International Baccalaureate®
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PHYSICS
HIGHER LEVEL
PAPER 1

Tuesday 20 May 2008 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

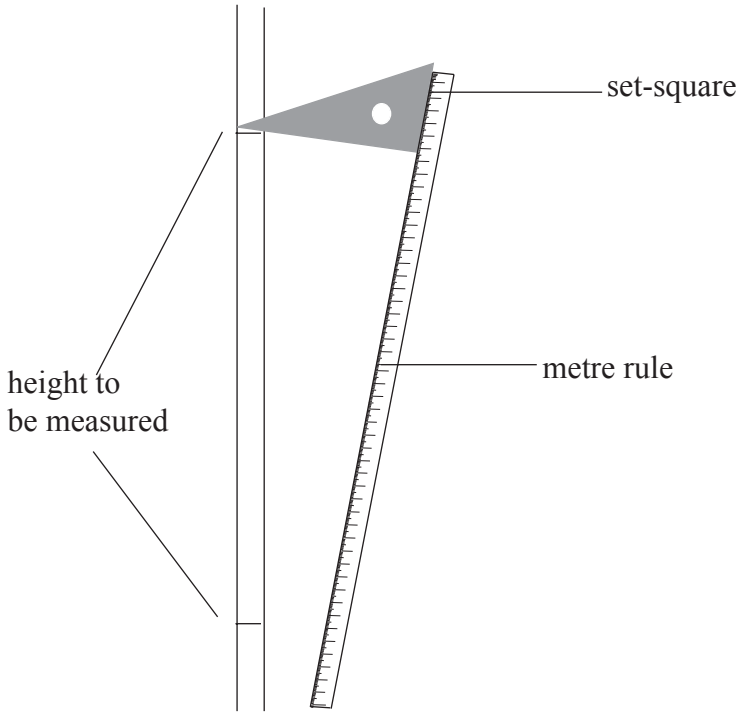
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.

1. Which list gives the masses of the particles in ascending order of magnitude?

least → greatest

A.	α-particle	β-particle	proton
B.	proton	α-particle	β-particle
C.	proton	β-particle	α-particle
D.	β-particle	proton	α-particle

2. A student uses a metre rule and a set-square to measure a series of vertical heights, as shown.



The metre rule is not vertical.
What type of error is reduced by using a set-square and what type of error is caused because the metre rule is not vertical?

	error reduced by use of set-square	**error caused by non-vertical ruler**
A.	random	random
B.	random	systematic
C.	systematic	random
D.	systematic	systematic

3. A small steel ball falls from rest through a distance of 3 m. When calculating the time of fall, air resistance can be ignored because

A. air is less dense than steel.

B. air resistance increases with the speed of the ball.

C. the air is not moving.

D. air resistance is much less than the weight of the ball.

4. The electrical resistance R of a component varies with temperature T according to the expression

$$R = R_0 e^{k/T}$$

where R_0 and k are constants.

A graph of the variation with $\frac{1}{T}$ of $\ln R$ is drawn and a straight line is obtained. The intercept on the $\frac{1}{T}$ axis is equal to

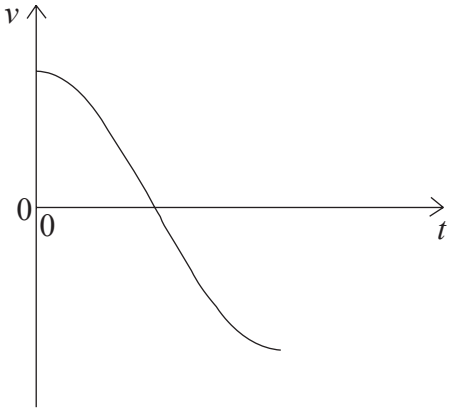
A. $-\ln R_0$

B. $-\frac{\ln R_0}{k}$

C. $\ln R_0$

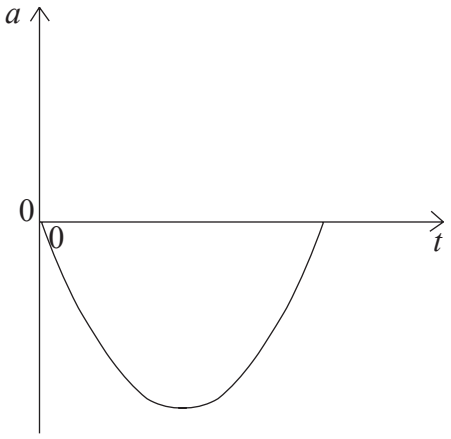
D. $\frac{\ln R_0}{k}$

5. The graph shows the variation with time t of the velocity v of an object moving along a straight line.



Which graph shows the variation with time t of the acceleration a of the object?

A.



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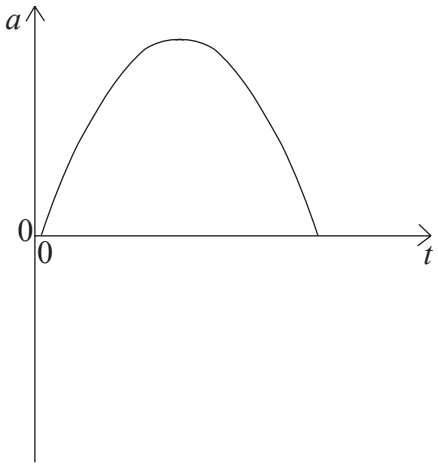
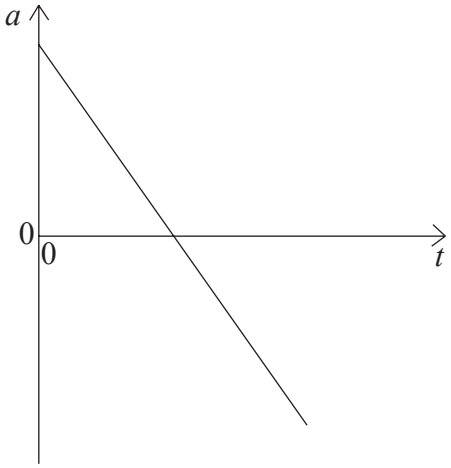
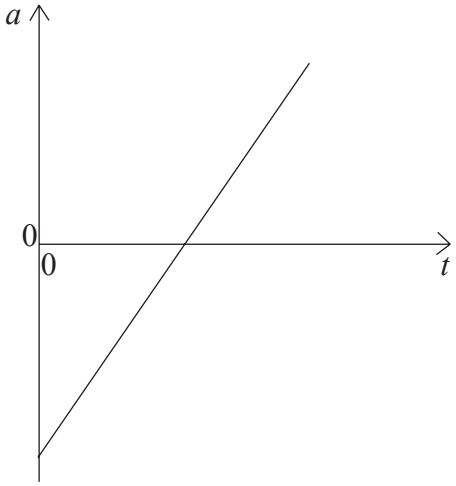


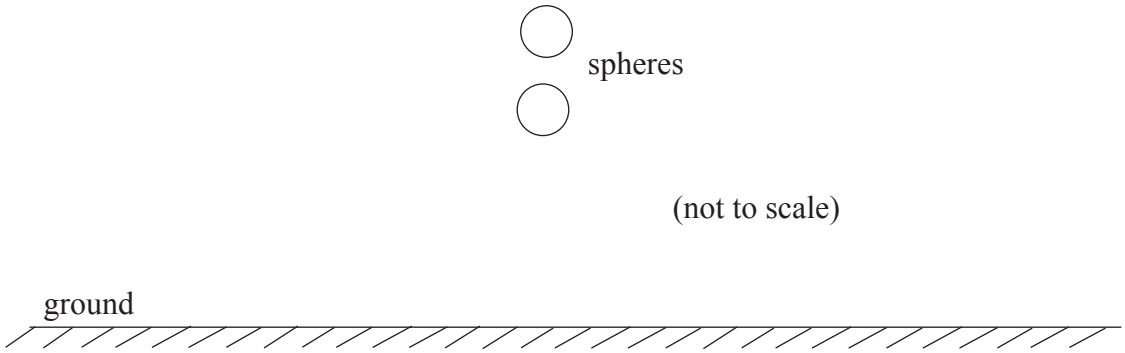
C.



D.



6. Two identical metal spheres are held above the ground as shown.



The separation between them is small compared to their distance above the ground. When the spheres are released, the separation of the spheres will

A. remain constant.

B. decrease continuously.

C. increase continuously.

D. increase initially and then remain constant.

7. What is the condition for an object to be in translational equilibrium?

A. The forces acting upwards are equal to the forces acting downwards.

B. The object must be at rest.

C. The object must be moving at constant speed.

D. There is no resultant force on the object in any direction.

8. A rocket is fired vertically into the air. When the rocket reaches its maximum height, the rocket explodes.

What change, if any, occurs in the momentum and in the kinetic energy of the rocket during the explosion?

	momentum	kinetic energy
A.	increases	increases
B.	increases	constant
C.	constant	increases
D.	constant	constant

9. A box of weight W is moved at constant velocity v along a horizontal floor. There is a constant frictional force F between the box and the floor.

What is the power required to move the box through a distance s?

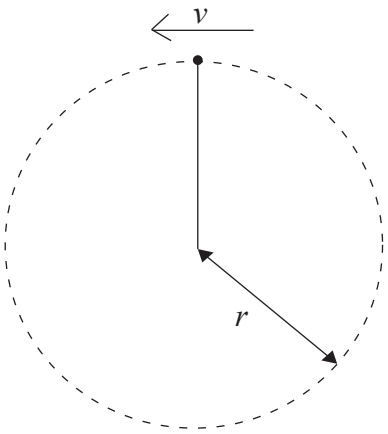
A. Fs

B. Fv

C. Ws

D. Wv

10. A stone of mass m is attached to a string. The stone is made to rotate in a vertical circle of radius r, as shown.



At the point where the stone is vertically above the centre of the circle, the stone has speed v.

Which of the following expressions gives the tension in the string?

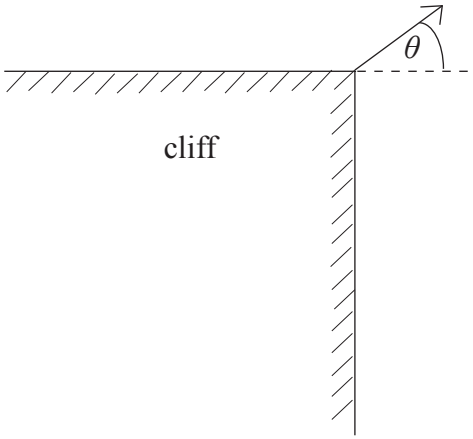
A. $mg - \frac{mv^2}{r}$

B. $\frac{mv^2}{r}$

C. $\frac{mv^2}{r} - mg$

D. $\frac{mv^2}{r} + mg$

11. A stone is thrown from the top of a cliff with speed v at an angle θ above the horizontal, as shown.



Air resistance is negligible and the acceleration of free fall is g.

What is the horizontal velocity of the stone a time t after the stone has been thrown?

A. $v \sin\theta$

B. $v \sin\theta - gt$

C. $v \cos\theta$

D. $v \cos\theta - gt$

12. The mass of Mars is approximately 0.1 times the mass of Earth and its diameter is approximately 0.5 times that of Earth.

What is the approximate gravitational field strength on the surface of Mars?

A. 2 N kg^{-1}

B. 4 N kg^{-1}

C. 25 N kg^{-1}

D. 50 N kg^{-1}

13. The gravitational potential at a point P above the surface of a planet is defined as the work done per unit mass in moving a small test mass

A. from point P to the surface of the planet.

B. from the surface of the planet to point P.

C. from point P to infinity.

D. from infinity to point P.

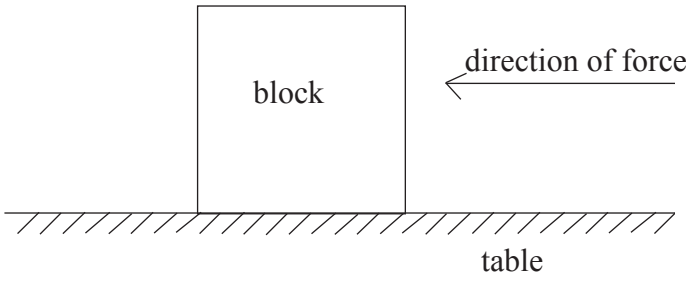
14. A satellite is placed in a circular orbit about the Earth.

Which of the following correctly shows the change in the kinetic energy and in the gravitational potential energy of the satellite with **increase** in the orbital radius?

	kinetic energy	**gravitational potential energy**
A.	increase	decrease
B.	increase	increase
C.	decrease	decrease
D.	decrease	increase

15. A wood block of weight W is resting on a horizontal table. The coefficient of static friction between the table and the block is μ_S and that of dynamic friction is μ_D.

A horizontal force is applied to the block as shown.



The force F is gradually increased from zero. What is the maximum force that can be applied to the block before the block begins to slide along the table?

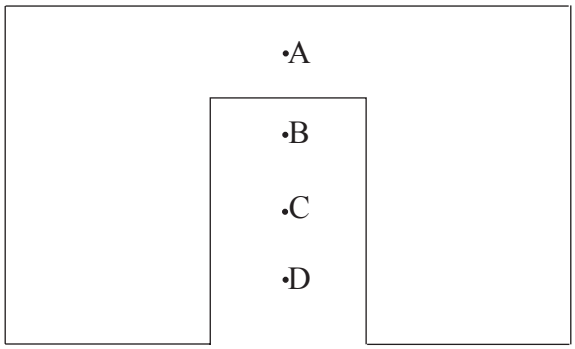
A. $(\mu_S - \mu_D)W$

B. $\mu_D W$

C. $\mu_S W$

D. $(\mu_S + \mu_D)W$

16. The shape shown below is cut from a uniform sheet of metal. At which of the points is the centre of gravity most likely to be found?



17. A copper block and a steel block each have the same mass. The copper block is at a higher temperature than the steel block.

The blocks are placed in thermal contact and they then reach thermal equlibrium. There is no energy exchange with the surroundings.

How do the magnitude of the change in temperature ΔT and the magnitude of the change in internal energy ΔU of the two blocks compare?

	ΔT	ΔU
A.	same	same
B.	same	different
C.	different	same
D.	different	different

18. A hot liquid X has specific heat capacity S_H. It is mixed with an equal mass of a cold liquid Y of specific heat capacity S_C.

The best estimate of the ratio

$$\frac{\text{temperature fall of liquid X}}{\text{temperature rise of liquid Y}}$$

is

A. $\frac{S_C}{S_H}$

B. $\frac{S_H}{S_C}$

C. $2\frac{S_C}{S_H}$

D. $2\frac{S_H}{S_C}$

19. A sample of an ideal gas is contained in a cylinder. The volume of the gas is suddenly decreased. A student makes the following statements to explain the change in pressure of the gas.

I. The average kinetic energy of the gas atoms increases.

II. The atoms of the gas hit the walls of the cylinder more frequently.

III. There are more atoms that are able to collide with the walls of the cylinder.

Which of these statements is true?

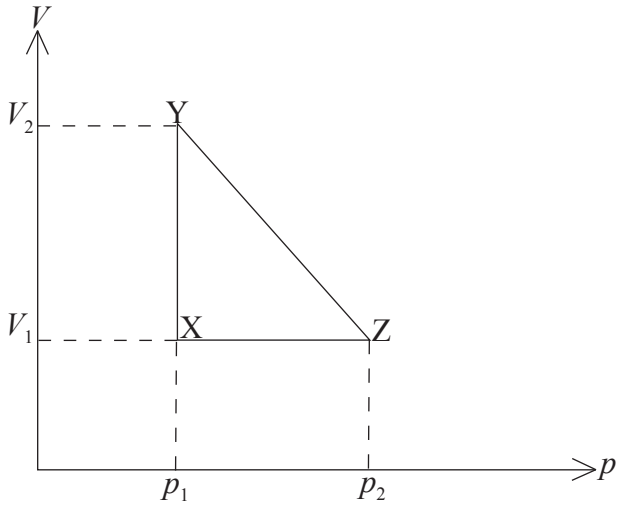
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

20. The graph shows the variation with pressure p of the volume V of a sample of gas.



The work done during the change of state from X to Y is

A. zero

B. $p_1 (V_2 - V_1)$

C. $p_2V_2 - p_1V_1$

D. $\frac{1}{2}(p_2 - p_1)(V_2 - V_1)$

21. Some liquid wax is placed in cool air so that the wax freezes. What are the changes, if any, in the entropy of the wax and of the cool air as the wax is freezing?

	freezing wax	cool air
A.	constant	increases
B.	increases	decreases
C.	decreases	constant
D.	decreases	increases

22. A light wave travelling through a vacuum is incident on a block of glass. What change, if any, occurs in the frequency and amplitude of the wave as it travels into the glass?

	frequency	amplitude
A.	decreases	decreases
B.	decreases	constant
C.	constant	decreases
D.	constant	constant

23. Which statement is true for standing (stationary) waves?

A. All points in the wave vibrate in phase.

B. There is no energy in a standing wave.

C. The wavelength of the wave is the distance between adjacent nodes.

D. Neighbouring points in the wave have different amplitudes of vibration.

24. A stationary source of sound emits waves of wavelength λ, period T and speed V. The source now moves with speed v in a straight line away from a stationary observer.

What are the wavelength and the speed of the wave as detected by the observer?

	wavelength	**speed**
A.	λ	$V + v$
B.	$\lambda - vT$	V
C.	λ	$V - v$
D.	$\lambda + vT$	V

25. Which **two** conditions are necessary for observable interference between two light beams?

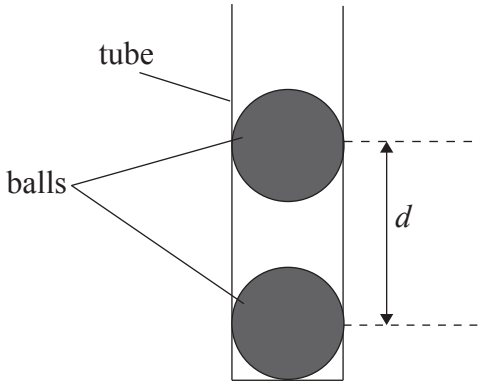
A. meet at a point constant phase difference

B. constant phase difference similar amplitude

C. same frequency similar amplitude

D. similar amplitude meet at a point

26. Two charged plastic balls are separated by a distance d in a vertical insulating tube, as shown.



The charge on each ball is doubled.

Coulomb's law applies to the force between the balls and friction with the walls of the tube is negligible.

What is now the separation of the balls?

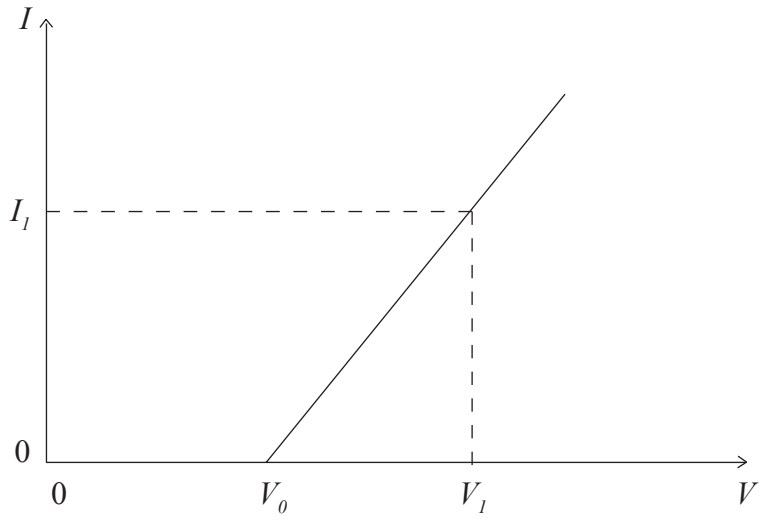
A. $\frac{d}{2}$

B. d

C. $2d$

D. $4d$

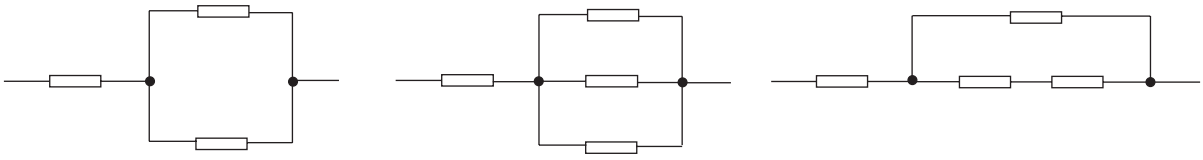
27. The graph shows the current-voltage (*I*-*V*) characteristic of an electrical component.



What is the resistance of the component at a potential difference V_1 and how does the resistance change, if at all, between potential differences V_0 and V_1.

	resistance at V_1	**change between V_0 and V_1**
A.	$\frac{(V_1 - V_0)}{I_1}$	no change
B.	$\frac{(V_1 - V_0)}{I_1}$	decreases
C.	$\frac{V_1}{I_1}$	no change
D.	$\frac{V_1}{I_1}$	decreases

28. Three networks X, Y and Z are shown below. Each resistor has the same resistance.



X Y Z

Which list shows the network resistances in increasing order of magnitude?

least → greatest

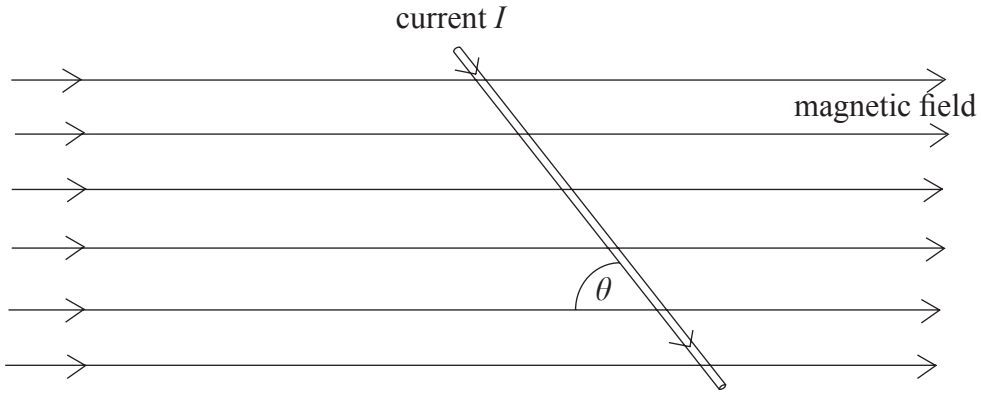
A. X Y Z

B. Y X Z

C. Y Z X

D. Z X Y

29. A straight conductor is in the plane of a uniform magnetic field as shown.



The current in the conductor is I and the conductor is at an angle θ to the magnetic field. The force per unit length on the conductor due to the current in the magnetic field is P. Which is the correct expression for the magnitude of the magnetic field strength?

A. $\frac{P\sin\theta}{I}$

B. $\frac{P\cos\theta}{I}$

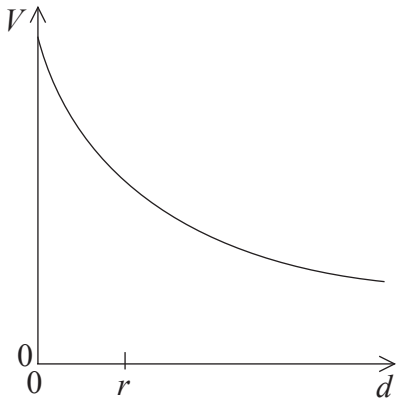
C. $\frac{P}{I\sin\theta}$

D. $\frac{P}{I\cos\theta}$

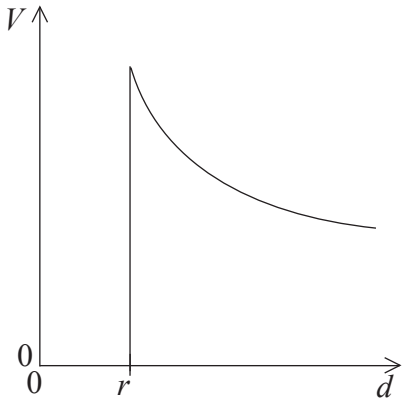
30. An isolated charged metal sphere has radius r.

Which diagram best shows the variation with distance d from the centre of the sphere of the potential V?

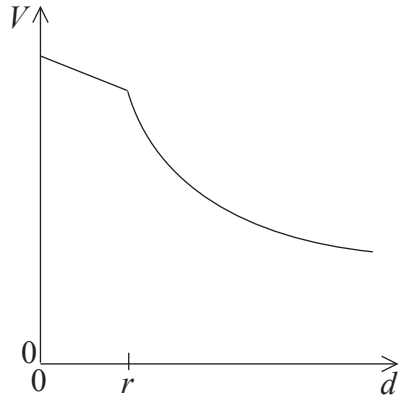
A.



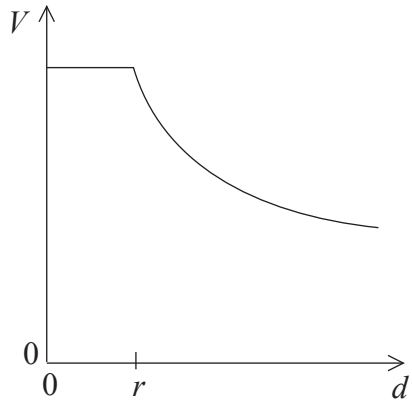
B.



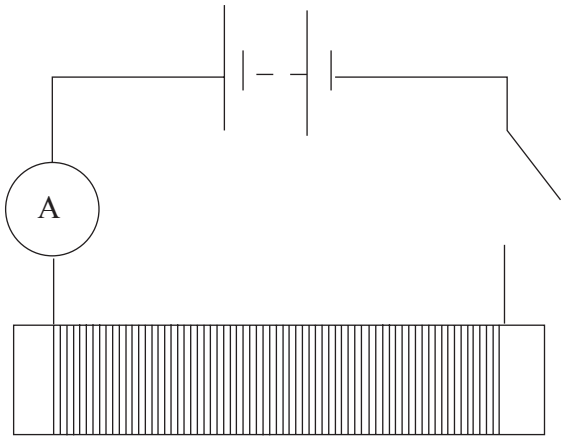
C.



D.



31. The diagram shows a coil of wire wound on an iron core.



When the switch is closed, the ammeter reading gradually increases from zero to a maximum value. What is the explanation for this gradual growth of current?

A. An e.m.f. is induced in the coil.

B. The e.m.f. of the battery is increasing.

C. The iron core has a very low resistance.

D. The battery has a large internal resistance.

32. High voltages are used for the transmission of electric power over long distances because

A. high voltages can be stepped down to any required value.

B. larger currents can be used.

C. power losses during transmission are minimized.

D. transformers have a high efficiency.

33. What is the description given to the ranges of the repulsive force and of the attractive force between protons in a nucleus?

	repulsive force	attractive force
A.	short range	long range
B.	short range	short range
C.	long range	long range
D.	long range	short range

34. β-particles may be detected using a Geiger-Muller tube connected to a high-voltage supply.

When β-particles enter the tube, they give rise to current pulses. These current pulses are produced because the β-particles

A. are attracted to the anode of the tube.

B. cause flashes of light in the tube.

C. cause ionisation of the gas in the tube.

D. give rise to nuclear reactions in the tube.

35. A student suggests that the following transformation may take place.

$$^{14}_{7}\mathrm{N} + ^{4}_{2}\mathrm{He} \rightarrow ^{17}_{8}\mathrm{O} + ^{1}_{1}\mathrm{p}$$

Measurement of rest masses shows that

$$\text{total rest mass}\left(^{14}_{7}\mathrm{N} + ^{4}_{2}\mathrm{He}\right) < \text{ total rest mass } \left(^{17}_{8}\mathrm{O} + ^{1}_{1}\mathrm{p}\right).$$

The student concludes that the reaction will

A. take place if the helium nucleus has sufficient kinetic energy.

B. always take place and the proton will be emitted with kinetic energy.

C. always take place but the proton will have zero kinetic energy.

D. never take place because there is no mass defect.

36. In an experiment to demonstrate the photoelectric effect, light of intensity L and frequency f is incident on a metal surface. The maximum photoelectric current is I and the stopping potential is V_S.

What change if any occurs in the maximum photoelectric current and in the stopping potential when light of the same intensity L but of frequency $2f$ is incident on the surface?

	maximum photoelectric current	**stopping potential**
A.	I	greater than $2V_S$
B.	less than I	greater than $2V_S$
C.	I	less than $2V_S$
D.	less than I	less than $2V_S$

37. The diameter of a nucleus may be estimated from

A. determinations of half-life.

B. gamma-ray spectra.

C. charged particle scattering experiments.

D. fusion and fission reactions.

38. The ratio of mass-to-charge was measured for a sample of a pure element in a mass spectrometer. The values obtained were

$$17.5\frac{m}{q} \qquad 18.5\frac{m}{q} \qquad 35.0\frac{m}{q} \qquad 37.0\frac{m}{q}$$

where $\frac{m}{q}$ is the mass-to-charge ratio for a hydrogen $\left({}_{1}^{1}\mathrm{H}\right)$ nucleus. The data suggest that two isotopes are present with masses

A. $17.5u$ and $18.5u$.

B. $17.5u$ and $37.0u$.

C. $18.5u$ and $35.0u$.

D. $35.0u$ and $37.0u$.

39. The half-life of a radioactive nuclide is 1×10^3 s.

What is the probability of decay per second of a nucleus of the nuclide, quoted to one significant digit?

A. 7×10^{-4}

B. 1×10^{-3}

C. 1×10^{3}

D. 7×10^{3}

40. Which of the following particles consist of quarks?

A. baryons and mesons

B. baryons and muons

C. gluons and mesons

D. gluons and muons