rest.

What is the energy of the photon and the wavelength of the photon when the electron moves away?

	Energy of photon	**Wavelength of photon**
A.	greater than E	less than λ
B.	less than E	less than λ
C.	greater than E	greater than λ
D.	less than E	greater than λ

40. Electron capture can be represented by the equation

$$p + e^- \rightarrow X + Y.$$

What are X and Y?

	X	**Y**
A.	proton	positron
B.	electron	positron
C.	neutron	electron antineutrino
D.	neutron	electron neutrino