INTERNATIONAL BACCALAUREATE
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BACHILLERATO INTERNACIONAL

PHYSICS
HIGHER LEVEL
PAPER 1

Monday 19 November 2001 (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.   Repeated measurements of a quantity can reduce the effects of

      A.   both random and systematic errors.

      B.   only random errors.

      C.   only systematic errors.

      D.   neither random nor systematic errors.

2.   The volume flow rate U of liquid flowing along a tube is measured as a function of the tube radius r. It is suspected that the relationship between U and r may be of **power law** form, *i.e.*

$$U = k\, r^{n} \text{ where } k \text{ and } n \text{ are constants.}$$

   If log U is plotted against log r and a straight line results, the value of the power n

      A.   is equal to the gradient of the graph.

      B.   is equal to the inverse of the gradient.

      C.   can be obtained from the intercept on the log U axis.

      D.   can be obtained from the intercept on the log r axis.

3.   The dots below show the positions of two moving objects at successive time intervals, with clock readings marked in seconds.
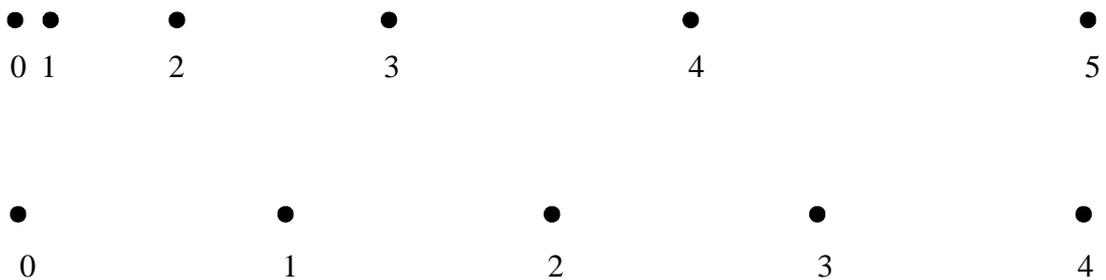
   Nearest to which clock reading will the **speeds** of the two objects be equal?

      A.   0 s

      B.   3 s

      C.   5 s

      D.   At no clock reading will the speeds be equal

4. Two stones P and Q are thrown from the top of a cliff, one straight up and the other straight down, at the same initial speed. Both eventually hit the ground.
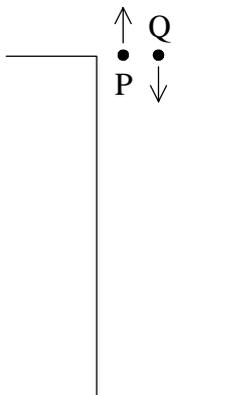
If air resistance is negligible, what will be true of the **speeds** with which the stones hit the ground?

A. Stone P hits the ground with the greater speed.

B. Stone Q hits the ground with the greater speed.

C. Both stones hit the ground with the same speed.

D. The comparative speeds of impact depend on the height of the cliff.

5. A car travels along a straight road. It first accelerates from rest, then travels at a constant velocity, then decelerates to a stop. It then remains at rest. Which graph below best represents the **displacement** s of the car as a function of time t?

Turn over
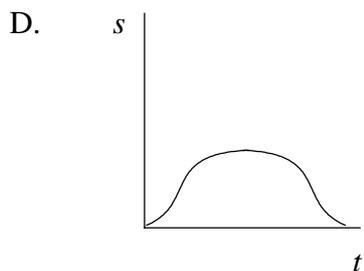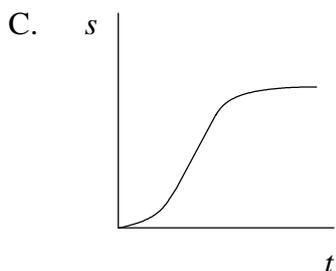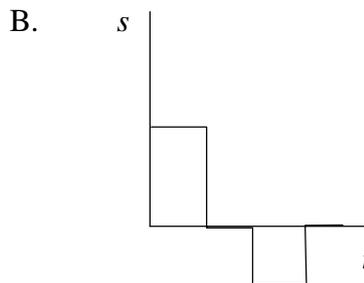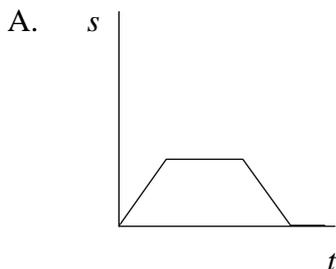
6. An iron cannon ball is projected horizontally from a cliff and lands on the ground below, a certain distance from the base of the cliff. Air resistance is negligible.
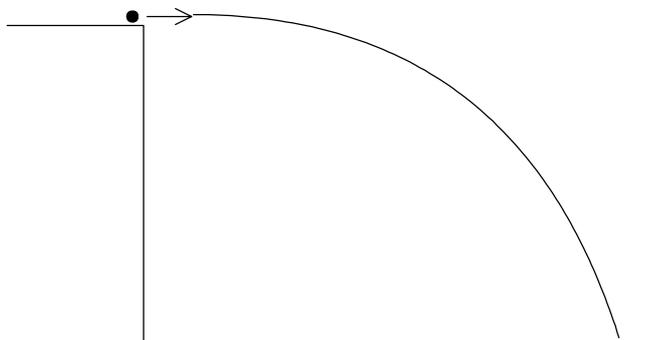
If a **more massive** iron ball were to be projected at the **same** speed,

A. it would land at the same place.

B. it would land closer to the cliff.

C. it would land further away.

D. it would land either further away or closer to the cliff depending on the height of the cliff and the speed of projection.

7. Two bodies P and Q on a frictionless horizontal surface are connected by a light cord. The mass of P is greater than that of Q. A force F is applied to Q as shown, accelerating the bodies to the right.

The magnitude of the force exerted by the connecting cord on **body P** will be

A. zero.

B. less than F but not zero.

C. equal to F.

D. greater than F.

8. A man pushes a car along a road. He exerts a force *F* on the car.
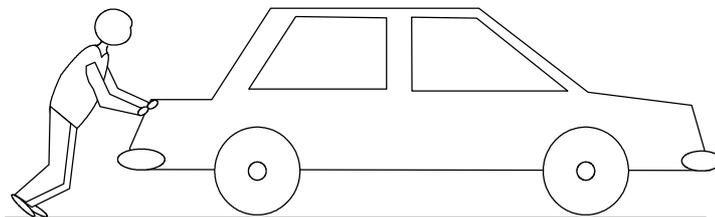
In this situation, what is the equal and opposite force to *F* (*i.e.* 'reaction' force) as referred to in Newton's third law?

A.   The force exerted **on** the person **by** the car.

B.   The force of friction **on** the car **by** the road.

C.   The force of gravity **on** the car **by** the earth.

D.   There is no reaction force if the car moves in the direction of *F*.

9. An amusement park ride sometimes called 'the fly' is a large cylinder which can rotate. A person stands against the wall, and after the cylinder is rotating at a certain rate the floor drops away. The person remains 'stuck' in position against the wall - like a fly.
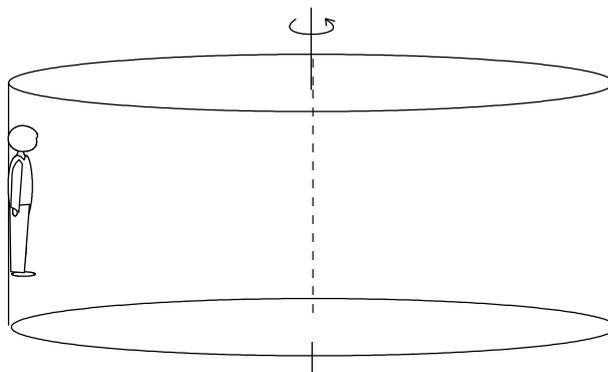
Which **one** of the following is the correct free-body force diagram showing all the forces acting on the person when the person is in the position shown above?

A.   B.   C.   D.

Turn over

10. A small explosion is used to separate a space capsule from its rocket, after the rocket fuel is used up.
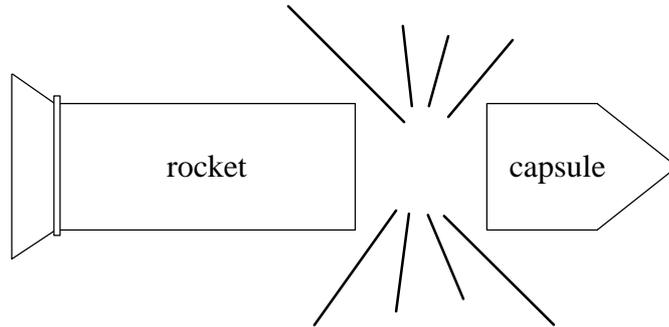
In this process, what happens to the total momentum and total kinetic energy of the system consisting of capsule plus rocket?

	Total momentum	**Total kinetic energy**
A.	Increase	Increase
B.	Increase	Unchanged
C.	Unchanged	Unchanged
D.	Unchanged	Increase

11. Assuming that the value of the gravitational constant G is known, which **one** of the following sets of data is needed to calculate the speed of a satellite in circular orbit around the earth?

A.   The mass of the earth, the mass of the satellite and the radius of the satellite's orbit.

B.   The mass of the satellite and the radius of its orbit.

C.   The mass of the earth and the radius of the satellite's orbit.

D.   The masses of the earth and the satellite.

12. A spring which obeys Hooke's law is initially unstretched. An increasing force is then applied to it, and when the applied force has reached magnitude F_{max}, the spring has extended by an amount e, as shown.
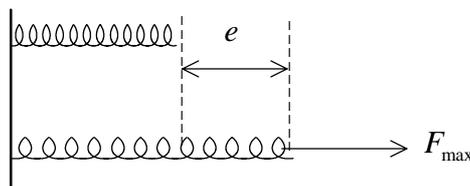
The work done in stretching the spring

A.   is $F_{max}\ e$.

B.   is $\dfrac{1}{2} F_{max}\ e$.

C.   is $\dfrac{1}{2} F_{max}\ e^2$.

D.   cannot be determined because the force varies during the process.

13. An enclosed gas is originally at $27\ °C$ at a certain pressure. The gas volume is then doubled as shown.
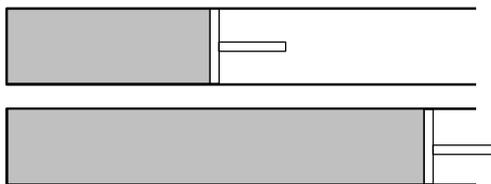
In order to restore the pressure to its original value, to what value must the temperature now be adjusted, at this new volume?

A. $-123\ °C$

B. $13.5\ °C$

C. $54\ °C$

D. $327\ °C$

14. When the volume of an enclosed gas is **increased** at a constant temperature, the pressure exerted by the gas on the container wall **decreases**. Consider the following statements as possible explanations for this:

    I.   the average speed at which the gas molecules strike the walls decreases.

    II.   the rate at which molecules strike a given area of the walls decreases.

The pressure decrease is explained by

A.   I only.

B.   II only.

C.   I and II.

D.   neither I nor II.

15. The atomic mass number of helium is 4 while that of neon is 20, and both are monatomic gases. When both gases are at the same temperature, the ratio of the average **speeds** of helium atoms to neon atoms will be

A. $1:1$.

B. $\sqrt{5}:1$.

C. $5:1$.

D. $25:1$.

16. Equal masses of water and alcohol, initially at different temperatures, are mixed. The specific heat capacity of water is **greater** than that of alcohol. The final temperature of the mixture will be

A.   equal to the sum of the two original temperatures.

B.   exactly midway between the two original temperatures.

C.   closer to the original temperature of the water than of the alcohol.

D.   closer to the original temperature of the alcohol than of the water.

17. 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 an identical bullet hitting the plate with **twice** the speed, what is the best estimate of the temperature increase?

A. ΔT

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

C. $2\,\Delta T$

D. $4\,\Delta T$

18. An ideal gas is enclosed in a cylinder fitted with a piston as shown below. The cylinder walls are thermally conducting. The gas is compressed **isothermally** by pushing the piston in slowly.

For this process, the thermal energy exchanged with the surroundings will be

A.   zero.

B.   less than the work done.

C.   equal to the work done.

D.   greater than the work done.

19. A ships engineer proposes generating energy for ships by inventing an engine which would take in sea water, extract some of its internal thermal energy and use this for driving the ship. The resulting cooled water would then be returned to the sea.

How do the first and second laws of thermodynamics relate to this proposed process?

|	**First law**	**Second law**
A.	Satisfied	Violated
B.	Satisfied	Satisfied
C.	Violated	Violated
D.	Violated	Satisfied

20. Circular water waves are produced by a dipper oscillating up and down into the water. The circles in the diagram represent wave crests moving outward on the water surface.
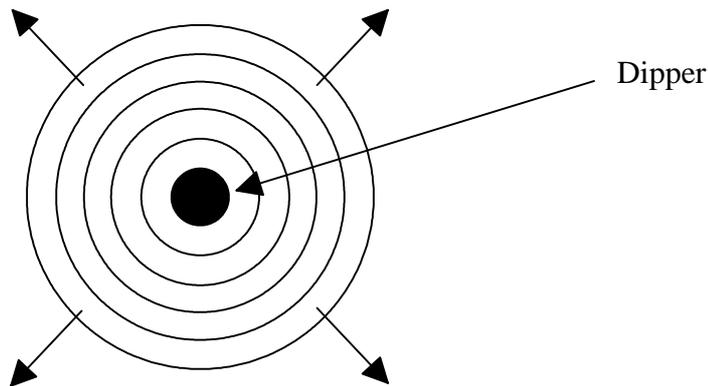
If the frequency of the dipper is doubled, the distance between the crests of the waves will

A.   remain unchanged.

B.   halve.

C.   double.

D.   quadruple.

21. Plane parallel wavefronts encounter the interface between one medium and another, as shown below. The wave speed is different in the two media.
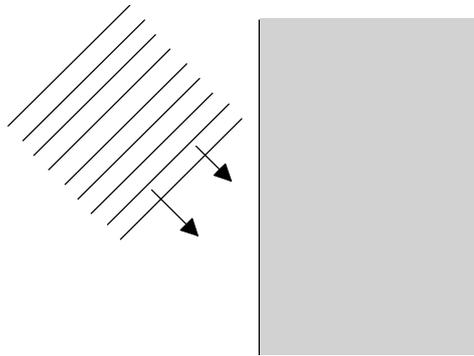
What will happen to the distance between wavefronts and the direction of travel of the wavefronts, as the waves enter the second medium?

	Distance between wavefronts	**Direction of wavefronts**
A.	Unchanged	Changes
B.	Unchanged	Unchanged
C.	Changes	Changes
D.	Changes	Unchanged

22. Light of wavelength λ is incident on two slits and produces a pattern of bright and dark fringes on a screen beyond the slits, as shown.

P

↑ ↑
Central Bright fringe
bright fringe
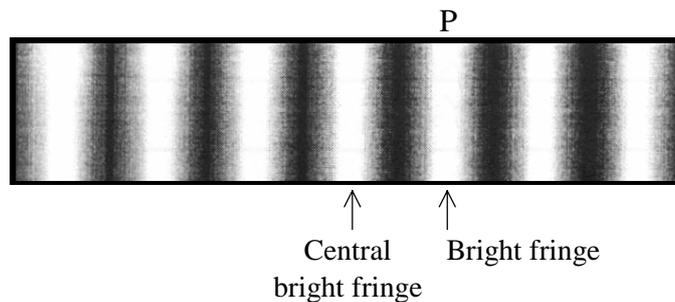
For the bright fringe marked P, what is the difference in path length from P to the two slits, in terms of the wavelength λ?

A.   zero

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

C. λ

D. 2λ

23. An organ pipe of length L is open at one end and closed at the other. The fundamental (lowest frequency) standing sound wave is set up in the pipe.
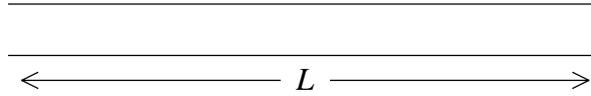

What is the wavelength of the fundamental, in terms of the length L of the pipe? Ignore any end correction.

A. $\dfrac{L}{4}$

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

C. $2L$

D. $4L$

24. When a train travels towards you sounding its whistle, the pitch of the sound you hear is different from when the train is at rest. This is because

A. the sound waves are travelling faster toward you.

B. the wavefronts of the sound reaching you are spaced closer together.

C. the wavefronts of the sound reaching you are spaced further apart.

D. the sound frequency emitted by the whistle changes with the speed of the train.

25. Two tuning forks of frequencies 250 Hz and 254 Hz are sounded together. Which **one** of the following will be heard?

A. Two distinguishable notes, one at 250 Hz and the other at 254 Hz.

B. A note at 252 Hz of constant loudness.

C. A note at 252 Hz fluctuating in loudness.

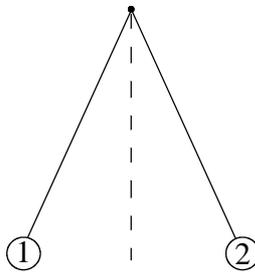D. A note which alternates in pitch between 250 and 254 Hz.

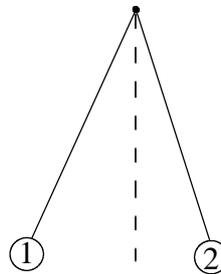**26.** Two equally charged balls of the same mass are suspended from strings and hang apart at an angle as shown.
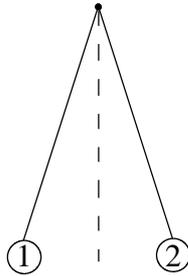
If the charge on **Ball 1 alone** were increased, how would the two balls hang?

unchanged
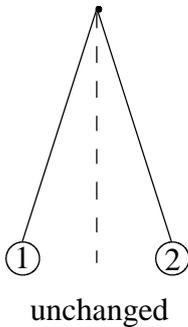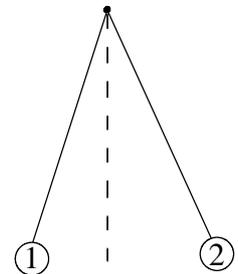
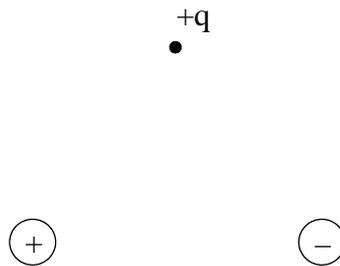A.   B.   C.   D.

27. A positive test charge + q is placed as shown, equidistant from two equal and opposite charges.

+q

Which **one** of the following gives the direction of the net force on the test charge?
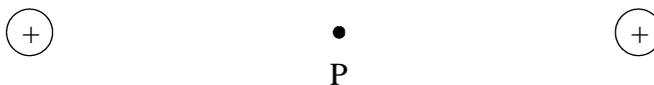
A.   B.   C.   D.

28. Point P is midway between two equal positive charges as shown.

$$(+) \qquad\qquad \bullet \qquad\qquad (+)$$
$$\text{P}$$

Which **one** of the following is true of the *electric field* and *electric potential* at point P?

	Field	**Potential**
A.	Zero	Zero
B.	Non-zero	Non-zero
C.	Zero	Non-zero
D.	Non-zero	Zero

29. A charged oil drop is between two parallel plates. The potential difference between the plates is adjusted so that the drop is at rest. If the oil drop coalesces (combines) with another **uncharged** oil drop, then the combined drop will

A. move upwards.

B. move downwards.

C. remain at rest.

D. move either upwards or downwards depending on the mass of the second drop.

30. A potential difference is applied across a pair of parallel plates in a vacuum. A proton between the plates experiences an acceleration of magnitude *a*. What would be the acceleration of an alpha particle?

A. $\dfrac{a}{4}$

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

C. a

D. $2a$

31. A fixed resistor R_1 and a variable resistor R are connected in series to a source of e.m.f. with negligible internal resistance. The variable resistance R is initially set **equal** to R_1.
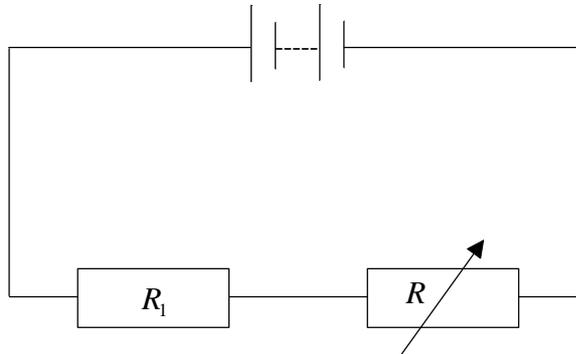
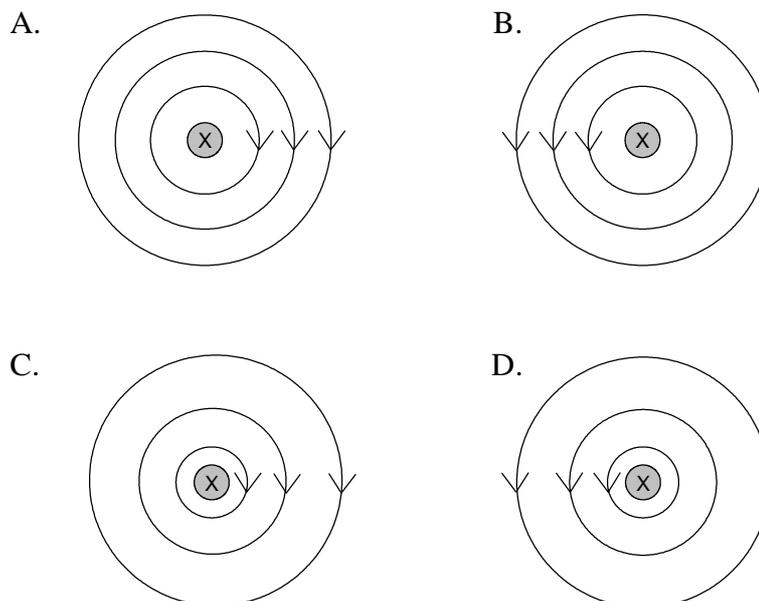If the variable resistance is now **doubled**, the current through the **fixed** resistor R_1 will
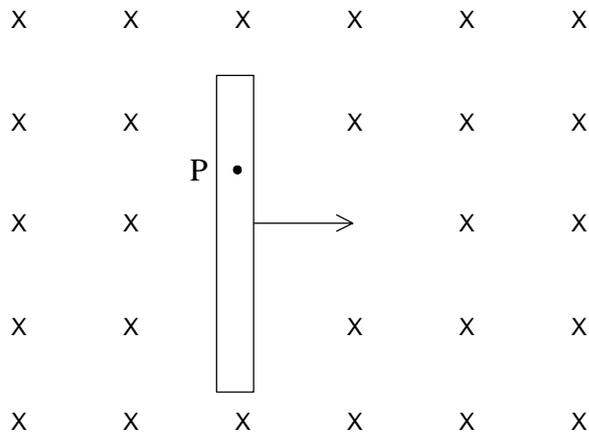
A.   decrease by a factor of 3.

B.   decrease by a factor of 2.

C.   decrease by a factor of 1.5

D.   remain unchanged.

32. A straight conductor carries current into the page as shown.

Which **one** of the following diagrams best represents the magnetic field pattern around the conductor?

A.

B.

C.

D.

33. A metal rod is moving at a steady speed perpendicular to a magnetic field as shown. A conduction electron in the rod is represented by the dot marked P.

```
    X       X       X       X       X       X

    X       X                   X       X       X

          P │ •
    X       X       │ ──────────→     X       X

    X       X       │           X       X       X

    X       X       X       X       X       X
```

In the steady state situation, while the rod moves steadily, the electron experiences (apart from gravity)

A.   both an electric and a magnetic force.

B.   neither an electric nor a magnetic force.

C.   a magnetic force only.

D.   an electric force only.

34. An AC generator produces a sinusoidal output e.m.f. If the frequency of rotation of the generator coil is **doubled**, then the **peak** output voltage

A.   remains unchanged.

B.   halves.

C.   increases by a factor of $\sqrt{2}$.

D.   doubles.

35. J J Thomson measured the charge-to-mass ratio $\dfrac{e}{m}$ of the electron by arranging that

    A.   electrons passed undeflected through crossed electric and magnetic fields.

    B.   electrons moved in a parabolic path in an electric field.

    C.   electrons moved in a circular arc in a magnetic field.

    D.   the weight of a charged oil drop was balanced by an upward electric force.

36. A beam of electrons striking a copper target produces X rays with the spectrum shown.
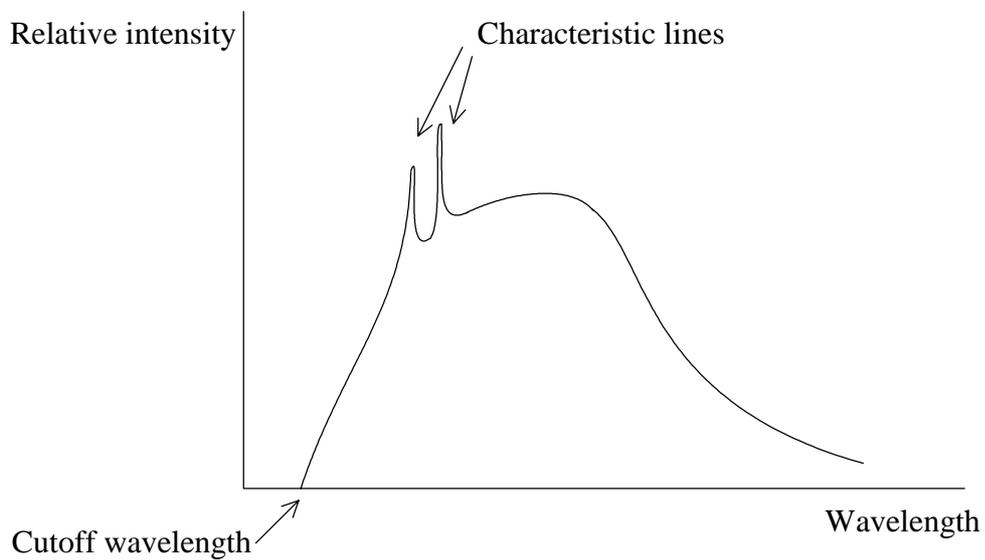
If the copper target is replaced with a different metal, how will the cutoff wavelength and characteristic lines of the new spectrum compare with the old?

	Cutoff wavelength	**Characteristic lines**
A.	Unchanged	Different
B.	Unchanged	Unchanged
C.	Different	Different
D.	Different	Unchanged

Turn over

37. Samples of two nuclides P and Q initially contain the **same number** of radioactive nuclei, but the half-life of nuclide P is **greater** than that of Q. How will the initial **activities** of the two samples compare?

    A.   Sample P will have the greater activity.

    B.   Sample Q will have the greater activity.

    C.   The activities will be the same.

    D.   The activities cannot be compared on the given information alone.

38. Nuclide X decays with a half-life of 20 days to stable nuclide Y. At a particular time, a sample consists of nuclides X and Y in the ratio 1 : 1. How much time will elapse before the ratio becomes 1 : 3?

    A.   20 days

    B.   40 days

    C.   60 days

    D.   80 days

39. In nuclear fission a heavy nucleus splits, while in nuclear fusion two light nuclei fuse. For these processes, does the **total rest mass** of the system increase or decrease?

	Fission	Fusion
A.	Decreases	Decreases
B.	Decreases	Increases
C.	Increases	Decreases
D.	Increases	Increases

40. A particle interacts with its antiparticle. Each has rest mass m. Which **one** of the following can occur?

    A.   A neutral particle is formed of rest mass $2m$.

    B.   A neutral particle is produced of mass m and kinetic energy mc^2.

    C.   The particles annihilate and two photons are produced, each of energy mc^2.

    D.   There is complete annihilation and all rest mass and energy disappears.