IBO

IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
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PHYSICS
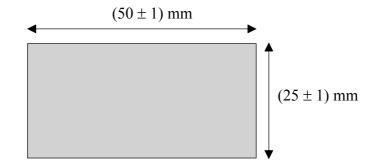**HIGHER LEVEL**
PAPER 1

Thursday 2 May 2002 (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 lengths of the sides of a rectangular plate are measured, and the diagram shows the measured values with their uncertainties.

(50 ± 1) mm

(25 ± 1) mm

Which of the following is the best estimate of the percentage uncertainty in the calculated **area** of the plate?

A. $\pm 2\%$

B. $\pm 4\%$

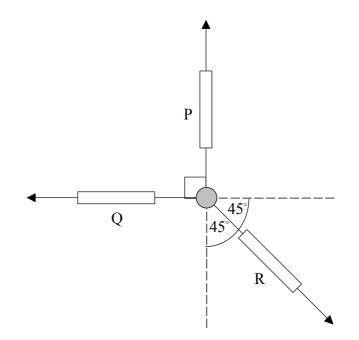C. $\pm 6\%$

D. $\pm 8\%$

2. The orbital periods T of planets in the solar system are related to their mean distances r from the Sun by

$$T^2 = k\,r^3 \text{ where k is a constant.}$$

If $\log T$ is plotted against $\log r$, the slope of the graph will be
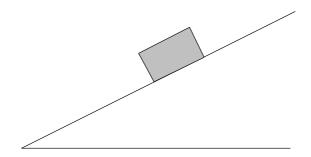
A. $\dfrac{3}{2}$.

B. 2.

C. 3.

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

3. A body on a smooth horizontal surface is attached to three spring scales P, Q and R as shown below. The body is in equilibrium with the scales pulling on it at the angles shown.

How do the **magnitudes** of the force readings F_P, F_Q and F_R on the scales compare?

A. $F_P = F_Q = F_R$
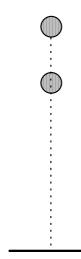
B. $F_R > F_P = F_Q$

C. $F_R < F_P = F_Q$

D. $F_P + F_Q = F_R$

Turn over

4. A block is at rest on a rough incline as shown.

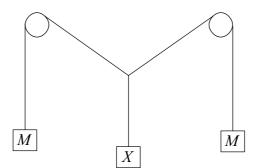The frictional force acting on the block along the incline is

A.   zero.

B.   equal to the weight of the block.

C.   greater than the weight of the block.

D.   less than the weight of the block.

5. Two identical stones are dropped simultaneously from different heights. Air resistance is negligible.

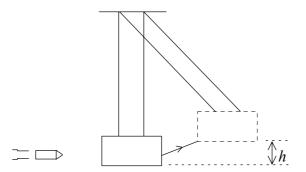
As the stones fall, the distance between them will

A.   increase continuously.

B.   decrease until they touch.

C.   remain the same.

D.   increase initially then remain the same.

6. A system with two pulleys and three hanging masses is in equilibrium as shown below. The two outer masses M are equal. Friction is negligible.

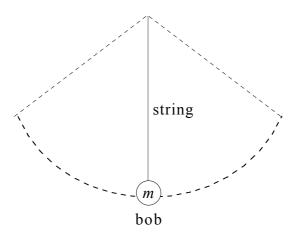If the middle mass X is pulled down a certain distance and then released, what will happen to it?

A.   It will stay in the new position.

B.   It will move even lower.

C.   It will come back up to its original position and stop.

D.   It will come back up past its original position and then oscillate about it.

7. The figure shows a "ballistic pendulum" arrangement used to determine bullet speeds. A bullet is fired into a block suspended from cords and the block with the embedded bullet swings as far as the position shown below. The measured quantities are the masses of the bullet and the block and the maximum height h to which the block rises after impact.

In order to calculate the **speed** with which the bullet struck the block, what principle(s) **or** law(s) should be applied in this situation?

A.   Newton's first and second laws

B.   Conservation of energy only

C.   Conservation of momentum only

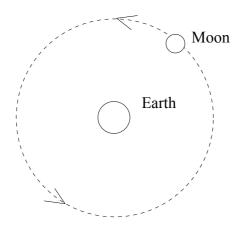D.   Both conservation of energy and conservation of momentum.

8. When an object undergoes simple harmonic motion, which of the following is true of the magnitude of the acceleration of the object?

    A.   It is uniform throughout the motion.

    B.   It is greatest at the end points of the motion.

    C.   It is greatest at the midpoint of the motion.

    D.   It is greatest at the midpoints and the endpoints.

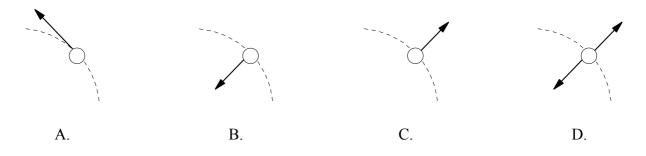**9.** A pendulum has a bob of mass m and swings in the arc shown below.

As the bob swings through the **lowest** point of its motion, the tension in the string will be

    A.   zero.

    B.   less than mg.

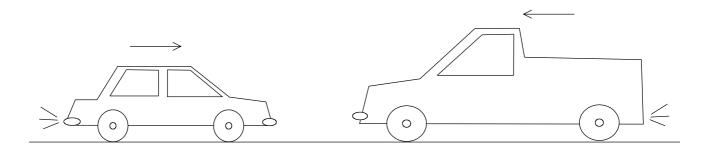   C.   equal to mg.

    D.   greater than mg.

10. The Moon orbits the Earth in a nearly circular orbit at constant speed as shown.

Which of the following diagrams correctly shows the force(s) acting on the Moon in the position shown above?

A.   B.   C.   D.

11. A car collides with a more massive truck.

During the collision, each vehicle exerts a force on the other. How do the magnitudes of these forces compare?
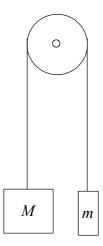
A.   The forces cannot be compared without knowing how the initial speeds compare.

B.   The magnitudes of the forces are equal.

C.   The force exerted by the truck is the greater.

D.   The force exerted by the car is the greater.

12. A radioactive nucleus at rest decays by emitting an alpha particle.
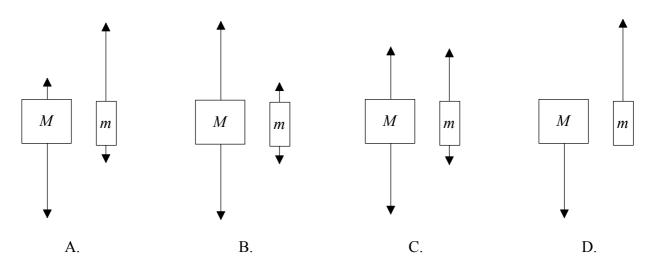
Just after emitting the alpha particle the daughter nucleus will have

    A.   zero kinetic energy and momentum.

    B.   kinetic energy equal in magnitude to that of the alpha particle.

    C.   momentum equal and opposite to that of the alpha particle.

    D.   both energy and momentum equal in magnitude to those of the alpha particle.

13. Two unequal masses M and m are connected by a light cord passing over a pulley of negligible mass. When released, the system accelerates.
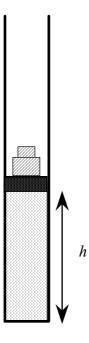
Ignoring friction, which figure below best shows the correct free-body force diagrams for the two masses in the moving system?

      A.   B.   C.   D.

14. The planet Uranus has a diameter about four times that of the Earth and is about fifteen times more massive than the Earth. Which of the following gives the best approximate value for the acceleration due to gravity near the surface of Uranus?

A. $2 \, \text{m s}^{-1}$

B. $9 \, \text{m s}^{-2}$

C. $36 \, \text{m s}^{-2}$

D. $150 \, \text{m s}^{-2}$

15. Ice at $0\,°\text{C}$ is mixed with water at $0\,°\text{C}$. Assume there is no energy exchange with the surroundings. Which of the following is correct?

A. All the ice will melt.

B. All the water will freeze.

C. No ice will melt and no water will freeze.

D. What will happen depends on the relative proportions of ice and water.

16.   A gas is in a vertical cylinder fitted with a piston. Weights are placed on the piston. When the gas is at 27 °C the piston is in equilibrium at height h above the base of the cylinder as shown below.
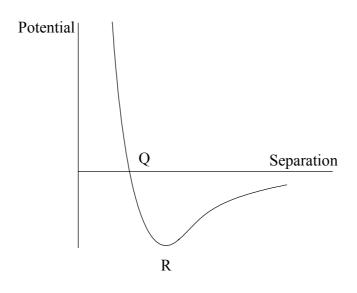

To what value should the gas temperature be increased for the piston to be in equilibrium at a height $2h$ above the base?

A.   54 °C

B.   150 °C

C.   327 °C

D.   600 °C

17.   When a gas is compressed adiabatically, the work done on the gas is

A.   zero.

B.   less than the change in internal energy, but not zero.

C.   equal to the change in internal energy.

D.   greater than the change in internal energy.

18. A lead bullet is fired into an iron plate, where it deforms and stops. As a result, the temperature of the lead increases by an amount ΔT. For a lead bullet having **twice** the mass but the same speed of impact, what would be the best estimate of its temperature increase?
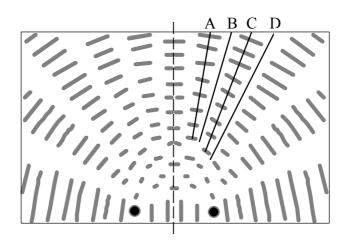
A. $\dfrac{1}{2}\Delta T$

B. ΔT

C. $\sqrt{2}\,\Delta T$

D. $2\,\Delta T$

19. The graph below shows interatomic potential versus separation for a pair of atoms in a solid.

Which feature of the curve best helps explain the phenomenon of the expansion of the solid with increasing temperature?

A.   The gradient of the curve at point Q.

B.   The gradient of the curve at point R.

C.   The graph is asymmetric about point R.

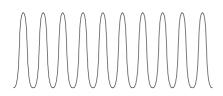D.   The graph is asymmetric about point Q.

Turn over

20. Two identical sources dipping in phase into water in a ripple tank generate the wave pattern shown below.

Along which of the labelled lines is the difference in path length from the two sources equal to **two** wavelengths?

A.   A

B.   B

C.   C

D.   D

21. Monochromatic light incident on two narrow parallel slits produces a fringe pattern on a screen, with the intensity distribution shown below.
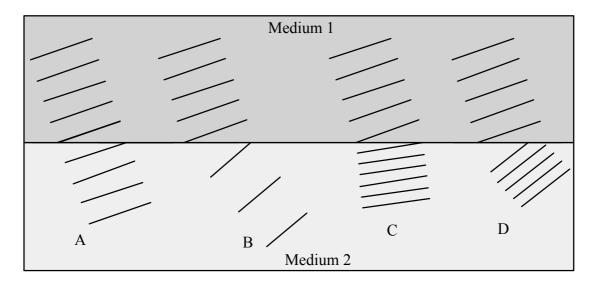

If the same slits were spaced **further apart**, which of the following diagrams best shows the intensity distribution pattern that would result?

A.

B.

C.

D.

Turn over

22. Plane wavefronts approach an interface between two media at an angle.

If the speed of the waves in medium 2 is **greater** than in medium 1, which of the labelled sets below best shows the wavefronts in medium 2?
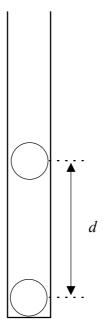

23. A strong wind is blowing in the direction P to Q as shown, at less than the speed of sound.

A whistle at Q emits sound of frequency f. Which of the following will be true for a listener at point P?

A.   No sound will be heard.

B.   The sound heard will have frequency less than f.

C.   The sound heard will have frequency f.

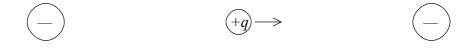D.   The sound heard will have frequency greater than f.

24. Two charged plastic balls in a vertical test tube are in equilibrium a distance d apart as shown.

If the charge on **each** ball were to be doubled, the distance between the balls in the test tube would become

A. $\sqrt{2}d$.

B. $2d$.

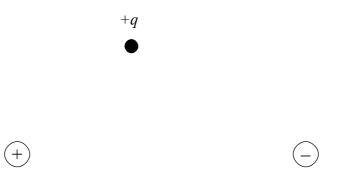C. $4d$.

D. $8d$.

25. A positive charge q is exactly midway between two equal negative charges as shown below.
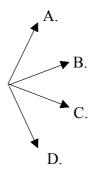

If q is displaced slightly from its equilibrium position, as indicated by the arrow, and then released, it would

A.   move back to its original position.

B.   move further from its original position.

C.   stay at rest at its new position.

D.   move back past its original position and then oscillate back and forth.

26. A positive test charge $+q$ is placed as shown, closer to a positive charge than a negative charge of equal magnitude.
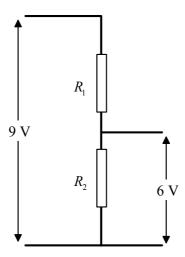
$+q$

●

$(+)$ $(-)$

Which of the arrows below best indicates the direction of the net electric force on the test charge?

A.

B.

C.

D.

27. To start a car with a flat battery, the battery can be connected to the battery in another car using two cables. These are called "jumper cables" or "jump leads" and have low resistance. Suppose a good quality jumper cable has resistance R. A cheaper cable of the same length but half the cable diameter would have resistance

A. $\dfrac{R}{4}$.
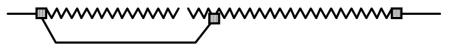
B. $\dfrac{R}{2}$.

C. $2R$.

D. $4R$.

28. A student constructs a "voltage divider" which will provide an output voltage of 6 V from an input voltage of 9 V. She connects two resistors R_1 and R_2 as shown.

The ratio of the resistances $R_1 : R_2$ must be

A. $1 : 2$.

B. $2 : 1$.

C. $2 : 3$.

D. $3 : 2$.

29. The element of an electric heater consists of a coil of resistance wire wound on a ceramic rod. The wire breaks at a point in the left half of the element as shown.

To get the heater working again temporarily, prior to buying a new element, a householder (unwisely) uses a piece of wire to "short across" the broken half as shown below.

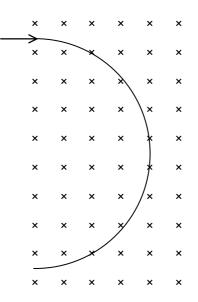Compared to the original heater the modified heater would generate approximately

A. a quarter of the power.

B. half the power.

C. twice the power.

D. four times the power.

Turn over

30. An electron and a proton start from rest near oppositely charged parallel plates in vacuum as shown.

Which of the following will be true of the kinetic energies of the two particles when they reach the opposite plates?

A. The proton will have the greater kinetic energy.

B. The electron will have the greater kinetic energy.

C. The kinetic energies of the two particles will be equal.

D. The kinetic energies of the two particles will be equal, but opposite in sign.

31. A charged particle is injected into a region of uniform magnetic field and travels in a circular arc.

If the particle were to be injected with a **greater speed**, what would be true of the magnetic force on it and the radius of its path?
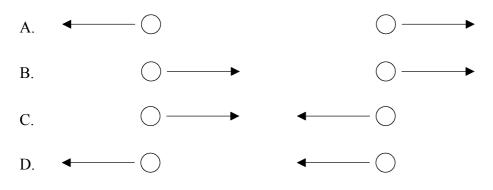
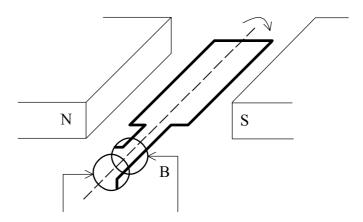|	Force	Arc radius
A.	greater	greater
B.	greater	smaller
C.	smaller	greater
D.	smaller	smaller

32. The diagram below represents the magnetic forces on two parallel wires P and Q carrying equal currents in opposite directions, perpendicular to the page.

P   Q

Suppose the current in wire P is now **reversed**, while that in Q is unchanged. Which diagram below best represents the forces that now act on the two wires?
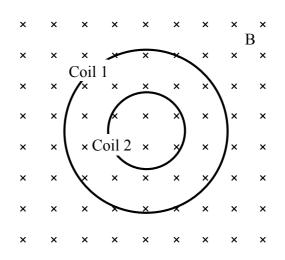
A.

B.

C.

D.

33. A simple electric generator is shown below. A single coil is rotated as indicated between magnetic poles N and S. Electrical contact between coil and external circuit is maintained through brushes B touching slip rings.

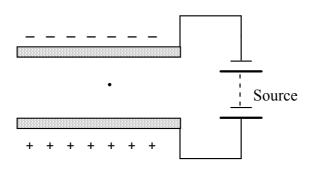At the instant when the rotating coil is oriented as shown, the output emf of the generator

A.   reverses direction.

B.   has the same value as in any other orientation of the coil.

C.   is zero.

D.   has its maximum value.

34. Two coils of different diameters are in the same uniform magnetic field B.

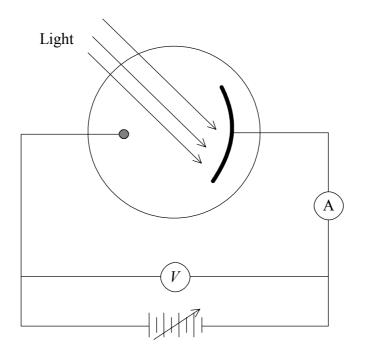If the magnitude of the magnetic field is increasing with time,

A.   the induced emf would be the same in each coil.

B.   the induced emf in coil 1 would be greater.

C.   the induced emf in coil 2 would be greater.

D.   the induced emfs in the two coils would be in opposite directions.

35. A charged oil drop is being observed between two horizontal parallel plates. The potential difference between the plates is adjusted so that the drop is at rest.

The drop is observed to suddenly start moving upwards. What could be the reason for this?

A.   The oil drop may have gained an electron.

B.   The oil drop may have lost an electron.

C.   The oil drop may have coalesced (joined) with another, uncharged, drop.

D.   The source of potential difference may have been switched off.

36. Monochromatic light is incident on a metal surface and the ejected electrons give rise to a current in the circuit. The maximum energy of the ejected electrons is determined by applying a reverse ("stopping") potential to reduce the current registered by the ammeter to zero.

If the intensity of the incident light is gradually increased, the stopping potential required will

A.   decrease.

B.   remain unchanged.

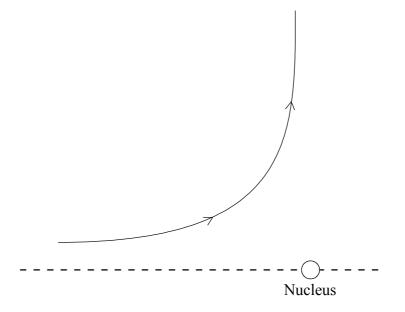C.   increase continuously.

D.   increase to a limiting value.

Turn over

37. A beam of electrons striking a copper target produces X-rays with the spectrum shown.

The accelerating potential experienced by the electrons in the X-ray tube is now adjusted to a different value. How will the cutoff wavelength and the characteristic line wavelengths of the new spectrum compare with the old?

	Cutoff wavelength	**Characteristic lines**
A.	unchanged	different
B.	unchanged	unchanged
C.	different	different
D.	different	unchanged

38. In a radioactive decay sequence, a radioactive nuclide of atomic number Z emits an alpha particle and the daughter nucleus then emits a negative beta particle. What is the atomic number of the resulting nuclide?

A. $Z - 4$

B. $Z - 2$

C. $Z - 1$

D. $Z + 1$

39. In a scattering experiment, an alpha particle approaches a nucleus and follows the path shown below. Assume that the recoil energy of the nucleus is negligible.

Nucleus

During the alpha particle's motion, its kinetic energy

A.   remains constant.

B.   decreases continuously.

C.   decreases then increases.

D.   increases then decreases.

40. In a stable nucleus there are many protons close to each other. The reason the protons do not fly apart due to mutual Coulomb repulsion is because

A.   the Coulomb force does not operate within nuclei.

B.   there are an equal number of electrons in the nucleus which neutralize the protons.

C.   the neutrons in the nucleus shield the protons from each other.

D.   attractive nuclear forces in the nucleus counteract the effect of the Coulomb forces.