IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

PHYSICS
HIGHER LEVEL
PAPER 1

Tuesday 4 May 2004 (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. The diameter of the nucleus of a hydrogen atom is of the order of

   A. 10^{-8} m.

   B. 10^{-15} m.

   C. 10^{-23} m.

   D. 10^{-30} m.

2. The unit, the electron-volt is equivalent to

   A. 1.6×10^{19} J.

   B. 1.0 J.

   C. 1.6×10^{-19} J.

   D. 9.1×10^{-31} J.

3. The time period T of oscillation of a mass m suspended from a vertical spring is given by the expression

   $$T = 2\pi \sqrt{\frac{m}{k}}$$

   where k is a constant.

   Which **one** of the following plots will give rise to a straight-line graph?

   A. T^2 against m

   B. $\sqrt{T}$ against $\sqrt{m}$

   C. T against m

   D. $\sqrt{T}$ against m

4. The power dissipated in a resistor of resistance R carrying a current I is equal to I^2R. The value of I has an uncertainty of $\pm 2\%$ and the value of R has an uncertainty of $\pm 10\%$. The value of the uncertainty in the calculated power dissipation is

A. $\pm 8\%$.

B. $\pm 12\%$.

C. $\pm 14\%$.

D. $\pm 20\%$.

5. Peter and Susan both stand on the edge of a vertical cliff.
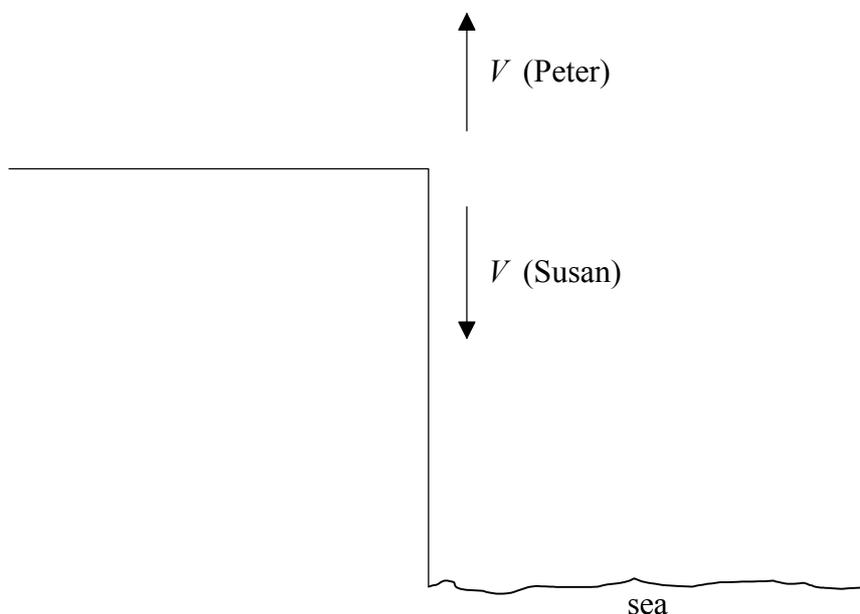
Susan throws a stone vertically downwards and, at the same time, Peter throws a stone vertically upwards. The speed V with which both stones are thrown is the same. Neglecting air resistance, which **one** of the following statements is true?

A. The stone thrown by Susan will hit the sea with a greater speed than the stone thrown by Peter.

B. Both stones will hit the sea with the same speed no matter what the height of the cliff.

C. In order to determine which stone hits the sea first, the height of the cliff must be known.

D. In order to determine which stone hits the sea first both the height of the cliff and the mass of each stone must be known.

6.   A small electrically charged sphere is suspended vertically from a thread. An oppositely charged rod is brought close to the sphere such that the sphere is in equilibrium when displaced from the vertical by an angle of $45°$.
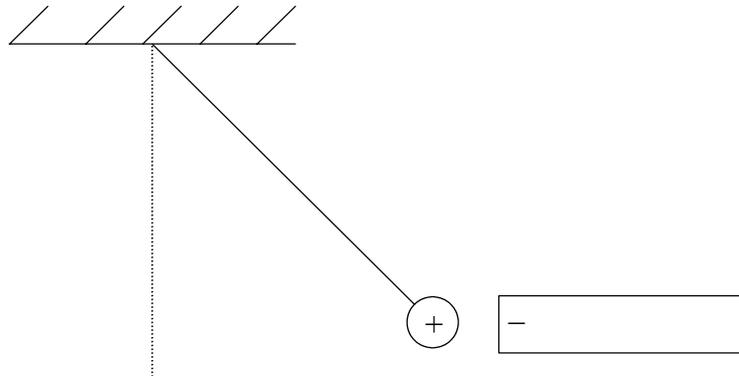
Which **one** of the following best represents the free body diagram for the sphere?

A.

B.

C.

D.
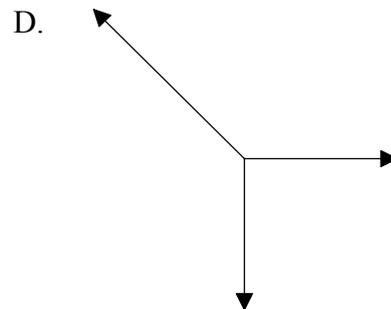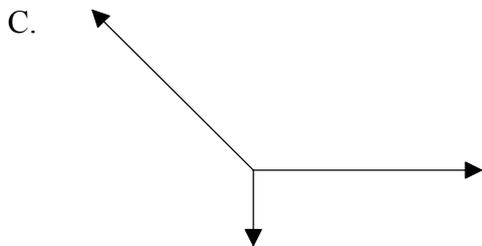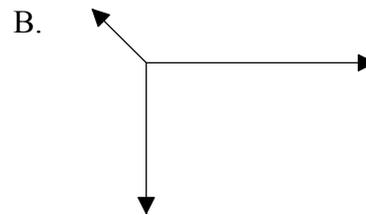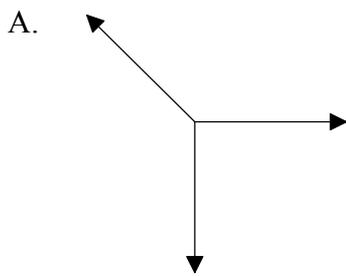
7.   An elevator (lift) is used to either raise or lower sacks of potatoes. In the diagram, a sack of potatoes of mass 10 kg is resting on a scale that is resting on the floor of an accelerating elevator. The scale reads 12 kg.

elevator ⟶   10 kg

scale
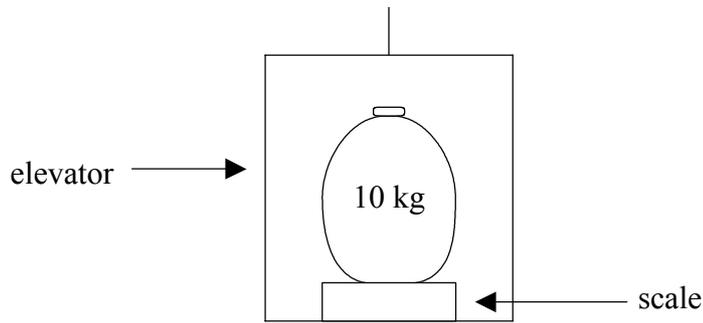
The best estimate for the acceleration of the elevator is

A. $2.0 \, \text{m s}^{-2}$ downwards.

B. $2.0 \, \text{m s}^{-2}$ upwards.

C. $1.2 \, \text{m s}^{-2}$ downwards.

D. $1.2 \, \text{m s}^{-2}$ upwards.

8.   A ball is dropped from rest at time $t = 0$ on to a horizontal surface from which it rebounds. Which **one** of the following graphs best shows the variation of **speed** v of the ball with time t from the time $t = 0$ to the time that the ball leaves the surface?

A.

B.

C.

D.
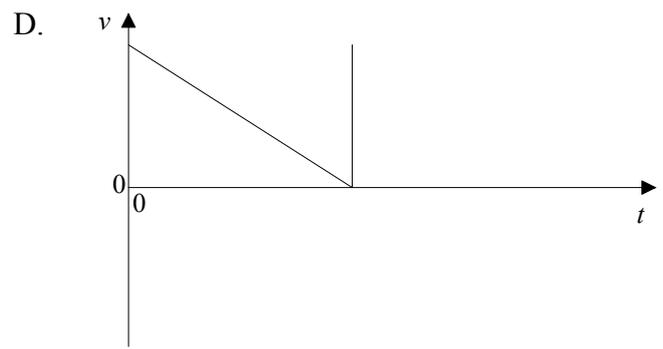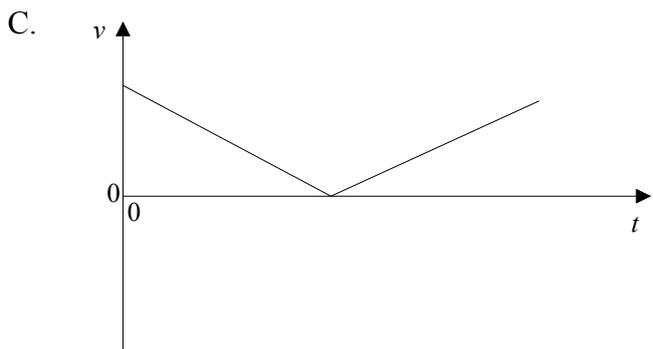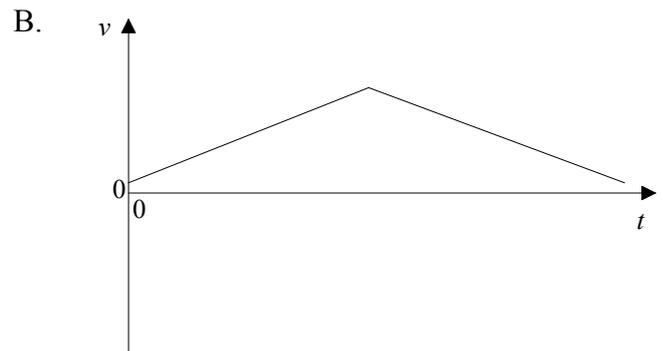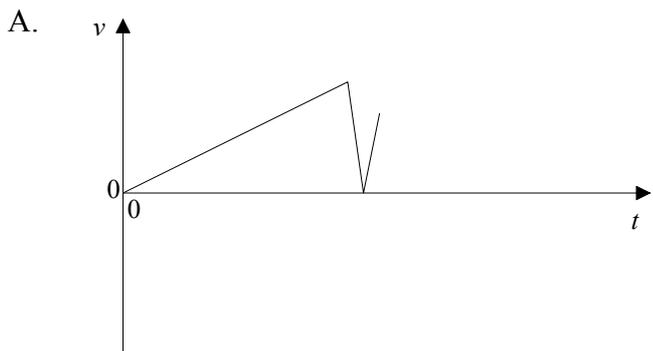
9.   The centripetal force that causes a car to go round a bend in the road is provided by

    A.   the force produced by the car engine acting on the wheels.

    B.   the friction between the tyres and the road.

    C.   the weight of the car.

    D.   the force exerted by the driver on the steering wheel.

10.   Which **one** of the following is a true statement concerning the vertical component of the velocity and the acceleration of a projectile when it is at its maximum height? *(The acceleration of free fall is g.)*

	Vertical component of velocity	**Acceleration**
A.	maximum	zero
B.	maximum	g
C.	zero	zero
D.	zero	g

11.   The acceleration of free fall of a small sphere of mass 5.0×10^{-3} kg when close to the surface of Jupiter is $25\ \mathrm{m\,s^{-2}}$. The gravitational field strength at the surface of Jupiter is

    A. $2.0 \times 10^{-4}\ \mathrm{N\,kg^{-1}}$.

    B. $1.3 \times 10^{-1}\ \mathrm{N\,kg^{-1}}$.

    C. $25\ \mathrm{N\,kg^{-1}}$.

    D. $5.0 \times 10^{3}\ \mathrm{N\,kg^{-1}}$.

12. Which **one** of the following graphs best shows the variation of the **total energy** E of a satellite orbiting the Earth with distance r from the centre of the Earth? *(The radius of the Earth is R.)*

A.

B.

C.

D.
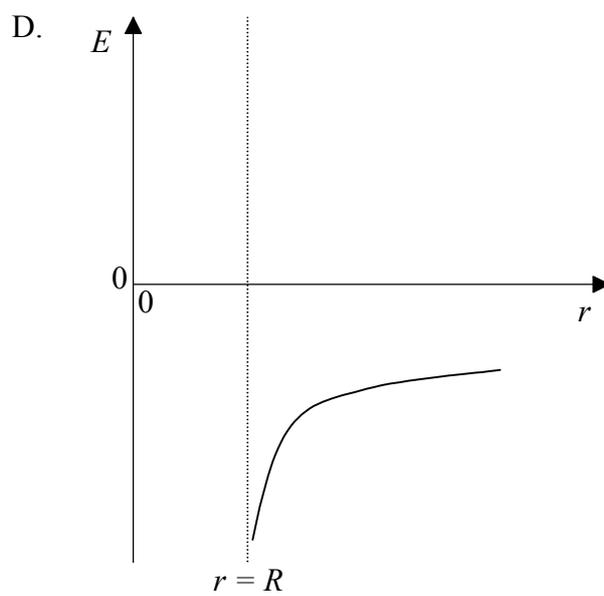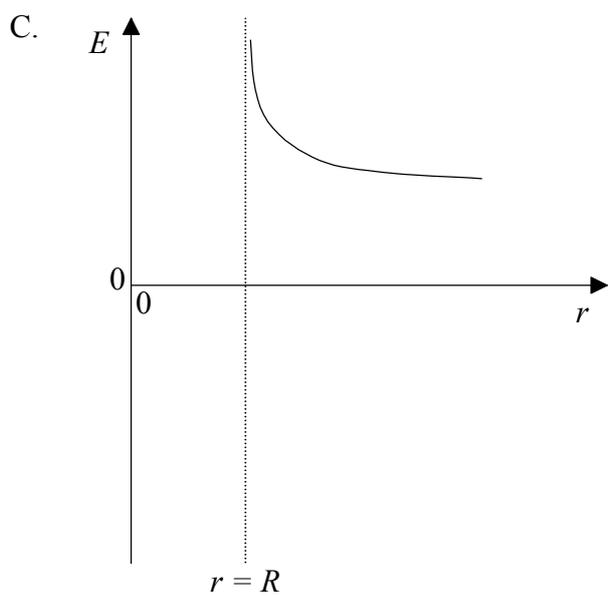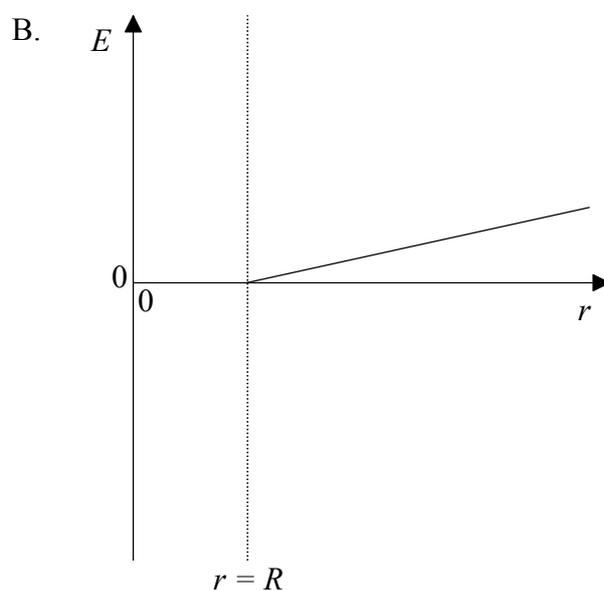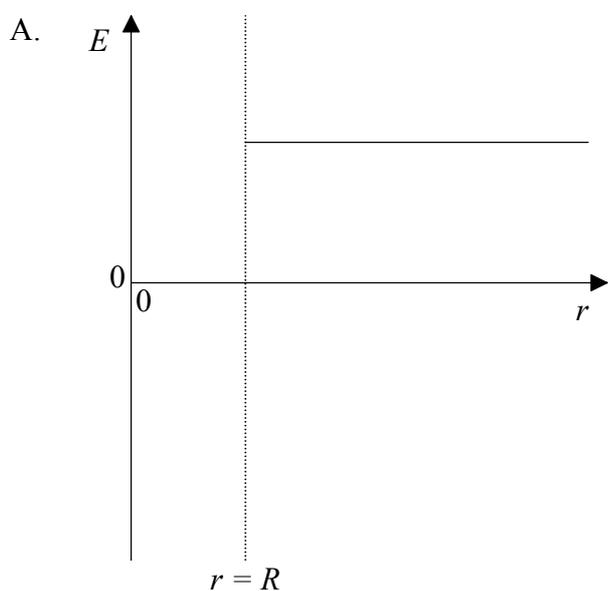
13. A block rests on a rough horizontal plane and a force P is applied to the block as shown.
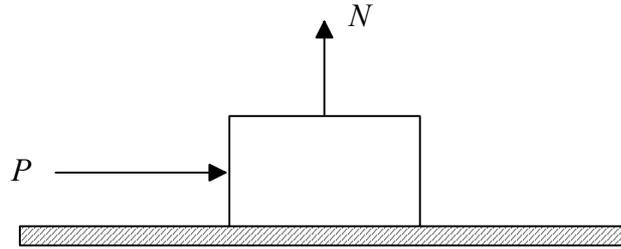
The normal reaction between the plane and the block is N and the frictional force between the block and the plane is F. The coefficient of static friction between the block and the plane is μ_S and initially P is zero.

As P is increased in value, which **one** of the following statements is true concerning the relationship between F, N and μ_S?

A. F is always equal to $\mu_S N$.

B. F is always greater than $\mu_S N$.

C. F is always less than $\mu_S N$.

D. F can be equal to $\mu_S N$.

14. For a body to be in both translational and rotational equilibrium

A.   it must not be in contact with any other objects.

B.   the net torque and the net force acting on it must be zero.

C.   the net torque acting on it must be zero.

D.   the net force acting on it must be zero.

15. Two identical boxes X and Y each contain an ideal gas.

Box X	**Box Y**
n moles	$2n$ moles
temperature T	temperature $\dfrac{T}{3}$
pressure P_X	pressure P_Y
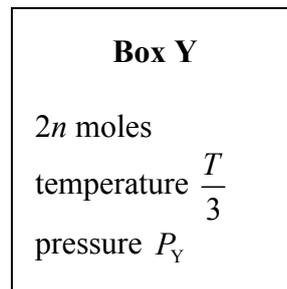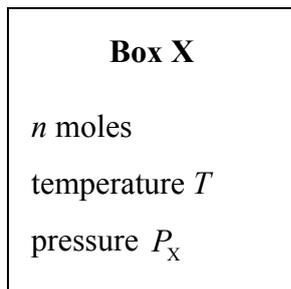
In box X there are n moles of the gas at temperature T and pressure P_X. In box Y there are $2n$ moles of the gas at temperature $\dfrac{T}{3}$ and pressure P_Y .

The ratio $\dfrac{P_X}{P_Y}$ is

A. $\dfrac{2}{3}$.

B. $\dfrac{3}{2}$.

C.   2.

D.   3.

16. The specific latent heat of fusion of a substance is defined as the amount of thermal energy required to change the phase of

A.   the substance at constant temperature.

B.   unit mass of the substance to liquid at constant temperature.

C.   unit mass of the substance at constant temperature.

D.   the substance to gas at constant temperature.

Turn over

17. A fixed mass of an ideal gas is heated at constant volume. Which **one** of the following graphs best shows the variation of Celsius temperature t with pressure p of the gas?

A.

B.

C.

D.
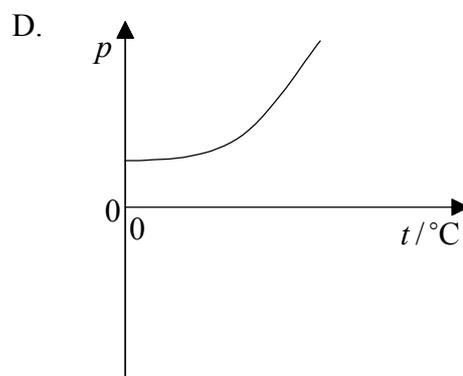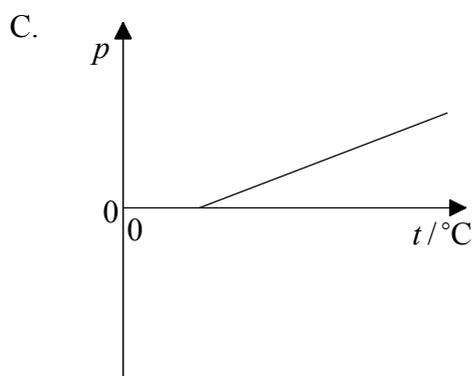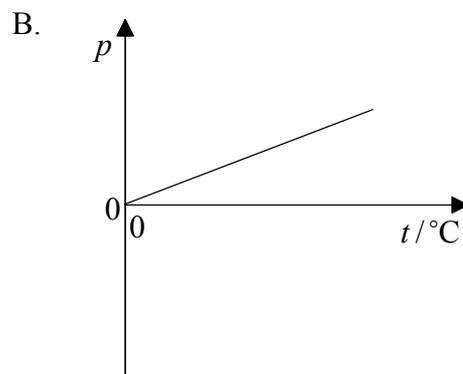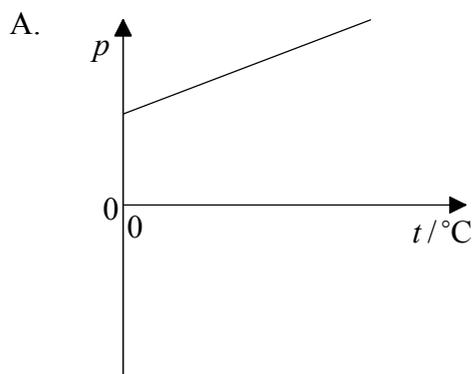
18. Which **one** of the following diagrams correctly shows the energy transfer paths for a heat pump operating between a hot and a cold reservoir?

A.

hot

heat pump

cold

B.

hot

heat pump

cold

C.

hot

heat pump

cold

D.

hot

heat pump
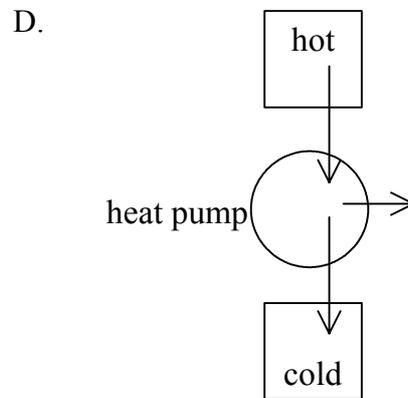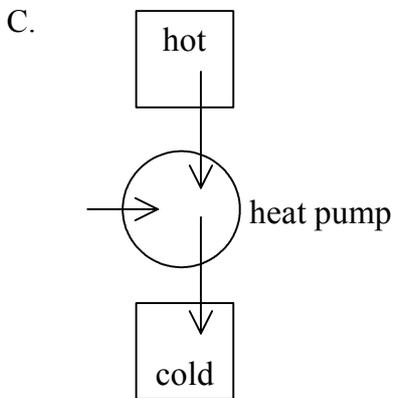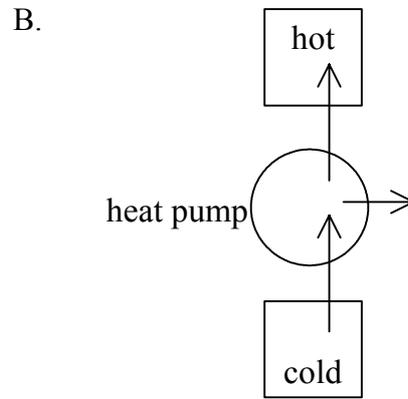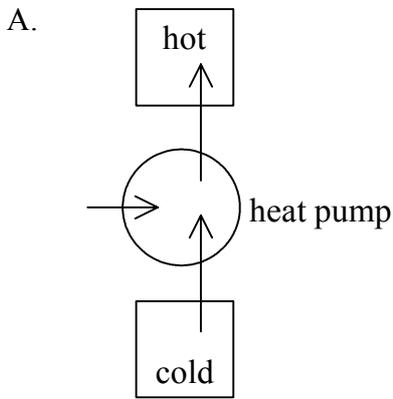
cold

19. A heat engine operates in a Carnot cycle between two reservoirs, a hot reservoir at temperature T_H and a cold reservoir at temperature T_C. The efficiency of the engine is 50 %. The temperature of the hot reservoir is increased to $2T_H$. The efficiency of the engine is now

A.   25 %.

B.   33 %.

C.   75 %.

D.   100 %.

20. A pipe, open at both ends, has a length L. The speed of sound in the air in the pipe is v. The frequency of vibration of the fundamental (first harmonic) standing wave that can be set up in the pipe is

A. $\dfrac{v}{2L}$.

B. $\dfrac{L}{2v}$.

C. $\dfrac{4v}{L}$.

D. $\dfrac{L}{4v}$.

21. Jeremy is walking alongside a building and is approaching a road junction. A fire engine is sounding its siren and approaching the road along which Jeremy is walking.
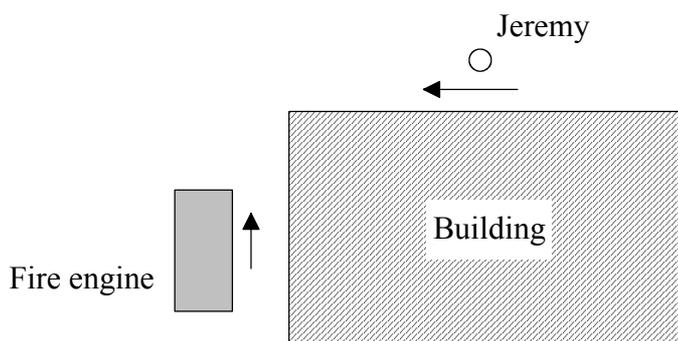
Jeremy cannot see the fire engine but he can hear the siren. This is due mainly to

A. reflection.

B. refraction.

C. the Doppler effect.

D. diffraction.

22. A piano tuner strikes and holds down the key on a piano that should produce a sound of frequency 440 Hz. At the same time he sounds a tuning fork that is known to have a frequency of 440 Hz. The resulting sound heard by the piano tuner fluctuates in loudness with a frequency of 2 Hz.

Which **one** of the following could be the frequency of the sound produced by the piano and the frequency of the sound heard by the piano tuner?

	Piano sound frequency / Hz	Frequency of sound heard by piano tuner / Hz
A.	438	441
B.	439	438
C.	441	442
D.	442	441

23. In the diagram below (which is not to scale), monochromatic light from a single narrow slit falls on two narrow slits S_1 and S_2. A system of interference fringes is observed on the screen.

monochromatic
light source   ○ S_1 screen

                                                    S_2

Single slit
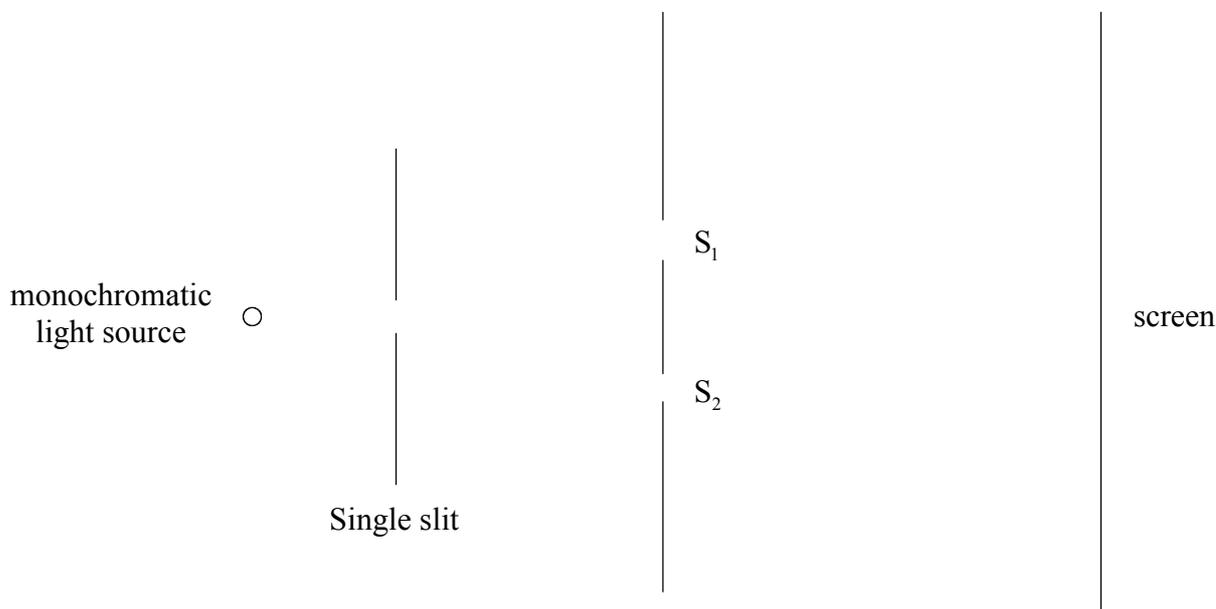
When the screen is moved further away from S_1 and S_2, which **one** of the following correctly describes what happens to the intensity of the bright fringes and the spacing of the bright fringes?

	Intensity of the bright fringes	**Spacing of the bright fringes**
A.	stays the same	increases
B.	stays the same	decreases
C.	decreases	increases
D.	decreases	decreases

24. Two lamps producing light of the same colour are placed close to one another. A two source interference pattern is not observed because

A.   the lamps do not emit light of a single frequency.

B.   the phase difference between the light from the lamps is continually changing.

C.   the intensity of the light emitted by the lamps is not the same.

D.   the two lamps are not exact point sources.

25. Two **positive** point charges P and Q are held a certain distance apart.

X · · · · · · · · · · · · · · P · · · · · · · · · · · Y · · · · · · · · · · · Q · · · · · · · · · · · Z
                           +   +

At which point(s) could the electric field strength, due to the charges, be zero?

A.   X only

B.   Y only

C.   Z only

D.   X and Z only

26. The *ampere* is defined in terms of

A.   the force between a magnet and a coil carrying a current.

B.   the force between two long current carrying wires.

C.   the amount of charge that passes any cross-sectional area of a wire in unit time.

D.   the number of electrons that pass any cross-sectional area of a wire in unit time.

27. Which **one** of the following shows a correct circuit, using ideal voltmeters and ammeters, for measuring the *I-V* characteristic of a filament lamp?

A.

B.

C.

D.

Turn over
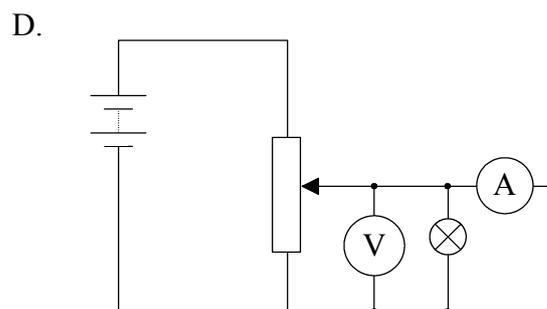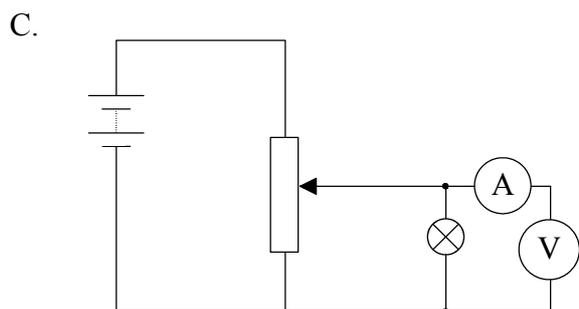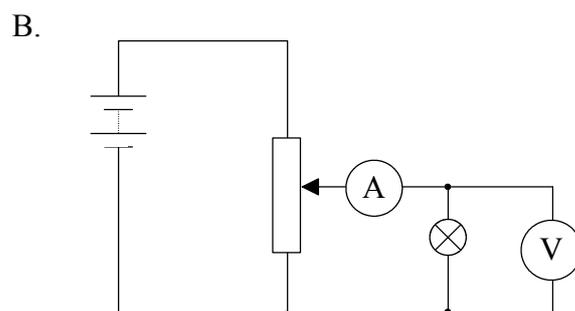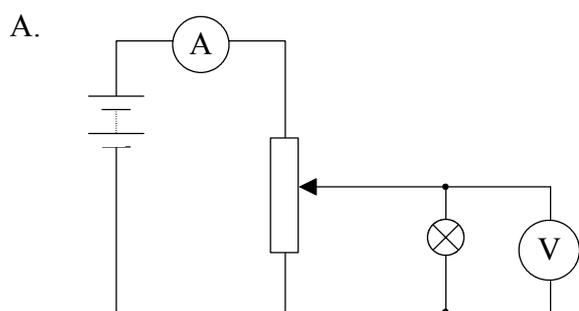
28. Which **one** of the following diagrams best represents equipotential surfaces due to a point charge? *(The point charge is represented by the filled circle.)*

A.
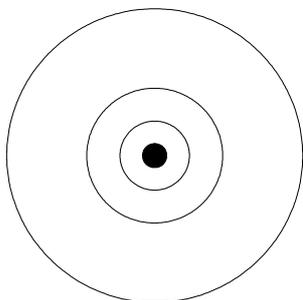
B.
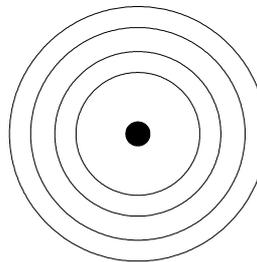
C.
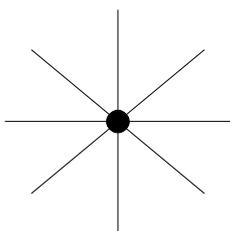
D.
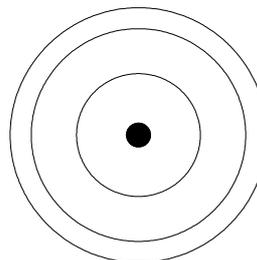
29. The diagram below shows two lines of equipotential in a region of a uniform electric field. Line X has a potential of +50 V and line Y has a potential of +100V. The distance between X and Y is 2.0 cm.

X   Y

+50 V   +100 V

◄2.0 cm►
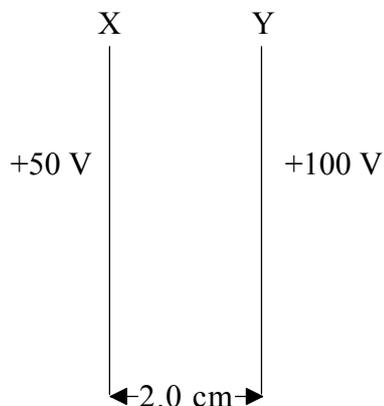
Which **one** of the following correctly gives the direction of the electric field and its strength?

	Direction	**Strength / V cm^{-1}**
A.	X → Y	25
B.	X → Y	100
C.	Y → X	25
D.	Y → X	100

30. A uniform magnetic field of strength B completely links a coil of area S. The field makes an angle ϕ to the plane of the coil.
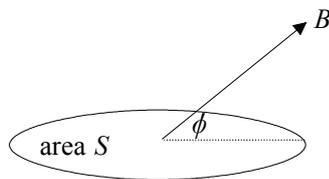
The magnetic flux linking the coil is

  A. BS.

  B. $BS\cos\phi$.

  C. $BS\sin\phi$.

  D. $BS\tan\phi$.

31. A resistor is connected in series with an alternating current supply of negligible internal resistance. The **peak value** of the supply voltage is V_0 and the **peak value** of the current in the resistor is I_0. The **average power** dissipation in the resistor is

  A. $\dfrac{V_0 I_0}{2}$.

  B. $\dfrac{V_0 I_0}{\sqrt{2}}$.

  C. $V_0 I_0$.

  D. $2V_0 I_0$.

32. A nucleus of the nuclide $^{223}_{87}\text{Fr}$ undergoes **positive** beta decay and the resulting nucleus then undergoes alpha decay to form the nucleus X. Which **one** of the following correctly identifies the atomic (proton) number and mass (nucleon) number of the nuclide X?

	Atomic number	Mass number
A.	84	219
B.	84	223
C.	86	219
D.	87	221

Turn over

33. In a laboratory when aluminium nuclei are bombarded with α-particles, the following reaction may take place.

$$_2^4\text{He} + _{13}^{27}\text{Al} \rightarrow _{15}^{30}\text{P} + _0^1\text{n}$$
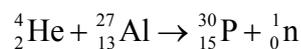
This reaction is an example of

  A.   nuclear fission.

  B.   nuclear fusion.

  C.   natural radioactive decay.

  D.   artificial transmutation.

34. Isotopes provide evidence for the existence of

  A.   protons.

  B.   electrons.

  C.   nuclei.

  D.   neutrons.

35. The de Broglie wavelength of a particle that has kinetic energy E_k is λ. The wavelength λ is proportional to

  A. E_k.

  B. $\dfrac{1}{E_k}$.

  C. $\dfrac{1}{\sqrt{E_k}}$.

  D. $E_k^{\ 2}$.

36. The Bohr model of the hydrogen atom is able to

  A.   predict accurate values for some of the wavelengths in the spectrum of atomic hydrogen.

  B.   account for the detailed structure of the spectral lines in the spectrum of atomic hydrogen.

  C.   explain the relative intensity of the different spectral lines in the spectrum of atomic hydrogen.

D. be extended to predict accurately, some of the wavelengths in the spectrum of oxygen.

37. Which **one** of the following gives evidence for the existence of nuclear energy levels?

    A.   Alpha particle scattering

    B.   Gamma ray spectra

    C.   Photoelectric effect

    D.   Matter waves

38. The nucleus $^{30}_{15}\text{P}$ undergoes radioactive decay to the nucleus $^{30}_{14}\text{Si}$. The particles emitted in the decay are

    A.   a positron and an antineutrino.

    B.   an electron and an antineutrino.

    C.   a positron and a neutrino.

    D.   an electron and a neutrino.

39. At an atomic scale, which **one** of the following correctly lists the four fundamental interactions in order of **increasing** strength?

    A.   electromagnetic, weak, gravity, strong

    B.   weak, gravity, electromagnetic, strong

    C.   gravity, weak, strong, electromagnetic

    D.   gravity, weak, electromagnetic, strong

40. The three classes of observed particles are

    A.   leptons, hadrons and exchange bosons.

    B.   leptons, quarks and hadrons.

    C.   mesons, leptons and exchange bosons.

    D.   hadrons, mesons and baryons.