INTERNATIONAL BACCALAUREATE
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PHYSICS
HIGHER LEVEL
PAPER 1

Monday 8 May 2000 (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.

1. In an adiabatic change for a fixed quantity of an ideal gas, the volume V and pressure P of the gas are related by

$$PV^{\gamma} = \text{constant}\text{, where } \gamma \text{ is a particular constant.}$$

Which one of the following plots would produce a linear graph?

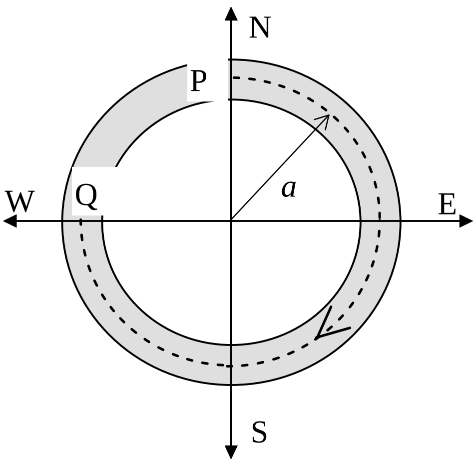
A. P against $\dfrac{1}{V}$

B. $\log P$ against $\dfrac{1}{V}$

C. $\log P$ against $\log V$

D. P against $\log V$

2. A motor car travels on a circular track of radius a, as shown in the figure.



When the car has travelled from P to Q its displacement from P is

A. $a\sqrt{2}$ southwest.

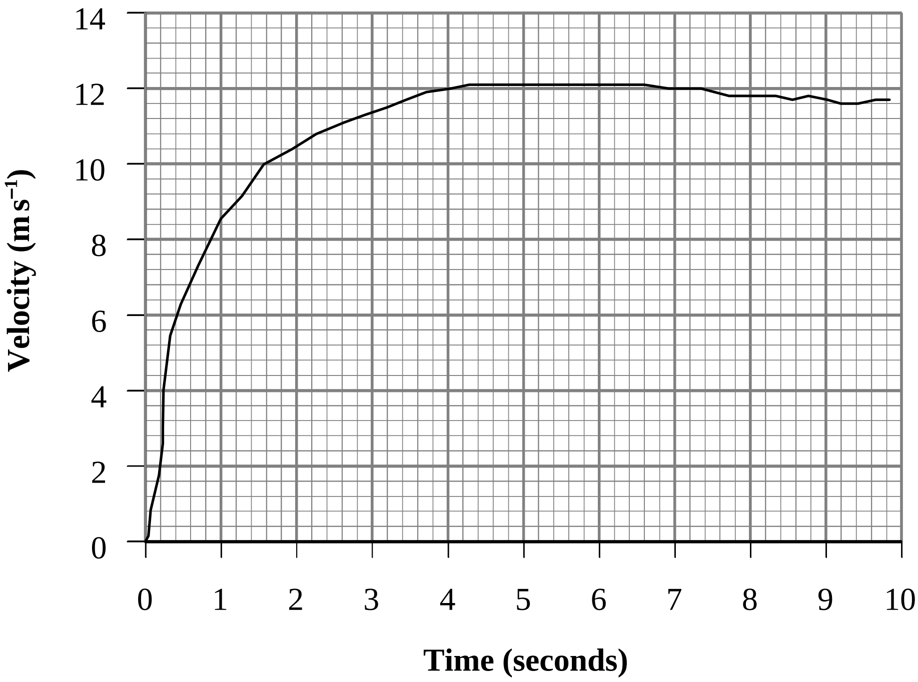
B. $a\sqrt{2}$ northeast.

C. $\dfrac{3\pi a}{2}$ southwest.

D. $\dfrac{3\pi a}{2}$ northeast.

3. The chart below shows velocity against time for Donovan Bailey, in his winning run in the 100 m at the 1996 Olympics.

1996 Olympics – 100 m final – Donovan Bailey



The best estimate of his acceleration 2 s after the start of the race is

A. 1.2 $m\,s^{-2}$.

B. 2.1 $m\,s^{-2}$.

C. 3.0 $m\,s^{-2}$.

D. 5.3 $m\,s^{-2}$.

4. Raindrops fall with constant speed during the later stages of their descent because

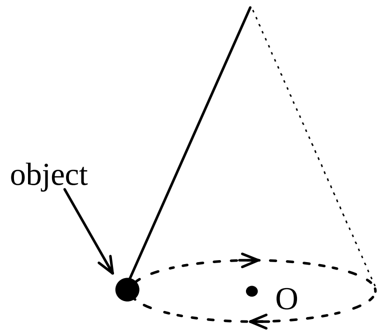
A. the gravitational force is the same for all drops.

B. air resistance just balances the force of gravity.

C. the drops all fall from about the same height.

D. the force of gravity is negligible for objects as small as raindrops.

5. A small object, suspended by a string, rotates with constant speed, in a horizontal circle as shown in the figure. Point O is at the centre of the circle.



Which one of the following statements is correct?

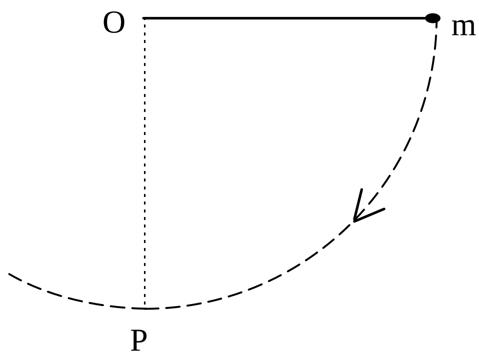
A. The object is in equilibrium.

B. There is a resultant force on the object directed away from O.

C. A force acts on the object in the direction of its motion.

D. There is a resultant force on the object directed towards O.

6. A small object of mass m is suspended from a fixed point O by a light, inextensible cord. The object is raised until the cord is horizontal and then released. It moves in an arc of a circle as shown in the figure.



When it passes through its lowest position at point P, the tension in the cord is

A. zero.

B. mg.

C. 2mg.

D. 3mg.

7. A particle is undergoing simple harmonic motion. When it is at its maximum displacement from its equilibrium position, which one of the following about its velocity and acceleration is correct?

	Velocity	**Acceleration**
A.	zero	maximum
B.	zero	zero
C.	maximum	zero
D.	maximum	maximum

8. A satellite is orbiting the earth in a circular orbit. Which one of the following properties of the satellite does **not** remain constant?

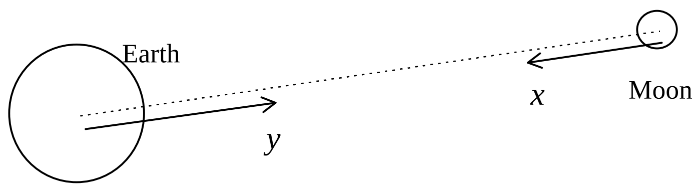
A. Kinetic energy

B. Gravitational potential energy

C. Angular momentum

D. Velocity

9. The Earth has approximately 81 times the mass of the Moon. There is a point between the Earth and the Moon where their resultant gravitational field is zero. If the distance to this point from the centre of the Earth is y and from the centre of the Moon it is x, the ratio of y/x is approximately



A. $(81)^{1/4}$

B. $(81)^{1/2}$

C. 81

D. 81^2

10. A nut on an outdoor piece of gym equipment cannot be turned with a spanner (wrench) because it has rusted – see **Figure A**. A gym instructor, in trying to loosen the nut, attaches a rope to the spanner as shown in **Figure B.** Assume the instructor pulls with the same force in both cases.

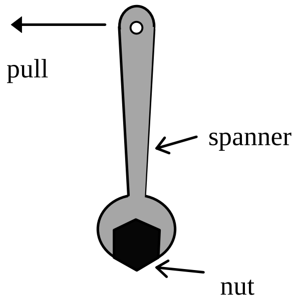


Figure A

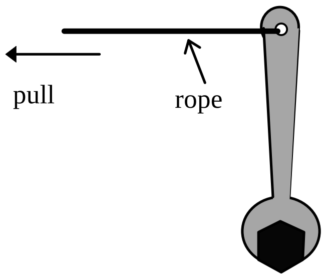


Figure B

The torque exerted on the nut in **Figure B** compared to that in **Figure A**

A. is less.

B. is greater.

C. is the same.

D. depends on the length of rope used.

11. The temperature of an ideal gas is a measure of the gas molecules'

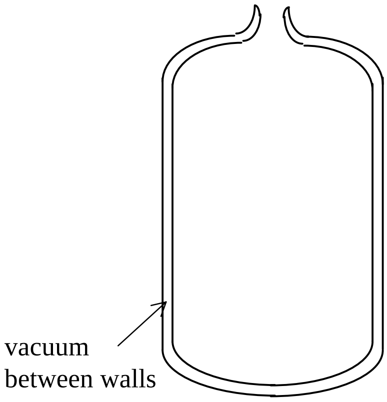
A. average velocity.

B. maximum velocity.

C. average kinetic energy.

D. total kinetic energy.

12. A vacuum flask (or Dewar flask) is an insulated container useful for storing hot or cold liquids (coffee, tea, liquid nitrogen, *etc.*). In its construction a vacuum is used to minimise energy transfer with the environment.



The vacuum reduces

A. radiation, convection and conduction losses.

B. convection and conduction losses.

C. convection losses only.

D. radiation losses only.

13. A small object of mass *m* at 100 °C is placed into an equal mass of water at 0 °C in a calorimeter. The specific heat capacity of the object is half that of the water. Assuming there are no energy transfers to the environment or to the calorimeter, the final equilibrium temperature of the object plus water will be

A. 67 °C.

B. 50 °C.

C. 33 °C.

D. 25 °C.

14. Two identical containers P and Q hold two different ideal gases at the same temperature. The number of moles of each gas is the same. The molecular weight of the gas in container P is twice that of the gas in Q. The ratio of the pressure in P to that of Q will be

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

B. 1.

C. $\sqrt{2}$.

D. 2.

15. The area under the Maxwell-Boltzmann speed distribution curve represents the

A. work done by the gas when it expands.

B. sum of the speeds of the molecules of the gas.

C. internal energy of the gas.

D. total number of molecules of the gas.

16. When the volume of a gas increases, it does work. The work done would be greatest for which one of the following processes?

A. Isobaric.

B. Adiabatic.

C. Isothermal.

D. The work done would be the same for all of the above.

17. A system absorbs 70 J of thermal energy and in the process does 40 J of work. The internal energy change is

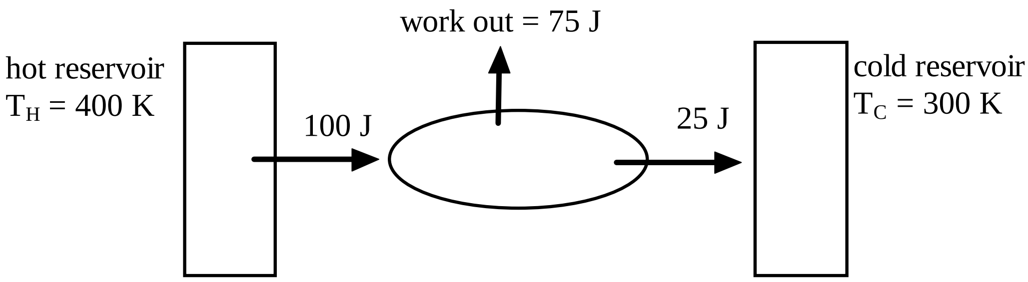
A. 30 J.

B. 40 J.

C. 70 J.

D. 110 J.

18. It is proposed to build a heat engine that would operate between a hot reservoir at a temperature of 400 K and a cold reservoir at 300 K. See the diagram below. In each cycle it would take 100 J from the hot reservoir, lose 25 J to the cold reservoir and do 75 J of work.



This proposed heat engine would violate

A. both the first and the second laws of thermodynamics.

B. the first but not the second law of thermodynamics.

C. the second but not the first law of thermodynamics.

D. neither the first nor the second law of thermodynamics.

19. Radio waves of wavelength 30 cm have a frequency of about

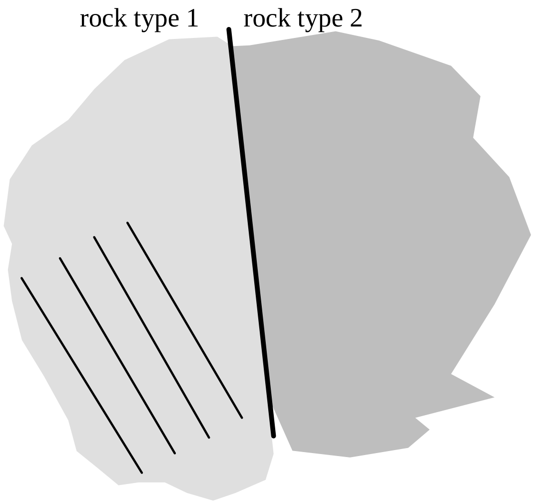
A. 10 MHz.

B. 90 MHz.

C. 1000 MHz.

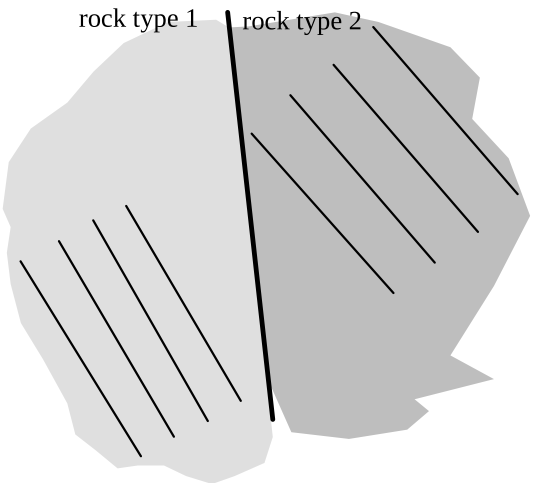
D. 9000 MHz.

20. The diagram below shows a plane **P** wave (pressure wave) from an earthquake, approaching the boundary between two different rock types. The speed of propagation in **rock type 2** is greater than in **rock type 1**.

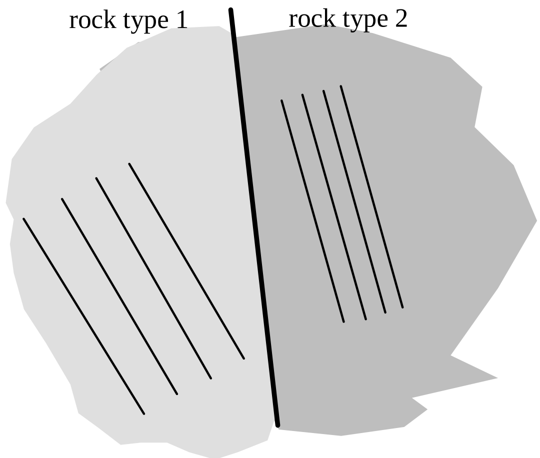


Which one of the following figures correctly shows the wavefronts for the refracted wave?

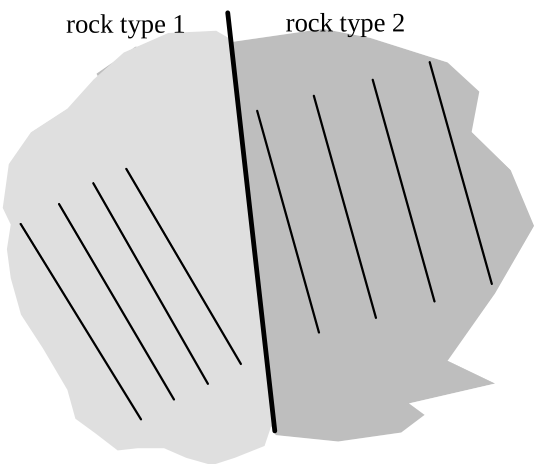
A.



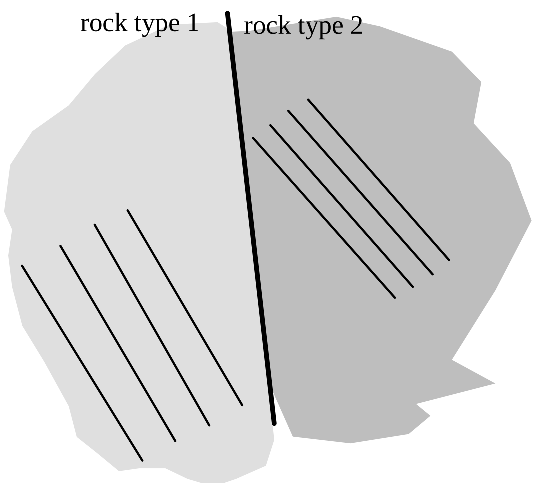
B.



C.



D.



21. For an organ pipe of length L, the fundamental frequency is proportional to

A. L.

B. $\frac{1}{L}$.

C. $\frac{1}{\sqrt{L}}$.

D. $\sqrt{L}$.

22. Two travelling waves, $y_1 = \mathrm{A}\sin(\omega t - kx)$ and $y_2 = \mathrm{A}\sin(\omega t + kx)$ are superposed on the same string. The distance between adjacent nodes of the resulting standing wave is

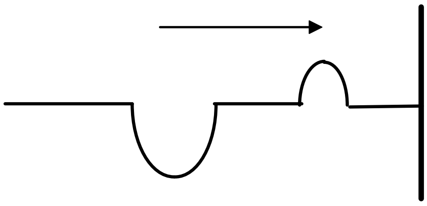
A. $\frac{\pi}{k}$.

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

C. $\frac{\pi}{2k}$.

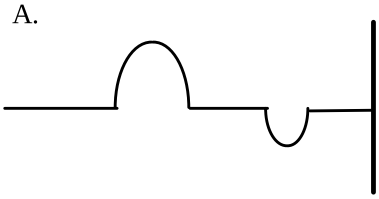
D. $\frac{2\pi}{k}$.

23. The figure below shows two idealised pulses travelling to the right along a string towards a fixed boundary.

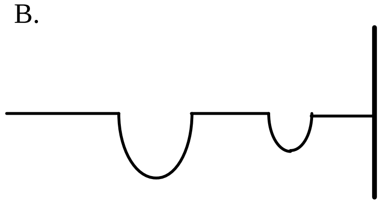


After both have been reflected the string shape could appear as

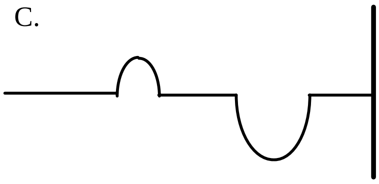
A.



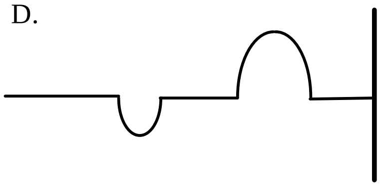
B.



C.



D.



24. Listed below are frequencies of tuning forks that are to be sounded in pairs. The largest number of beats will be heard from which pair of tuning forks?

A. 201 and 200 Hz

B. 253Hz and 260 Hz

C. 535 and 540 Hz

D. 1420 and 1424 Hz

25. Interference phenomena can be demonstrated using light. This is evidence that

A. under some conditions light behaves as a stream of particles.

B. light is a transverse wave.

C. light is electromagnetic in character.

D. light has wave characteristics.

26. Colours seen in oil slicks floating on the surface of water are due to

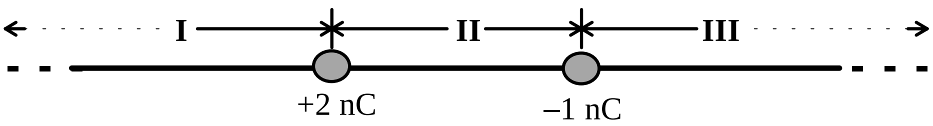
A. interference.

B. dispersion.

C. refraction.

D. diffraction.

27. Two point charges, +2 nC and –1 nC, are fixed in position along a line as shown in the diagram below. A third charge of +1 nC is placed along the line so that the resultant electrostatic force on it is zero. In which of the three regions **I**, **II**, **III**, could the third charge be placed?



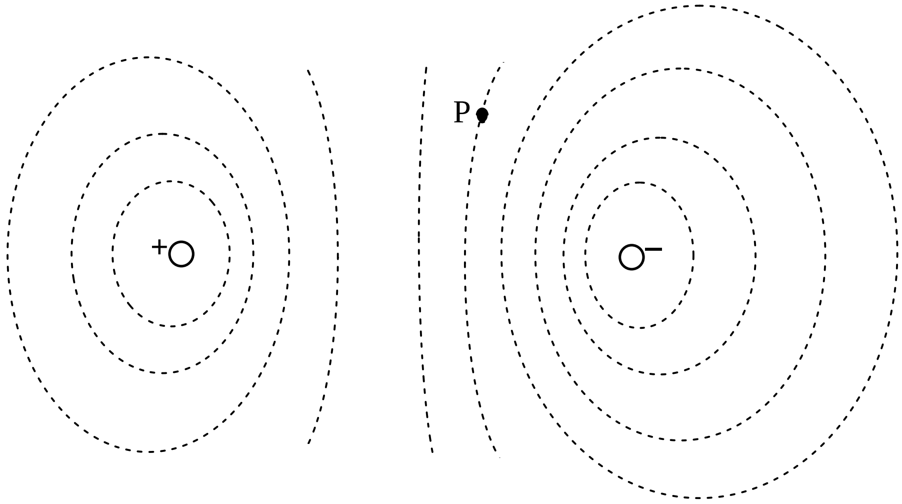
A. Region **I** only

B. Region **II** only

C. Region **III** only

D. Regions **I** or **III**

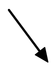
28. The diagram below shows equipotential lines in the vicinity of two unequal charges.



Which one of the arrows below best represents the direction of the force that would act on a small positive test charge placed at the point P?

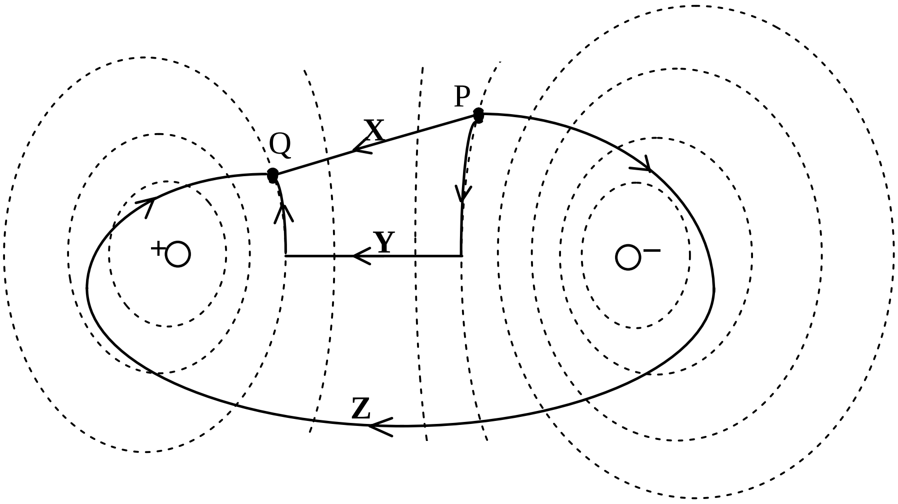
A. 

B. 

C. 

D. 

29. Consider moving the small positive test charge from point P in the situation shown in the diagram of question 28 to point Q, along three different paths **X, Y** or **Z**. Which one of the statements below is correct?



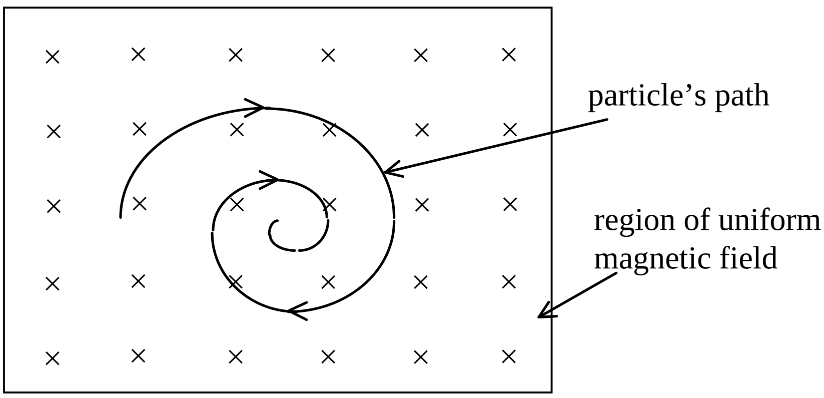
A. The work done is least for path **X**.

B. The work done is the greatest for path **Z**.

C. The work done is zero for path **Y**.

D. The work done is the same for all paths.

30. The figure below shows a region of uniform magnetic field directed into the page. A charged particle, moving in the plane of the page, follows a clockwise spiral path of decreasing radius as shown.



The best explanation for this is that the particle is

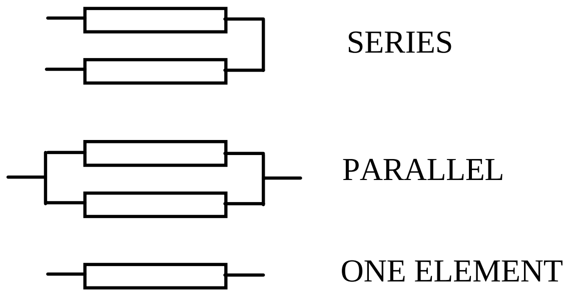
A. positively charged and slowing down.

B. negatively charged and slowing down.

C. positively charged and speeding up.

D. negatively charged and speeding up.

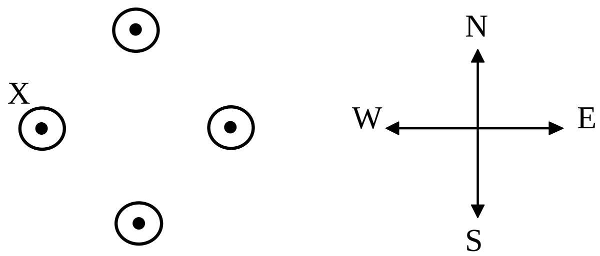
31. An electric heater has three settings for its selector switch – low, medium, and high. The heater has two identical resistive elements that can be connected in three different ways, as shown in the figure.



Which line in the table below indicates the way the heating elements must be connected to a power supply in order to provide the three settings?

	High	**Medium**	**Low**
A.	parallel	series	one element
B.	series	parallel	one element
C.	series	one element	parallel
D.	parallel	one element	series

32. Four long straight parallel wires carry equal currents directed vertically out of the page. They are arranged on the corners of a square as shown in the figure below.



The direction of the resultant magnetic force exerted on the wire labelled X is

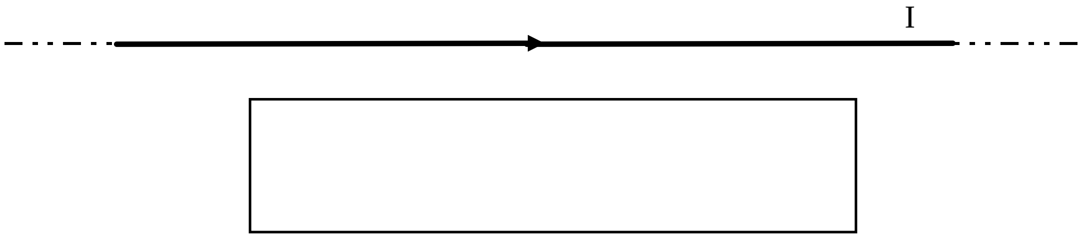
A. south.

B. north.

C. west.

D. east.

33. A long straight wire is in the plane of a rectangular conducting loop of wire. The straight wire carries a constant current I as shown in the figure below and is moved towards the rectangular loop.



While the wire is being moved towards the rectangular loop, the current in the loop

A. is always zero.

B. flows clockwise around the loop.

C. flows counterclockwise around the loop.

D. alternates, first one way then the opposite way around the loop.

34. Thomson conducted an experiment to measure the ratio of the charge to mass of cathode rays. At one point in the experiment, an electric field was aligned

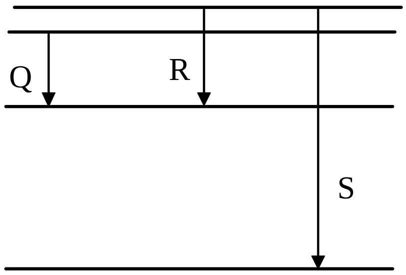
A. parallel to the gravitational field.

B. perpendicular to the gravitational field.

C. parallel to a magnetic field.

D. perpendicular to a magnetic field.

35. The diagram below, which is drawn to scale, shows some of the atomic energy levels of a fictitious element. The three transitions shown result in radiation in the ultraviolet (UV), red and yellow regions of the spectrum. Which one of the choices below correctly identifies the transitions?



	UV	red	yellow
A.	Q	R	S
B.	S	Q	R
C.	R	S	Q
D.	S	R	Q

36. The electron-volt is a unit of

A. charge.

B. energy.

C. electrical potential difference.

D. electric field.

37. A nucleus of mass M has Z protons, each of mass m_p, and N neutrons each of mass m_n. Its binding energy is given by

A. $(Zm_p - M)c^2$

B. $(M + Zm_p + Nm_n)c^2$

C. $(Zm_p + Nm_n - M)c^2$

D. $(Zm_p + Nm_n)c^2$

38. Radioactive Polonium 214 can decay into Polonium 210 by emitting an alpha particle followed by

A. a negative beta particle and a gamma ray.

B. two negative beta particles.

C. an alpha particle and a negative beta particle.

D. two positive beta particles.

39. When ${}^{235}_{92}\mathrm{U}$ is bombarded by neutrons, nuclear fission can occur. In one possible fission reaction, the two nuclides ${}^{141}_{56}\mathrm{Ba}$ and ${}^{92}_{36}\mathrm{Kr}$ are produced. How many **additional** neutrons are produced?

A. 3

B. 2

C. 1

D. 0

40. Electromagnetic radiation of a certain intensity is incident on a metallic surface with a work function of 3 eV. Photoelectrons are produced with a maximum kinetic energy of 1 eV. If the frequency of the incident radiation is doubled, the maximum kinetic energy of the photoelectrons will be

A. 2 eV.

B. 4 eV.

C. 5 eV.

D. 7 eV.